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# Retos de la transición energética en el País Vasco para la próxima década

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**PRESENTACIÓN**

*Ekonomiaz* es una revista semestral con proyección internacional, editada desde 1985 por el Departamento de Economía y Hacienda del Gobierno Vasco y dirigida por un Consejo de Redacción profesional, que tiene por objeto el fomento del análisis y el debate económico con un enfoque regional y especial atención al campo aplicado a la economía vasca.

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## **RETOS DE LA TRANSICIÓN ENERGÉTICA EN EL PAÍS VASCO PARA LA PRÓXIMA DÉCADA** / TRANTSIZIO ENERGETIKOAREN ERRONKAK HURRENGO HAMARKADAN EUSKADIN / *CHALLENGES OF THE ENERGY TRANSITION IN THE BASQUE COUNTRY FOR THE NEXT DECADE*

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# *Introducción*

Cuando hace año y medio iniciamos el trabajo de coordinación de este volumen, el reto medioambiental se había situado en el centro del debate económico en la Unión Europea (UE). El Pacto Verde Europeo, publicado en diciembre de 2019, planteaba una estrategia de crecimiento y competitividad de la UE para los próximos años centrada en la sostenibilidad medioambiental (Comisión Europea, 2019).

La crisis provocada por la pandemia del coronavirus despertó el temor de que perdiera peso el enfoque en la sostenibilidad medioambiental, dada la urgencia sanitaria y la gravedad de la posterior crisis económica. A pesar de ello, la Comisión Europea mantuvo el Pacto Verde Europeo como uno de los pilares del plan de recuperación económica, siendo ámbitos como la energía limpia, una industria eficiente y con bajas emisiones y la movilidad sostenible, las áreas que impulsaran el crecimiento del PIB, del empleo y de la competitividad en la Unión Europea en los próximos años.

En este contexto, presentamos este monográfico de *Ekonomiaz-Revista Vasca de Economía*, que tiene como objetivo explorar algunas cuestiones relevantes dentro del amplio cajón de sastre que es la llamada «transición energética» y analizar posibles implicaciones para el País Vasco.

## La transición energética

El principal objetivo del proceso de cambio del sistema energético hacia un sistema energético sostenible a largo plazo, conocido como transición energética (Grubler, 2012), es reducir de manera drástica las emisiones de Gases de Efecto Invernadero (GEI) asociadas a este –alrededor del 73 % de las emisiones globales (Ritchie, 2020). Si bien en el pasado se tendía a identificar la transición energética con la transformación del sistema de producción y distribución de energía en uno «limpio», en la actualidad el concepto de transición energética implica la transformación de toda la economía en una economía sostenible, con cero emisiones netas, incluyendo también cambios en el lado de la demanda de energía.

A largo plazo, esta transformación tendrá un impacto muy significativo sobre la organización y el funcionamiento de todos los sectores y actividades económicas (producción, distribución y consumo de materias primas, incluida la energía, y de todos los bienes y servicios), sobre el crecimiento económico (Fankhauser y Jotzo, 2018), la competitividad de las empresas (Zhang, 2019) y el bienestar de la población (TNO, n.d).

Los procesos de transición energética en Europa están entrando en una nueva fase, tras una etapa (que puede situarse entre la aprobación de los «objetivos 20-20-20» en 2007 y 2020) en la que se han logrado grandes avances en la transformación del *mix* de generación eléctrica hacia un sistema más limpio y ha aumentado la madurez tecnológica y comercial de determinadas fuentes renovables (eólica y fotovoltaica, principalmente).

La actual fase del proceso de transición energética implica necesariamente no solo continuar aumentando, de manera significativa, la penetración de energías renovables en la matriz energética, sino también avanzar rápidamente hacia una mayor electrificación y descarbonización del consumo final de energía y mejorar de manera sustancial la eficiencia energética en toda la economía. La nueva etapa de la transición energética se caracterizará por la irrupción, el despliegue y la interacción de múltiples tecnologías innovadoras (hidrógeno, captura, uso y almacenamiento de carbono, gases renovables, combustibles sintéticos eficientes, etc.), el declive de las tecnologías de generación convencionales (p. ej., el carbón), tensiones entre distintos actores protagonistas en la transformación y la reconfiguración de muchos sectores y cadenas de valor de la economía (Markard, 2018). También surgen incertidumbres, por ejemplo, en torno al futuro de la energía nuclear o el papel del gas natural como «combustible-puente» de la transición energética.

## La amplitud del proceso de transición energética

La necesidad de alcanzar un sector energético y una economía con cero emisiones netas implica que resulten ya inseparables las políticas energética y climática. En este sentido, el conjunto de políticas energéticas del País Vasco (y España) están estrechamente relacionadas con la estrategia sobre energía y clima de la UE. Esta, a su vez, da respuesta a los compromisos asumidos en el *Acuerdo de París* de diciembre de 2015, que obliga a los países firmantes a poner en marcha las transformaciones necesarias para limitar el aumento de la temperatura global del planeta a 2º C (en lo posible, a 1,5º C).

Los objetivos en materia de energía se basan en principios arraigados desde hace más de dos décadas, cuando se aprobaron las primeras directivas de la electricidad y del gas natural: lograr una energía limpia para todos los europeos, manteniendo la seguridad de suministro y la competitividad de la economía. Estos principios se plasmaron en los «objetivos 20-20-20» relativos a reducción de emisiones de GEI, penetración de energías renovables y eficiencia energética, y se han mantenido en el *Paquete de Energía Limpia* (o paquete de invierno), cuyas principales piezas legislativas fueron aprobadas en 2018. En el horizonte 2030, la UE ha marcado objetivos cuantitativos para estas tres variables (emisiones, renovables y eficiencia energética), cuyo cumplimiento supondrá cambios radicales en los sistemas energéticos en toda Europa.

En el horizonte 2050, el objetivo es aún más ambicioso: la UE pretende lograr en esa fecha una economía con cero emisiones netas y ha incluido este hito en la llamada *Ley del Clima Europea*.

La implementación de esta estrategia energía-clima dará lugar a cambios muy significativos en el lado de la demanda de energía. En las próximas tres décadas, el énfasis en la lucha contra el cambio climático se centrará de manera especial en cambiar la forma de consumir energía en sectores de la economía como el transporte, la industria, la edificación o la agricultura, por ejemplo, donde todavía no se ha iniciado el proceso de descarbonización a gran escala.

Además, los consumidores adoptarán un papel más activo en el sistema energético y en los mercados de energía que el que han desempeñado hasta ahora, pudiendo actuar como productores con capacidad de gestión de la energía a través del almacenamiento (estacionario o móvil, p. ej., en baterías de los vehículos eléctricos).

## Herramientas y factores de éxito

El éxito de este proceso de transición energética dependerá de la evolución e interacción de múltiples variables. No existe una única solución ni un conjunto de herramientas estándar para resolver el reto de alcanzar una economía con cero emisiones netas (Grillitsch y Hansen, 2019; Mattes *et al.*, 2015).

Por ejemplo, deberá combatirse, a través de campañas de información y concienciación, la relativa pasividad ante los cambios en ciernes por parte de muchos de los agentes económicos, que deberán ser protagonistas activos de la transformación (Niamir y Filatova, 2016).

La gradualidad de las medidas, a partir de una hoja de ruta clara que tenga sus primeras implicaciones en el futuro inmediato, facilitará la transformación de actividades, empresas y cadenas productivas sin poner en riesgo las fuentes de creación de valor y riqueza en la economía.

Por otro lado, en los próximos años cobrará una gran relevancia el desarrollo de mecanismos de financiación innovadores para las inversiones necesarias en tecnologías limpias y eficientes, nuevos esquemas de apoyo a la creación de empresas y nuevos modelos de negocio. Nuevas formas de financiación basadas en esquemas de colaboración público-privada, en la «financiación verde y sostenible» de las entidades bancarias, en bonos verdes o en esquemas de *project finance* por fondos de inversión verdes (Lamperti *et al.*, 2019) permitirán maximizar el potencial multiplicador de los incentivos públicos a la inversión y facilitarán las inversiones por parte de las empresas de menor tamaño. Esta cuestión será especialmente relevante a corto plazo, para poder maximizar las oportunidades que generará la difusión de fondos de financiación dentro del programa NextGenerationEU.

El apoyo decidido a las *start-ups* que abanderen nuevos modelos de negocio mediante esquemas de incubadora y aceleración, el fomento de las redes de *business angels*, etc., y nuevos esquemas de colaboración en materia de I+D+i, serán herramientas que permitirán poner en valor las capacidades tecnológicas y de investigación a través de una transferencia efectiva de conocimiento a la industria.

Deberá apoyarse una reforma de la fiscalidad energética y medioambiental que induzca los cambios tecnológicos y de comportamiento necesarios para avanzar en la descarbonización y alcanzar la sostenibilidad económica, social y medioambiental a largo plazo. Estos cambios deberán garantizar el equilibrio fiscal de las distintas Administraciones en el corto, medio y largo plazo.

Debe hacerse frente también a la necesidad de incrementar el capital humano especializado en áreas relacionadas con la transición energética (p. ej., programas de estudios técnicos especializados en energía, economía circular, análisis y gestión de datos, nuevos materiales, electrónica, estadística, etc.) (Orkestra, 2019).

Este amplio proceso plantea además la necesidad de abordar cuestiones relativas a los territorios concretos en los que se va a llevar a cabo. Aunque el objetivo de la transición energética es global, las principales transformaciones tendrán lugar en ámbitos más locales (p. ej., regiones, comarcas o municipios). En cada territorio, la adaptación deberá llevarse a cabo protegiendo y fomentando sus fortalezas económicas y sociales, aprovechando las oportunidades para desarrollar ventajas competitivas sostenibles y garantizando una transformación justa para todos los sectores económicos y los segmentos de la población más afectados por este cambio (Calvert, 2016; Newell y Mulvaney, 2013; Köhler *et al.*, 2019).

## El desafío del País Vasco para 2021-2030

En el caso del País Vasco, por ejemplo, deben tenerse en cuenta, a la hora de valorar las oportunidades y las amenazas que supone el proceso de transición energética, las peculiaridades relacionadas con la orografía, la historia y la estructura económica, la tipología del tejido empresarial y el entorno sociopolítico e institucional.

El objetivo último es llevar a cabo la transformación del sistema energético vasco garantizando que, con una industria intensiva en energía y recursos naturales relativamente escasos, se disponga de energía a un coste competitivo y con reducido impacto medioambiental. Además, deberán protegerse simultáneamente las bases de la competitividad de la economía vasca, estrechamente relacionadas con las fortalezas del sector industrial. Finalmente, deberá involucrarse a todos los agentes e instituciones de manera eficiente para explotar las sinergias e intereses comunes de una manera coordinada y alcanzar los resultados deseados en términos del bienestar de la sociedad. El reto de la transición energética para el País Vasco, por tanto, es triple: (a) energético-medioambiental; (b) tecno-industrial; y (c) de gobernanza.

Para hacer frente a este triple reto, en el momento de escribir estas líneas se debate una Ley vasca de transición energética y cambio climático que establecerá las bases de un marco legislativo que deberá favorecer la consecución de los objetivos energéticos y medioambientales, la materialización de avances en I+D+i en materia energética y de sostenibilidad y la consolidación de una política tecnológica e industrial coherente con las fortalezas de la economía vasca y con los objetivos estratégicos que se persiguen. En este contexto, se plantea también una revisión de la *Estrategia Energética de Euskadi 2030* (EVE, 2017), que quedará encuadrada en el *Plan Estratégico de Transición Energética y Cambio Climático*.

El nuevo marco legislativo y de planificación estratégica de la energía, junto con la *Agenda Basque Country 2030*, la *Ley de Sostenibilidad Energética* de 2019 y otras estrategias gubernamentales (p. ej., la *Estrategia de Cambio Climático 2050 del País Vasco* y la *Estrategia de Economía Circular de Euskadi 2030* y las distintas iniciativas de cada Territorio Histórico y de los municipios vascos), permitirán integrar y alinear todas las políticas relevantes (industrial, educativa, energética, medioambiental, etc.) con el objetivo común de mejorar la competitividad de la economía vasca y la sostenibilidad del modelo económico y energético a medio y largo plazo.

## El reto medioambiental

La descarbonización de la industria y del sector del transporte supone un reto mayúsculo para el País Vasco. Aunque desde el año 2000 las emisiones de GEI de la economía vasca se han reducido de manera considerable, alcanzar en 2030 los objetivos de emisiones –una reducción de unos 3 Mt de $CO_2$, en línea con la adhesión del Gobierno Vasco al *Acuerdo de París* de 2015 (Gobierno Vasco, 2016)– y de eficiencia energética (mejora de la intensidad energética en un 33 %), requerirá una profunda transformación de la matriz energética vasca.

Para ello, deberá aumentar la penetración de tecnologías renovables de generación de energía eléctrica (fundamentalmente, eólica terrestre y marina y energía solar fotovoltaica) y producirse un avance significativo en la electrificación de la economía. Sin embargo, la capacidad de penetración de las energías renovables es limitada en el País Vasco, debido a factores orográficos y a la existencia de recursos meteorológicos limitados (viento y radiación solar) (IDAE, 2011; Sancho *et al.*, 2012).

El gas natural se mantendrá como una relevante fuente de flexibilidad para el sistema eléctrico, dando cobertura a la penetración de energías renovables hasta que aumente la capacidad de almacenamiento y de gestión de la demanda. Todo esto requerirá la transformación de las redes energéticas en redes más inteligentes y con capacidad de integrar los nuevos recursos energéticos distribuidos y, especialmente, los dispositivos de almacenamiento y los vehículos eléctricos.

En el lado del consumo, deberán desplegarse soluciones y tecnologías con bajas o nulas emisiones en sectores como la industria o el transporte, responsables del 64 % del total de las emisiones en el País Vasco en 2017 (Gobierno Vasco, 2020). Esto supone un reto muy ambicioso para la industria vasca, muy intensiva en energía (principalmente, electricidad y gas). Deberá apostarse por continuar avanzando en la electrificación del consumo y por la utilización de nuevos vectores energéticos, como el hidrógeno, y combustibles más eficientes y con bajas emisiones (p. ej., gases verdes o *e-fuels*).

En la industria, la innovación tecnológica en equipamientos bajos en emisiones y en almacenamiento de energía (con especial enfoque en el aprovechamiento de calor residual de alta y media temperatura) y el desarrollo de nuevas soluciones para almacenar y utilizar $CO_2$, por ejemplo, serán vías clave para avanzar en la descarbonización.

Además, debe acelerarse el proceso de descarbonización del consumo de energía en los sectores residencial y terciario. En estos casos, las tendencias que se observan en el entorno europeo apuntan al incremento en la utilización de energía eléctrica (p. ej., bombas de calor) y las energías renovables en usos como la climatización o el desarrollo de soluciones comunitarias innovadoras donde sea posible (*district heating*).

Será también clave en este proceso incrementar de forma notable la eficiencia en el uso de los recursos materiales y energéticos en los sectores manufactureros y en la industria pesada. Deberán impulsarse mejoras en eficiencia energética (en todos los sectores), tanto tecnológicas (nuevos sistemas de gestión de energía y procesos, etc.) como mediante el despliegue de nuevos modelos de consumo (autoconsumo, comunidades energéticas, etc.) y avanzar en el desarrollo de la economía circular (especialmente en el sector industrial, donde el ecodiseño, el reciclaje, la utilización de nuevos materiales eficientes y la aplicación de nuevos procesos de reutilización de materiales, remanufactura o mantenimiento pueden dar lugar a grandes ganancias económicas).

Ante la posibilidad de que no se alcancen en el País Vasco los objetivos medioambientales fijados en el horizonte 2030, parece también necesario explorar la viabilidad del cumplimiento de otras alternativas, como el refuerzo de las interconexiones energéticas o la utilización de sumideros de carbono y la flexibilidad que podrían ofrecer los mecanismos de compensación previstos en el *Acuerdo de París* (Schneider *et al.*, 2020).

## El reto tecnológico e industrial

En paralelo al reto medioambiental, el País Vasco deberá desplegar una política tecnológica e industrial que, a partir las fortalezas de la economía vasca, permita explotar las oportunidades económicas, tanto en términos del desarrollo de fuentes de competitividad sostenible en distintos ámbitos de la economía como en la creación de empleo o en la contribución a un mayor bienestar de la ciudadanía.

Estas fortalezas se han desarrollado en torno a sectores y segmentos clave en la transición energética; p. ej., cadenas de valor como las de redes eléctricas, electrónica de potencia, energías renovables, *oil & gas*, componentes de automoción y otros sectores pujantes y emergentes, como el del almacenamiento de energía eléctrica, los servicios ligados a la digitalización y la industria 4.0, la economía circular o determinadas tecnologías ligadas a la movilidad eléctrica (Álvaro y Fernández, 2019). La especialización de muchas empresas vascas en la integración de diferentes tecnologías (digitalización, tecnologías limpias, almacenamiento, etc.) y en el desarrollo e implementación de soluciones energéticas de alto valor añadido en distintos sectores industriales, es otra fuente de fortalezas.

La política tecnológica e industrial de los próximos años deberá orientarse hacia el desarrollo de nuevos modelos de negocio basados en la digitalización de equipamientos y procesos, la servitización, el fomento de la innovación tecnológica y no tecnológica y el enfoque en el análisis y la gestión de los datos para desarrollar nuevas soluciones y servicios para los clientes.

Además, deberá apoyarse la transformación de sectores tradicionalmente potentes en el País Vasco, como el de *oil & gas* o el de componentes de automoción, hacia la creación de valor en productos, servicios y actividades más alineados con la transición energética (p. ej., hidrógeno, biocombustibles, nuevos productos derivados del petróleo eficientes y de bajas emisiones, gases renovables o combustibles alternativos en el transporte, en el caso de *oil & gas*, y tecnologías para el despliegue de la movilidad eléctrica, componentes de baterías eléctricas y servicios asociados, etc., en el caso del sector de automoción).

En resumen, el País Vasco puede convertirse en un «laboratorio de referencia» en ámbitos de la transición energética como las redes energéticas inteligentes (electricidad y gas natural), el almacenamiento de energía, la economía circular, la movilidad eléctrica y vectores energéticos como el hidrógeno. En este sentido, la apuesta por la economía del hidrógeno que están realizando los agentes económicos y las instituciones vascas (Corredor Vasco del Hidrógeno y otras iniciativas) aparece como una vía para poner en marcha proyectos colaborativos de carácter estratégico y con un gran impacto en distintas cadenas de valor.

Para ello, será fundamental continuar apoyando toda la cadena de actividades de I+D+i, especialmente en los niveles de madurez tecnológica (TRL) más altos y cercanos a la comercialización de soluciones que contribuyan de forma eficiente a reducir las emisiones de $CO_2$ (IEA, 2020) por su impacto sobre la productividad y competitividad de la economía vasca y la potencial capacidad de generar «*first-mover advantages*» en nichos de actividad muy variados relacionados con la transición energética y donde puedan desarrollarse ventajas competitivas sostenibles (Karkatsoulis *et al.*, 2016).

Los retos energéticos y medioambientales a los que se enfrenta el sector energético vasco representan también una oportunidad de crecimiento para otros sectores de la economía vasca, a través de la colaboración en innovación tecnológica, la cooperación inter-empresarial y la identificación de nuevas oportunidades de negocio en cadenas de valor convergentes (p. ej., *oil & gas* e hidrógeno, redes eléctricas y recursos energéticos distribuidos o redes energéticas, almacenamiento y movilidad eléctrica).

**El reto de la gobernanza**

La transformación de calado que supone la transición hacia una economía con cero emisiones netas requiere un gran apoyo social, empresarial e institucional y un esquema de gobernanza eficiente.

Conseguir el apoyo y el compromiso de la sociedad y de los agentes económicos e institucionales con el proceso de transición energética es imprescindible para que este sea exitoso, ya que la transformación necesaria para alcanzar los objetivos marcados requerirá un cambio profundo en los comportamientos de todos los agentes económicos y tendrá impactos asimétricos entre sectores económicos (y dentro de los mismos sectores) y entre segmentos de la población.

Casos como los de Alemania, Francia o el Reino Unido muestran la importancia de mantener el apoyo social al proceso de transición energética a través de un elevado nivel de concienciación, información sobre los beneficios de la misma para toda la sociedad, transparencia en el proceso y esquemas de compensación para aquellos segmentos de la población y sectores económicos en riesgo (p. ej., por pobreza energética o «fuga de carbono»).

Para minimizar los efectos negativos de potenciales conflictos entre cadenas de valor o entre empresas con posicionamientos empresariales diferenciados, deberán establecerse objetivos y planes que pongan en valor las sinergias y complementariedades entre actividades. Las medidas de mayor impacto deberán adoptarse cuanto antes para favorecer una transición gradual hacia el nuevo sistema energético que permita a los agentes económicos llevar a cabo con el mínimo coste los cambios necesarios para seguir siendo competitivos.

Debe alcanzarse un alto grado de coordinación e interacción entre política energética, política industrial y política medioambiental, ya que la transformación que sufrirá el tejido productivo del País Vasco en los próximos años definirá las bases de la competitividad de la economía vasca durante las próximas décadas. El ejemplo alemán muestra cómo puede reorientarse la política económica, industrial y de innovación hacia el fomento y la consolidación del liderazgo en tecnologías energéticas con bajas o nulas emisiones, generando al mismo tiempo crecimiento económico en torno a actividades sostenibles.

El nuevo impulso a la transición energética ofrece una oportunidad para avanzar en la eficiencia del modelo de gobernanza energética-medioambiental en el País

Vasco. Esto se conseguirá mediante objetivos bien identificados, definidos y medibles, una planificación/hoja de ruta clara, una definición concreta del papel de las distintas instituciones y los distintos agentes en el proceso de implementación, seguimiento, etc., incluyendo mandatos específicos a agencias clave en el proceso, mecanismos de seguimiento y supervisión y revisión de la planificación y esquemas que garanticen el cumplimiento de los objetivos fijados.

La gobernanza vertical o multinivel del proceso debe basarse en la identificación de los roles de las distintas Administraciones y entidades y en el desarrollo de un marco de colaboración que facilite la captación de fondos para impulsar las inversiones necesarias. Esto requerirá articular órganos/foros de coordinación vertical con participación del Gobierno Vasco, las Diputaciones Forales y, especialmente, las comarcas y los municipios.

En el ámbito horizontal, todos los actores deberán comprometerse con los objetivos del proceso y con las distintas estrategias y planes, incluyendo la agenda vasca de sostenibilidad (Agenda Euskadi 2030). Deberán articularse igualmente órganos o foros de coordinación multi-agente e intersectoriales en torno a prioridades estratégicas en la transición energética, la adaptación al cambio climático y la transformación de la economía en una con cero emisiones netas.

## Sobre el contenido de este monográfico

Este número cuenta con ocho artículos académicos, acompañados por dos *policy letters*, que tratan temas relevantes de la transición energética y que permiten tener una imagen más completa de las implicaciones del proceso de transición energética para el País Vasco.

Además de analizar el impacto económico de la transición energética, se abordan aspectos generales (estrategias de especialización, gobernanza, financiación) relacionados con palancas para impulsar el impacto positivo y facilitar la transformación, y otras cuestiones específicas como las estrategias de sostenibilidad por parte de las empresas o el desarrollo de los recursos energéticos distribuidos.

La amplitud, el calado y la complejidad de esta transformación impiden que este monográfico pueda abarcar todos los ámbitos y cuestiones relevantes. Entre los elementos no abordados en este monográfico, aun cuando en algunos casos se realicen apuntes al respecto, se encuentran, por ejemplo, la política energética y la regulación, la geopolítica de la energía, los nuevos desarrollos tecnológicos o la justicia y el equilibrio de los procesos de transformación (la llamada «transición justa»).

En el primer artículo, **Luz Dary Beltrán** y **M. Carmen Delgado** valoran el impacto económico positivo de las inversiones destinadas a la transición energética en el País Vasco, en términos de producción, PIB y empleo, utilizando modelos multisectoriales basados en la Matriz de Contabilidad Social del País Vasco.

**Mari Jose Aranguren**, **James Wilson** y **Edurne Magro** analizan cómo la estrategia de especialización inteligente (RIS3) y las políticas de innovación del País Vasco ofrecen un marco para materializar las oportunidades de la transición energética, incorporando el elemento de la sostenibilidad medioambiental en las estrategias y políticas energéticas y climáticas.

**Thomas Hoppe** reflexiona sobre cuáles son las enseñanzas que pueden extraerse del proceso de desarrollo de una nueva gobernanza de la transición energética en el ámbito regional, a partir de un análisis del caso de los Países Bajos, donde se está estructurando un modelo de gobernanza que se sitúa en un plano intermedio entre el nivel estatal y el nivel municipal.

Un grupo de **investigadores de DeustoTech**, **Deusto Business School**, **Tecnalia, EVE, Clúster de la Energía** y el **Ayuntamiento de Bilbao** reflexionan, a partir de la experiencia de un proyecto piloto de desarrollo de distritos de energía positiva en Bilbao, sobre cómo articular esquemas de gobernanza *bottom-up* que faciliten la transformación energética en espacios urbanos.

Por otra parte, **Jorge Fernández** y **Macarena Larrea** analizan el papel de los Gobiernos regionales como impulsores de ecosistemas de financiación verde eficientes que actúen como palanca para facilitar las inversiones en nuevas tecnologías limpias y en proyectos sostenibles, señalando las principales implicaciones para el País Vasco.

La necesidad de los agentes económicos de incorporar la sostenibilidad como un eje de actuación es tratada en dos artículos. Por un lado, **Salvador Acha**, **Aitor Soler** y **Nilay Shah** identifican las mejores prácticas para la reducción de las emisiones de $CO_2$ en organizaciones con una elevada huella carbono y exploran la situación del País Vasco.

Por otro lado, **Jaime Menéndez**, **Jorge Fernández** y **Andrés Araujo** presentan un marco para analizar las estrategias de sostenibilidad de las empresas de *oil & gas* y analizan el caso concreto de Petronor en el País Vasco.

**Roberto Álvaro**, **Jesús Fraile**, **Julia Merino** y **Sandra Castaño** analizan el impacto de diferentes esquemas de regulación del autoconsumo compartido para facilitar la integración de las energías renovables y del vehículo eléctrico y fomentar la participación activa de los consumidores.

En la parte final del monográfico, **Henry Wang** reflexiona en un *policy letter* sobre cómo las nuevas políticas de cambio climático, energías renovables y neutralidad de carbono pueden conducir al crecimiento económico en una economía industrial como la vasca.

**Jacques Le Cacheux**, a su vez, analiza la necesidad de introducir un ajuste fiscal del carbono en las fronteras de la UE para proteger a la industria europea durante el proceso de transformación en una industria sostenible.

Además de los artículos y *Policy Letters* ya mencionados, en el apartado de Otras Colaboraciones, **Mirene Begiristain**, **Enekoitz Etxezarreta**, **Jon Morandeira** y **Ariane Kareaga** proponen en su trabajo un sistema de indicadores que ayude y oriente en el objetivo social de los emprendimientos sociales y cooperativos, para dirigirlos hacia una dimensión transformadora. La propuesta se ha desarrollado en colaboración con miembros de la red cooperativa Olatukoop (Red de Fomento de la Economía Social y Transformadora) involucrados, desde una perspectiva de investigación acción participativa, en el desarrollo del programa Koopfabrika, que busca promover la economía social y el emprendimiento cooperativo.



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# *Hitzaurrea*



Duela urte eta erdi bolumen hau koordinatzeko lanari ekin genionean, ingurumen-erronka Europar Batasuneko (EB) eztabaida ekonomikoaren erdigunean kokatu zen. Europako Itun Berdea 2019ko abenduan argitaratu zen, eta EBren hazkunde- eta lehiakortasun-estrategia bat planteatzen zuen datozen urteetarako, ingurumen-iraunkortasunean zentratua (Europako Batzordea, 2019).

Koronabirusaren pandemiak eragindako krisiak ingurumenaren iraunkortasunaren ikuspegiak pisua galduko zuen beldurra piztu zuen, osasun-premia eta ondorengo krisi ekonomikoaren larritasuna zirela eta. Hala eta guztiz ere, Europako Batzordeak eutsi egin zion Europako Itun Berdeari, ekonomia suspertzeko planaren oinarrietako bat izan baitzen, eta, hala, hurrengo urteetan Europar Batasunean BPGren, enpleguaren eta lehiakortasunaren hazkundea bultzatuko zuten eremuak izan ziren, besteak beste, energia garbia, industria eraginkorra eta emisio gutxikoa eta mugikortasun iraunkorra.

Testuinguru horretan, *Ekonomiaz-Revista Vasca de Economía* aldizkariaren monografiko hau aurkezten dugu. Monografiko honen helburua «trantsizio energetikoa» deituriko saski-naski zabalaren barruan zenbait gai garrantzitsu eta Euskadirentzat izan daitezkeen ondorioak aztertzea da.

## Trantsizio energetikoa

Energia-sistema luzera begirako energia-sistema iraunkor baterantz (Grubler, 2012) aldatzeko prozesuaren helburu nagusia da sistema hari lotutako berotegi-efektuko gasen (BEG) emisioak nabarmen murriztea –emisio globalen % 73 inguru (Ritchie, 2020). Iraganean trantsizio energetikoa energia ekoizteko eta banatzeko sistema «garbi» bihurtzearekin identifikatzen bazen ere, gaur egun trantsizio energetikoaren kontzeptuak ekonomia osoa ekonomia iraunkor bihurtzea dakar, zero emisio garbirekin, baita energia-eskarian ere aldaketak eginez ere.

Luzera begira, eraldaketa horrek eragin handia izango du sektore eta jarduera ekonomiko guztien antolaketan eta funtzionamenduan (lehengaien ekoizpena, banaketa eta kontsumoa, energia barne, eta ondasun eta zerbitzu guztiak barne), hazkunde ekonomikoan (Fankhauser eta Jotzo, 2018), enpresen lehiakortasunean (Zhang, 2019) eta herritarren ongizatean (TNO, n.d).

Europako trantsizio energetikoaren prozesuak fase berri batean sartzen ari dira, etapa baten ondoren (2007an eta 2020an «20-20-20 helburuak» onartzearen artean koka daitekeena). Etapa horretan, aurrerapen handiak egin dira elektrizitatea sortzeko *mix*a sistema garbiago baterantz aldatzeko, eta iturri berriztagarri jakin batzuen heldutasun teknologikoa eta komertziala handitu da (eolikoa eta fotovoltaikoa, batez ere).

Trantsizio energetikoaren egungo faseak, energia berriztagarriak matrize energetikoan modu esanguratsuan sartzen jarraitzeaz gain, energiaren azken kontsumoaren elektrifikazio eta deskarbonizazio handiagorantz azkar aurrera egitea eta ekonomia osoan eraginkortasun energetikoa nabarmen hobetzea dakar. Trantsizio energetikoaren etapa berriak ezaugarri hauek izango ditu: teknologia berritzaile anitzen agerpena, hedapena eta interakzioa (hidrogenoa, karbonoaren atzematea, erabilera eta biltegiratzea, gas berriztagarriak, erregai sintetiko eraginkorrak, etab.), ohiko sorkuntza-teknologien gainbehera (adibidez, ikatza), ekonomiaren sektore eta balio-kate askoren eraldaketan eta birkonfigurazioan protagonista izan diren aktoreen arteko tentsioak (Markard, 2018). Halaber, zalantzak sortzen dira, adibidez, energia nuklearraren etorkizunaren inguruan edo gas naturalak trantsizio energetikoaren «zubi-konbinagarri» gisa duen paperaren inguruan.

**Trantsizio energetikoaren prozesuaren zabaltasuna**

Zero emisio garbi dituen energia-sektorea eta ekonomia lortzeko beharrak energia- eta klima-politikak bereizezinak izatea dakar. Alde horretatik, Euskadiko (eta Espainiako) energia-politikek lotura estua dute EBko energiari eta klimari buruzko estrategiarekin. Estrategia horrek, era berean, 2015eko abenduko *Parisko Akordioan* hartutako konpromisoei erantzuten die. Akordio horretan, herrialde sinatzaileak behartzen dira planetaren tenperatura globalaren hazkundea 2º C-ra (ahal den neurrian, 1,5º C-ra) mugatzeko beharrezko aldaketak abian jartzera.

Energiaren arloko helburuak duela bi hamarkada baino gehiagotik, elektrizitatearen eta gas naturalaren lehen zuzentarauak onartu zirenetik, errotutako printzipioetan oinarritzen dira: energia garbia lortzea europar guztientzat, hornidurаren segurtasunari eta ekonomiaren lehiakortasunari eutsiz. Printzipio horiek «20-20-20 helburuetan» islatu ziren, berotegi-efektuko gasen emisioak murrizteari, energia berriztagarriak sartzeari eta energia-eraginkortasunari buruzkoetan. Eta *Energia Garbiaren Paketean* («neguko paketea») mantendu dira, 2018an onartu baitziren legegintza-pieza nagusiak. 2030erako, EBk helburu kuantitatiboak ezarri ditu hiru aldagai horietarako (emisioak, berriztagarriak eta eraginkortasun energetikoa), eta horiek betetzeak aldaketa erradikalak eragingo ditu sistema energetikoetan Europa osoan.

2050erako, helburua are anbizio handiagokoa da: EBk zero isurketa garbiko ekonomia lortu nahi du, eta mugarri hori *Europako Klimaren Legean* sartu du.

Energia-klima estrategia hori ezartzeak aldaketa oso esanguratsuak eragingo ditu energia-eskarian. Datozen hiru hamarkadetan, aldaketa klimatikoaren aurkako borrokaren arreta berezia jarriko da ekonomiaren sektoreetan energia kontsumitzeko modua aldatzean, hala nola garraio-sektorean, industrian, eraikuntzan edo nekazaritzan; izan ere, sektore horietan oraindik ez da karbonoa kentzeko prozesua eskala handian hasi.

Gainera, kontsumitzaileek orain arte baino paper aktiboagoa hartuko dute energia-sisteman eta energia-merkatuetan, eta energia kudeatzeko gaitasuna duten ekoizle gisa jardun ahal izango dute biltegiratzearen bidez (egonkorra edo mugikorra, adibidez, ibilgailu elektrikoen baterietan).

**Tresnak eta arrakasta-faktoreak**

Trantsizio energetikoko prozesu horren arrakasta aldagai askoren bilakaeraren eta elkarreraginaren araberakoa izango da. Ez dago irtenbide bakar bat, ezta tresna estandarren multzo bat ere, zero emisio garbiko ekonomia bat lortzeko erronkari aurre egiteko (Grillitsch eta Hansen, 2019; Mattes *et al.,* 2015).

Adibidez, informazio- eta kontzientziazio-kanpainen bidez, eragile ekonomiko askoren pasibotasun erlatiboari aurre egin beharko zaio, eraldaketaren protagonista aktiboak izan beharko baitute (Niamir eta Filatova, 2016).

Neurriak mailakatzeak, etorkizun hurbilean lehen inplikazioak izango dituen ibilbide-orri argi batetik abiatuta, jarduerak, enpresak eta ekoizpen-kateak eraldatzea erraztuko du, ekonomian balioa eta aberastasuna sortzeko iturriak arriskuan jarri gabe.

Bestalde, datozen urteetan garrantzi handia hartuko du teknologia garbi eta eraginkorretan egin beharreko inbertsioak finantzatzeko mekanismo berritzaileak, enpresak sortzen laguntzeko eskema berriak eta negozio-eredu berriak garatzeak. Lankidetza publiko-pribatuko eskemetan, banku-erakundeen «finantzaketa berde eta iraunkorrean», bonu berdeetan edo inbertsio-funts berdeen bidezko *project finance* eskemetan oinarritutako finantzaketa-modu berriek (Lamperti *et al.,* 2019) inbertsiorako pizgarri publikoen ahalmen biderkatzailea maximizatzea ahalbidetuko dute, eta enpresa txikienek inbertsioak egitea erraztuko dute. Gai hori bereziki garrantzitsua izango da aurki, NextGenerationEU programaren barruan finantzaketa-funtsen hedapenak sortuko dituen aukerak maximizatu ahal izateko.

Inkubagailu- eta azelerazio-eskemen bidez negozio-eredu berriak zabaltzen dituzten *start up* direlakoei laguntza irmoa ematea, *business angels* sareak eta abar sustatzea, eta I+G+b arloko lankidetza-eskema berriak teknologia- eta ikerketa-gaitasunei balioa ematea ahalbidetuko duten tresnak izango dira, ezagutza industriara modu eraginkorrean transferituz.

Energia- eta ingurumen-fiskalitatearen erreforma babestu beharko da, deskarbonizazioan aurrera egiteko eta luzera begira iraunkortasun ekonomikoa, soziala eta ingurumenekoa lortzeko beharrezkoak diren aldaketa teknologikoak eta portaera-aldaketak eragiteko. Aldaketa horiek administrazioen zerga-oreka bermatu beharko dute aurki, epe ertainean eta luzera begira.

Trantsizio energetikoarekin lotutako arloetan espezializatutako giza kapitala handitzeko beharrari ere aurre egin behar zaio (adibidez, energian, ekonomia zirkularrean, datuen analisi eta kudeaketan, material berrietan, elektronikan, estatistikan eta abarretan espezializatutako azterketa teknikoen programak) (Orkestra, 2019).

Prozesu zabal horretan, gainera, beharrezkoa da prozesu hori gauzatuko den lurralde zehatzei buruzko gaiak jorratzea. Trantsizio energetikoaren helburua globala bada ere, eraldaketa nagusiak eremu lokalagoetan egingo dira (adibidez, erregioetan, eskualdeetan edo udalerrietan). Lurralde bakoitzean, egokitzapena bere indargune ekonomiko eta sozialak babestuz eta sustatuz egin beharko da, lehia-abantaila iraunkorrak garatzeko aukerak aprobetxatuz eta aldaketa horrek gehien eragiten dien sektore ekonomiko eta biztanleria-segmentu guztientzat bidezko eraldaketa bermatuz (Calvert, 2016; Newell eta Mulvaney, 2013; Köhler *et al.*, 2019).

**Euskadiren 2021-2030erako erronka**

Euskadiren kasuan, adibidez, kontuan hartu behar dira, trantsizio energetikoaren prozesuak dakartzan aukerak eta mehatxuak baloratzeko orduan, orografiarekin, historiarekin eta egitura ekonomikoarekin lotutako berezitasunak, enpresa-ehunaren tipologia eta ingurune soziopolitiko eta instituzionala.

Azken helburua da euskal energia-sistema eraldatzea, energia eta baliabide natural gutxi samarreko industria intentsibo batekin, energia kostu lehiakorrean eta ingurumen-inpaktu txikiarekin izatea bermatuz. Gainera, aldi berean babestu beharko dira EAEko ekonomiaren lehiakortasunaren oinarriak, industria-sektorearen indarguneekin lotura estua dutenak. Azkenik, eragile eta erakunde guztiak modu eraginkorrean inplikatu beharko dira sinergia eta interes komunak modu koordinatuan ustiatzeko eta gizartearen ongizateari dagokionez lortu nahi diren emaitzak lortzeko. Euskal Autonomia Erkidegorako trantsizio energetikoaren erronka, beraz, hirukoitza da: (a) energetiko-ingurumenekoa; (b) tekno-industriala; eta (c) gobernantzakoa.

Erronka hirukoitz horri aurre egiteko, lerro hauek idazterakoan trantsizio energetikoaren eta klima-aldaketaren euskal lege bat eztabaidatzen ari da. Lege horrek legegintza-esparru baten oinarriak ezarriko ditu, energia- eta ingurumen-helburuak lortzen, energiaren eta iraunkortasunaren arloko I+G+b alorreko aurrerapenak gauzatzen eta EAEko ekonomiaren indarguneekin eta lortu nahi diren helburu estrategikoekin koherentea den teknologia- eta industria-politika sendotzen laguntzeko. Testuinguru horretan, *2030erako Euskadiko Energia Estrategia* (EEE, 2017) berrikustea ere planteatzen da, *Trantsizio Energetikoaren eta Klima Aldaketaren Plan Estrategikoa*ren barruan.

Energiaren lege- eta planifikazio-esparru estrategiko berriak, *Basque Country 2030 Agendarekin,* 2019ko *Iraunkortasun Energetikoaren Legearekin* eta gobernuko beste estrategia batzuekin batera (adib., *2050eko Euskadiko Klima Aldaketa Estrategia* eta *2030erako Euskadiko Ekonomia Zirkularraren Estrategia* eta lurralde historiko bakoitzaren eta EAEko udalerrien ekimenak), politika garrantzitsu guztiak (industria, hezkuntza, energia, ingurumena, etab.) integratzea eta lerrokatzea ahalbidetuko du, EAEko ekonomiaren lehiakortasuna eta ekonomia- eta energia-ereduaren iraunkortasuna hobetzea epe ertainera eta luzera begira.

**Ingurumenaren erronka**



Industriaren eta garraio-sektorearen deskarbonizazioa erronka larria da Euskadirentzat. 2000. urteaz geroztik EAEko ekonomiaren BEG emisioak nabarmen murriztu badira ere, 2030ean emisioen helburuak –3 Mt inguru CO2 murriztea, Eusko Jaurlaritza 2015eko *Parisko Akordioa*ri (Eusko Jaurlaritza, 2016) atxikitzearen ildotik– eta energia-efizientziaren helburuak (energia-intentsitatea % 33 hobetzea) lortzeko, EAEko energia-matrizea sakon eraldatu beharko da.

Horretarako, energia elektrikoa sortzeko teknologia berriztagarrien sarrera areagotu beharko du (batez ere lurreko eta itsasoko haize-energia eta eguzki-energia fotovoltaikoa), eta aurrerapen esanguratsua egin ekonomiaren elektrifikazioan. Hala ere, energia berriztagarrien sartze-ahalmena mugatua da Euskadin, faktore orografikoengatik eta baliabide meteorologiko mugatuengatik (haizea eta eguzki-erradiazioa) (IDAE, 2011; Sancho *et al.*, 2012).

Gas naturala sistema elektrikoaren malgutasun-iturri garrantzitsua izango da, eta energia berriztagarrien sartzeari sarea emanez, harik eta eskariaren biltegiratze- eta kudeaketa-ahalmena handitu arte. Horrek guztiak energia-sareak sare adimentsuago bihurtzea eskatuko du, banatutako energia-baliabide berriak eta, bereziki, biltegiratzeko gailuak eta ibilgailu elektrikoak integratzeko gaitasunarekin.

Kontsumoari dagokionez, industrian edo garraioan emisio txikiak dituzten edo batere emisiorik ez duten soluzioak eta teknologiak zabaldu beharko dira, Euskal Autonomia Erkidegoko emisio guztien % 64ren erantzule baitira 2017an (Eusko Jaurlaritza, 2020). Hori asmo handiko erronka da EAEko industriarentzat, oso intentsiboa energian (batez ere, elektrizitatean eta gasean). Kontsumoaren elektrifikazioan aurrera egiten jarraitzearen aldeko apustua egin beharko da, baita energia-bektore berriak erabiltzearen aldekoa ere, hala nola hidrogenoa eta erregai eraginkorragoak eta emisio txikiak dituztenak (adibidez, gas berdeak edo *e-fuelak*).

Industrian, emisio baxuko ekipamenduen eta energia biltegiratzearen berrikuntza teknologikoa (bereziki tenperatura altuko eta ertaineko hondar-beroaren aprobetxamendua) eta CO2 biltegiratu eta erabiltzeko soluzio berrien garapena, adibidez, funtsezko bideak izango dira deskarbonizazioan aurrera egiteko.

Gainera, bizitegi- eta hirugarren sektoreetako energia-kontsumoa deskarbonizatzeko prozesua bizkortu behar da. Kasu horietan, Europan hautematen diren joeren arabera, energia elektrikoaren (adibidez, bero-ponpak) eta energia berriztagarrien erabilera areagotu egiten da, hala nola klimatizazioa edo irtenbide komunitario berritzaileen garapena, ahal den neurrian (*district heating*).

Prozesu horretan funtsezkoa izango da, halaber, manufaktura-sektoreetan eta industria astunean baliabide materialen eta energetikoen erabileraren eraginkortasuna nabarmen handitzea. Energia-eraginkortasunean hobekuntzak bultzatu beharko dira (sektore guztietan), bai teknologikoak (energia kudeatzeko sistema berriak eta prozesuak, etab.), bai kontsumo-eredu berriak zabalduz (autokontsumoa, energia-komunitateak, etab.), eta ekonomia zirkularraren garapenean aurrera egin beharko da (bereziki industria-sektorean, non ekodiseinuak, birziklapenak, material eraginkor berrien erabilerak eta materialak berrerabiltzeko, berriz manufakturatzeko edo ekonomikoki mantentzeko prozesu berriak aplikatzeak eragin baitezakete).

Euskal Autonomia Erkidegoan 2030erako ezarritako ingurumen-helburuak ez lortzeko aukeraren aurrean, beharrezkoa dirudi beste aukera batzuk betetzearen bideragarritasuna aztertzea ere, hala nola interkonexio energetikoak indartzea edo karbono-hustutegiak erabiltzea eta *Parisko Akordioan* aurreikusitako konpentsazio-mekanismoek eskain lezaketen malgutasuna (Schneider *et al.*, 2020).

**Erronka teknologikoa eta industriala**

Ingurumen-erronkarekin batera, Euskadik teknologia- eta industria-politika bat hedatu beharko du, EAEko ekonomiaren indarguneak oinarri hartuta, aukera ekonomikoak ustiatu ahal izateko, bai ekonomiaren hainbat eremutan lehiakortasun iraunkorreko iturriak garatzeari dagokionez, bai enplegua sortzeari dagokionez, bai herritarren ongizate handiagoa lortzeari dagokionez.

Indargune horiek trantsizio energetikoan funtsezkoak diren sektore eta segmentuen inguruan garatu dira; adibidez, balio-kateak, hala nola sare elektrikoak, potentzia-elektronika, energia berriztagarriak, *oil & gasa,* automobilgintzako osagaiak eta beste sektore indartsu eta gorabideko batzuk, hala nola energia elektrikoaren biltegiratzea, digitalizazioari eta 4.0 industriari lotutako zerbitzuak, ekonomia zirkularra edo mugikortasun elektrikoari lotutako teknologia jakin batzuk (Álvaro eta Fernández, 2019). EAEko enpresa asko espezializatu dira hainbat teknologia integratzen (digitalizazioa, teknologia garbiak, biltegiratzea, etab.) eta industria-sektore desberdinetan balio erantsi handiko energia-soluzioak garatzen eta ezartzen. Hori ere bada indarguneen beste iturri bat.

Datozen urteetako teknologia- eta industria-politika negozio-eredu berriak garatzera bideratu beharko da, honako hauek oinarri hartuta: ekipamenduen eta prozesuen digitalizazioa, zerbitizazioa, berrikuntza teknologikoaren eta ez-teknologikoaren sustapena, eta bezeroentzako irtenbide eta zerbitzu berriak garatzeko datuen analisirako eta kudeaketarako ikuspegia.

Gainera, Euskal Autonomia Erkidegoan tradizionalki indartsuak izan diren sektoreen eraldaketa bultzatu beharko da, hala nola, *oil & gas*arena edo automobilgintzako osagaiena, trantsizio energetikoarekin lerrokatuago dauden produktu, zerbitzu eta jardueretan balioa sortzerantz (adibidez, hidrogenoa, bioerregaiak, petroliotik eratorritako produktu berriak eta emisio gutxikoak, gas berriztagarriak edo erregai alternatiboak garraioan, *oil & gas*aren kasuan, eta mugikortasun elektrikoa hedatzeko teknologiak, bateria elektrikoen eta horri lotutako zerbitzuen osagaiak, etab., automobilgintzaren sektorearen kasuan).

Laburbilduz, Euskadi «erreferentziazko laborategi» bihur daiteke trantsizio energetikoaren eremuetan, hala nola sare energetiko adimendunak (elektrizitatea eta gas naturala), energiaren biltegiratzea, ekonomia zirkularra, mugikortasun elektrikoa eta hidrogenoa bezalako bektore energetikoak. Esangura horretan, eragile ekonomikoak eta euskal erakundeak (Hidrogenoaren Euskal Korridorea eta beste ekimen batzuk) hidrogenoaren ekonomiaren alde egiten ari diren apustua balio-kate desberdinetan eragin handia duten lankidetza-proiektu estrategikoak abian jartzeko bide gisa agertzen da.



Horretarako, funtsezkoa izango da I+G+Bko jarduera-kate osoa babesten jarraitzea, batez ere heldutasun teknologikoko mailarik altuenetan eta CO2 emisioak (IEA, 2020) modu eraginkorrean murrizten laguntzen duten soluzioen komertzializaziotik hurbil daudenetan, EAEko ekonomiaren produktibitatean eta lehiakortasunean duten eraginagatik eta «*first-mover advantages*» sortzeko gaitasunagatik trantsizio energetikoarekin lotutako oso jarduera-nitxo anitzetan eta abantaila lehiakor iraunkorrak gara daitezkeenetan (Karkatsoulis *et al.*, 2016).

EAEko energia-sektoreak aurrez aurre dituen energia- eta ingurumen-erronkak hazkunde-aukera bat ere badira EAEko ekonomiako beste sektore batzuentzat, berrikuntza teknologikoko lankidetzaren, enpresen arteko lankidetzaren eta balio-kate konbergenteetan negozio-aukera berriak identifikatzearen bidez (adibidez, *oil* & *gasa* eta hidrogenoa, sare elektrikoak eta energia-baliabide banatuak edo energia-sareak, biltegiratzea eta mugikortasun elektrikoa).

### Gobernantzaren erronka

Zero emisio garbi dituen ekonomia baterako trantsizioak garrantzi handia du, eta horrek babes sozial, enpresarial eta instituzional handia eta gobernantza-eskema eraginkorra eskatzen ditu.

Gizarteak eta eragile ekonomiko eta instituzionalek trantsizio energetikoko prozesuari babesa eta konpromisoa ematea lortzea ezinbestekoa da prozesua arrakastatsua izan dadin; izan ere, ezarritako helburuak lortzeko beharrezkoa den eraldaketak aldaketa sakona eskatuko du eragile ekonomiko guztien portaeretan, eta inpaktu asimetrikoak izango ditu sektore ekonomikoen artean (eta sektore berberen barruan) eta biztanleriaren segmentuen artean.

Alemaniaren, Frantziaren edo Erresuma Batuaren kasuek erakusten dute garrantzitsua dela trantsizio energetikoaren prozesurako gizarte-babesa mantentzea, hauetaz baliatuta: kontzientziazio-maila handia, gizarte osoarentzat dituen onurei buruzko informazioa, prozesuaren gardentasuna eta arriskuan dauden biztanleriaren segmentu eta sektore ekonomikoentzako konpentsazio-eskemak (adibidez, pobrezia energetikoa edo «karbono-ihesa»).

Balio-kateen arteko edo enpresa-posizionamendu bereiziak dituzten enpresen arteko balizko gatazken ondorio negatiboak minimizatzeko, helburuak eta planak ezarri beharko dira, jardueren arteko sinergiei eta osagarritasunei balioa emateko. Inpaktu handieneko neurriak lehenbailehen hartu beharko dira energia-sistema berriranzko pixkanakako trantsizioa errazteko, eragile ekonomikoek lehiakorrak izaten jarraitzeko beharrezkoak diren aldaketak ahalik eta kostu txikienarekin egin ditzaten.

Energia-politikaren, industria-politikaren eta ingurumen-politikaren arteko koordinazio- eta interakzio-maila handia lortu behar da; izan ere, Euskadiko ekoizpen-sareak datozen urteetan jasango duen eraldaketak definituko ditu EAEko ekonomiaren lehiakortasunaren oinarriak datozen hamarkadetan. Alemaniako ereduak erakusten du nola birbidera daitekeen ekonomia-, industria- eta berrikuntza-politika emisio gutxi edo batere ez duten teknologia energetikoen lidergoa sustatzera eta finkatzera, eta, aldi berean, jarduera iraunkorren inguruko hazkunde ekonomikoa eragin.

Trantsizio energetikoaren aldeko bultzada berriak aukera ematen du Euskal Autonomia Erkidegoko energia- eta ingurumen-gobernantzaren ereduaren eraginkortasunean aurrera egiteko.

Prozesuaren maila anitzeko gobernantza edo gobernantza bertikala administrazio eta erakundeen rolak identifikatzean oinarritu behar da, bai eta beharrezko inbertsioak bultzatzeko funtsak lortzea erraztuko duen lankidetza-esparru bat garatzean ere. Horretarako, koordinazio bertikaleko organoak/foroak antolatu beharko dira, Eusko Jaurlaritzaren, foru-aldundien eta, bereziki, eskualdeen eta udalerrien parte-hartzearekin.

Eremu horizontalean, eragile guztiek konpromisoa hartu beharko dute prozesuaren helburuekin eta estrategia eta planekin, iraunkortasunaren EAEko agenda (Euskadi Agenda 2030) barne harturik. Era berean, eragile anitzeko eta sektorearteko koordinazio-organo edo -foroak egituratu beharko dira, trantsizio energetikoko lehentasun estrategikoen, klima-aldaketara egokitzearen eta egungo ekonomia zero emisio garbiko ekonomia bihurtzearen inguruan.

## Monografiko honen edukiari buruz

Zenbaki honek zortzi artikulu akademiko ditu, bi *policy letterrekin* batera, trantsizio energetikoko gai garrantzitsuak jorratzen dituztenak eta Euskal Autonomia Erkidegorako trantsizio energetikoaren prozesuaren inplikazioen irudi osoagoa izatea ahalbidetzen dutenak.

Trantsizio energetikoaren eragin ekonomikoa aztertzeaz gain, eragin positiboa bultzatzeko eta eraldaketa errazteko palankekin lotutako alderdi orokorrak (espezializazio-estrategiak, gobernantza, finantzaketa) eta beste gai espezifiko batzuk jorratzen dira, hala nola Enpresen iraunkortasun-estrategiak edo banatutako energia-baliabideen garapena.

Eraldaketa horren zabaltasuna, sakonera eta konplexutasuna dela eta, ezinezkoa izan da monografiko honek esparru eta gai garrantzitsu guztiak jorratzea. Monografiko honetan jorratu ez diren elementuen artean daude, kasu batzuetan horri buruzko oharrak egiten badira ere, adibidez, energia-politika eta erregulazioa, energiaren geopolitika, garapen teknologiko berriak edo justizia eta eraldaketa-prozesuen oreka («bidezko trantsizioa» deritzona).

Lehen artikuluan, **Luz Dary Beltrán**ek eta **M. Carmen Delgado**k Euskadin trantsizio energetikora bideratutako inbertsioen eragin ekonomiko positiboa balioetsi dute, ekoizpenari, BPGari eta enpleguari dagokienez, EAEko Kontabilitate Sozialaren Matrizean oinarritutako sektore anitzeko ereduak erabiliz.

**Mari Jose Aranguren**, **James Wilson** eta **Edurne Magro** ikertzaileek aztertu dute nola espezializazio adimenduneko estrategiak (RIS3) eta Euskadiko berrikuntza-politikek trantsizio energetikoaren aukerak gauzatzeko esparrua eskaintzen duten, ingurumen-iraunkortasunaren elementua energia- eta klima-estrategia eta -politiketan txertatuz.

**Thomas Hoppe**k gogoeta egin du eskualde-mailako trantsizio energetikoaren gobernantza berria garatzeko prozesutik atera daitezkeen irakaskuntzei buruz, Herbehereetako kasuaren azterketatik abiatuta. Izan ere, bertan, gobernantza-eredu bat egituratzen ari da, estatu-mailaren eta udal-mailaren artean.

**DeustoTech**, **Deusto Business School**, **Tecnalia**, **EEE**, **Energiaren Klusterra** eta **Bilboko Udaleko ikertzaile** talde batek gogoeta egin du, Bilbon energia positiboko barrutiak garatzeko proiektu pilotu baten esperientziatik abiatuta, *bottom-up* gobernantza-eskemak antolatzeko moduari buruz, hiri-espazioetan eraldaketa energetikoa errazteko.

Bestalde, **Jorge Fernández**ek eta **Macarena Larrea**k eskualdeetako gobernuek finantzaketa berdeko ekosistema eraginkorren bultzatzaile gisa duten eginkizuna aztertu dute, teknologia berri garbietan eta proiektu iraunkorretan inbertsioak errazteko palanka gisa jardun dezaten, eta Euskadirentzako inplikazio nagusiak adierazi.

Eragile ekonomikoek iraunkortasuna jarduera-ardatz gisa txertatzeko duten beharra bi artikulutan aztertzen da. Alde batetik, **Salvador Acha**, **Aitor Soler** eta **Nilay Shah** egileek karbono-aztarna handia duten erakundeetan CO2 emisioak murrizteko jardunbide onenak identifikatu eta Euskal Autonomia Erkidegoaren egoera aztertzen dute.

Bestalde, **Jaime Menéndez**ek, **Jorge Fernandez**ek eta **Andrés Araujo**k *oil & gas* enpresen iraunkortasun-estrategiak aztertzeko esparru bat aurkeztu dute, eta, Euskadin, Petronor kasu zehatza aztertu dute.

**Roberto Álvaro**k, **Jesús Fraile**k, **Julia Merino**k eta **Sandra Castaño**k autokontsumo partekatua arautzeko eskema desberdinen eragina aztertu dute, energia berriztagarrien eta ibilgailu elektrikoaren integrazioa errazteko eta kontsumitzaileen parte-hartze aktiboa sustatzeko.

Monografikoaren azken zatian, **Henry Wang**ek *policy letter* batean hausnartu du klima-aldaketaren, energia berriztagarrien eta karbono-neutraltasunaren politika berriek nola ekar dezaketen hazkunde ekonomikoa EAEkoa bezalako ekonomia industrial batera.

**Jacques Le Cacheux**ek**,** era berean, EBko mugetan karbonoaren doikuntza fiskala sartzeko beharra aztertzen du, industria europarra industria iraunkor bihurtzeko prozesuan babesteko.

Aipatutako artikulu eta *Policy Letter*rez gain, beste Kolaboratzaile Batzuk atalean, **Mirene Begiristaine**k, **Enekoitz Etxezarreta**k, **Jon Morandeira**k eta **Ariane Kareaga**k ekintzailetza sozial eta kooperatiboen helburu sozialean laguntzen eta orientatzen duen adierazleen sistema bat proposa-tzen dute, haiek dimentsio eraldatzaile baterantz bideratzeko. Proposamena Olatukoop (Ekonomia Soziala eta Eraldatzailea Saretzen) kooperatiba-sareko kideekin lankidetzan garatu zen, eta ikerketa ekintza partehartzailearen ikuspegitik, Koopfabrika programaren lanketan laguntzen ari da, gizarte-ekonomia eta kooperatiba-ekintzailetza sustatzeko.

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# *Introduction*

When we started the task of coordinating this special issue a year and a half ago, the environmental challenge had already been placed at the center of the economic debate in the European Union (EU). The European Green Deal, published in December 2019, proposed a strategy for economic growth and competitiveness for the UE, focused on environmental sustainability (European Commission, 2019).

The coronavirus crisis raised fears that the focus on environmental sustainability would lose weight, given the sanitary emergency and the severity of the subsequent economic crisis. Despite this, the European Commission maintained the European Green Deal as one of the pillars of the economic recovery plan, with areas such as clean energy, efficient and low-emissions industry and sustainable mobility being drivers of GDP growth, employment and competitiveness in the European Union in the coming years.

In this context, we present this special issue of Ekonomiaz-Revista Vasca de Economía, which aims to explore some relevant issues within the wide-ranging process known as «energy transition» and to analyze potential implications for the Basque Country.

**The energy transition**

The main objective of the process of transformation of the energy system into a sustainable energy system in the long term, known as energy transition (Grubler, 2012), is to drastically reduce greenhouse gas (GHG) emissions associated with this sector --about 73% of global emissions (Ritchie, 2020). While in the past there was a tendency to identify the energy transition with the shift of the energy production and distribution system into a «clean» one, nowadays the concept of energy transition implies the transformation of the entire economy into a sustainable, net-zero emissions economy, including changes on the energy demand side as well.

In the long run, this transformation will have a very significant impact on the organization and functioning of all economic sectors and activities (production, distribution and consumption of raw materials, including energy, and of all goods and services), on economic growth (Fankhauser and Jotzo, 2018), on the competitiveness of firms (Zhang, 2019) and on the well-being of the population (TNO, n.d).

Energy transition processes in Europe are entering a new phase, after a stage (which can be dated between the approval of the «20-20-20 targets» in 2007 and 2020) in which substantial progress has been made in transforming the electricity generation mix towards a cleaner system and the technological and commercial maturity of certain renewable sources (wind and photovoltaic, mainly) has increased.

The current phase of the energy transition process necessarily involves not only continuing to significantly increase the penetration of renewable energies in the energy matrix, but also moving rapidly towards greater electrification and decarbonization of final energy consumption and substantially improving energy efficiency throughout the economy. The new stage of the energy transition will be characterized by the irruption, deployment and interaction of multiple innovative technologies (hydrogen, carbon capture, use and storage, renewable gases, efficient synthetic fuels, etc.), the decline of conventional generation technologies (e.g., coal), tensions between different actors involved in the transformation and the reconfiguration of many sectors and value chains in the economy (Markard, 2018). Uncertainties also arise, for example, regarding the future of nuclear power or the role of natural gas as the «bridge fuel» of the energy transition.

**The broad scope of the energy transition process**

The need to achieve a zero-net-emissions energy sector and economy means that energy and climate policy are now inseparable. In this sense, the whole set of energy policies of the Basque Country (and Spain) are closely related to the energy and climate strategy of the EU. This, in turn, responds to the commitments made through the Paris Agreement of December 2015, which obliges the signatory countries to implement the necessary transformations to limit the increase in the global temperature of the planet to 2 ºC (and, if possible, to 1.5 ºC).

The energy policy objectives of the EU are based on principles that have been embraced for more than two decades, when the first electricity and natural gas directives were adopted: to achieve clean energy for all Europeans while maintaining the security of supply and the competitiveness of the economy. These principles were embodied in the «20-20-20 targets» regarding GHG emission reductions, renewable energy penetration and energy efficiency, and have been maintained in the Clean Energy Package (or «winter package»), the main pieces of legislation of which were adopted in 2018. For 2030, the EU has set ambitious quantitative targets for these three variables (emissions, renewables and energy efficiency). Meeting these goals will entail radical changes in energy systems across Europe.

The target for the year 2050 is even more ambitious: the EU aims to achieve a net-zero emissions economy by that date and has included this milestone in the so-called European Climate Law.

The implementation of this energy-climate strategy will lead to very significant changes on the energy demand side. Over the next three decades, the emphasis of the fight against climate change will focus on transforming the way energy is consumed in sectors of the economy such as transport, industry, buildings or agriculture, for example, where the process of large-scale decarbonization has not yet begun in earnest.

In addition, consumers will take on a more active role in the energy system and energy markets than they have thus far, being able to act as producers with the capacity to manage energy through storage (either stationary or mobile, using for instance, the batteries of electric vehicles).

**Success factors and tools**

The success of this energy transition process will depend on the evolution and interaction of multiple variables. There is no single solution or standard set of tools to solve the challenge of achieving a zero net emissions economy (Grillitsch and Hansen, 2019; Mattes *et al.*, 2015).



For example, the relative passivity of many economic agents (who will have to be active protagonists of the transformation) towards the changes in the making, will have to be countered with information and awareness campaigns (Niamir and Filatova, 2016).

The graduality of the measures, based on a clear roadmap that has its first implications in the immediate future, will facilitate the transformation of activities, companies and production chains without jeopardizing the sources of value and wealth creation in the economy.

On the other hand, the development of innovative financing mechanisms for the necessary investments in clean and efficient technologies and new support schemes for the creation of companies and new business models will become very important in the coming years. New forms of financing based on public-private partnership schemes, on «green and sustainable financing» by banks and other investors, on green bonds or on project finance schemes by green investment funds (Lamperti *et al.*, 2019), will maximize the multiplier potential of public investment incentives and facilitate investments by smaller companies. This issue will be particularly relevant in the short term, in order to maximize the opportunities that will be generated by the diffusion of financing funds within the NextGenerationEU program.

Strong support for start-ups that champion new business models through incubator and acceleration vehicles, the promotion of business angel networks, etc., and new collaboration schemes in R&D will be tools that will help to increase the value of technological and research capabilities through an effective transfer of knowledge to industrial companies.

A reform of energy and environmental taxation should be backed to induce the technological and behavioral changes that are required to make significant progress in decarbonization and achieve long-term economic, social and environmental sustainability. These changes must guarantee at the same time the fiscal balance of the different layers of government in the short, medium and long run.

The need to increase specialized human capital in areas related to the energy transition (e.g., through specialized technical study programs in energy, circular economy, data analysis and management, new materials, electronics, statistics, etc.) must also be addressed (Orkestra, 2019).



This broad process also raises the need to deal with issues related to the specific territories in which it is to be carried out. Although the goal of the energy transition is global, the main transformations will take place at more local levels (e.g., regions, counties or municipalities). In each territory, the transformation will have to be tailored by protecting and fostering its economic and social strengths, taking advantage of opportunities to develop sustainable competitive advantages, and ensuring an equitable transformation for all economic sectors and segments of the population most affected by this change (Calvert, 2016; Newell and Mulvaney, 2013; Köhler *et al.*, 2019).

**The challenge of the Basque Country for 2021-2030**

In the case of the Basque Country, for example, the specificities related to its orography, history and economic structure, the typology of the business fabric and the socio-political and institutional environment must all be taken into account when assessing the opportunities and threats posed by the energy transition process.

The ultimate objective is to carry out the transformation of the Basque energy system, ensuring at the same time that, with an energy-intensive industry and relatively scarce natural resources, energy is available at a competitive cost and with reduced environmental impact. In addition, the bases of competitiveness of the Basque economy, closely related to the strengths of the industrial sector, must be protected. Finally, all agents and institutions must be efficiently engaged in the process in order to exploit synergies and common interests in a coordinated manner and achieve the desired results in terms of increased social well-being. The challenge of the energy transition for the Basque Country, therefore, is threefold: (a) energy-environmental; (b) techno-industrial; and (c) of governance.

In order to face this triple challenge, a Basque law on energy transition and climate change is being drafted at the time of writing these lines, which will establish the bases of a legislative framework that should favor the achievement of energy and environmental objectives, the materialization of advances in R&D in energy and sustainability activities and the consolidation of a technological and industrial policy that is coherent with the strengths of the Basque economy and with the strategic objectives pursued by the Basque Country. In this context, a review of the Basque Energy Strategy 2030 (EVE, 2017) is also planned, which will be framed within the new Basque Strategic Plan for Energy Transition and Climate Change.

The new legislative and strategic energy planning framework, together with the Basque Country 2030 Agenda, the 2019 Energy Sustainability Law and other government strategies (e.g., the 2030 Circular Economy Strategy and the various initiatives within each Historical Territory and the Basque municipalities), will make it possible to integrate and align all relevant policies (industrial, educational, energy, environmental, etc.) with the common goal of improving the competitiveness of the

Basque economy and the sustainability of the economic and energy model in the medium and long term.

**The environmental challenge**

The decarbonization of industry and the transport sector is a major challenge for the Basque Country. Although GHG emissions in the Basque economy have been considerably reduced since 2000, reaching the 2030 emissions targets -a reduction of about 3 Mt of $CO_2$, in line with the Basque Government's adherence to the 2015 Paris Agreement (Basque Government, 2016)- and energy efficiency goals will require a profound transformation of the Basque energy matrix.



This will require an increase in the penetration of renewable power generation technologies (mainly onshore and offshore wind and solar photovoltaic) and a significant advance in the electrification of the economy. However, the potential additional penetration of renewable energy is limited in the Basque Country, due to orographic factors and the existence of limited meteorological resources (wind and solar radiation) (IDAE, 2011; Sancho *et al.*, 2012).

Natural gas will remain a relevant source of flexibility for the electricity system, providing a back-up for the penetration of renewable energies until storage and demand management capacity increase. All this will require the transformation of energy grids into smart grids, with the capacity to integrate new distributed energy resources and, especially, storage devices and electric vehicles.

On the consumption side, solutions and technologies with low or zero GHG emissions will have to be deployed in sectors such as industry or transport, responsible for 64% of total emissions in the Basque Country in 2017 (Basque Government, 2020). This is a very ambitious challenge for the Basque industry, which is energy intensive (using mainly electricity and natural gas). A commitment must be made to keep on advancing in the electrification of consumption and the use of new energy vectors, such as hydrogen, and more efficient fuels with low emissions (e.g., green gases or e-fuels).

In the industrial sector, technological innovation in low-emissions equipment and energy storage (with a special focus on the use of high- and medium-temperature waste heat) and the development of new solutions for storing and utilizing $CO_2$, for example, will be key levers to boost decarbonization.

In addition, the process of decarbonizing energy consumption in the residential and buildings sectors must be accelerated. In these cases, the trends observed in the European context point to an increase in the use of electrical energy (e.g., heat pumps) and renewable energy in uses such as air conditioning or the development of innovative communal solutions where possible (district heating).

It will also be key in this process to significantly increase efficiency in the use of material and energy resources in the manufacturing and heavy industry sectors. Improvements in energy efficiency (in all sectors) should be promoted, both technologically (new energy and process management systems, etc.) and through the deployment of new consumption models (self-consumption, energy communities, etc.) and the development of the circular economy should be fostered (especially in the industrial sector, where eco-design, recycling, the use of new efficient materials and the application of new processes for the reutilization of materials, remanufacturing or maintenance can lead to major economic gains).

Given the possibility that the environmental objectives set for the 2030 horizon will not be achieved in the Basque Country, it also seems necessary to explore the feasibility of using alternative compliance tools and options, such as increasing energy interconnections or using carbon sinks and the flexibility provided by the compensation mechanisms in the Paris Agreement (Schneider *et al.*, 2020).

**The technological and industrial challenge**

In parallel to the environmental challenge, the Basque Country will have to implement a technological and industrial policy that, leveraging the strengths of the Basque economy, will make it possible to exploit economic opportunities, both in terms of the development of new sources of sustainable competitiveness in different areas of the economy and the creation of employment or in terms of increased welfare of citizens.

These strengths have been developed in sectors that are key to the energy transition; e.g., value chains such as electrical grids, power electronics, renewable energy, oil & gas, automotive components and other booming and emerging sectors, such as electrical energy storage, digitalization and industry 4.0 services, circular economy or technologies related to electric mobility (Álvaro & Fernández, 2019). The specialization of many Basque companies in integrating different technologies (digitization, clean technologies, storage, etc.) and in developing and implementing high-value-added energy solutions in different industrial sectors is another source of strength.

Technological and industrial policy in the coming years should be oriented towards fostering the development of new business models based on the digitization of equipment and processes, servitization of assets, promotion of technological and non-technological innovation within firms and a focus on data analysis and management to develop new solutions and services for customers.

In addition, the transformation of traditionally powerful sectors in the Basque Country, such as oil & gas or automotive components, should be supported by providing incentives to reorient them towards the creation of value in products, services and activities more aligned with the energy transition (e.g. hydrogen, biofuels, new efficient and low-emission petroleum products, renewable gases or alternative fuels in transportation, in the case of oil & gas, and technologies for the deployment of electric mobility, electric battery components and associated services, etc., in the case of the automotive sector).

In short, the Basque Country can become a «reference, state-of-the-art lab» in areas of the energy transition such as smart energy networks (electricity and natural gas), energy storage, circular economy, electric mobility and energy vectors such as hydrogen. In this sense, the commitment to developing the hydrogen economy being made by Basque economic agents and institutions (i.e., the so-called Basque Hydrogen Corridor and other initiatives) seems like a way to implement collaborative projects of a strategic nature and with a great impact on different value chains.

To this end, it will be essential to continue supporting the entire spectrum of R&D activities, especially at the highest levels of technological maturity (TRL) and close to the commercialization of solutions that efficiently contribute to reducing $CO_2$ emissions (IEA, 2020) due to their impact on the productivity and competitiveness of the Basque economy and their potential capacity to generate «first-mover advantages» in different activity niches related to the energy transition and where sustainable competitive advantages can be developed (Karkatsoulis *et al.*, 2016).

The energy and environmental challenges faced by the Basque energy sector also represent an opportunity for other sectors of the Basque economy to grow, through collaboration in technological innovation, cross-company cooperation and the identification of new business opportunities in converging value chains (e.g., oil & gas and hydrogen, electricity grids and distributed energy resources or energy networks, storage and electric mobility).

**The challenge of governance**

A transformation of the magnitude of the said transition to a zero net emissions economy requires strong social, business and institutional support and an efficient governance scheme.

Achieving the support and guaranteeing the commitment of society and of economic and institutional agents to the energy transition process is essential for it to be successful, since the transformation needed to achieve the objectives set will require a profound change in the behavior of all economic agents and will render asymmetrical impacts between economic sectors (and within the same sectors) and also between segments of the population.

Cases such as Germany, France or the United Kingdom show the importance of maintaining social support for the energy transition process through a high level of awareness, information on the benefits of the transition for society as a whole, transparency in the process and compensation schemes for those segments of the population and economic sectors at risk (e.g., derived from energy poverty or «carbon leakage»).

To minimize the negative effects of potential conflicts between value chains or between companies with substantially different business positioning, objectives and plans should be established to highlight synergies and complementarities between activities. The measures with the greatest impact should be adopted as soon as possible to favor a gradual transition to the new energy system. This will allow economic agents to carry out the changes necessary to remain competitive at the minimum cost.

A certain degree of coordination and interaction between energy policy, industrial policy and environmental policy must also be achieved, since the transformation that the productive fabric of the Basque Country will undergo in the coming years will define the basis for the competitiveness of the Basque economy over the coming decades. The German example shows how economic, industrial and innovation policies can be reoriented towards the promotion and consolidation of leadership in energy technologies with low or zero emissions, while generating economic growth around sustainable activities.

The new impetus to the energy transition offers an opportunity to advance in the efficiency of the energy-environmental governance model in the Basque Country. This will be achieved through well-identified, defined and measurable objectives, a clear planning/roadmap, a concrete definition of the role of the different institutions and agents in the process of implementation, monitoring, etc., including specific mandates to key government agencies, mechanisms for monitoring and supervision and continuous review of the planning and schemes to ensure compliance with the objectives set.

The vertical or multilevel governance of the process should be based on the identification of the roles of the different governments and entities and on the development of a collaboration framework to facilitate raising capital to promote the necessary investments. This will require the articulation of vertical coordination bodies/fora with the participation of the Basque Government, the Provincial Councils and, especially, the counties and municipalities.

Horizontally, all stakeholders must commit to the objectives of the process and to the different strategies and plans, including the Basque sustainability agenda (Agenda Euskadi 2030). Multi-agent and intersectoral coordination bodies or fora should also be articulated around strategic priorities related to the energy transition, the adaptation to climate change and the transformation of the economy into one with zero net emissions.

**About the contents of this special issue**

This issue includes eight academic articles, accompanied by two policy letters, which deal with relevant issues of the energy transition and paint a more complete picture of the implications of the energy transition process for the Basque Country.

Besides analyzing the economic impact of the energy transition, general aspects related to levers that boost positive impacts and facilitate the transformation are addressed (specialization strategies, governance, financing), as well as other specific issues, such as sustainability strategies by companies or the development of distributed energy resources.

The breadth, depth and complexity of this transformation make it impossible for this special issue to cover all relevant areas and issues within the energy transition. Among the issues not addressed explicitly in this monograph, even if in some cases mentions are made, are, for example, energy policy and regulation, the geopolitics of energy, new technological developments or the fairness and balance of the transformation processes (the so-called «just transition»).



In the first article, **Luz Dary Beltrán** and **M. Carmen Delgado** assess the positive economic impact of investments made as part of the energy transition strategy in the Basque Country, in terms of production, GDP and employment, using multisectoral models based on the Social Accounting Matrix of the Basque Country.

**Mari Jose Aranguren**, **James Wilson** and **Edurne Magro** analyze how the Smart Specialization Strategy (RIS3) and the innovation policies of the Basque Country offer a framework to materialize the opportunities of the energy transition, incorporating the element of environmental sustainability in energy and climate strategies and policies.

**Thomas Hoppe** reflects on what lessons can be learned from the process of developing a new governance of the energy transition at the regional level, based on an analysis of the case of the Netherlands, where a governance model is being structured at an intermediate level between the state and the municipal level.

A group of researchers from **DeustoTech**, **Deusto Business School**, **Tecnalia**, **EVE**, **Clúster de la Energía** and the **Bilbao City Council** reflect, based on the experience of a pilot project for the development of positive energy districts in Bilbao, on how to articulate bottom-up governance schemes that facilitate energy transformation in urban spaces.

**Jorge Fernández** and **Macarena Larrea** analyze the role of regional governments as drivers of efficient green finance ecosystems that act as a lever to facilitate investments in clean technologies and sustainable projects, pointing out the main implications for the Basque Country.

The need for economic agents to incorporate sustainability as an axis of action is dealt with in two articles. On the one hand, **Salvador Acha**, **Aitor Soler** and **Nilay Shah** identify the best practices for the reduction of $CO_2$ emissions in organizations with a high carbon footprint and explore the situation in the Basque Country.

On the other hand, **Jaime Menéndez**, **Jorge Fernández** and **Andrés Araujo** present a new framework for analyzing the sustainability strategies of oil & gas companies, applying it to the specific case of Petronor in the Basque Country.

**Roberto Álvaro**, **Jesús Fraile**, **Julia Merino** and **Sandra Castaño** analyze the impact of different regulation schemes for energy communities to facilitate the integration of renewable energy and electric vehicles and encourage the active participation of consumers.

In the final part of the special issue, **Henry Wang** reflects in a policy letter on how new climate change, renewable energy and carbon neutrality policies can lead to economic growth in an industrial economy such as the Basque one. **Jacques Le Cacheux**, in turn, analyzes the need to introduce a carbon tax adjustment at EU borders to protect the European industry during the process of transformation into a sustainable industry.

In addition to the articles and Policy Letters alredy mentioned and within the Special Section in this issue, **Mirene Begiristain**, **Enekoitz Etxezarreta**, **Jon Morandeira** and **Ariane Kareaga** propose a system of indicators to help and guide social and cooperative enterprises towards social transformation. The indicators have been developed in collaboration with members of the cooperative network Olatukoop (Red de Fomento de la Economía Social y Transformadora) involved, from a participatory action research perspective, in the development of the Koopfabrika program, which seeks to promote the social economy and cooperative entrepreneurship.

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# *Impacto multisectorial de las políticas en materia de transición energética en el País Vasco*

## *Multisectoral impact of energy transition policies in the Basque Country*

**Actualmente los posibles efectos nocivos del cambio climático sobre el planeta preocupan a gobiernos y ciudadanos, que intentan conseguir un futuro más sostenible con sus políticas y comportamientos. Así, el Gobierno Vasco cuenta con la Estrategia Energética 2030, que permite vislumbrar los hitos que se han de conseguir para tal fin, a partir de actuaciones en materia de política energética. Esta investigación analiza el impacto económico que tendrá la inversión destinada a la transición energética de la región. Para ello, se utilizan modelos multisectoriales basados en la Matriz de Contabilidad Social del País Vasco para el año 2019. Entre los principales resultados se encuentra que la inversión acumulada para el periodo 2016-2030 se traduce en un incremento del 5,7% de la producción total y del 6,2% del PIB de la región.**

*Gaur egun, klima-aldaketak planetan izan ditzakeen ondorio kaltegarriek kezkatu egiten dituzte gobernuak eta herritarrak, euren politikekin eta portaerekin etorkizun iraunkorragoa lortzen saiatzen ari baitira. Hala, Eusko Jaurlaritzak 2030 Energia Estrategia du, horretarako lortu behar diren mugarriak ikusteko aukera ematen duena, energia-politikaren arloko jardueretatik abiatuta. Ikerketa honek eskualdeko trantsizio energetikorako inbertsioak izango duen eragin ekonomikoa aztertzen du. Horretarako, 2019rako EAEko Kontabilitate Sozialaren Matrizean oinarritutako sektore anitzeko ereduak erabiltzen dira. Emaitza nagusien artean, hauxe dugu: 2016-2030 aldirako metatutako inbertsioaren ondorioz, ekoizpen osoa % 5,7 hazi da, eta eskualdeko BPGa, berriz, % 6,2.*

Currently, the possible harmful effects of climate change on the planet concern governments and citizens, who try with their policies and behaviors to achieve a more sustainable future. Thus, the Basque government has the Energy Strategy 2030, which allows a glimpse of the milestones to be achieved for this purpose, based on actions in energy policy. This research analyzes the economic impact of investment in the region's energy transition. For this, multisectoral models are used based on the Social Accounting Matrix of the Basque Country for 2019. Among the main results is that the accumulated investment for the period 2016-2030 translates into an increase of 5.7% in total production and 6.2% of the region's GDP.

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## *Índice*



**Palabras clave:** transición energética, matrices de contabilidad social, modelos multisectoriales, análisis de impacto.

**Keywords:** energy transition, social accounting matrices, multisectoral models, impact analysis.

**Nº de clasificación JEL:** C67, Q48, R13

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## 1. INTRODUCCIÓN

El descontrolado consumo de combustibles fósiles es una de las principales causas del calentamiento global, que traerá grandes consecuencias en ámbitos medioambientales, sociales y económicos a nivel mundial, lo cual muestra la necesidad de generar cambios en los patrones de consumo, aumentando la eficiencia energética, consumiendo menos energías fósiles y migrando hacia energías renovables. Para esto, son necesarias políticas y medidas que encaminen hacia la transición energética, con el fin de lograr que el aumento de la temperatura global causada por las emisiones de gases invernadero no supere los 2°C a través de la limitación de la explotación y el uso de combustibles fósiles (McGlade y Ekins, 2015).

De acuerdo con Nordensvärd y Urban (2015), lograr esta transición energética implica diferentes transformaciones en las actividades económicas de una sociedad, a partir del abandono de ciertas fuentes de energía y la incorporación de otras en un horizonte temporal de largo plazo. Dichas transiciones se han producido en diferentes eras de la humanidad, debido a la necesidad de adaptación a los recursos limitados del planeta que son demandados por el desarrollo económico paulatino.

A través de diferentes acuerdos internacionales se ha buscado migrar hacia un modelo energético sostenible que garantice seguridad en el suministro, costes energéticos competitivos y beneficios medioambientales. Este interés a nivel mundial ha llevado a unir esfuerzos como el logrado con el Acuerdo de París y a las propuestas de la Unión Europea, las cuales buscan una mejor ruta para una verdadera transformación energética.

La atención despertada por diferentes países, regiones y ciudades ha hecho posible que se generen acciones y políticas en torno al cambio climático, y el País Vasco no es la excepción; el Gobierno Vasco creó y aprobó la Estrategia de Cambio Climático Klima 2050 en el 2015, cuyos objetivos se alinean a las políticas europeas y a la Estrategia Energética de Euskadi 2030.

De acuerdo con Nazca (2019), el País Vasco ha enviado nueve acciones climáticas, de las cuales cuatro son cooperativas y cinco individuales[1]; cinco están relacionadas con la reducción de emisiones, una con la eficiencia energética, dos con la energía renovable y una transversal, mostrando así, estar a la vanguardia a nivel mundial en materia energética.

El País Vasco, en términos del Producto Interno Bruto (PIB) per cápita, ha mantenido en los últimos años el ritmo de convergencia total con la UE15, con una tasa media de crecimiento para el periodo 2015-2019 de 2,6%, mostrando una economía estable (Euskadi, 2020).

Este crecimiento se ve reflejado en el PIB, el cual aumentó en 2019 un 2,2% respecto al año anterior vía demanda interior, donde, de acuerdo con información de Euskadi (2020), todas las ramas de la actividad productiva realizaron aportaciones positivas al valor añadido. Por el contrario, la industria vasca para el año 2019 tuvo un crecimiento del 1,1%, por debajo del año 2018, mostrando de esta forma una pérdida de dinamismo.

Una de las principales características de la economía vasca es su perfil industrial; según las cuentas económicas, el sector industrial aporta el 35% al total de empleos a precios básicos registrados en la tabla Insumo-Producto, así como el 24% del valor

[1] Dichas acciones son: Alianza de ambición climática: cero emisiones netas 2050; RegionAdapt; States and Regions Annual Disclosure; Under2Coalition; reducir las emisiones en toda la región en un 30% para 2030 en comparación con los niveles de 2005; reducir las emisiones totales en un 80% para 2050 en comparación con los niveles de 2005; aumentar la eficiencia energética primaria en toda la región en un 33% para 2030 en comparación con 2016; aumentar la participación de energías renovables en el consumo de electricidad en toda la región al 40% para 2050; aumentar la participación de las energías renovables en el consumo de energía en toda la región al 21% para 2030.

añadido bruto (VAB) en el año 2019[2], resaltando la industria pesada, la cual presenta una elevada intensidad de emisiones.

En materia de energía, el País Vasco tiene un sistema energético basado en el uso de energías fósiles; sin embargo, las emisiones y el crecimiento del PIB a partir del año 2002 han mostrado una clara desvinculación, con un crecimiento de emisiones en menor proporción que el PIB (EcoEuskadi, 2020).

Otra característica presentada es su alta dependencia con el exterior, expuesta a la volatilidad de los precios energéticos del mercado a nivel mundial. Asimismo, las emisiones de Gases de Efecto Invernadero (GEI) se han visto reducidas a partir del 2016, debido a la disminución de la intensidad energética del sector industrial, producto de la crisis económica del 2008.

Algo similar sucede con el uso de las energías renovables, las cuales han aumentado su participación cada vez más en el consumo interior bruto de energía vasco. En el año 2016 las energías renovables representaron el 8% del consumo interior bruto de energía en el País Vasco[3]. Para el periodo 2010-2014, los principales descensos en consumo los tuvieron el carbón (-31%) y las energías renovables (-23%); la energía eléctrica y el gas natural presentaron reducciones del 13% y 10% respectivamente, mientras que el petróleo y sus derivados permanecieron igual.

Por su parte, los sectores productivos que más consumo de energía han reportado son las manufacturas (42%) y el transporte (37%), siendo este último el que presenta más consumo energético de derivados del petróleo. No obstante, el sector industrial ha mostrado un comportamiento descendente, mejorando en el año 2016 la intensidad energética un 3% respecto al año anterior, mientras que las emisiones de $CO_2$ se redujeron en 900.000 toneladas[4].

En este sentido, el Gobierno Vasco ha continuado tomando medidas en términos de materia energética y su lucha contra el cambio climático, ya que se requieren todos los esfuerzos posibles adicionales a los ya existentes para evitar efectos irreversibles. En los últimos años ha emprendido diferentes acciones y compromisos, aprobando, como se ha indicado, en 2015 la Estrategia de Cambio Climático Klima 2050, definida de tal manera que sus objetivos sean consistentes con las políticas europeas, así como con la Estrategia Energética de Euskadi 2030, la cual está alineada a los objetivos energéticos climáticos definidos por la Unión Europea, que resultan ser la base para el análisis cuantitativo propuesto en esta investigación.

Esta última estrategia presenta los esfuerzos y objetivos en eficiencia energética, renovables, desarrollo tecnológico e infraestructura, incluyendo la reducción de emisiones y el aumento de renovables en línea con la estrategia climática. A grandes

2 De acuerdo con información de Eustat (2020).

3 Información obtenida de la Estrategia Energética de Euskadi 2030 (2016).

4 Según el Ente Vasco de la Energía (2020).

rasgos incluye dos vertientes: energías renovables, con las que se busca que el 17% del consumo final en 2025 y el 21% en 2030 sea renovable; y eficiencia energética, en la que se establece una cuota de ahorro del 21% en 2025 y del 25% en 2030, siendo estos últimos menores a los definidos en el país y a nivel europeo.

De igual forma, se incluyen unos objetivos a largo plazo para el sistema energético del País Vasco, de tal manera que la incorporación progresiva de las energías renovables y la energía eléctrica en la industria, los edificios y el transporte permitan cumplir con un consumo cero de petróleo para usos energéticos en el 2050 (Ararteko, 2018). Como contribución a los objetivos de la Estrategia Vasca de Cambio Climático 2050, se plantea reducir las emisiones de gases de efecto invernadero de Euskadi en al menos un 40% a 2030 y en al menos un 80% a 2050, respecto al 2005. Como último objetivo de largo plazo, se espera una completa desvinculación de los combustibles fósiles y emisiones netas cero de gases de efecto invernadero a lo largo del siglo, teniendo como único suministro energético las energías renovables[5].

Esta investigación plantea analizar el impacto que la inversión destinada a la transición energética de la región tendrá sobre la economía vasca y sus sectores productivos, utilizando como base para el análisis la información recogida en la Estrategia Energética 2030, en términos de producción, PIB y empleo[6]. Para ello, se plantea como marco metodológico un modelo multisectorial basado en una matriz de contabilidad social (MCS) para el País Vasco, elaborada a partir del Marco Input Output, publicado por el Instituto Vasco de Estadística.

Como muestran diferentes investigaciones, el análisis de impacto de políticas energéticas es un tema de gran interés, ya que ejercer estas políticas mencionadas en párrafos anteriores requiere grandes inversiones, cuyas implicaciones repercuten tanto en el medioambiente como en la economía, así como en todos los agentes que la conforman. Por ello, este trabajo aporta a la literatura desde otra perspectiva diferente, al analizar el impacto de las estrategias energéticas propuestas sobre la economía vasca y sus sectores productivos en materia de producción, PIB y empleo, adicionales a los impactos ambientales que por ende se esperan.

Resulta novedoso el enfoque metodológico usado para abordar el impacto económico de la estrategia energética en el País Vasco en esta investigación, ya que no se ha detectado un análisis similar basado en modelos multisectoriales.

Sin embargo, se ha demostrado que las metodologías multisectoriales son adecuadas para medir simultáneamente los efectos de diferentes medidas en materia energética entre las principales variables macroeconómicas y en el empleo, tal como

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[5] Información recopilada a partir de la Estrategia Energética de Euskadi 2030 (2016).

[6] Producción total son todos los bienes y servicios producidos por todos los trabajadores de la región e insumos (bienes intermedios) aplicados a la producción y el PIB sería únicamente los bienes y servicios finales producidos por la región.

lo muestran Füllemann y Moreau (2019), quienes estiman los impactos en el empleo de los esfuerzos realizados en materia de transición energética en Suiza, en sectores como la industria, el transporte y la construcción, así como de la sustitución de combustibles fósiles por fuentes de energía renovables, contabilizando tanto la oferta como la demanda de energía. Además, analizan escenarios de transición energética a través de tablas *input-output*. Como resultado, obtienen un impacto positivo de la transición energética en el empleo, donde la eficiencia energética y las energías renovables retienen una mayor proporción del valor agregado a nivel nacional que en una cadena de suministros de combustibles fósiles.

Por su parte, Lehr, Lutz y Edler (2012) analizan las implicaciones en el mercado laboral alemán de una gran inversión en energías renovables, basada en el programa energético del país para el año 2010. Como resultados, encuentran que las simulaciones de los diferentes escenarios planteados presentan efectos positivos sobre el empleo neto.

Cansino *et al.* (2012) estiman las intensidades energéticas sectoriales de la economía española a través de un análisis de multiplicadores basado en una Matriz de Contabilidad Social (MCS) para España en el año 2006[7]. Como resultado, destacan la existencia de variaciones entre sectores, siendo los propios sectores energéticos los que mayores necesidades presentan.

Para dar cumplimiento al objetivo de la investigación, en este trabajo se construye una MCS de la economía del País Vasco, que además de servir de base de datos para ese análisis se podría aplicar para analizar diferentes medidas de política económica, quedando como una gran aportación a la literatura. Con esta se plantea un análisis multisectorial siguiendo la metodología tradicional de Leontief ampliado a una MCS, ya que hace posible captar los efectos que se generan en la actividad económica a través de las relaciones del flujo circular de la renta, permitiendo medir el impacto en la producción, el PIB y el empleo que genera la inversión asignada para llevar a cabo las políticas de transición energética en esta región, y así identificar el impacto económico en torno a las decisiones tomadas en materia energética.

Entre los resultados más importantes se muestra que la inversión realizada con la Estrategia Energética se traduce en un incremento del 5,7% de la producción total y del 6,2% del PIB de la región para el acumulado del periodo 2016-2030. En términos anuales se traduce para el año 2019 en un aumento del 0,38% para el caso de la producción total y un 0,41% en el PIB. Asimismo, el incremento en la producción

[7] Diferentes investigaciones abordan el análisis del impacto de la transición energética a través de metodologías multisectoriales mediante diferentes enfoques: económicos, en empleo, en emisiones, en comercio internacional [Cardenete (2012); Böhringer, Keller y Werf (2013); Creutzig *et al.* (2013); Guevara y Rodrigues (2016); Arto y Dietzenbacher (2014)] reforzando la importancia de estas metodologías para analizar tanto políticas económicas de diversas índoles, así como problemáticas que afectan a diferentes agentes económicos y que impactan directamente en la producción, el PIB y el empleo de una economía.

se asocia a la generación de un total de 3.696 puestos de trabajo en la economía vasca para el año 2019. Por lo que, la aplicación de la Estrategia Energética de Euskadi 2030 acarrea un impacto positivo y relevante sobre la actividad económica de la región que puede cuantificarse en 2,7 veces más que la inversión realizada.

Estos resultados refuerzan los hallazgos comentados en otras investigaciones, pues los impactos generados con la Estrategia Energética se pueden visualizar y analizar desde diferentes enfoques, donde no solo gana el medioambiente, sino que además repercute en la economía y en la sociedad, siendo este análisis una gran contribución a la literatura desde un enfoque económico.

El presente artículo queda estructurado en cinco apartados; el segundo de ellos hace una descripción de la metodología empleada y brevemente muestra cómo fue construida la MCS para el País Vasco y las fuentes de información utilizadas. El tercer apartado define el diseño del vector de impacto realizado; el cuarto presenta los resultados obtenidos, para finalmente, en el quinto apartado incluir las conclusiones más relevantes.

## 2. METODOLOGÍA Y BASE DE DATOS

El modelo usado en esta investigación forma parte de los llamados modelos lineales de equilibrio general (MLEG). Como se mencionó en el apartado anterior, estos modelos han demostrado ser adecuados para analizar los efectos de diversos tipos de políticas públicas, ya que muestran el impacto que genera cualquier política económica, a través de los efectos directos, indirectos e inducidos en todos los sectores.

De esta manera, los Modelos Input-Output (MIO) desarrollados por Leontief (1941) pero ampliados a una MCS, permiten captar todas las interdependencias entre los sectores industriales e institucionales de una economía; en particular, los efectos producidos en las variables endógenas debido a un cambio en una variable exógena, usando multiplicadores. Los MLEG asumen los precios como exógenos y se realiza el análisis partiendo de las relaciones contables que se derivan de la MCS similar a la Tabla Input-Output (TIO), pero más completa ya que la MCS tiene en cuenta el flujo circular de la renta, permitiendo captar los efectos desde los sectores productivos hacia los sectores receptores de rentas.

Siguiendo a Stone (1978) y Pyatt y Round (1979), primero se definen las cuentas que se consideran exógenas, se realiza una variación en estas cuentas exógenas y se observa qué sucede con el resto de las cuentas que constituyen el total de la economía. Las cuentas exógenas son las que se determinan fuera del sistema económico y representan posibles instrumentos de política económica[8].

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[8] Como se mencionaba anteriormente, el modelo descrito ha sido ampliamente utilizado en diferentes estudios. Con el objetivo de ampliar la información con respecto a la metodología empleada se recomienda seguir a Campoy-Muñoz, Cardenete y Delgado (2017), Cardenete y Delgado (2013), Beltrán, Cardenete y Delgado (2019), Cámara y Marcos (2007).

Para el caso de esta investigación, se toma como cuentas endógenas las actividades productivas y los sectores institucionales a excepción del Gobierno, el cual se considera exógeno junto con el sector exterior.

Como introducción a la formulación matemática del modelo usado, el Cuadro nº 1 muestra las relaciones contables de la MCS, una vez que se definen las cuentas endógenas y exógenas[9]. El subíndice *m* hace referencia a las cuentas endógenas y el subíndice *k* a las cuentas exógenas.

*Cuadro nº 1.* **SUBMATRICES DE LA MCS**

| | Cuentas endógenas | Cuentas exógenas | Total |
|---|---|---|---|
| Cuentas endógenas | $Y_{mm}$ | $X_{mk}$ | $Y'_{m}$ |
| Cuentas exógenas | $X_{km}$ | $X_{kk}$ | $Y'_{k}$ |
| Total | $Y_{m}$ | $Y_{k}$ | |

*Fuente:* elaboración propia con base en Cámara y Marcos (2007).

De esta manera, $Y_{mm}$ es una matriz que contiene las relaciones entre cuentas endógenas; $X_{km}$ contiene las relaciones entre cuentas endógenas y exógenas; $X_{mk}$ representa los *shocks* de las cuentas exógenas en las endógenas; $X_{kk}$ contiene solo las relaciones entre cuentas exógenas. Los totales quedarán conformados de la siguiente manera: $Y_m$ e $Y_k$ son matrices columna que totalizan los ingresos y gastos de las cuentas endógenas; $Y'_m$ e $Y'_k$ son matrices fila que totalizan los gastos de las cuentas endógenas y de las cuentas exógenas respectivamente.

Ya definidas las cuentas endógenas y exógenas, se procede a construir la matriz de propensiones medias al gasto ($A_{mm}$). Esta resulta de dividir los elementos de la matriz $Y_{mm}$ y $X_{km}$ entre el total de la columna. Esta matriz $A_{mm}$ recoge los pagos realizados a la cuenta $i$ por cada unidad de ingreso de $j$, de la siguiente manera:

$$a_{ij} = \frac{Y_{ij}}{Y_j}, \quad i,j = 1,\dots,n \tag{1}$$

A continuación, se agrega un vector de componentes exógenos representado por $X_A$, $X_F$, $X_P$ y $X_C$; un vector que representa el nivel de ingresos de las cuentas endóge-

[9] El modelo se plantea siguiendo la desagregación planteada en Cámara y Marcos (2007).

nas representado por $Y_A$, $Y_F$, $Y_P$ y $Y_C$, y finalmente, un vector de pagos de las cuentas endógenas a las exógenas $P_A$, $P_F$, $P_P$ y $P_C$.[10]

Resultando:

$$Y_i = \sum_{j=1}^{n} \left(\frac{Y_{ij}}{Y_j}\right) Y_j = \sum_{j=1}^{m} a_{ij}\, Y_j + \sum_{j=m+1}^{m+k} a_{ij} Y_j; \quad n = m + k \tag{2}$$

La ecuación anterior también se puede expresar como sigue:

$$\begin{bmatrix} Y_A \\ Y_F \\ Y_P \\ Y_C \end{bmatrix} = \begin{bmatrix} C_I & 0 & C_F & I \\ W & 0 & 0 & 0 \\ 0 & R & T & 0 \\ 0 & 0 & S & 0 \end{bmatrix} \cdot \begin{bmatrix} Y_A \\ Y_F \\ Y_P \\ Y_K \end{bmatrix} + \begin{bmatrix} X_A \\ X_F \\ X_P \\ X_c \end{bmatrix} \tag{3}$$

Donde $C_I$ es la matriz insumo-producto de coeficientes técnicos; $W$ es la matriz de coeficientes de retribución a los propietarios de los factores provenientes de los sectores productivos; $R$ es la matriz de coeficientes de distribución de los ingresos que se generan durante todo el proceso productivo provenientes de los factores de producción hacia las instituciones privadas; $C_F$ es la matriz de propensiones medias al consumo; $T$ son los coeficientes de transferencias entre los sectores; $S$ son las propensiones al ahorro; $I$ son los coeficientes de inversión.

Finalmente, la matriz $Y_m$ queda dividida en cuatro submatrices $A_{mm}$, $A_{mk}$, $A_{km}$, y $A_{kk}$, quedando de la siguiente manera:

$$Y_m = A_{mm} Y_m + A_{mk} Y_k \tag{4}$$

$Y_m$ e $Y_k$ representan los ingresos totales tanto de las cuentas endógenas como de las exógenas y $A_{mm}$ es la matriz de propensiones medias al gasto de las cuentas endógenas, cuyos elementos son los coeficientes técnicos que se obtienen con la TIO. Ahora, se despeja $Y_m$ y queda la ecuación matricial así:

$$Y_m = (I - A_{mm})^{-1} \cdot A_{mk} \cdot Y_k \tag{5}$$

$$Y = M \cdot X_m \tag{6}$$

Donde $(I - A_{mm})^{-1}$ es llamada $M$ y es la matriz de multiplicadores lineales; esta matriz muestra el impacto que genera un aumento unitario en las cuentas exógenas sobre las rentas de cada una de las cuentas endógenas. En otras palabras, indica las

[10] Los subíndices A, F, P y C denotan las cuentas consideradas endógenas respectivamente.

cuentas que generan mayores efectos expansivos en los ingresos de la economía total. Por otro lado, se tiene a $A_{mk}.Y_k$ como $X_m$ y representa las inyecciones de ingreso emitidas por las cuentas exógenas y recibidas por las endógenas[11]. Cambios en la ecuación 6 permiten generar las simulaciones propuestas en esta investigación, como se podrá ver en el siguiente apartado.

Para el análisis planteado, se construyó una MCS para el País Vasco llamada SamEusk-2015, siguiendo a Cardenete (1998), Moniche y Cardenete (2001), Rodríguez, Cardenete y Llanes (2005) y Cardenete y Sancho (2006), con el fin de presentar un marco actualizado y completo, que incluya todas las transacciones económicas que se producen entre todos los agentes de la economía y las interrelaciones mutuas entre sus diferentes estructuras productivas, de distribución del ingreso y del consumo, que permitan cerrar el flujo circular de la renta.

Para esto, se tiene como principal fuente estadística el marco Input-Output de Euskadi para el año 2015 SEC 2010 (Eustat, 2020), partiendo de la tabla simétrica a precios básicos en miles de euros. Asimismo, se usó la Contabilidad Nacional de España del año 2015 SEC 2010 con las cuentas de renta de los hogares serie 2000-2017 en su enfoque institucional construidas por el INE (2019).

Para su elaboración se respetó la estructura de la TIO, teniendo 85 sectores productivos. Adicionalmente, se han incluido algunas cuentas para complementar la información aportada por la TIO, especialmente la relacionada con la estructura impositiva. Además de las actividades productivas, la SamEusk-2015 presenta dos cuentas para los factores productivos (trabajo y capital), dos cuentas para los sectores institucionales (hogares y Administración pública), una cuenta de ahorro/inversión, y los impuestos considerados (cotizaciones sociales de los empleadores, cotizaciones sociales de los empleados, impuestos netos sobre productos, IRPF) y el sector exterior[12].

La estructura de la MCS queda conformada por cuatro matrices, como se observa en el Cuadro nº 2. Las cuatro matrices mostradas resumen todo el comportamiento económico del País Vasco, a partir de las transacciones realizadas entre los sectores productivos y los sectores institucionales, donde las matrices de consumos intermedios, de factores primarios y de empleos finales deben cumplir la identidad contable que afirma que la producción bruta total es igual a la demanda total.

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[11] Para la modelización se utilizó el Software SimSipSam creado para el Banco Mundial por Parra y Wodon (2009). A partir de esta herramienta y la base teórica especificada anteriormente, es posible replicar las simulaciones realizadas en esta investigación.

[12] Se identificaron como cuentas endógenas las actividades productivas, los factores productivos y los hogares. Como cuentas exógenas se tienen la Administración pública, la cuenta de ahorro/inversión y el sector exterior.

*Cuadro nº 2.* **ESQUEMA DE LA SAMEUSK-2015**

| | Ramas homogéneas<br>(1…85) | Factores productivos<br>(86) Trabajo<br>(87) Capital | Sectores institucionales<br>(88) consumidores<br>(90) cotizaciones sociales de los empleadores<br>(91) impuestos netos sobre los productos<br>(92) IRPF<br>(93) Cotizaciones sociales a los empleados<br>(94) Gobierno | (89) Ahorro inversión | (95) Sector exterior |
|---|---|---|---|---|---|
| Ramas homogéneas<br>(1…85) | Matriz de consumos intermedios (I) | Matriz de empleos finales (III) | | | |
| Factores productivos<br>(86) Trabajo<br>(87) Capital<br>Sectores institucionales<br>(88) consumidores<br>(90) cotizaciones sociales de los empleadores<br>(91) impuestos netos sobre los productos<br>(92) IRPF<br>(93) Cotizaciones sociales a los empleados<br>(94) Gobierno<br>(89) Ahorro inversión<br>(95) Sector exterior | Matriz de factores primarios (II) | Matriz de cierre (IV) | | | |

*Fuente:* elaboración propia.

De esta manera, la matriz de consumos intermedios queda conformada a partir de las relaciones intersectoriales tomadas de la TIO del País Vasco, cuya suma de entradas da como resultado el consumo intermedio de la economía, registrando todas las transacciones de bienes y servicios intermedios entre las ramas homogéneas (cuentas 1-85).

La matriz de factores primarios incluye los recursos utilizados por cada sector productivo, cuya información fue obtenida y reestructurada a partir de los datos contables incorporados en la TIO del País Vasco, la cual incluye una desagregación impositiva que permite el posterior análisis del impacto de políticas fiscales.

En este caso, los factores productivos: trabajo (86) y capital (87), fueron obtenidos a partir de la remuneración de asalariados, el consumo de capital fijo y el excedente neto de explotación/rentas mixtas, respectivamente. Además, se desagregó la carga impositiva mediante las cotizaciones sociales a los empleadores (90), los impuestos netos sobre productos (91) y el IRPF (92); todos ellos obtenidos directamente de la TIO. Los impuestos netos sobre productos se obtuvieron a partir de la suma de los impuestos netos sobre los productos y otros impuestos netos sobre la producción.

Esta matriz se cierra con las importaciones (95), que incluyen las procedentes del resto del país, de la Unión Europea y del resto del mundo, tomadas de la TIO.

La tercera matriz corresponde a los empleos finales. Esta matriz incluye el gasto total de la economía doméstica incluida en la cuenta de consumidores (87), la cuenta ahorro/inversión (88) que representa la capacidad o necesidad de financiación de los sectores productivos, el Gobierno que recoge la actividad del sector público al ser un agente económico y las exportaciones realizadas al resto del Estado, a la Unión Europea y al resto del mundo. Como fuente estadística se usó la TIO del País Vasco, obteniendo los valores directamente de esta.

Finalmente, se tiene la matriz de cierre. A partir de esta se cierra el flujo circular de la renta, principal característica de una MCS. Dicha matriz comienza con la incorporación de información relacionada con el ingreso de los hogares y se conforma a partir de la remuneración de asalariados menos las cotizaciones sociales de los empleadores, la suma del excedente neto de explotación y el consumo de capital fijo, los cuales representan los ingresos recibidos por trabajo (celda (88,86)) y capital (celda (88,87)). De igual forma, incluye las transferencias procedentes del Gobierno (celda (88,94)) obtenidos a partir de la contabilidad regional de España. Posteriormente, se tienen las transferencias del resto del Estado, la Unión Europea y el resto del mundo (celda (88,95)), tomando los saldos de las compras de los no residentes en el territorio económico y de las compras de los residentes fuera del territorio económico.

*Cuadro nº 3.* **MCS PARA EL PAÍS VASCO AGREGADA, SAMEUSK-2015**

| | | 1-85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sectores productivos | L | K | C | S/I | Cotizacio-nes sociales | Impuestos netos sobre productos | IRPF | Cotizaciones sociales a los empleados | Gobierno | Sector exterior | Total |
| 1-85 | Sectores productivos | 70,628,395 | | | 36,199,729 | 14,942,514 | 0 | 0 | 0 | 0 | 11,388,350 | 42,225,933 | 175,384,921 |
| 86 | L | 25,320,359 | | | | | | | | | | | 25,320,359 |
| 87 | K | 28,753,950 | | | | | | | | | | | 28,753,950 |
| 88 | C | 0 | 25,320,359 | 28,753,950 | 0 | 0 | 0 | 0 | 0 | 0 | 11,914,984 | -6,433,174 | 59,556,119 |
| 89 | S/I | 0 | 0 | 0 | 17,013,220 | 0 | 0 | 0 | 0 | 0 | -7,856,308 | 5,785,602 | 14,942,514 |
| 90 | Cotizaciones sociales | 7,497,876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,497,876 |
| 91 | Impuestos netos sobre productos | 1,605,980 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,605,980 |
| 92 | IRPF | 0 | 0 | 0 | 5,109,739 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,109,739 |
| 93 | Cotizaciones sociales a los empleados | 0 | 0 | 0 | 1,233,431 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,233,431 |
| 94 | Gobierno | 0 | 0 | 0 | 0 | 0 | 7,497,876 | 1,605,980 | 5,109,739 | 1,233,431 | 0 | 0 | 15,447,026 |
| 95 | Sector exterior | 41,578,361 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 41,578,361 |
| | Total | 175,384,921 | 25,320,359 | 28,753,950 | 59,556,119 | 14,942,514 | 7,497,876 | 1,605,980 | 5,109,739 | 1,233,431 | 15,447,026 | 41,578,361 | |

*Fuente:* elaboración propia.

Por el lado del gasto, está el pago del IRPF (celda (92,88)) y las contribuciones sociales de los empleados (celda (93,88)), ambos obtenidos de la contabilidad regional de España a partir de las cuentas de rentas de los hogares. Para complementar el ingreso y gasto de los consumidores se tiene la cuenta que representa la capacidad de ahorro/inversión (celda (89,88)) obtenida como saldo del ajuste del ingreso y gasto, ya que se carece de información contable para identificar este rubro.

De manera similar, se incluye la información relacionada con el ingreso y el gasto del Gobierno. Desde el punto de vista de los ingresos, se identifica toda la recaudación de impuestos directos e indirectos generados y pagados por los sectores productivos y por los consumidores (celdas (94,90), (94,91), (94,92) y (94,93)). Por último, se usa como cuentas de cierre el valor de los déficits o superávits tanto del Gobierno (celda (89,94)) como del sector exterior (celda (89,95)), saldos obtenidos a partir de la información contable proporcionada por el INE.

En el Cuadro nº 3 se incluye la SamEusk-2015 de manera agregada, donde los ingresos son iguales a los gastos. A partir de esta es posible representar la economía del País Vasco, generando un instrumento de análisis económico.

## 3. ANÁLISIS DE IMPACTO

La realización del análisis de impacto requiere, como pasos previos, la actualización de la MCS del País Vasco para el año 2015 construida para este análisis, así como la estimación del montante económico del *shock* exógeno derivado de la inversión recogida en la Estrategia Energética de Euskadi 2030 (2016). A continuación, se detallan ambos aspectos, permitiendo así una mejor comprensión de los efectos económicos que se mostrarán en el siguiente apartado.

### 3.1. Actualización de la MCS del País Vasco al año 2019

Como se ha comentado, la base de datos estadística empleada para realizar el análisis propuesto es la MCS del País Vasco realizada a partir del MIO del año 2015 publicado en el Instituto Vasco de Estadística. Dicha MCS, además de ser construida, ha sido actualizada por los autores mediante la aplicación de métodos de actualización (método de entropía cruzada) sobre la MCS del País Vasco para el año 2015.

Tal y como se ha apuntado, la utilización de la MCS aporta mayor riqueza informativa que la TIO. Además, en este caso concreto, se ha decidido actualizar al año 2019 con los últimos datos macroeconómicos publicados por el Instituto Vasco de Estadística, para analizar el impacto de la Estrategia Energética de Euskadi en uno de los años que recoge su plan (2016-2030).

Además, con el objetivo de facilitar la lectura del análisis, se han agregado los sectores productivos pasando de 85 a 11 ramas de actividad. El Cuadro nº 4 muestra la estructura de cuentas de la MCS para el País Vasco: como puede observarse, la matriz consta de un total de 21 cuentas, 11 relativas a actividades económicas, 2 cuentas para los factores productivos, 1 cuenta para el consumo, 5 cuentas para los sectores institucionales, y 2 cuentas más para la inversión y el sector exterior. Los datos correspondientes a cada cuenta se contabilizan en miles de euros.



*Cuadro nº 4.* **ESTRUCTURA DE LA MCS PARA EL PAÍS VASCO 2019**

| | | | |
|---|---|---|---|
| 1 | Agricultura, ganadería y pesca | 12 | Trabajo |
| 2 | Industria | 13 | Capital |
| 3 | Energía eléctrica, gas, vapor y aire acondicionado | 14 | Consumo |
| 4 | Suministro de agua, saneamiento y gestión de residuos | 15 | Cotizaciones sociales |
| 5 | Construcción | 16 | Impuestos netos sobre productos |
| 6 | Comercio | 17 | IRPF |
| 7 | Transporte | 18 | Cotizaciones sociales a los empleados |
| 8 | Actividades postales y de correos | 19 | Gobierno |
| 9 | Investigación y desarrollo | 20 | Ahorro / Inversión |
| 10 | Administración pública | 21 | Sector exterior |
| 11 | Resto de Servicios | | |

*Fuente:* elaboración propia.

### 3.2. Estimación del shock exógeno de la inversión para la consecución de los objetivos energéticos planteados en la Estrategia energética de Euskadi 2030

Según la Estrategia energética de Euskadi 2030 del Departamento de Desarrollo Económico y Competitividad del Gobierno Vasco, para la consecución de los objetivos energéticos planteados se deben promover unas inversiones en el conjunto de sectores de 4.930 millones de euros en el período 2016-2030. Por áreas destacan las inversiones a realizar en los sectores consumidores (66%) y en nuevas instalaciones de generación eléctrica renovable (29%) (ver Cuadro nº 5).

Por tipología de inversiones, estas se concentran en eficiencia energética (45%) y aprovechamiento de recursos renovables (50%). De los 2.249 millones de euros de inversión en eficiencia energética en los sectores consumidores, el principal esfuerzo inversor es el de los servicios en su conjunto. La distribución de las inversiones sectoriales en eficiencia para el periodo se muestra en el Cuadro nº 6.

*Cuadro nº 5.* **MOVILIZACIÓN DE INVERSIONES POR ÁREAS 2016-2030**

(en millones de euros)

| Áreas | Movilización de inversiones |
|---|---|
| Sectores Consumidores (66%) | 3.254 |
| Generación energía renovable (29%) | 1.430 |
| Investigación (5%) | 247 |
| Inversiones totales 2016-2030 | 4.930 |

*Fuente:* elaboración propia a partir de la Estrategia Energética de Euskadi (2016).

*Cuadro nº 6.* **DISTRIBUCIÓN DE INVERSIONES SECTORIALES EN EFICIENCIA Y RENOVABLES 2016 – 2030**

(en millones de euros)

| Sectores | Distribución de inversiones sectoriales | | Total |
|---|---|---|---|
| | Sectorial eficiencia | Sectorial renovables | |
| Primario | 9 | 0 | 9 |
| Industria | 291 | 60 | 351 |
| Residencial | 739 | 230 | 969 |
| Transporte | 358 | 0 | 358 |
| Edificios Administración | 448 | 220 | 668 |
| Servicios privados | 403 | 490 | 893 |
| | 2.249 | 1.000 | 3.249 |

*Fuente:* elaboración propia a partir de la Estrategia Energética de Euskadi (2016).

Por otra parte, y para completar las inversiones, las de generación de energía eléctrica renovable conectada a red supondrían alrededor de 1.440 millones de euros, en gran medida debido a la incorporación de nuevas instalaciones eólicas e instalaciones de biomasa y solar, y las de I+D por importe de 246,5 millones de euros.

Una vez presentadas las inversiones, seguidamente se presenta el destino a cada cuenta de la MCS del País Vasco del montante económico del total de la inversión. Para ello, y como consecuencia de que la MCS recoge los flujos económicos de un solo año, se ha realizado una división lineal de las inversiones en cada uno de los años (ver Cuadro nº 7), asignando a cada uno un montante de 311,6 millones de euros[13].

*Cuadro nº 7.* **DISTRIBUCIÓN DE LAS INVERSIONES POR RAMAS DE ACTIVIDAD DE LA MCS DEL PAÍS VASCO 2019**

(en millones de euros)

| | Ramas de Actividad | 2016-2030 | 2019 |
|---|---|---|---|
| 1 | Agricultura, ganadería y pesca | 8,96 | 0,6 |
| 2 | Industria | 351,2 | 23,4 |
| 3 | Energía eléctrica, gas, vapor y aire acondicionado | 1440 | 78,7 |
| 4 | Suministro de agua, saneamiento y gestión de residuos | 0 | 0,0 |
| 5 | Construcción | 969,2 | 64,6 |
| 6 | Comercio | 0 | 0,0 |
| 7 | Transporte | 358,4 | 23,9 |
| 8 | Actividades postales y de correos | 0 | 0,0 |
| 9 | Investigación y desarrollo | 246,5 | 16,4 |
| 10 | Administración pública | 668 | 44,5 |
| 11 | Resto de Servicios | 893,2 | 59,5 |
| | TOTAL | 4.935,6 | 311.6 |

*Fuente:* elaboración propia.

## 4. RESULTADOS

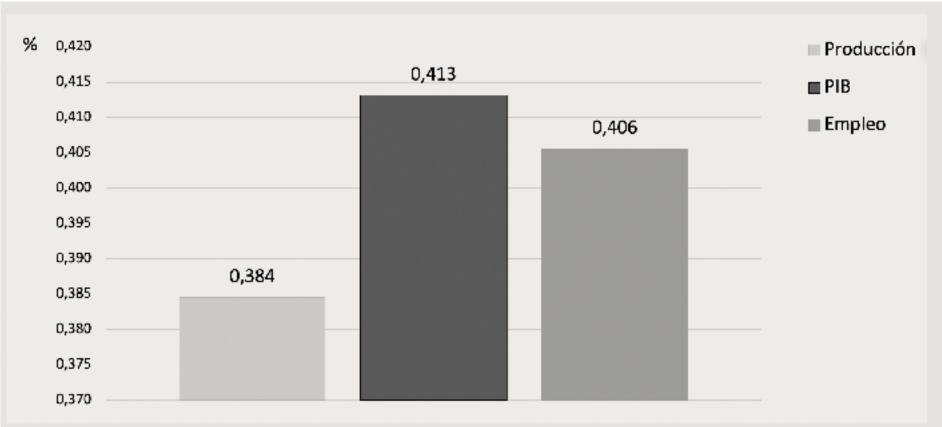
Ya estimado el montante del *shock* de demanda y las actividades económicas donde dicho *shock* se produciría, se procede a estudiar la incidencia que tendrían las inversiones programadas en la Estrategia Energética de Euskadi sobre el conjunto de la economía vasca en términos de producción, PIB y empleo. Para ello, se recurre a la MCS del País Vasco que refleja las interrelaciones entre los sectores productivos y la demanda final para la economía de la región durante el año 2019. A continuación, en el Gráfico nº 1 se muestran los cambios producidos sobre la producción total, el

[13] Debido a la falta de datos para poder asignar el importe de la inversión total a cada año objeto de estudio, se decide realizar un reparto lineal en los 15 años del periodo de la estrategia.

PIB y el empleo derivados del impacto que sobre la economía del País Vasco tendrá la inclusión del valor monetario de la demanda estimada asociada al conjunto de inversiones recogidas en la Estrategia Energética de Euskadi.

*Gráfico nº 1.* **CAMBIOS EN LA PRODUCCIÓN TOTAL, EN EL PIB Y EN EL EMPLEO EN EL PAÍS VASCO EN EL AÑO 2019**

(porcentaje)




*Fuente:* elaboración propia.

Como puede observarse, el impacto de las inversiones es ligeramente superior en el agregado del PIB, en comparación con el agregado de la producción total y el empleo; la consecución de las inversiones tendría unos efectos positivos tanto sobre la producción total como sobre el PIB regional y el empleo. Así, las inversiones para el año 2019[14] se traducen en un aumento medio anual de la economía del 0,384% medido en términos de producción total, mientras que en términos del PIB será del 0,413% y de empleo del 0,406%. Por tanto, en el caso de valorar las inversiones referentes al periodo total de la Estrategia Energética de Euskadi, la incidencia en la producción de la economía del periodo 2016-2030 sería del 5,8%, del 6,2% para el PIB y del 6,09% en el caso del empleo.

En términos de montante económico, el *shock* de demanda derivado de la inversión se traduciría en un incremento anual de la producción vasca y del PIB de 850,64 millones de euros y 330 millones de euros respectivamente, y en la generación de 3.696 puestos de trabajos equivalentes anuales. Por ramas de actividad (Gráfico nº 2), *el shock* de demanda genera un mayor cambio en los sectores, donde directamente recae la inversión, como es el de energía eléctrica, gas, vapor y aire

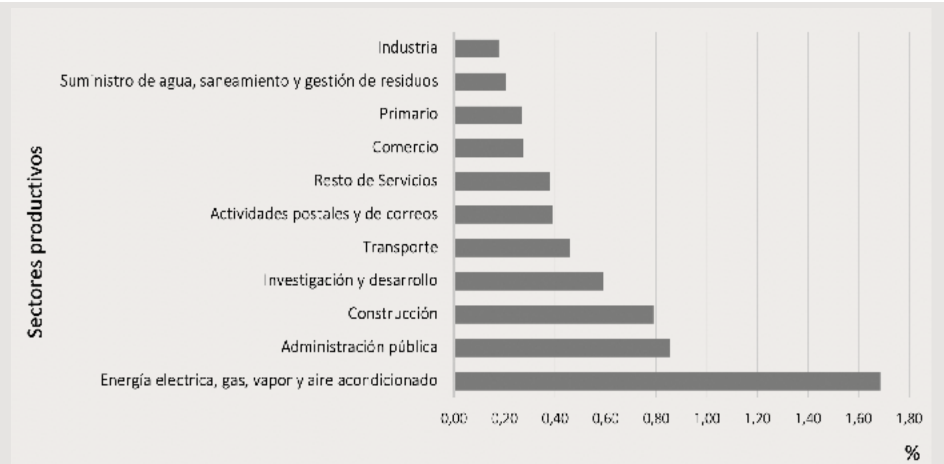
[14] Las inversiones para el año 2019 son iguales a las inversiones totales previstas divididas por 15 años.

acondicionado, con variaciones superiores al conjunto regional, concretamente de 1,69%. Le siguen en importancia las ramas de Administración pública (0,85%) y construcción (0,79%), ambas con un incremento ligeramente superior a la media regional. Las ramas que menos impacto recogen son las del sector primario, suministro de agua, saneamiento y gestión de residuos y la rama de industria, todas ellas con incrementos de producción inferiores a la media.



*Gráfico nº 2.* **CAMBIOS EN LA PRODUCCIÓN TOTAL POR RAMAS DE ACTIVIDAD EN EL AÑO 2019**

(porcentaje)




*Fuente:* elaboración propia.

## 5. CONCLUSIONES

El objetivo de este trabajo de investigación es analizar qué impacto económico tienen las inversiones definidas en la hoja de ruta de la Estrategia Energética de Euskadi 2030 para alcanzar los objetivos marcados.

Mediante el empleo de un modelo económico multisectorial, construido a partir de la MCS de la economía del País Vasco para el año 2019 (realizada exclusivamente para este trabajo de investigación), se ha estimado el impacto sobre la producción total, el PIB y el empleo de la región que tiene la inyección en la economía de la inversión recogida en la Estrategia Energética. Esta metodología resulta novedosa para analizar el impacto, ya que nunca se ha llevado a cabo un análisis de este tipo para el impacto de políticas energéticas en la región vasca.

Tal y como apuntan los resultados, las inversiones tienen una repercusión positiva en todas las ramas de actividad de la economía, siendo especialmente destacables las ramas de energía eléctrica, gas, vapor y aire acondicionado, con variaciones superiores al conjunto regional, concretamente de 1,69%. Le siguen en importancia las ramas de Administración pública (0,85%) y construcción (0,79%), ambas con un incremento ligeramente superior a la media regional. Las ramas que menos impacto recogen son las del sector primario, suministro de agua, saneamiento y gestión de residuos y la rama de industria, todas ellas con incrementos de producción inferiores a la media.

De lo anterior cabe concluir que la ejecución de la inversión en la Estrategia Energética de Euskadi 2030, ejerce un impacto positivo y relevante sobre la actividad económica de la región que puede cuantificarse en más del doble de la misma (2,7 veces más[15]), derivado de su actividad, que afecta a los diferentes sectores de la economía, ya sea de manera directa, indirecta o inducida. Por tanto, se podría decir que invertir en transición energética no solo es positivo en términos de mejora medioambiental sino también en términos de mejora económica regional.

Como línea de investigación futura, se podría ampliar el estudio realizado en este artículo con un modelo de equilibrio general aplicado (MEGA). Los modelos de multiplicadores lineales utilizados para este análisis están basados en la teoría de Leontief (antecedente de los MEGA) y cuentan con ciertas limitaciones fundamentadas en la estructura de coeficientes fijos que presentan (y por tanto implican economías lineales en costes y precios fijos). Esta cuestión quedaría resuelta usando un MEGA, con el que se podría conocer el impacto específico en cada año de la estrategia energética.

[15] Ratio del importe total de la inversión sobre el impacto en producción total de la economía vasca.

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# *Smart specialisation strategies and energy transition: An exploratory analysis of the case of the Basque Country**

**Energy transition is a core element of the sustainability transition around which the European Union's post-COVID recovery strategies are built. While these strategies are being designed primarily by EU Member States, the regional level will be critical for their success. Firstly, because regions are key 'implementers on-the ground' of European and national policies. Secondly, because the place-specificities of regions make them ideal 'laboratories' for experimenting with the innovations needed for sustainability transitions. This opens an important research question around how regional innovation policy, and more precisely how the regional smart specialisation strategies (S3) that have been developed over recent years, could provide a 'ready-made' framework for discovery and experimentation oriented explicitly to energy transitions. This paper explores this question by combining discussion of the concepts of S3 and energy transitions with an exploratory analysis of the S3 experience in the specific case of the Basque region. The paper highlights that moving from a S3 to a Sustainable S3 (or S4) will require enhancing the connectedness of different parts of existing strategies so that energy transition goals are approached in a holistic manner.**

La transición energética es un elemento clave en la transición a la sostenibilidad en torno a la cual se están creando las estrategias de recuperación pos-COVID en la Unión Europea. Aunque dichas estrategias son diseñadas fundamentalmente por los estados miembros de la UE, el ámbito regional puede ser crítico para el éxito de las mismas. En primer lugar, porque las regiones son «actores clave sobre el terreno» de las políticas nacionales y europeas. Segundo, porque las características de cada región las convierten en 'laboratorios' ideales para experimentar con las innovaciones necesarias para la transición hacia la sostenibilidad. Esto plantea una importante cuestión de investigación sobre cómo las políticas regionales de innovación y, más concretamente, cómo las estrategias regionales de especialización inteligente (S3) que han sido desarrolladas en los últimos años, podrían aportar un marco 'ready-made' para la experimentación y el descubrimiento orientados explícitamente a transiciones energéticas. Este artículo analiza esta cuestión combinando el debate sobre los conceptos de S3 y transiciones energéticas, con un análisis exploratorio de la experiencia S3 en el caso específico de la región vasca. El artículo pone de manifiesto que pasar de un S3 a un S3 sostenible (o S4) exigirá la mejora de la conexión entre diferentes partes de las estrategias existentes para que las metas de la transición energética se aborden de manera holística.

*Trantsizio energetikoa funtsezko elementua da Europar Batasunean COVID osteko berreskuratze-estrategiak sortzen ari diren iraunkortasunerako trantsizioan. Estrategia horiek, funtsean, EBko estatu kideek diseinatzen dituzte, baina eskualde-eremua erabakigarria izan daiteke estrategia horiek arrakasta izan dezaten. Lehenik eta behin, eskualdeak politika nazionalen eta europarren «eragile giltzarriak» direlako. Bigarrenik, eskualde bakoitzaren ezaugarriek jasangarritasunerako trantsizioa egiteko beharrezkoak diren berrikuntzekin esperimentatzeko 'laborategi' idealak bihurtzen dituztelako. Horrek ikerketa-gai garrantzitsu bat planteatzen du: berrikuntzako eskualde-politikek eta, zehazkiago, azken urteotan garatu diren espezializazio adimenduneko eskualde-estrategiek (S3) esperimentaziorako eta aurkikuntzarako 'ready-made' esparru bat ekar lezaketela, esplizituki trantsizio energetikoetara bideratuta. Artikulu honek gai hori aztertzen du S3 eta trantsizio energetikoen kontzeptuei buruzko eztabaida eta S3 esperientziaren analisi arakatzailea konbinatuz EAEren kasu espezifikoan. Artikuluak agerian uzten du S3 batetik S3 jasangarri (edo S4) batera pasatzeak dauden estrategien zatien arteko lotura hobetzea eskatuko duela, trantsizio energetikoaren xedeak modu holistikoan landu daitezen.*

* Spanish version available at https:/euskadi.eus/ekonomiaz.

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**Keywords**: smart specialisation strategies, energy transition, sustainability, regional innovation policy.

**Palabras clave:** estrategias de especialización inteligente, transición energética, sostenibilidad, política regional de innovación.

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## 1. INTRODUCTION

Transition towards more sustainable economies and societies is a challenge that is common to all countries and regions, and today forms the lynchpin of the recovery and growth strategies that are being developed for a post-COVID world. Indeed, a central element of the European Commission's Next Generation EU recovery programme is to convert the *European Green Deal* that was published in 2019 into an EU growth strategy that will both 'repair' and 'prepare' for the next generation (European Commission, 2020a). We can therefore expect a large injection of funds and a range of radical measures oriented to promoting a sustainable transition over the coming years. Energy transitions are a pivotal ingredient in sustainability transitions due to both the impact of energy generation and use on $CO_2$ emissions and the fact that energy usage permeates all parts of the economy. From a policy perspective, therefore, there are important questions around how best to foster transitions in the energy systems that underlie our socioeconomic activity. Moreover, there is an emerging focus on the spatial dimension of energy transitions (and sustainability transitions more broadly) (Coenen *et al.*, 2015; Hansen and Coenen, 2015; Chlebna and Mattes, 2020), suggesting that regions have a particularly important role to play in policy implementation.

This opens an interesting research agenda with regards to how the regional role in energy transitions can be effectively articulated. Given that innovation and experimentation are at the heart of energy transitions there is a natural link with regional innovation policy, which in recent years has been heavily influenced in Europe through the design and implementation of smart specialisation policies (S3) (Foray, 2015; Foray *et al.*, 2009; Hassink and Gong, 2019). How then can these S3, which have now been evolving for several years in regions across Europe, be leveraged to support energy transition at the regional level?

The aim of this paper is to explore that question by combining discussion of the concepts of S3 and energy transitions with insights on the S3 experience in a specific case. The Basque Country region, in the north of Spain, is an industrial region with an important energy sector. Moreover, it has explicitly developed an S3 since 2014, and has included energy as one of the core prioritised activities. Reflecting on how the S3 has been articulated, particularly with respect to the energy priority, aims to shed light on some of the benefits and stumbling blocks involved in leveraging existing S3 processes as a basis from which to accelerate regional energy transitions, and indeed sustainability transitions more generally. The case study has been built from analysis of a range of policy documents and semi-structured interviews with representatives of organisations involved in the Basque S3 from 2016 onwards.

The paper is structured as follows. Section 2 discusses the concepts of smart specialisation strategies and energy transition. Section 3 then zooms in on the concept of energy transition in its international, Spanish and Basque context. Section 4 explores the case of the Basque Country S3 and its relation to energy transition, and Section 5 draws conclusions.

## 2. SMART SPECIALISATION FOR SUSTAINABILITY TRANSITIONS

### 2.1. Smart specialisation strategies (S3)

The emergence and development of smart specialisation strategies (S3) in Europe is part of a progressive booming of interest in territorial strategy-making over the last two decades that brings together several streams of academic and policy analysis (Valdaliso and Wilson, 2015). Firstly, there has been a well-acknowledged geographical turn in the analysis of economic development in general, which has been rooted especially in an increasingly nuanced understanding of the importance of place as a context for innovation, and for innovation policies (Asheim and Gertler, 2005; Barca *et al.*, 2012; Cooke and Morgan, 1998; Shearmur *et al.*, 2016). This focus on the geography of innovation has intersected with analysis of the structural transformation of economies over time – via emerging economic complexity (Hidalgo and Hausmann, 2009) or related and unrelated variety (Boschma and

Frenken, 2011; Frenken *et al*., 2007) – and with proposals for new forms of industrial policy to provide a strategic impetus to economic development (Rodrik, 2004; Bailey *et al*., 2015). Finally, concern with a strategic approach to territorial development is also reflected in burgeoning recent analysis of the need for innovation to respond to societal challenges, including that of ensuring environmental sustainability (Breznitz *et al*., 2018; Kuhlman and Rip, 2018; Mazzucato, 2017).

In the context of these various debates, the concept of S3 has emerged and evolved in the European context as a practical approach to providing strategic direction to regional innovation policies. Initially prompted by the work of the European Commission's *Knowledge for Growth Expert Group* (Foray *et al*., 2009), the idea that every region in Europe should develop an S3 was subsequently promoted through an *ex-ante* conditionality for access to innovation funding under the European Regional Development Fund (ERDF) during the period 2014-2020. This led to regions across Europe embarking on a journey of experimentation with designing and implementing S3.

S3 require regions to prioritise their research and innovation investments to facilitate the structural transformation of their economies. In this sense, Foray (2015, p. 25) notes that smart specialisation «is a new word to describe an old phenomenon: the capacity of an economic system (a region for example) to generate new specialties through the discovery of new domains of opportunity and the local concentration and agglomeration of resources and competences in these domains». Rather than being determined 'top-down' by government, this process of structural transformation should emerge through a 'bottom-up' discovery process that draws on the collective intelligence of businesses, universities, government bodies and other key territorial actors.

S3 therefore require a significant paradigm shift in innovation policy, most notably from a planning logic to a process logic, which in turn requires new forms of governance and distributed leadership among a wide cast of actors (Aranguren *et al*., 2017). Indeed, in this sense Morgan (2017, p. 569) has described the S3 experiment as «the most ambitious regional innovation programme ever to be launched in the European Union». The scale of ambition is reflected in emerging literature analyzing the early experiences of regions with regards such a challenging process (for example, Aranguren *et al.,* 2019a; Capello and Kroll, 2016; Cvijanovic *et al*., 2020; Trippl *et al*., 2019). It is also reflected in the recent debate sparked by Hassink and Gong's (2019) framing of 'six critical questions' identified in academic analysis of the S3 experience (Benner, 2020; Foray, 2019, 2020; Hassink and Gong, 2019).

The Covid-19 pandemic that began in 2020, together with the advent of a new European funding programming period in 2021, mark an inflection point for S3, particularly given the firming of consensus around the need to embark on more radical transition towards sustainable forms of economic development. While regions across Europe will continue to develop and evolve their S3, supported by ongoing commitment to this framework from the European Commission, the scenario in which they do so is changing.

In particular, the crisis (and post-crisis) scenario raises new challenges in terms of positioning regional strategies alongside the strategies being developed at other administrative levels. On the one hand, the large 'missions' associated with resisting the health crisis and with the transitions required for long-term recovery from associated socio-economic crises require certain scale, at national and European levels. On the other hand, they also require on-the-ground implementation. Thus, while the leadership of the *Next Generation EU* recovery strategies rests largely with EU Member States and the European Commission, the effectiveness of these strategies will rely on implementation at the regional, city and local levels, and in turn on their fit with strategic thinking at these levels. This implies a pivotal role for regional S3 as bridging these dynamics, in which they will need to ensure a delicate balance in acting strategically in a regional context while also engaging in national & EU strategic initiatives that need to be implemented locally.

More generally, S3 will also need to evolve to reflect the societal challenges associated with the need for accelerating ongoing green, digital and social transitions that have wide and deep implications for European industry. These transitions predate the COVID-19 pandemic and are well-reflected for example in the *European Green Deal* (European Commission, 2019), the *New Industrial Strategy for Europe* (European Commission, 2020b) and the *2030 Agenda for Sustainable Development* (United Nations, 2015), among others. Most recently, the European Commission's first *Strategic Foresight Report* (European Commission, 2020c) sets out four dimensions of resilience – socioeconomic, green, digital and geopolitical – as the new compass for policies to guide Europe's recovery. At the heart of these four inter-related dimensions is the capacity of European industry to adapt and transform itself.

While one of the weaknesses of the S3 process to date has been the lack of real integration of societal challenges and/or civil society actors, these transformations will require cooperation across a wide range of actors in precisely the way that S3 were envisaged to foster. In particular, it is widely acknowledged that the transition towards a more environmentally sustainable economy and society will need to permeate regional S3 to leverage cooperation between business, education-research, government and civil society explicitly towards required technological, organisational and societal solutions.

### 2.2. **Sustainability transitions and the European Green Deal**

The *European Green Deal*, launched at the end of 2019, was expected from its inception to become a key pillar of future economic development strategies and policies, together with the *New Industrial Strategy for Europe* that was published a few months later. The green deal has as a main objective to «transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use» (European Commission, 2019, p.2). This is a highly ambitious goal as many interconnected socioeconomic systems within the European economy are currently heavily resource-dependent and carry a large environmental footprint. Thus, a transition capable of delivering that objective requires several complex system transitions that need to be accomplished simultaneously; what have been analysed in the literature as sustainability transitions.

While this strategy was launched before the COVID-19 pandemic fundamentally altered the socioeconomic landscape in Europe, sustainability transitions have since become even more relevant in academic and public debates amidst a sense that the pandemic offers opportunities for 're-setting' certain economic and social trajectories. Indeed, the European Commission has positioned green and digital transitions at the forefront of the *Next Generation EU* recovery strategy. This implies that an enormous amount of European funds projected for the period 2021-2024 will be directed towards these path shifts.

The *European Green Deal* considers several elements and areas for action, most notably sustainable energy, circular economy, clean transport, biodiversity, food and agriculture, and green finance and industry. Acknowledging the relevance of all of these interconnected areas, we can highlight three principal transitions that offer the most potential for large scale savings in $CO_2$ emissions: mobility transition, energy transition and agro-food transition (EEA, 2019). Moreover, digital transition could also be considered as enabling transition that is intimately related with each of these.

Sustainability transitions literature has focused during the last decades on conceptualising and analysing the transformation processes of industries, systems and societies towards more sustainable modes of production and consumption. Indeed, sustainability transition scholars argue that changes in socio-technical systems in both the production and consumption systems are needed at the same time in order to break existing pathways (Geels, 2002). These transformative changes are not only technological in nature but also behavioural and social (Schot and Steinmuller, 2018). Therefore, innovation policy under this paradigm should not seek only for more technological innovation *per se* but a combination of technological and social innovation that has a clear directionality in terms of moving towards more sustainable ways of doing things.

This directionality reveals itself in several characteristics that can be seen to define sustainability transitions (Köhler et al., 2017). Firstly, transitions are long-term processes, not only because radical innovations need time to be developed but also because they need time to be diffused and accompanied by other less radical and/or social innovations so they can substitute previous established paradigms. One example of this could be the electric vehicle as opposed to those powered by an internal combustion engine. Related to this time dimension, a second key element is the multi-dimensionality of sustainable transitions, because socio-technological systems are composed of multiple and diverse elements that inter-connect with one another: technologies, markets, industries, infrastructures, policy, user practices, etc. Moreover, this inherent multi-dimensionality implies that multiple types of actors are both protagonists and affected by transitions. This leads to a third key characteristic, the contested nature of sustainability transitions given that not all actors have the same position towards change. Indeed, following Wanzenböck *et al.* (2019) such contestation is characteristic of complex and uncertain problems where the solution is in multiple hands. It implies that multi-scalar frameworks, where different actors are involved in both problem definition and solution, are useful approaches to conceptualise sustainability transitions such as energy transition.

In this context of long-term, multi-dimensional and contested processes, it is important to acknowledge the relevance of experimentation within transitions (Schot and Geels, 2008), which forms the basis for new innovations to arise from specific niches, some of which can subsequently be scaled-up. These experimentation processes are more likely to arise in local environments where small initiatives comprising a full range of different actors can not only emerge but can also be applied and tested. However, the literature on sustainability transitions has been rather silent about the specific role of regions and the importance of regional context for innovation (Coenen *et al.*, 2015).

Hansen and Coenen (2015) bring together insights on the importance of place for sustainability transitions, highlighting the relevance of localised policies, institutions, resource endowments, technological and industrial specialisations, and market dynamics. In this regard, there are now more voices that plead for a place-based approach for implementing the European Green Deal (McCann and Soete, 2020; Larosse *et al.*, 2020) or a particular role for regions in the pandemic recovery (CoR, 2020). Indeed, two sets of reasons stand out for considering regions as relevant administrative units for fostering the transformations required to move towards the Green Deal objectives. Firstly, every region faces a different context, in terms of its natural resources, industrial structure, consumption patterns and environmental problems. For that reason, they are natural spaces for experimenting with transitions. Secondly, regions control many of the assets, capabilities and policy levers that the Green Deal requires for its effective implementation.

In summary, the *European Green Deal* can be considered as a ‘mission’ in terms of its scale, but one that encapsulates significant territorial diversity in both problems and solutions. It can only be achieved, therefore, by articulating a ‘bottom up’ regional implementation (McCann and Soete, 2020). As discussed above, smart specialisation strategies (S3) incorporate some of the needed ingredients for such a regional articulation of the Green Deal as a transition. In particular, S3 share a transformative aim and rely on a governance model (or entrepreneurial discovery process) that it is multi-actor and that favours experimentation. In addition, multiregional collaboration in the S3 sphere has been strengthened in recent years through the European Commission's *Smart Specialisation Thematic Platforms*.

These key characteristics of S3 suggest that they are a valuable vehicle for the regional articulation of sustainability transitions, implying that they could make an explicit leap from S3 to S4 (Sustainable Smart Specialisation Strategies).[1] In the remainder of the article we seek to explore this possibility through the analysis of one of the principle sustainability transitions – the energy transition – in the specific context of the Basque Country.

## 3. ENERGY TRANSITION IN THE CONTEXT OF THE BASQUE COUNTRY

### 3.1. Energy transition: Concept and principles

Energy transition as a core sustainability transition refers to the shift towards zero net emissions. In a broad sense, energy transition can be defined as the period and process needed to transition from one energy model to another, characterized by: (1) a drastic reduction in greenhouse gas emissions; (2) a greater penetration of renewable energy sources, in both the fields of primary energy and final energy, and especially in the generation of electric energy; and (3) a strong reduction in energy consumption by reducing energy intensity and improving energy efficiency in all processes of energy use and in all its forms (Club Español de la Energía, 2020).

Due to the omnipresence of energy in all economies, this process of changing the energy model requires profound changes across all economic sectors. Moreover, it requires changes on both the production and the consumption sides, as well as in the development of new technologies and in the promotion of organisational changes, for example towards a circular economy. Energy transitions are highly complex, therefore, and so difficult to characterize and to predict their evolution. Nevertheless, Blazquez *et. al* (2020) have developed a framework, based on four key propositions, that is oriented to provide some general guidelines on energy transitions for policymakers, companies and investors.

A first principle of Blazquez *et al.*'s (2020) framework is that current energy transition is driven by policies and not only by technology improvements, which differs from previous energy transitions. As the policies implemented vary between countries, two identical countries can achieve the same level of decarbonization with a different energy mix, a different level of energy supplied, and a different level of prices. A second principle is that energy transition disrupts liberalized electricity markets and undermines their economic foundation. Liberalized electricity markets are being disrupted by renewable technologies that changes their rules, so markets need to be redesigned to efficiently integrate these renewable technologies, which

[1] The suggestion of a transition from S3 to S4 was made by Mikel Landabaso in February 2020 in an opinion article for the European Commission's Joint Research Centre in Seville.

have lower marginal costs but are less predictable and not dispatchable on demand. A third principle is that given current technologies and technological perspectives, the transition to renewable sources is going to be incomplete. However, an incomplete transition to renewables does not necessarily imply a high level of carbon emissions as technologies to capture and store $CO_2$ can eliminate most of the negative externalities from fossil fuels. Finally, a fourth principle refers to the fact that there is a change in consumer preferences for cleaner energy, which generates demand for business models that move from 'energy only' (based on lowest price) towards 'energy services' (integrating other facets).

Building on the earlier discussion of the place specificities of sustainability transitions, there are also important principles of energy transitions related to their place-based economic, social and institutional dynamics. Indeed, Chlebna and Mattes (2020) explore the fragility of regional energy transitions, which they argue are «determined by the interaction and interdependency between actors, institutions and technologies» (p. 76). While the inherent fragility of regional energy transitions stems from complex endogenous dynamics that vary in different phases of the transition, their analysis highlights that «it is the region's embeddedness in development dynamics on multiple scales, which makes it particularly susceptible to fragility» (p. 76). With this in mind, we now turn to situate the Basque energy transition context within the broader Spanish, European and international contexts.

### 3.2. **Targets of energy transitions in European, Spanish and Basque contexts**

In the international arena multilateral agreements are key elements to alleviate climate change because, while being a global problem that affects all countries on the planet, its solution is channelled through the actions of individual countries. In 2015 the United Nations approved 17 Sustainable Development Goals under its Agenda 2030 (United Nations, 201). No other branch of activity is as present as energy in this strategy to overcome the great challenges that the planet faces to ensure its sustainability. Goal 7 is focused specifically on affordable and clean energy, and energy is also instrumental in several other goals, most notably goals 9 (industry, innovation and infrastructure), 11 (sustainable cities and communities), 12 (responsible consumption and production) and 13 (climate action). Also in 2015, at the United Nations 21st Conference of the Parties (COP) in Paris, 195 countries reached a long-term multilateral commitment to limit the increase in the planet's temperature by below 2ºC, and preferably by 1.5ºC, compared to pre-industrial levels. That same meeting underlined the importance of the involvement of civil society and companies, alongside governments, in the pursuit of the required reductions in greenhouse gas emissions. Finally, at the 2019 climate summit in New York 77 countries pledged to reduce their $CO_2$ emissions to zero by 2050.

The European Union has long been a pioneering world region with regards to the energy transition that is pivotal for meeting these international climate agreements. Indeed, following the signing of the Kyoto Protocol in 1997, the Green Package for Integrated Energy and Climate Policies (2007), Winter Package for 2030 (2016), and 2050 long-term strategy to be climate-neutral (2018) have marked commitment and global leadership in the energy transition. The 2020 European Green Deal goes further still, and clearly positions environmental sustainability as a strategy for economic growth and increased competitiveness. Specific objectives that have been set along the way include:

- 40% reduction in $CO_2$ emissions from 1990 to 2030 (2014 European Council), increased to 50-55% in the European Green Deal;
- 30% renewable energy in final energy by 2030 (2018 European Council and Parliament);
- 32.5% improvement in energy efficiency by 2030 (compared to 1990) (2018 European Council and Parliament);
- Other measures of electricity market design, self-consumption, security of electricity supply, governance and actions to help coal-intensive regions (2018 European Council and Parliament);
- Achieving net-zero emissions by 2050 (2018 EU long-term strategy); and
- Conversion of the European Investment Bank into a Climate Bank and creation of a Just Transition Fund to help the groups or sectors most negatively affected by the transition (2020 European Investment Bank, Climate Bank Roadmap).

Moreover, under the European Green Deal, a new European Climate Law is in process of being developed to enshrine the 2050 climate-neutrality objective into EU law.

The Spanish energy transition is evolving under this global and European context. By early 2019 the 28 EU member states had sent the European Commission first drafts of their 'Integrated National Energy and Climate Plans'. The Spanish plan (Ministerio para la Transición Energética y Reto Demográfico, 2020) places its objectives among the most ambitious in terms of renewables and energy efficiency. Among these national objectives are:

- Reduce greenhouse gas emissions by 23% by 2030 and to zero by 2050;
- Double the share of renewables in the final energy mix to 42% by 2030, and achieve a 100% renewable electricity system by 2050;
- 39.5% improvement in energy efficiency by 2030; and
- Penetration of 5 million electric vehicles and that by 2040 passenger cars and commercial vehicles will be zero emissions.

Beyond the objectives set in government-led policies and strategies, the actions and strategies of business, research, education, civil society and a range of other actors all become highly relevant for implementation of energy transitions. Moreover, as argued in the previous section the required innovation and experimentation processes are situated above all in the regional, urban and local spheres.

Turning to the Basque Country, therefore, the long term vision of the current Basque Energy Strategy 2030 (EVE, 2017) is the «progressive evolution of the Basque socioeconomic model, especially in relation to industry, buildings and transport, towards a new model of lower energy consumption, with progressive incorporation of renewable energy, and with electrical energy as the main energy vector». The long-term objectives for the period 2016-2030 are specifically:

- Zero oil consumption for energy uses in 2050, which requires a structural change in the transport system;
- Reduction of greenhouse gas emissions in the Basque Country by at least 40% by 2030 and by at least 80% by 2050, with respect to 2005; and
- 40% renewable energy in consumption by 2050.

In the context of the more demanding conditions that will characterise the new European Climate Law, however, this vision is considered outdated and the Basque Government is currently working on a new Law on Energy Transition and Climate Change for 2022.

## 4. BASQUE S3 AND ENERGY TRANSITION

In the context of the principles and strategies set out in the previous section, it is widely acknowledged within the Basque Country that the great challenge related to the energy transition over the next 10 years is to achieve a significant reduction in emissions in sectors in which little progress has thus far been made, such as transport and industry. Due to the weight and importance of industry in the region, which accounts for around 20% of GDP, industrial transformation will require significant innovation (in fuels, processes, technologies, use of equipment, data, etc.). In this section we explore the mechanics and evolution of the Basque Country's smart specialisation strategy (S3) as a lever for fostering this energy transition in the industrial sphere. The analysis has been informed by a range of policy documents and semi-structured interviews with representatives of organisations involved in the Basque RIS3 from 2016 onwards (see Aranguren *et al.*, 2016 and 2019b for more details).

### 4.1. Basque Smart Specialisation Strategy (S3)

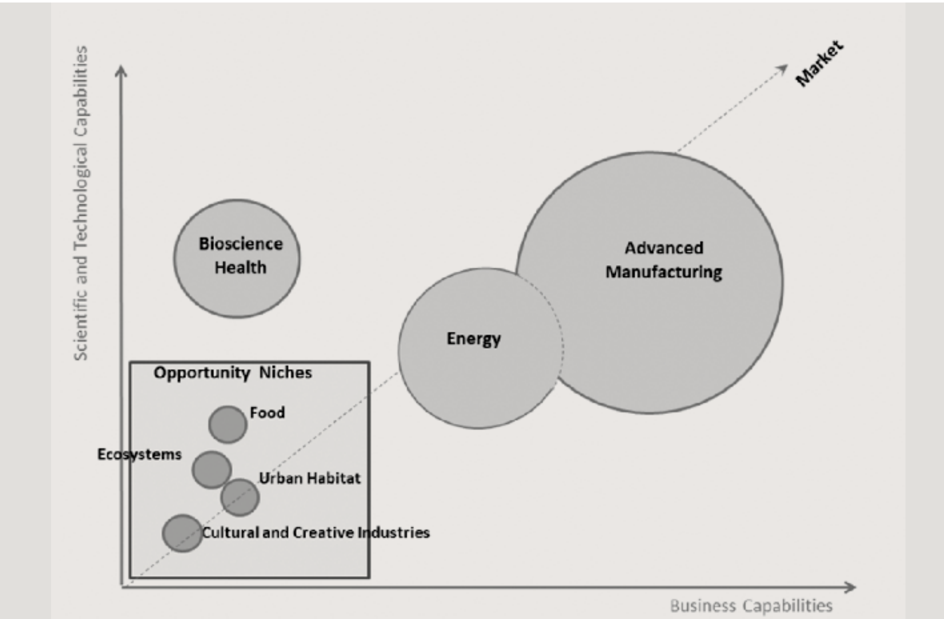
The Basque S3 to date has been formally embodied in the *2020 Science Technology and Innovation Plan (STIP)*, which was published in 2014 (Basque Government, 2014)[2]. Informally, however the S3 has antecedents that significantly pre-date this plan, and it is important to conceive of the strategy within this bigger picture. In this regard, Valdaliso (2015) provides a detailed analysis of the evolution of Basque competitiveness strategy over the last four decades, in which three distinct phases

[2] In February 2021 the new Basque Science, Technology and Innovation Plan (PCTI2030) was officially launched as an evolution of the S3 strategy implemented between 2014 and 2020.

can be highlighted. Following the statute of autonomy in 1979, the 1980s was defined by the creation of a new regional government and administration, alongside the need to promote substantial industrial restructuring of the economy in response to deep economic crisis. This process evolved in the 1990s into a strategy explicitly built around clusters that was geared towards improving the efficiency of Basque firms, fostering non-R&D-based diversification, and promoting internationalisation. In turn, this evolved in the 2000s into a sustained focus on innovation and science-driven industrial diversification, laying the immediate foundations for the Basque S3.

Thus, the foundations of the current S3 are deep, and the 2020 STIP can be seen as an evolution of both the previous STIP and of other plans and initiatives (Aranguren *et al.*, 2016), including existing strategies for advanced manufacturing, biosciences and energy, and the activities of cluster organisations supported under the long-running cluster policy (Konstantynova, 2017; Aranguren and Wilson, 2013). The 2020 STIP itself was elaborated from 2013, building in the first instance on a diagnostic analysis to define priorities based on industrial capabilities, scientific capabilities and market opportunities. Advanced manufacturing, energy and biosciences-health were identified as three *strategic priority areas*, and the four *opportunity niches* of food, ecosystems, urban habitat and creative and cultural industries also emerged as secondary focal points (see Figure 1).

*Figure 1.* **BASQUE RIS3 PRIORITIES**




*Source:* Aranguren *et al*. (2016).

Following the publication of the 2020 STIP in 2014, the S3 has been progressively implemented through the establishment of several new governance mechanisms. Most notably, these have included steering groups designed to foster processes of entrepreneurial discovery in each of the three priority areas and four opportunity niches. These have since evolved flexibly, at different speeds and in different directions, based on a set of ground rules that established the principles of involving actors from across the triple helix of government, business and research and focussing collective entrepreneurial discovery activities on the identification of more granular technologies, market opportunities and projects to prioritise (Aranguren et al., 2016, 2019b).

More than the other priority areas and opportunity niches, the activities of the energy priority have built explicitly on pre-existing dynamics, most notably those related to the EnergiBasque strategy (led by the Basque Energy Agency, EVE) and to the Energy Cluster Association (ECA). One of the main objectives of the energy priority that guides its activities is to consolidate leading Basque firms as global technological leaders so they can drive the value chain focused on products and services with high added value. The ECA was established in 1997 and groups together several value chains that include producers and distributors of different forms of energy, manufacturers of capital goods and components, engineering firms and other companies offering specialised services for the energy industry. It has around 200 members, and made up of a small core of very large firms – some of them global leaders in their respective industries – and a larger number of small and medium-sized enterprises, most of which have a high degree of internationalisation (Valdaliso et al., 2015). When the steering group for the energy priority was set up in November 2015, it was decided that the ECA should take leadership to ensure a business-oriented focus (Aranguren *et al.*, 2016). Moreover, the activities of the steering group initially maintained continuity with the nine working groups already in place for the strategic areas defined in the EnergiBasque strategy, from which a series of strategic initiatives were identified (*Ibid*, 2016).

As the steering group activity has progressed over time, SMEs from other related sectors have become involved, universities have begun to play a greater role, and the strategy itself has evolved (Aranguren *et al.*, 2019b). In particular, the strategic focus has taken on three new value chains – offshore energy, smart grids and resource efficient manufacturing – which have significant crossover with other clusters and sectors. Moreover, there is a clear awareness of «a specific challenge related to energy transitions, and more generally to the integration of market and social issues into the currently predominant technological focus of the activities» (*Ibid.*, 2019, p. 18).

### 4.2. **Basque S3 as a lever for energy transition**

As one of the three priority areas identified within the Basque S3, the energy sector has been a key focal point for Basque industrial and innovation policies since

2014 and has built on a much longer trajectory in energy policy over the previous decades. This has centred on a set of strong industrial and research actors in the energy field, such as large multinational companies in the oil and gas sector and internationally regarded technology centres. In addition, the ECA has played a key intermediary role in bringing together these different actors and fostering collaborative dynamics oriented towards articulating common strategic actions. Indeed, that the ECA includes members from across all key value chains and across the triple helix has put it in a prime position to be able to define the innovation strategy associated with the energy area of the S3 from the 'bottom-up'.



As mentioned above, the ECA had already been involved in defining a collaborative innovation and technology strategy – EnergiBasque – prior to the advent of the S3. This defined strategic areas mainly focused on electricity as an energy vector and its connection through smart grids, and with energy storage included as an enabling technology. However, this strategy changed from 2015 onwards, with the configuration and work of the actors included in the energy priority steering group of the Basque S3. The result was a shift to seven strategic areas and two enabling technologies. These strategic areas are related with energy generation (oil and gas), with a strong emphasis on renewable generation (wave power, wind power and solar-thermoelectric power), smart grids (electricity grids) and efficient consumption (energy efficiency and electric mobility).

During the implementation of the S3 the work being carried out by the different working groups defined for the energy priority has recognised the existence of significant synergies beyond traditional industrial value chains and technology areas. This has led to a reconfiguration around three new, cross-cutting value chains, which have important connections with activities in other areas of the S3 strategy: offshore energy, smart grids and resource efficient manufacturing. These value chains were selected for further exploration and development according to three criterium:

- New business opportunities in high growth markets.
- Strong capacities present in the Basque Country.
- Existing challenges that can be tackled by common technological solutions.

The evolution of the strategic focus towards these 'non-traditional' value chains is thus based on Basque industrial and technological capabilities and considering the market potential of each of the strategic areas. While they are in themselves strongly related to the specific challenges of energy transition in the Basque Country and are expected to contribute to the reduction of emissions, to energy efficiency and to renewable generation, they remain strongly oriented towards the supply side of energy value chains. Indeed, a clear weakness exists in terms of the integration of the demand side, through close involvement of consumers (i.e. high energy intensive industries) and civil society actors. This can be seen by the fact that most of the actors that have been involved in the steering group activities belong to the energy field.

Nevertheless, there has been an evolution in terms of the broadening of actors and focus over recent years, with the progressive integration of SMEs specialised in other sectors – particularly the ICT sector, related to digitalisation challenges – in the different working groups within the energy priority of the S3 (Aranguren *et al.*, 2019b). Moreover, there has been increasing attention afforded to connections between the energy priority area and other Basque RIS3 priority areas, most notably:

- Connections with the advanced manufacturing *steering group*, in order to work on the area of energy efficiency for industry, advanced manufacturing for power generation in hostile environments (i.e. wind offshore), and advanced manufacturing for the electric vehicle;
- Connections with the *ecosystems* and *urban habitat steering groups* in areas such as energy efficiency in buildings and infrastructures for electric vehicle (re-charging infrastructures).

While these are steps in the right direction, the transversal nature of energy transition challenges across all economic activities suggests that energy transition should be incorporated more horizontally throughout the whole of the S3 strategy. This will respond to the need to interconnect the transitions of different systems for sustainability, something that has been highlighted by the EEA (2019). For example, the *food* opportunity niche must respond to challenges related to emissions throughout its value chains, an element that could also be addressed as business opportunities for companies in both the energy and food sectors. In addition, the opportunity niche related to *ecosystems* could be conceived more transversally through the Basque S3 by incorporating green challenges to all priority areas. This would mean sharing green and energy transition goals as territorial goals and not only dependent on the current actors involved in the energy priority. Planning for the next strategy period, which is reflected in a new 2030 Basque Science, Technology and Innovation Plan 2030, does appear to be moving in this direction. While the 7 areas (priorities and opportunity niches) will be maintained, three *transversal lead initiatives* are foreseen, two of them related to green and energy transition goals (electric mobility and circular economy). The way in which these initiatives are reflected in practice is likely to be critical for positioning energy transition challenges within the evolution of the Basque S3.

In particular, the broadening of green transition goals to the whole S3 strategy, essentially moving from an S3 towards an S4 (Sustainable Smart Specialisation Strategy), will require further evolution of governance mechanisms. According to McCann & Soete (2020), implementing an S4 involves reinforcing a mission-oriented policy with non-neutrality, direction, and a system approach. We have already reflected the key intermediary role of the ECA during the first stage of the Basque S3, but the role of the Basque regional government and its Energy Agency (EVE) also stands out since the 1980s. In particular, these two institutions have provided strategic coordination mechanisms and have fostered shared vision around energy-relevant industrial and technological fields, especially during the initial phases of S3 design and early implementation. In the more recent implementation of the S3 they have taken a step back to enable a greater role for large and globally-leading energy companies, who are now coordinating projects in which a range of other actors are involved (including SMEs). However, as analysed by Aranguren *et al.* (2019b), one of the biggest remaining challenges is to continue widening participation in strategic processes. Indeed, although the leading role of key companies is seen as positive in terms of innovation and technology development, a lack of engagement of other actors and/or intermediaries could bias the process towards specific interests.

Given the transversal nature of energy transitions, such widening in the governance of S3 will be critical if S3 are to provide an effective lever for the energy transition challenges of Basque industry across the board. Moreover, the need to address inter-regional and multi-level governance of the Basque S3 more effectively has also been identified (Aranguren *et al.*, 2016, 2019b). In terms of energy transition specifically, this chimes with Chebna and Mattes (2020) observations on the fragility of regional energy transitions being influenced by their multi-level context and to their call for further research on inter-regional dynamics. In the Basque case, the energy strategy is already connected to European Union networks, initiatives and projects, such as the Smart Specialisation Platform on Energy (S3P-Energy), and it will be important to build on these dynamics to ensure the regional specificities of energy transitions within the S3 are able to identify synergies and scaling possibilities with other regions.

## 5. CONCLUSIONS

Energy transition is a pivotal element of the green transition around which the European Union's post-COVID recovery strategies are built. Yet while these strategies are being designed primarily by EU Member States, the regional (and sub-regional) administrative levels will be critical for their success. Firstly, because regions are key 'implementers on-the ground' of European and national policies. Secondly, because the place-specificities of regions make them ideal 'laboratories' for experimenting with the innovations needed for sustainability transitions. In this respect, the paper has explored how the regional smart specialisation strategies that have been developed over recent years could provide a 'ready-made' framework for discovery and experimentation oriented explicitly to energy transitions. They are an ideal starting point because S3 themselves are designed to be built from existing regional assets and capabilities, and to engage a wide range of stakeholders from across the quadruple helix (government, knowledge organisations, firms and civil society). This also implies, however, that regions with a longer trajectory in industrial development and innovation related to energy transition will be better positioned for leveraging their S3 towards energy transition challenges. This is the case of the Basque Country region, which has developed a long-term energy strategy over several decades, together with a strong trajectory in industrial and innovation policy.

Through an exploratory analysis of the Basque Country S3, the paper has provided insights about how the processes and mechanisms put in place for an S3 could work in leveraging energy transition. In this case the potential is clear, given the central role of energy as one of three strategic priorities within the S3. However, the analysis points to the need to ensure the involvement of a wide range of actors from across the different parts of the quadruple helix. In particular, we have highlighted how in the Basque case the demand side – in terms of consumers, users, and/or representatives from civil society more broadly – is not yet well represented in the discovery dynamics that could support energy transition. This missing element in the social dynamics surrounding energy transition, which by nature is a socio-technical transition, could be seen as a source of «fragility» in the transition process (Chlebna and Matte, 2020).

Other potential sources of fragility highlighted by this case include the potential for vested interests to emerge when experimentation projects imply certain technological paths, for example in working groups that become very narrowly focused and/or isolated from other dynamics. This implies that incorporating different configurations of actors and projects within inter-connected working groups will be important to ensure broad-based experimentation, as will fostering connections between the working groups within the energy priority and those being developed in other priority areas of the S3, and indeed international connections capable of developing synergies beyond the region. More generally, experimentation with and monitoring of new and inclusive governance mechanisms is likely to be a key success factor in ensuring that S3 dynamics are capable of effectively galvanising energy transition across the whole economy.

There are indeed some lessons on governance from the Basque case, most notably relating to the importance of intermediaries in terms of bridging different interests and fostering sustained strategic vision and actions. Indeed, at a time when regions across Europe were first designing their S3, Aranguren and Wilson (2013) highlighted the conceptual similarities between cluster policies and S3, using Basque cluster policy to illustrate how policy-makers could leverage cluster organisations to foster entrepreneurial discovery dynamics. The role of the Energy Cluster Association (ECA) in the Basque S3 process to date, as analysed here, has borne out many of the arguments made then. In particular, the case shows the importance of this intermediary role in the initial stages of the strategy, whereby the pre-existing cluster dynamics gave the energy priority steering group a 'head start'. As implementation of the strategy took pace, the integral involvement of a well-established intermediary also enabled the relatively fast transition of leadership of working groups and projects to the private sector.

A final key message from the analysis of the Basque case to date refers to the scale of ambition of energy transition goals and their relevance for the green transition across the entire economy. While S3 contain many of the ingredients for supporting ambitious energy transitions, their design in sometimes isolated priority areas can provide a barrier to wholesale transformation that permeates across the regional economy. The increasingly cited need to move from S3 to S4 (sustainable smart specialisation strategies) will require enhancing the connectedness of different parts of existing strategies so that energy transition goals are approached in a holistic manner.



This paper has focused on exploring the link between a new generation of regional innovation policies and the need for energy transitions, illustrated through an analysis of key elements in this link as revealed in the context of the Basque Country case. However, there remains an important research agenda ahead, to deepen such conceptual, exploratory analysis with detailed study of concrete practices, projects and activities that arise from the S3 dynamics and that could constitute mechanisms for change that drive energy transitions.

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# *Governing regional energy transitions? A case study addressing meta-governance of thirty energy regions in the Netherlands*[*]

**There is increasing scholarly and policy attention to energy transition at the regional scale. This perspective article presents empirical insights from the Netherlands, a frontrunner that has been experimenting with, formulating and scaling regional energy strategies to thirty 'energy regions', with the goal of these regions contributing to the national climate goal, including but not limited to 35 TWh of solar and wind energy. The research question is: What insights can be taken from the governance of regional energy transition in the Netherlands? Results reveal six issues that require the attention of policymakers: the trade-off between top-down and bottom-up; transparency in costs and benefits; lack of governing capacity; fit with current institutional frameworks; systemic efficiency and optimisation; and fair participation.**

*Cada vez es mayor la atención que se presta a la transición energética a escala regional en el ámbito político y académico. Este artículo expone las experiencias empíricas de los Países Bajos, líderes en experimentación, formulación y desarrollo de estrategias energéticas regionales en treinta «regiones energéticas», con el objetivo de que estas regiones contribuyan al reto climático nacional, incluyendo pero no limitándose a 35 TWh de energía solar y eólica. La pregunta a plantear es la siguiente: ¿Qué lecciones se pueden aprender de la gobernanza de la transición energética regional en los Países Bajos? Los resultados revelan seis cuestiones que exigen la atención de quienes formulan las políticas: el término medio entre top-down y bottom-up, transparencia de costes y beneficios, falta de capacidad de gobierno, adaptación a los actuales marcos institucionales, eficiencia y optimización sistémica, y participación justa.*

Gero eta arreta handiagoa ematen zaio eskualde mailako trantsizio energetikoari esparru politikoan eta akademikoan. Artikulu honek Herbehereetako esperientzia enpirikoak azaltzen ditu, liderrak baitira hogeita hamar «energia-eskualdetan» eskualdeko energia-estrategien esperimentazioan, formulazioan eta garapenean. Esperientzia horien bidez, eskualde horiek klima-erronka nazionalean lagundu dezakete, eguzki-energiaren eta energia eolikoaren 35 TWh-ra mugatu gabe. Galdera hau egin behar da: Zer lezio ikas daitezke Herbehereetako eskualdeko trantsizio energetikoaren gobernantzatik? Emaitzek agerian uzten dituzte politikak egiten dituztenen arreta eskatzen duten sei gai: *top-down* eta *bottom-up* terminoen artekoa, kostuen eta etekinen gardentasuna, gobernu-gaitasunik eza, egungo esparru instituzionaletara egokitzea, efizientzia eta optimizazio sistemikoa, eta bidezko parte-hartzea.

* Spanish version available at https:/euskadi.eus/ekonomiaz.

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**Keywords:** climate policy, metagovernance, multilevel governance, energy transition; regional governance.

**Palabras clave**: política climática, metagobernanza, transición energética, gobernanza regional.

**JEL codes**: P18, Q28, Q48

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## 1. BACKGROUND

Recently there is more scholarly and policy attention to the region as administrative entity in which sustainable energy transitions can be governed (de Leeuw & Groenleer, 2018; Hoppe & Miedema, 2020; Kempenaar, Puerari, Pleijte, & van Buuren, 2020; Lutz, Fischer, Newig, & Lang, 2017; Mattes, Huber, & Koehrsen, 2015). Energy transition refers to a significant change for an energy system that could be related to one or a combination of resource use, system structure, scale, economics, end use behaviour and energy policy (Grübler, 1991). It does not only focus on (the change of) one technology, energy source, or policy, but instead focuses on systemic change of an entire energy system (e.g. an electricity system changes systemically following the change of its electricity generation mix, leading to for example new grid requirements and institutional change) (Geels, 2002). In sustainable energy transitions goals include $CO_2$ emission reductions, an increase in the rate of energy saving, and the energy system getting progressively more sustainable, using more renewable energy sources while replacing fossil fuel sources (Kemp, 2011). In order to achieve these goals state and non-state actors use their agency and undertake both individual and collective action. To coordinate strategy and actions to achieve sustainable energy transition goals in society governments engage in energy transition governance (Grin, Rotmans, & Schot, 2010). This not only includes national government induced governing but also applies to decentralised levels of government (Bulkeley H, 2005; Hoppe & Miedema, 2020).

Similar to supranational, national and local governance of climate change mitigation or low carbon energy transition, collective strategy and action also take place at the regional level. Taking a polycentric governance approach – which assumes decision-making between multiple semi-autonomous interdependent state and non-state actors (Aligica & Tarko, 2012; Ostrom, 1999) – or a multilevel governance approach – which assumes interdependency, cross-level interaction and coordination between actors at different tiers of government (Hooghe, 2001) – it is not surprising that the regional level deserves more attention. Recent attention to the region not only follows from the argument that it is a formerly forgotten level in climate policy that also needs attention, but that it is also the level where top-down policies and bottom-up initiatives are confronted with one another. In order to understand the governance of regional energy transition (RET) it is necessary to understand what regional governance is actually about. According to Fürst (2004) regional governance pertains to «forms of regional self-control in response to deficits and as a supplement to market and state control. It occurs where the interaction of state, municipal and private-sector actors is required in order to deal with problems. Therefore, it can be seen as an «intermediate form of control» (Fürst, 2004). Other scholars see regional governance as a coordination mechanism to resolve interlocal issues, e.g. (Feiock, 2007).

RET can be defined as a regional approach to drastically transform energy systems (van Engelenburg & Maas, 2018). Next to greening energy systems by increasing the use of renewable energy sources, this also includes energy savings and co-benefits, like job creation and contributing to the wellbeing of regional communities (Holm Olsen, 2014; Puppim de Oliveira, 2013). RET, however, is not easily realised. Whereas there are many civic initiatives at the regional level in many countries, they contribute but hardly leave a substantial mark on the greening of regional energy sectors at the system level. In the absence of sufficient civic and market pressure the drastically greening of regional energy systems arguably becomes a public sector matter provided that regional politics decides that public sector intervention is required. However, generation of electricity from renewable sources (and hence change of the electricity generation mix) is a liberalized activity in the EU, with investments freely made by economic agents. Public authorities may get involved in energy planning activities, and use certain economic incentives to support the use or renewable energy sources, like subsidies, tax rates, feed-in-tariffs, and the like.

When it is decided that the public sector uses its agency to mobilise other actors and resources to achieve RET this is in the form of governance, which can either be done in the form of a regional authority governing RET – with the regional authority as a central, monocentric governing agent and regional stakeholders at the receiving end as target groups – or taking more of a polycentric governance approach which fits contemporary regional forms of governance fairly well (Klok, Denters, Boogers, & Sanders, 2018; Wäckerlin, Hoppe, Warnier, & de Jong, 2019) – assuming the regional authority as one of the actors depending on interaction with other state and non-state actors at both the regional and other levels. Regardless of the forms of governing taken in order to realise RET, inter-actor coordination is required to make sure that actors commit themselves to achieving the collective goal of realising RET, establishing joint visions, joining forces to establish sufficient capacities, co-create (i.e. actively involving citizens and stakeholders in the work of government or public decision-making (Parks *et al.*, 1981), for example, to formulate policy or co-design future pathways), regional strategies, formulate and implement policy mixes, set-up regional experiments, and align their actions to implement RET effectively, (Hoppe & Miedema, 2020). Although attention to RET and the governance thereof is increasing, there is still limited attention to the governance of RET in practice. Empirical studies that presume to address RET either focus on the local or sometimes the provincial level and not the region as 'supra-municipal' level in which inter-municipal disputes are resolved or issues are discussed and coordinated. Only a few empirical studies actually focus on regions as level in between the provincial and local level in which actions are undertaken to govern energy transitions (Hoppe & Miedema, 2020; Kempenaar *et al.*, 2020; Loorbach & Rotmans, 2010).

Governance of RET can also be viewed from a responsive or innovation oriented perspective. Looking for a way to govern energy transitions regionally has the advantage of taking an approach that more specifically fits the regional conditions, be more responsive to regional needs and offering more of a tailor made approach than implementing a Top-Down alternative central government. In this sense it can also be seen as a response to failed governance approached by (Dutch) central government from 1990s onward in the planning of wind energy in regions with characteristics favourable to wind energy park operation. A key shortcoming was central government passing by on regional needs, giving municipalities and local communities little say in the siting of wind park locations, leading to poor social acceptance, civil unrest and eventually public resistance when the latter got hold of the deals that were made with industrial wind park developers planning to erect wind turbines without local consent (Wolsink, 1996; Wolsink, 2007). Moreover, many objections were raised by local stakeholders to slow down and prevent the construction of onshore wind parks (Akerboom, 2018). The message was clear: governing by closing down deals with energy market players while at the same time neglecting regional actors was a doomed approach. In response to this a need to develop a new, working mode of governance emerged. This can be seen in light of innovation of governance: searching for and using new ideas to develop new models of governance that work better.

When the purpose is to change or improve governance by means of innovation – assuming that this does not work in incremental fashion – one way to do so is using a specific metagovernance strategy, assuming that spaces of governance are not exclusively territorial and that reference to hierarchy indicates the key role of state power, that is the «governance of governance», with «multispatial metagovernance» (Jessop, 2002; Jessop, 2016). Metagovernance can be used to improve or change governance approaches that have failed in the past. It can be applied in a sense similar to Transition Management (TM) using a long term vision and goal, while developing pathways, policy, means of experimentation and discursive actor arenas to govern transitions (Kemp, Rotmans, & Loorbach, 2007; Loorbach, 2007). Next to focusing on multiple sectoral domains, a metagovernance approach may also focus on mobilising action among different levels of government, or even seek to change institutions, next to supporting change in governance arrangements. In addition this requires developing and replacing policy instruments mixes (Kern & Howlett, 2009; Kern, Rogge, & Howlett, 2019). This approach can also be applied with the aim to change governance structures with regard to RET. It calls for change in organisational structure, actor configuration, and institutions.

A country that is currently using such an approach to govern RET in a novel way is the Netherlands, which has been experimenting with RET governance and has recently scaled the approach to a national program with thirty so-called 'energy regions'[1]. In the present paper energy regions are defined as a partnership between actors on a regional scale to promote energy transition. These energy regions are a new phenomenon as they form no part of current constitutional-legal decentralised government, and there is no legal basis to them. Formally, they do not exist (Elzinga & Lunsing, 2020). Yet, despite this fact they have come into existence and have been assigned a key role in the national energy transition structure (SER, 2018). Within this structure the thirty energy regions have fair degree of autonomy but are coordinated and facilitated by the «National Programme Regional Energy Strategies» ('NP RES' from here onwards), organised at central state level.

Although the application to the energy domain is new the regional governance approach is not. As with previous forms of new regional governance in recent years, decentralised – in particular local – authorities were requested by the central government to cooperate in the formation of partnerships. Initially, these had a non-

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[1] See appendix at the end of the article.

committed character, but were perceived as quite compelling by decentralised authorities. Eventually this resulted in some sort of mandatory voluntary cooperation. Via a law that takes precedence over general legislation the formal legislator (at national level) was able to transfer powers from the decentralised authorities to the new partnerships – in the case of RET in the Netherlands to the energy regions. Transferring these powers did contribute to a higher degree of national control (Elzinga & Lunsing, 2020), and increased central government's ability to govern.

The goal of this perspective paper is to create more insight into how RET governance is shaped, implemented, what energy regions are and how they work, how actors and multi-spatial tiers of government interact, and what governance issues emerge during this process. In this paper governance structure and empirical developments are analysed, addressing RET as a complex, multi-actor challenge, taking a reflective research approach. The main research question is: What insights can be taken from the governance of regional energy transition in the Netherlands, as a country experimenting with innovation of governance at the regional scale?

This paper is structured as follows. Section 2 presents research design and methodology, which mostly pertains to the use of a single case study approach, with qualitative data from reports from expert meetings, newspaper articles, online media, expert reports, expert interviews and case study reports. Section 3 presents a chronological overview of the emergence, structure and implementation of regional energy governance across thirty energy regions in the country. Section 4, then, addresses pressing governance issues. The paper ends with a conclusion, including suggestions for future research.

## 2. RESEARCH DESIGN, METHODOLOGY AND RESEARCH FRAMEWORK

In this paper, the research approach is that of a single case study. This was selected to explore and describe the governance of RET as a complex societal phenomenon in its real-life context, using in-depth, rich data (Yin, 2003). The case study selected in the present study is the Netherlands. This case was selected because the country can be considered a frontrunner in regional energy transition governance. This is unprecedented. The case study addresses the period between 2016 – when the first ideas were conceived and the first experimental pilots launched – until 2021 when a national program had been set up supporting thirty energy regions across the country. Whereas the present study mostly focuses on the general development, coordination and organisation of regional energy transitions from a national – metagovernance – perspective, the study also pays attention to illustrative pratices and development at the decentralised level, i.e. in a number of energy regions (e.g. Zealand, West-Brabant, and North-East-Brabant). In terms of data collection, treatment and analysis the present study can be classified as qualitative research. Data collection involved desk study reports, newspaper and online articles, secondary data, and insights from three M.Sc and B.A. graduation studies at Delft University of Technology (covering three energy regions and over thirty expert interviews), all using a case study research approach. In addition, discussions and an expert interview were conducted with public officials at the NP RES programme organisation. Data analysis pertained to qualitative data analysis, including text interpretation of the aforementioned qualitative data, with text interpretation and reflection on empirical data using the theoretical lens of the Governance Assessment Tool framework (Bressers, Bressers, Kuks, & Larrue, 2016).

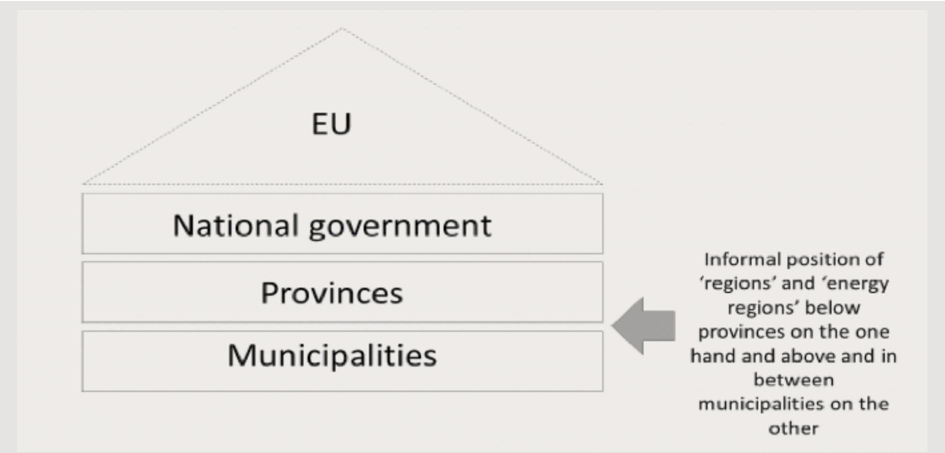
The Governance Assessment Tool (GAT) concerns a framework that enables the analysis of governance quality on a certain issue in a given context. It can also be used to assess or evaluate the quality of policy implementation of a given policy or policy process. The conceptual basis of the framework goes back to a long tradition of implementation studies as a subdomain to policy studies. More particularly it has a background in the Contextual Interaction Theory (de Boer & Bressers, 2011), which can be viewed as a «third generation» policy implementation theory in which policy implementation is not only viewed as a monocentric top-down process but as a multi-actor interaction process that is influenced by different context layers. In a similar fashion to the Contextual Interaction Theory, the Governance Assessment Tool framework sheds light on multi-actor and multi-level situations that influence the implementation of policies and projects under complex and dynamic conditions (Bressers *et al.*, 2016). From the governance literature theoretical frameworks, the Governance Assessment Tool framework is arguably the most comprehensive one covering the key governance dimensions, i.e. vertical (levels and scales) (Hooghe, 2001); horizontal (actors, networks, collaborative governance) (Bressers & O'Toole Jr, 1998; Klijn, 2008); problem perceptions and goals (Hoppe, 2010); policy congruency and alignment to strategy (Kern & Howlett, 2009); and resources, (policy) instruments, and 'policy mixes' (Bemelmans-Videc, Rist, & Vedung, 2011; Bressers & Klok, 1988; Kern *et al.*, 2019). As such, it covers multiple dimensions that can also be found in polycentric governance. Moreover, the attention to different (vertical) levels and scales, goals, alignment to strategy, and policy mixes also allows to reflect on the use of metagovernance in the RET context.

## 3. EMERGENCE, DEVELOPMENT AND STRUCTURE OF RET GOVERNANCE

Attention to energy transition at the regional level goes back a long time in the Netherlands. It has a background in national government, enabling decentralised government to formulate climate policies of their own. Since 2001 provinces – just like municipalities – could request funding from the national governments to formulate their own policy and build capacities. Ever since the provincial government has been enabled to do so and 'rich' counterparts were able to fund their own climate policies. For example, including schemes to co-fund innovative local renewable energy or community energy initiatives (Hoppe, Kooijman-van Dijk, & Arentsen, 2011; Warbroek & Hoppe, 2017). Ambition and intensity varied across provinces, in particular between the rich ones – often with financial assets after selling shares in former provincial energy companies following the liberalisation of the energy market in the Mid 2000s – and their poorer counterparts (Arentsen, 2009). Although it stimulated action at the regional level there was no such thing as regional energy transition or climate mitigation policy. Due to its constitutional state structure, the Netherlands entails a rich body of decentralised administrative bodies that have a fair amount of autonomy - yet less than the States – 'Bundesländer – in Germany) (Boogers, Klok, Denters, Sanders, & Linnenbank, 2016) – or the Autonomous Communities in Spain, for instance. Next to local, provincial and decentralised functional governmental bodies (e.g. Water Boards), the country also has some sort of regional governance, which applies to a number of societal domains including healthcare, safety & policing, environmental affairs, and transport & mobility. It concerns issues that cannot only be arranged at the municipal level, but also requires supra- and inter-municipal coordination.

Despite this fact, there are basically no regional administrative entities that possess any form of autonomy. In the Netherlands, the region is not considered a formal tier of government. The country's original constitutional state structure in terms of levels of government contains (from top to bottom): national or central government, provincial government, and municipalities (See Figure 1). The EU was added to the original structure more recently. In addition to the provinces and municipalities there are also functional decentralised governments, in particular the water boards.

*Figure 1.* **CONSTITUTIONAL STATE STRUCTURE WITH DIFFERENT LEVELS OF GOVERNMENT IN THE NETHERLANDS**




*Adapted from:* (Bovens *et al.*, 2017).

Until 2015 administrative city-regions existed, but after a trial period the idea was abandoned. What was left was regions settling inter- and supra-municipal affairs. Here, several legal-organisational models are used, with the so-called «administrative arrangements» – introduced in 1984 – as the most prominent form. It serves to provide the formal foundation for collaboration between municipalities, provinces and water boards, mostly focused on the strengthening of inter-municipal collaboration. (Ibid.). Although climate (mitigation) policy has been around in the Netherlands since national government started formulating progressive environmental policy following the 1987 Brundtland report «Our Common Future» (Coenen, 1999), and the provincial and local governments adopting climate policies (strongly varying between jurisdictions) (Hoppe & Coenen, 2011), the regional level basically remained void of climate policy until 2016.

### 3.1. **Regional Energy Transition Pilots**

In 2016, the Association of Netherlands Municipalities (VNG) took the initiative to explore whether climate mitigation policy and more particularly low carbon energy transition could be governed at the regional level. It was aligned to the national 'Energy Agreement' (2013), which entailed the metagovernance and policy which was followed by the Dutch national government to contribute to climate change mitigation goals of the IPCC (i.e. Kyoto protocol) and the European Union (with amongst others a 14% share of renewables in the national energy mix). In response to the 2015 Paris COP21 Summit – in late 2016, the Dutch cabinet issued its 'Energy Agenda' which presented the region as a (potential) government level where energy transitions could be realised (Schuurs & Schwencke, 2017).

At that time the decentralised governments formulated the idea to organise pilot experiments that would focus on RET. VNG (muicipalities) and IPO (provinces) wanted the energy transition policy domain on a regional scale with more say for decentralised authorities. They felt that this time they should take the lead, and not the central government. This was also related to frustration they had experienced from decentralisation in the healthcare domain. Central government was subsequently involved out of necessity.

To initiate action, VNG drew the idea to make a Deal together with the national government (i.e., the ministries of Economic Affairs, the Interior and Kingdom Relations, and Infrastructure and the Environment), the Union of Water Boards (UvW) and the Association of Provinces of the Netherlands (IPO) to start RET governance experiments. This led to the development of the so-called «Regional energy strategy pilots» deal. Between 2016 and 2017, seven energy regions were selected to explore and learn how regional governance in the energy transition domain could be organised and developed (Schuurs & Schwencke, 2017). Issues explored included: What ambitions can municipalities and other regional actors share and where do they need to increase their collaboration efforts?; How familiar are municipalities and other regional actors with the regional challenge, and how to explore and estimate the spatial and economic impact of the regional energy transition?; What is already done in the region with regard to the energy transition, and what else can municipalities and other regional actors do, and what is required in terms of knowledge, expertise, and what is the fit with current legislation and regulations?; And finally, which tasks and roles lie with which party in the region, and what would be a fair and justified division of tasks, costs and benefits? (Schuurs & Schwencke, 2017).



Eventually, pilots commenced in seven energy regions. To support them a total budget of 1.5 million euros was made available. In five energy regions (i.e., West-Brabant, Hart van Brabant, Midden-Holland, Fryslân and Drechtsteden) a project manager was appointed to support a project team of regional stakeholders (including public officials from multiple municipalities in the region), and served to guide the team towards developing a regional energy strategy with a long-term strategy including a step-by-step plan for the short term - to become energy neutral by or before 2050. The two energy regions remaining (i.e., North Veluwe and the Eindhoven metropolitan region) were allowed to delegate regional stakeholders to participate in a community of practice. The seven energy regions were also encouraged to share experiences. All seven received a budget to organise workshops and 'ateliers' with regional stakeholders in order to discuss and explore issues of climate, energy and spatial affairs, and co-create problem perceptions, visions, goals and strategies how to achieve them (Schuurs & Schwencke, 2017). Ateliers serve to involve stakeholders in discursive settings to co-research ongoing issues and find common problem definitions, co-create future visions and goals, and co-develop pathways and roadmaps to achieve them (Kempenaar *et al.*, 2020).

In 2017 the pilots were evaluated. Results showed that the pilot regions differ greatly in the degree of regional cooperation. Whereas inter-actor cooperation was well developed in some of the regions, sometimes even with regional administrative/executive bodies (i.e. using 'common schemes' to coordinate matters), it was more of incidental nature in others. Another insight from the pilot Deal was that regional energy strategy is developed in a more or less informal framework, in which public, private parties and civil society collaborate and coordinate actions. The way in which general and daily governance, organisation and implementation would be arranged is up to the actors involved, and is inherent to the autonomy the energy regions had to organise and coordinate their own regional energy transition strategies. Not surprisingly, variation was found in the ways the (pilot) energy regions organised this (Schuurs & Schwencke, 2017). More in general, the regional project organisation often consisted of a steering group, a program team with a program manager, and a regional coordinator responsible for the strategy process. These included several thematic working groups. In many regional project teams, the participants were surprised how complicated and comprehensive the (regional) energy transition issue was, both in terms of process and the scope. An important benefit attributed to the pilots was that the parties involved experienced collaboration while working on a topic that was previously not familiar to them. This helped to raise awareness about the urgency and scope of the challenge while also stressing the importance of inter-actor dependency (Schuurs & Schwencke, 2017).

The pilots also revealed that the process of RET policymaking is complicated. Because the energy region is not a formal tier of government processing a regional energy transition strategy into formal policy is only possible through decision-making in the formal decision-making bodies of the participating decentralised governments (i.e. mostly municipalities, but also provinces and water boards). In the pilots local administrations were advised to use the regional energy strategy (RES) as a foundation for local spatial plans and co-developing visions to anchor the spatial impact in policies and plans. In other words, after presenting a RES with concrete recommendations, it was up to municipalities to make decisions about it. Finally, the evaluation showed that having sufficient implementation capacity available is of great importance. In line with this local administrations were advised to ensure that the plans and projects are implemented or adjusted (i.e. via implementing organisations), and would require an adaptive and programmatic approach (Schuurs & Schwencke, 2017). In sum, the evaluation of the RES pilots stressed that more work should be done to advance the RET policies and governance.

### 3.2. The 2018 Climate Agreement and the road to Regional Energy Transition Strategies

In 2018 the Dutch national government negotiated the national ‘Climate Agreement’ in close collaboration with societal partners from the public, private and civic sectors. It included a regional governance approach that foresaw thirty Dutch energy regions contributing a fair share to the national renewable energy goal of at least 35 TWh in wind and solar energy production (including both distributed generation and utility-scale wind and PV installations; other renewable electricity generation technologies are not included in this goal). This would align with the $CO_2$ emission reduction goal of 49% by 2030 (as compared to the 1990 level) (SER, 2018). The Climate Agreement and the related 2019 Climate Law would pave the way for the organisation and implementation of so-called ‘Regional Energy Strategies’ (RESs), giving regional energy transition governance a concrete and visible character for the first time. As with the pilots, the initiative did not come from the central government. During the 2016-17 Climate Agreement negotiations, the decentralised governments said: «This is ours. We want more say», also based on experiences with the RES pilots. In the summer of 2018, during the negotiations on the Climate Agreement, a discussion started between the Ministry of Economic Affairs and Climate Policy and the Ministry of the Interior and Kingdom Relations on the one hand and the local and other decentralised authorities on the other. This led to the development of ideas about the organisation of the energy regions and the design of NP RES. It should be noted here that at the time there were still some hostile feelings between decentralised and central government, because the decentralised authorities felt disadvantaged. RVO, the national government agency that was to implement NP RES was initially seen as part of the central government and was therefore not welcome at consultations between the decentralised authorities.

At that time it was also determined which would become the energy regions. Oddly, these were (and are currently) not in line with existing formal decentralised structures, nor with the EU NUTS regions system. The energy regions were established in consultation with the relevant decentralised authorities, which expressed their preferences in doing so. Energy regions were designed taking into account existing decentralised administrative network structures. This initially led to establishing 37 energy regions. But the central government decided this was too much and started to exert pressure. That led to an integration of energy regions, after which 30 remained.

An overview of the energy regions can be found here: https://www.regionale-energiestrategie.nl/resregios/default.aspx and in the Appendix.

### 3.2.1. *Meaning*

In the national Climate Agreement RES has been defined in three separate ways. First, as an (policy) instrument to organise the spatial integration of the energy transition with social (i.e. citizen) involvement; second, as a means to support long-term regional inter-actor collaboration; and third, as a 'product' (i.e. text or 'policy' document) describing regional energy and low carbon goals, with deadlines, and including strategies (i.e. policy) on how to achieve this (Energiestrategie, 2019b).

### 3.2.2. *Relative autonomy in policymaking of decentralised public authorities*

In the RES approach, some degree of regional autonomy is allowed. The elaboration of the goals set for the RES in the Climate Agreement is not imposed by national government on decentralised administrative bodies. Instead, energy regions have a certain degree of autonomy to develop strategies on their own on how to achieve energy transition goals while contributing a fair share to the national goal. At the regional level stakeholders can give substance to the goals by participating in public decision-making, so that an independent regional pathway be developed, in particular in relation to large-scale generation of onshore wind and solar energy. According to some this can be considered a «constitutional novelty», basically giving some policymaking authority to a non-existing administrative entity to formulate and eventually implement a policy with drastic environmental, economic, social and even institutional repercussions (van der Steen, Ophoff, van Popering-Verkerk, & Koopmans, 2020). More in general, the magnitude and complexity of the issue at hand and the scale on which this requires coordination calls for innovation of governance, resulting in the RES approach as a compromise between top-down national government induced meta-governance and bottom-up regional initiatives and projects (Hoppe & Miedema, 2020).

### 3.2.3. ***Goals***

The goals of the RES governance approach are: 1) To attain a quantitative target for the energy regions: by 2030 at the latest, the energy regions will jointly produce at least 35 TWh of electricity from wind and large-scale onshore solar PV systems; 2) To draw up a Regional Heat Structure (RSW) with which they take control of the use of supra-local heat sources for municipal heat plans. The aim of the thirty energy regions individually developing RESs is to arrive at a regionally supported strategy following joint effort between social partners, the business community, governments and residents. As spatial impact is of key importance to the discourse in every energy region the RES is often considered as an approach to discussing and organising spatial integration of the energy transition with social involvement in a way to arrive at a social-political legitimate approach (Matthijsen *et al.*, 2021). Moreover, implications of the RES governance approach could become drastic and go beyond energy and spatial matters, property ownership, health, and landscape. Even freedom and prosperity would not be left untouched by it, according to some (Jesse, Koekkoek, Udo, Wentzel, & Zijlstra, 2020).

### 3.2.4. ***Organising the metagovernance of RET***

In their effort to develop RESs of their own, all energy regions are supported by the national government. This is done via the National RES Program, which was established to support the thirty energy regions in making the RESs by developing and sharing knowledge, offering process support and facilitating a learning community. NP RES connects parties, puts bottlenecks on the agenda and identifies opportunities for linking to realise the ambitions. Support to energy regions from the NP RES comes in different forms. For example, in the process of developing the regional structure heat (RSW), an expert pool is made available, set up and coordinated by the Netherlands Enterprise Agency (RVO) (Energiestrategie, 2019b). NP RES can be considered as a metagovenance structure to facilitate RES formation and implementation processes at the regional scale.

The question can be raised why a decentralised approach with an important role for the regions was chosen? In addition to the aforementioned discussion initiated by the local authorities and started in 2017-18, the organisational set-up also deserves attention. The COP21 in Paris (2015) was used as a good practice, example, as there was a solid basis there with thematic consultation tables where quality discussions were held with experienced administrators and officials. This was adopted in the Dutch RET negotiations. In addition, it was important that the central government would guarantee the autonomy of regions and value it in the process. In addition, it was also considered important that a good inter-administrative consultation structure was created and that decision-making processes were properly supported (by a professional external process manager). VNG, IPO, UvW and the two ministries were the client for this. They managed a quartermaster group, that prepared ideation regarding the formation of the NP RES in which the interests of the five clients were taken into account, whereby the frameworks were designed in consultation with the energy regions. This also applied to the guide and other supporting documents that NP RES would produce to support the energy regions. In addition, it was considered important to develop a feeling for each other and to allow these consultations to return, whereby there was less strict control over the use of central government resources, and more reasoning and acting based on trust.

### 3.2.5. *Governance structure and phase-wise approach*

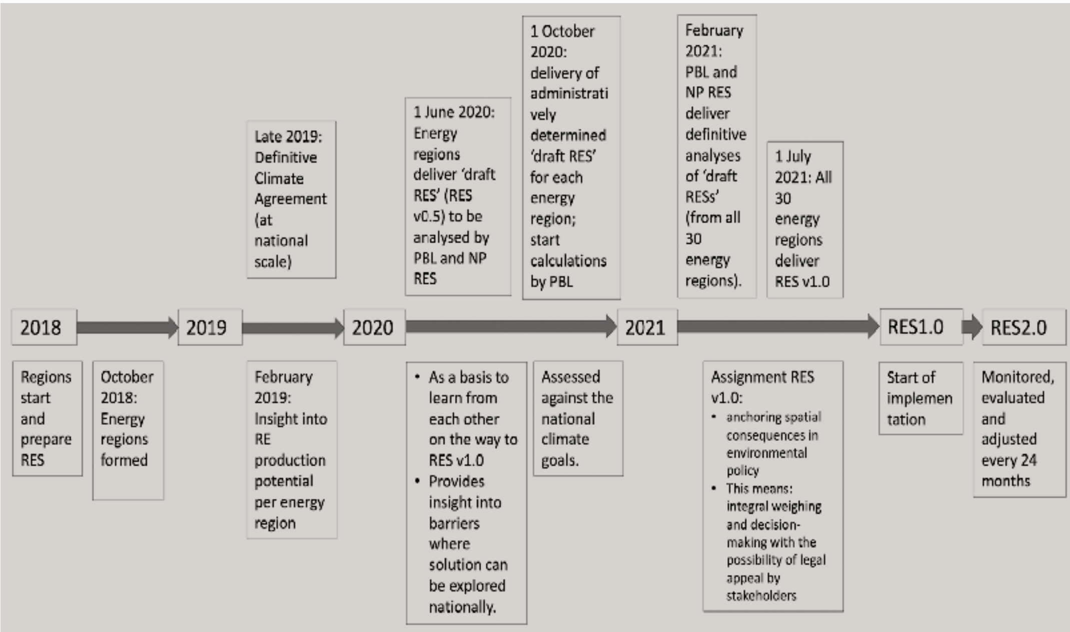
In each energy region, provincial and local governments (but also Water Boards), social partners, network operators, the business community and residents are expected to work out regional choices, pertaining to the generation of onshore wind and solar energy production, issues regarding the sustainable heating transition in the built environment, and the required storage and energy infrastructure that go along with these choices. Based on these choices each energy region is expected to formulate a regional 'offer' (i.e. quantitative electricity generation from wind and solar, and a $CO_2$ reduction bid). This requires a trade-off between four components: i) Quantity in terms of electricity and heat production; ii) Use of space (i.e., land); iii) Administrative and social support; and iv) Energy system efficiency (mostly related to electricity grids coping with increasing amounts of distributed generation) (Energiestrategie, 2019b). When reflecting on praxis in energy regions it can be argued that a fairly technocratic approach is taken. This includes looking for potential «search areas» to plan wind and solar parks, or where there are possible heat sources available, or possibilities for sun-on-roof installations, or where multiple use of space can take place. This process also takes legal obstacles into account (Participatiecoalitie, Natuur en Milieufederaties, RES, Klimaatbeweging & Koepel, 2020).

The RES process has a lead time until 2030. To support publicly legitimate decision-making, it is considered important that all public stakeholders (i.e., municipal councils, the provincial council and the general boards of the Water Boards) are properly included and prepared from the start of the process. For this, an administrative starting document (initial memorandum or similar document, yet without any legal implications) is drafted containing the goal(s), planning, organisation, and attention to address spatial and legitimacy issues. In the next step each energy region is expected to present a draft RES to the NP RES (on 1 June 2020). In the period up to the submission of this policy document, the decentralised authorities' branch organisations (e.g., VNG, IPO, UvW), together with the energy regions, started a process that would provide input for creating a regional «allocation system» (entitled

«Route 35»). This process ran (partly) parallel with the trajectory of the RESs with the aim to arrive at fair and equitable starting points. In the Summer of 2020 RES formation processes mostly included public and some semi-public and private sector players. The draft versions of the RES for all energy regions were then presented to PBL (the Netherlands Environmental Assessment Agency) (on 1 October 2020), with the latter assessing whether the RES plans formulated in all energy regions would add up to achieving the national goals. If not met, then energy regions would be given four months to arrive at new distribution with the presumption of jointly achieving the national goals. The energy regions then had until 1 July 2021 to determine the «definitive RES» (i.e. 'RES version 1.0').



*Figure 2.* **PHASE-WISE APPROACH TO RES**




*Adapted from:* (RES, 2020).

The majority of the RESs are expected to become incorporated into municipal and provincial spatial-environmental policies and plans by Mid-2021 (with legal mandates mostly with the municipalities). Afterwards, the RES is updated at least every two years. The 'RES version 2.0' (to be offered to the NP RES on March 1, 2023) entails a further elaboration and possible revision of its predecessor (i.e. the 'RES 1.0' version). In this version, new insights and developments with regard to heat sources and location choices for renewable generation are expected to be implemented. Decisions about new infrastructure and storage locations should also be included in the 'RES 2.0' version (Energiestrategie, 2019b). For both the 'draft RES' (2020), the RES1.0

version and further RES amendments public participation of regional stakeholders and citizens is foreseen. NP RES leaves it up to the energy regions to organise this regionally. An overview of the phase-wise approach to RES is presented in Figure 2.

To oversee performance and progress the Netherlands Environmental Assessment Agency (PBL) monitors and evaluates RES formulation and implementation processes (including incorporation into spatial-environmental policies and plans). However, to enable PBL to conduct this task it is important that the regional actors – like distributed system operators, housing associations and other relevant parties involved in RES organisation – provide the necessary data. Both in monitoring and development of RESs energy modelling is required to process the data and run analysis and scenarios that back decision-making. The possible use of models and of commercial agencies that advise on the further development of the RES on that basis is a choice of the energy regions themselves. Different energy models are available to support spatial and energy analysis (Matthijsen *et al.*, 2021). It should be noted here that two reservations apply. First, local and regional energy modelling is usually outsourced to commercial consultancy and engineering firms with little direct involvement of public officials (Henrich, Hoppe, Diran, & Lukszo, 2021). Second, data availability is complicated due to dispersed ownership and a lack of demand-side data (Diran, Hoppe, Ubacht, Slob, & Blok, 2020).

The financing of NP RES and the support of the regional processes until 2021 came from the Climate Budget of the central government. This was initially 15 million euro per year. But this turned out to be insufficient. Subsequently, a revised budget allocation key was made after negotiation with the energy regions.

### 3.2.6. *Organising citizen participation*

Citizen participation and social support for RESs are considered of great importance in the NP RES. Here, participation means different things: e.g., process participation, financial participation, or ownership participation. Financial bonds and an environmental fund can be seen as means that contribute to participation. In RES formation, participation entails the following goals: (i) realising social acceptance of the RES and the measures that come along with it; (ii) increasing informed decision-making by making use of the knowledge, experiences of residents, companies and social organisations; (iii) realising social support for making decisions that influence RES formation; and (iv) ensuring community ownership, so that residents, companies and social organisations feel that they become co-owners of the RES (Energiestrategie, 2019b). RES formation in energy regions can only be considered successful once residents and regional organisations are involved in just participatory processes. This means that they are involved from the outset, feel as if they are taken seriously, participate in a deliberative way, and are treated in a fair, just way (Wolsink, 2007). In the participation process, a number of values are of key importance. These include that benefits of renewable energy projects should remain local as much as possible and be carefully integrated into the landscape, with a focus on people and nature. Moreover, this may bring the benefit of residents working together on energy transition themes and projects, eventually becoming energy transition ambassadors (Participatiecoalitie, Natuur en Milieufederaties *et al.*, 2020).



To support the energy regions, a collaborative civil society initiative was launched in 2019 under the name 'Participation Coalition', including the civic organisations HIER opgewekt, Energie Samen, Natuur en Milieufederaties, Buurkracht and LSA Residents, which represent among others community energy and renewable energy cooperatives (REScoops) in the Netherlands. Community energy refers to social communities engaging in action on energy-related issues. Community actions, for example, involve campaigns to save energy, neighbourhood solar installation schemes or community-owned wind turbines (Bomberg & McEwen, 2012). In the Netherlands, the Participation Coalition works on detailing participation in the energy transition, the spatial-environment section and neighborhood-oriented approaches, with the aim of developing RESs that can be considered socially legitimate. This includes a focus on participative planning, careful integration, establishing at least 50% local ownership of regional renewable energy projects, supporting citizen involvement in policy formulation and implementation processes, and fostering inclusiveness by also looking after low-income communities and assuring that their interests are also addressed in RES formation (Participatiecoalitie (Natuur en Milieufederaties *et al.*, 2020).

#### 3.2.7. ***Assessment of RES proposals presented by the energy regions***

After analysing the draft RESs submitted by 27 energy regions in June 2020, PBL published an interim analysis report in February 2021. This showed that a lot of work had been conducted by the energy regions in a relatively short amount of time, resulting in well-founded strategies containing information on the key performance fields. Most importantly, the calculated sum of the regional plans resulted in a total of 52.5 TWh, exceeding the initial 35 TWh goal. This was considered a good starting point for achieving the 2030 target, even though RES project plans were at the time mostly in the initial project phase and fundamental choices still had to be made. In addition it should be noted that approximately half of the cumulative wind and solar energy generation as proposed by the energy regions consisted of the production of renewable electricity from already existing and planned installations and from projects that may be realised in the short term (i.e. pipeline projects). The other half consists of production based on plans that were still hardly concrete it the time of writing and were considered 'ambitious' (Matthijsen *et al.,* 2021).

The analysis also revealed that there was a lot of uncertainty concerning a number of pressing issues. This pertained to removing and replacing old wind turbines, the degree to which 'pipeline projects' are (to be) realised, the shaping of regional (spatial) plans, and uncertainties regarding the calculation method used (by PBL). The analysis also showed that substantial additional investments in the electricity network are required, and that a bottleneck was expected regarding the availability of sufficient workers that the capacities required to implement the energy projects (Matthijsen *et al.*, 2021). Oddly, these issues had not been addressed in the proposals by the energy regions, and were only revealed as problematic during and after the PBL assessment. Another insight from the analysis concerned the choice for renewably energy production technology in energy regions and the implications this would have. Most energy regions were found to be opting for solar panels on a large scale, favouring solar over wind energy (for spatial and socio-political reasons). Although this would offer social benefits, it has the disadvantage that the costs to society will be more than a billion euros higher in case the current plans are implemented (van Santen, 2020).

Next to the quantitative analysis of the energy proposals by the energy regions the Participation Coalition analysed participatory performance in the energy regions, using a survey among civic and community energy organisations in all thirty energy regions. The survey found that various draft plans showed broad support for local ownership of new large-scale solar and wind projects. Most energy regions had adopted the 50% local ownership target in their draft RESs. However, at the time there were little concrete actions nor plans drawn up to follow up. Summarising the survey results the Participation Coalition concluded that there is somewhat of a basis to embed participation in RESs, but «there is still a lot of homework to be done» (Participatiecoalitie, Natuur en Milienfederaties *et al.*, 2020). The largest concern pertained to the proper and timely involvement of residents in the RES. In summer 2020, RES formation processes often included public and some semi-public and private sector players, but only limited numbers of citizens or grassroots organisations. It was argued that RESs should open up much more to (unorganised) residents and social partners such as companies, farmers, residents' initiatives / REScoops and nature and environmental organisations, to become the truly social project they were intended to be» (Schwencke, 2021) (p.15). Civil society was simply not sufficiently involved at the time, it was argued. Moreover, although the importance of participation had become acknowledged by public officials in most energy regions participation did not take off quite well. This was related to problems with regard to a lack of know-how and organisational capacity available at decentralised governments to facilitate participatory processes. To support public organisations the Participation Coalition organised masterclasses in half of the energy regions to inform and train civil servants and officials on how to engage with citizens and grassroots organisation, and organise participatory processes (Participatiecoalitie, Natuur en Milieufederaties *et al.*, 2020).

## 4. PRESSING GOVERNANCE ISSUES

Since 2016 esperience has been gained in the Netherlands with the governing of regional energy transition leading to establishing a national approach to develop strategies in thirty energy regions accross the country. Although a lot has been done and accomplished over a five-year-period this also requires that a critical perspective is taken. This is done by focusing on a number of issues, i.e., trade-off between top-down and bottom-up governance; lack of transparency in costs and benefits; lack of governing capacity; fit with institutional frameworks; systemic problems; fair participation and the role of community energy. Other important governance issues like enforcement, funding and management of funds, non-compliance and penalties, conflict resolution, free riding, are addressed within the six issues below.

### 4.1. A trade-off between top-down and bottom-up governance?

Taking a public administration perspective RES was welcomed by a number of decentralised administrative bodies. The decentralised approach of the Climate Agreement – the division into thirty 'energy regions' – gave provinces and municipalities a fairly important yet responsible role; more than in many other societal domains. This is illustrated by Deputy De Bat, of the Provincial Executive of Zealand who expressed: «The provinces matter again» (Van der Walle, 2020). Although provincial administrations were handed a central role this should be considered with great care. 'Energy regions' and RES are, for example, not codified in current formal law. Energy regions – i.e. clusters of municipalities that must deliver an energy strategy – have no constitutional status and are not legally bound to achieve national goals.

Developing energy regions and leaving implementation to municipalities is in line with a recurring trend in national government structure, with national government setting goals and policy priorities, developing metagovernance, while leaving implementation (and related cost) to decentralised public bodies (*in casu* involved in formally non-existing energy regions). This process often starts voluntarily, but when municipal councils argue that the approach set by the national government will not work or needs change, then there will be pressure from the national government to get it done after all. In other words, coercion will follow. In the context of the NP RES this means that wind turbines and solar fields will be installed anyway, and probably on the terms of the national government (Rengers & Houtekamer, 2020) that will top-down determine where large-scale wind and solar parks will be planned and installed. This will most likely antagonise citizens who visited websites, participated in (serious) energy games, energy ateliers, consultation and participation evenings (Bekebrede, van Bueren, & Wenzler, 2018; Kempenaar *et al.*, 2020), and who duly believe that the (regional) energy transition comes from below and that everyone can participate. In doing so there is an inherent risk of endangering political legitimacy and trust in government once national government uses coercion to govern regional energy transition in its own way, neglecting the preferences of regional citizens and stakeholders. Nonetheless, according to insiders the likelihood of central government using coercion is low. Although the issue was raised a lot at the beginning of the RES process no distribution was made on how to achieve the 35 TWh goal. It was not to be imposed on the energy regions from above. Subsequently, «Route 35» was developed from the bottom up by the energy regions. If the goal ultimately will not be achieved, the energy regions will consult with each other to arrive at a new distribution in order to achieve the target. In the last resort, central government can nevertheless still intervene. However, due to the favorable outcome of the PBL assessment in February 2021, Route 35 has been put on hold for the time being.

There is another issue that requires careful attention and concerns another recurring trend in the way the Netherlands is governed. Public (executive) bodies increasingly manage societal issues together, often with other stakeholders participating. This interaction offers flexibility and strength in tackling important problems but may also cause problems that can easily offset these advantages. The problem is that these administrations manage together (often at the regional level when policy domains are structured in such a way that are coordinated at that particular level), while democratic direction, control and accountability are limited to a single administration (e.g. often at the local level), which affects the functioning of municipal councils, provincial councils and other representative bodies. This issue is also highly relevant to RES development (Boogers, 2020), but comes with inherent risks to compliance to collective decisions made at the regional level in the RES.

In practice, there is not only friction between central and decentralised government but also between regional and local interests. After development of draft RESs at the regional level the municipal councils and boards are asked to adopt it. They are expected to commit themselves to the guiding regional principles and the principle of the assessment framework, taking a regional (and not a local) perspective. However, these will be examined locally, whether this is considered desirable, feasible or whether deviations are required (Jesse *et al.*, 2020).

When reflecting on the approach in which the RES process has been set up, there are basically two differing rationales: either technocratic or socio-political. In defining the RES approach, national government by means of NP RES develops metagovernance that applies a presumably depoliticised, yet managerial and technocratic approach into co-designing of RESs at the regional level. This gives a false impression. Energy transitions should not be considered merely a technological nor political affair. According to the Participation Coalition, it should be seen as primarily a social transition, in which social involvement is a requirement and must be supported by technology and politics (Participatiecoalitie (Natuur en Milieufederaties *et al.*, 2020). The two are inherently depending on each other. And technological and systemic choices will inevitable bear a highly sensitive political impact, and vice versa. One way in which this manifests is the energy regions setting quantitative ambitions, which inherently depends on making technical choices supported by regional socio-cultural and economic interests. The PBL calculation of draft RES bids showed that energy regions favour solar over wind energy. From a spatial and social-legitimacy perspective this makes a lot of sense. However, preferring solar energy is more expensive in the end. Moreover, the yield from wind turbines on the one hand and solar parks on the other is out of proportion resulting in higher social costs (van Santen, 2020). Although this looks odd from the perspective of deployment of generation capacity as a liberalised activity in energy markets, which is assumed to be simply be carried out by agents according to market forces – this reflects a new practice in the Netherlands in which regional policy preferences in renewable energy generation work through in spatial policy, which inherently prefers  local community values (in favour of solar parks) to economic gains by market parties and those only seeking utility or profit maximisation (in favour of wind parks).

### 4.2. **Lack of transparency in costs and benefits**

There is a contradiction in the current approach to regional energy transition. Whereas the Climate Agreement and the RES approach were conceived centrally, implementation and realisation will take place locally. For the energy regions, this means installing a substantial number of large-sized wind turbines and sacrificing (agricultural) land to construct solar power installations. Arguably, without the pressure from NP RES many of the current energy regions would not have considered formulating RESs.

It may be expected that the RESs provide insight into the costs and benefits and weigh the risks against reaching the intended goals. This could include inevitable burdens for citizens (in terms of costs induced by the installation of in particular wind turbines and to a lesser extent solar parks, like disturbed horizon esthetics, decreased crop yield for farmers due to shadow working, assumed detrimental impact on health, noise, and assumed decrease of property prices) in the energy regions should probably be compensated where possible. However, thus far little has been established on how to do this (Jesse *et al.*, 2020). In addition, according to assessment of some of the draft RESs by the ‘Green Audit Office’ costs and risks are hardly mentioned in the draft RES documents. For example, in the North-East Brabant region the draft RES did not estimate the costs involved. Neither did it indicate how security of supply of electricity will be guaranteed, what exactly the damage to the landscape is, the impact of the proposed installations on the living environment, nor the conflict between space-intensive energy and private property law. In summary, the draft RES did not give administrators the opportunity to assess, within the framework of the general principles of good governance, whether the task is feasible within a budget acceptable to the region (not assuming the costs market parties have to make for investment in renewable energy generating plants, nor DSOs making investments in adjusting regional electricity grids to cope with increased distributed generation) and whether the final situation will be acceptable to its citizens. In addition, the Green Audit Office argues that the tone used in the draft RES is excessively positive; it gives the impression of an advertising brochure (Jesse *et al.*, 2020). In summary, insight and transparency in current costs and benefits at the systems level of RET in energy regions is currently lacking.

### 4.3. **Lack of governing capacity**

In order to fulfill their role in the energy transition decentralised administrative bodies – in particular municipalities – need sufficient governing capacity (Vringer, de Vries, & Visser, 2021). This is hardly the case among those involved in RES processes. As RES formation is something new to them, energy regions did recently not exist, and knowledge is lacking, public officials are confronted with a great deal of novelties and unknowns. Moreover, this all takes place in difficult times with high demand on municipalities that are subject to budget cuts (in general regarding budgets necessary for local public service delivery; not related to renewable energy generation of some sort), and are suffering from limited capacity (van den Akker, Buitelaar, Diepenmaat, Heeger, & van Vliet, 2019). Currently, small and medium-sized municipalities suffer from a lack of experience in multiple ways, from being understaffed – with the environmental officials working part-time on RES assignments, to lacking knowledge in energy planning, lacking key competences like leadership, strategic orientation and situational awareness, conceptual ability, negotiation skills and flexibility. Extra capacity is needed, but given the tightness of the labor market, it is questionable whether this will be available in time (Participatiecoalitie Natuur en Milieufederaties *et al.*, 2020).

Capacity problems are not limited to public organisations, though (Van den Akker *et al.*, 2019). Social housing associations and REScoops have thus far only played a limited role, and have not released much capacity. And although distributed system operators (DSOs) have some capacity they still expect problems when RESs reach the implementation phase. A survey by the Platform 31 – a knowledge and network organisation addressing trends within cities and regions – identified inadequate workforce as a big problem (Van den Akker *et al.*, 2019). As a consequence to a lack of capacity among decentralised governments the RES tasks are outsourced to project organisations, staffed by civil servants and externally hired workers from consultancy agencies, who have to work with market parties and DSOs to find suitable and profitable locations for solar fields and wind farms (Rengers & Houtekamer, 2020). This might conflict with the ability of public organisations to learn from these experiences themselves, developing know-how among their staff members, and building capacities of their own. In a sense, it keeps them dependent on market parties.

### 4.4. **Fit with current institutional frameworks**

As RES can be considered a governance novelty, and an issue that covers multiple societal domains, it is insufficiently connected with existing institutional frameworks. A number of problems manifest when RES plans are drafted and are considered against current regulations and policies, with a number of legal and policy barriers occurring. This includes barriers encountered in the following regulatory domains: (i) the heating system legislation missing instruments to support the heat transition; (ii) the Energy Act too much limiting the role of DSOs; (iii) provincial and municipal policy opposing wind energy generation; (iv) nature preservation legislation ex Natura 2000; (v) regulation regarding radar and low flight routes; (vi) landscaping and heritage regulation, i.e. 'the New Dutch waterline' and Unesco areas; the Nature Conservation Act with regard to bats and protected bird species (Energiestrategie, 2019a).

Next to conflict with current regulations, there are many practical problems with the main economic incentive policy to those wanting to plan and operate wind and solar energy projects: i.e. the SDE++ subsidy (in English: Sustainable Energy Incentive Scheme; focusing on the generation of renewable energy and lowering of $CO_2$ emissions) from the Dutch Ministry of Economic Affairs and Climate Policy (which finances the scheme, not the energy regions themselves). The SDE++ incentive entails a subsidy and works as a Feed-in Tariff. The problem with SDE++ has to do with the fact that renewable energy (and low carbon) projects must be completed within three years (the many projects that take more time to realise are excluded), the subsidy system having flaws while being of little use to small energy consumers and farmers (Ibid.). Needless to say, these issues should be addressed to avoid hindering RES implementation over the next years. Anchoring a RES in a legitimate spatial legal framework is of key importance. Here, good timing of the processes for the legal anchoring of the RESs and coordination between municipalities, provinces and central government are of great importance. Another issue concerns the moment at which the (new) Environmental Act will enter into force (this Act also covers important spatial legal frameworks). This needs careful alignment with RES planning and implementation (Ibid.) although it does not cover energy regions themselves because they are formally not existing.

### 4.5. **Efficiency and optimisation problems with regional energy systems**

RES formation also encounters a number of problems that play out at the system level. For example, plans are developed that only focus on solar and wind energy generation but fail to address distribution and transmission, and energy system planning in general. A particular issue concerns limited net capacity. For example, this caused serious problems in the case of the RES in the Zealand energy region. The number of solar panels and wind turbines on the Schouwen-Duiveland and Tholen peninsulas had increased so much over recent years that the power grid in

North Zealand could not cope with it anymore. However, new large-scale solar and wind farms were already planned in the RES but would not be able to feed electricity back into the grid any more. According to the DSO's spokesman the power grid is almost at its limit. Solving this problem would require making an extra connection to the national high-voltage grid with construction. This would take seven to ten years approximately (Balkenende, 2020).

Other electricity system problems derive from focusing on optimising RESs within energy regions, while neglecting interconnectedness and interdependency between energy regions. More in general, RES formulation bears the risk of affording poor attention to efficiency and system optimisation (Matthijsen *et al.*, 2021), which is surprising because system integration and optimisation are becoming one of the key objectives in the EU energy and climate policy. «Only making the power system more sustainable does not work, certainly not within the boundaries of the energy regions. The RES process is a very good process, with bottom-up participation, but no thought has yet been given in terms of optimisation and system efficiency», according to a spokesperson of DSO Liander (van Santen, 2020).

Taking a systems perspective, the RES process approach can be criticised in four ways: First, the energy proposals from the energy regions (in the draft RES) largely consist of an «ambition» that has not yet been translated into concrete search areas. Although the ambition is generally high and considered realistic (by those involved from energy communities), it is not explicated where exactly the intended solar fields and wind farms are to be sited. Second, energy regions have paid a lot of attention to solar energy generation and have a preference for small solar parks and low wind turbines. This is because they have clear reservations against large scale wind parks and the negative impact they have locally. The combination of sun and wind is hardly ever made. This also means that many substations and cables will have to be installed, with additional effects on space and the landscape and on the wallets of citizens. Third, although there is sufficient ambition for the generation of sustainable energy, this is lacking for energy saving. Finally, there is hardly any coordination between the different energy regions. Moreover, what is (still) missing in many places is an elaboration of the spatial integration and how nature and landscape are included or weighed in this (Participatiecoalitie, Natuur en Milieufederaties *et al.*, 2020).

### 4.6. **Fair participation and the role of community energy**

In all energy regions REScoops have participated in the process toward developing a draft RES document. In a number of energy regions, the energy cooperatives have a place at the table, in a broader steering group or in the program council. If there is a regional REScoop branch organisation, then representation takes place organised under that flag, with the latter supporting local REScoops in their interaction with the municipalities and other stakeholders.

*Table 1.* **RESULTS OF THE GOVERNANCE ASSESSMENT ANALYSIS**

| Governance dimension | Current situation with regard to governing RET |
|---|---|
| (i) Levels and scales | • All relevant tiers of government are involved - i.e. national, provincial, local.<br>• A seemingly coherent metagovernance structure is implemented in the form of NP RES, with guidance of vertical and horizontal coordination and conflict resolution issues, yet in the absence of formal codification.<br>• However, decentralised government bodies interact less coherent and with great variation. This applies to intensity, with national and provincial government and community energy showing fairly high intensity, but with variation among municipalities. |
| (ii) Actors and networks | • Actor involvement and interaction mostly concerns public sector organisations.<br>• Semi-public actors like DSOs are involved as well, but involvement of business, citizens and community energy varies.<br>• In many regions RES formulation and implementation is a one-sided affair; there is an over-representation of supply-side energy market actors, and under-representation of demand-side actors. |
| (iii) Problem perceptions and goal objectives | • RES goals and strategies give the impression that perceptions about RES objectives are shared among those actors involved.<br>• Yet, this is misleading, as national government on the one side and regional actors on the other have diverging interests and view problems differently (including NIMBY-ism and a feeling that costs and benefits are not equally shared between central and decentralised actors). |
| (iv) Strategies and instruments | • In the 2016-2021 period congruence between goals and strategies, and alignment between strategies and instruments, as well as policy coherence have increased. The NP RES metagovernance structure was basically designed to support this.<br>• In the meanwhile essential supportive incentive policies like the renewable energy supporting scheme (from SDE+ to SDE++) have been adjusted to support regional and cooperatively developed project in the near future.<br>• Nonetheless, a lot is still unclear about the overall policy mix on how the State is going to support regional actors. This leads to uncertainty and standstill with regional actors taking a passive, waiting attitude.<br>• Enforcement and accountability have hardly been arranged in a formal sense. Compliance is based on mutual trust developed during intergovernmental deliberation processes. |
| (v) Responsibilities and resources | • Responsibilities have been assigned among most actors, but those assigned to the energy region lack a formal legal position. With the dispersion of decentralised decision-making power and a lack of political and socio-economic priority in municipalities commitment to goals and compliance to joint regional strategies is not sure.<br>• Moreover, governing capacity at most decentralised and executive bodies is below par. This basically also applies to civic and community energy organisations in participatory processes.<br>• Critical resources appear unevenly distributed in favour of national government, commercial project developers, energy companies and DSOs. |

*Source*: own elaboration.

In the translation into policy visions and frameworks of municipalities and provinces, attention is paid to the conditions for participation of the environment, and in particular, the pursuit of ownership of the local environment. In 2020 national government came up with a proposal for developing a new economic incentive to support collective renewable energy production, which is crucial to the REScoop movement (a new version to the so-called 'zip code rose' scheme (Kooij, Lagendijk, & Oteman, 2018). A renewed subsidy scheme starts in 2021 (with a new, simplified subsidy scheme based on performance / production (in kWh) (Schwencke, 2021).

Although citizens and REScoops participating in RES processes is of great social important value, one should not forget that this sometimes causes problems for REScoops, because they mostly rely on voluntary involvement of citizens. According to a REScoop spokesman, «There are too little (REScoop) volunteers involved in the process who constantly encounter paid employees from the municipality, province, DSOs and others. The enthusiasm to sit at the table unpaid is declining» (Schwencke, 2021) (p.17). However, participating in the RES process seems to have also benefitted REScoops. In the North-Holland province (covering multiple energy regions), «The position of the cooperatives has become much stronger during the RES period. The cooperatives are required to complete 50% local ownership. Municipalities and project developers engage with local REScoops. This is in their benefit as project developers do not receive a legal permit without active involvement of residents (i.e. REScoops). REScoops are having an impact and that is clearly noticeable behind the scenes. Their role is (institutionally) reinforced by the RESs.» (Schwencke, 2021) (p.18).

### 4.7. **Governance assessment**

Based on the information presented in this section the governance quality of the NP RES metagovernance was assessed using the Governance Assessment framework (Bressers *et al.*, 2016). The results reveal that although governance structures have increasingly developed since 2016 – in large part due to the formation and implementation of NP RES – a number of challenges remain. These include involvement of and compliance by municipalities (where essential decision-making takes place), lack of involvement of civic and business sector actors, a difference in problem perception and socio-technical solutions proposed between central and regional actors, lack of capacity among actors who are key in the implementation stage, and limited, uncertain policy instruments made available to support RES implementation. An overview of the results are presented in Table 1.

## 5. **CONCLUSION**

The present paper started with the following research questions: What insights can be taken from the governance of regional energy transition in the Netherlands between 2016 and 2021, as a country experimenting with innovation of governance at the regional scale?

First, RET can be considered a very complex issue, in terms of multi-actor involvement and interdependency, institutional fit, and because of its immerse socio-technical nature and inherent socio-political character. Second, to cope with this complexity and the transformational nature of the issue demonstration pilots were organised, taking an 'experimentation and learning' approach, using co-creative settings (somewhat in line with Transition Management (Kempenaar *et al.*, 2020; Loorbach, 2007; Loorbach & Rotmans, 2010). Third, the Dutch case revealed that metagovernance (Jessop, 2016) was applied to structure governance arrangement in a way to manage complexity, create focus, and develop a stepwise time plan that was to be followed by all regional partners in all thirty 'energy regions' in the nation, while using a policy 'blueprint' for RES formulation. Fourth, the case revealed that a number of pressing issues emerged that cannot be left untouched by policymakers if they want to avoid the RET process from derailing. These issues concern: making a trade-off between top-down and bottom-up governance; a lack of transparency in costs and benefits; a lack of governing capacity; fit with institutional frameworks; efficiency and optimisation problems of energy system; and assuring fair participation and the role of community energy.

To assess the overall quality of NP RES a governance assessment analysis was conducted. This showed that involvement and compliance of crucial administrative bodies can be considered a risk to the collective enterprise; that there is a lack of involvement of civic and business sector actors; that there are differences in problem perception and socio-technical solutions proposed between central and regional actors; that there is a lack of capacity among actors who are key in the implementation stage; and that limited, uncertain policy instruments have been made available by central government to support RES implementation.

Energy transitions should not be considered merely a technological nor political affair. According to the Participation Coalition it is primarily a social transition, in which social involvement is a requirement and must be supported by technology and politics. In sum, a lot has been done and has been achieved in the Netherlands (against many odds), but the future is far from sure, because many things have not been arranged formally, key decentralised authorities lack capacity to act, there is uncertainty about the resources made available by central government to incentivize market actors and community energy initiatives, there is civic unrest regarding the installation of large-scale wind parks, solar plants and heating infrastructures in the country. Moreover, these are only a few of the challenges ahead. Next to these issues are more criticisms to the RES approach. For example, there is little to no detail about the wind and solar installation sites, and there is a lack of inter-regional coordination. Several questions arise: Is the RES process realistic?; Is there a stable governance configuration or is it too loosely organised? How is the vertical coordination institutionalised, with sufficient regulations and policies to address emerging issues? And should the RES approach not be seen as merely a disguised approach for central government to gain more vertical control over decentralised public authorities? And can the RES approach be perceived as a stable governance arrangement to support the RET and the ET of the country as a whole? Can it be expected to work without further institutionalisation? And how is the RES eventually enforced when regional partners do not comply anymore with agreements prior made on contribution to collective action?

The present study has limitations that need mentioning. First, the NP RES is an ongoing public program, and cannot be evaluated from a policy perspective because it has not finalised yet. Second, the present study mostly used secondary data. Third, no quantitative overview nor analysis was given, although overviews are available by now (see the following report by PBL: (Matthijsen *et al.*, 2021). Fourth, the present study focused on the general governance approach taken (i.e. metagovernance) and did focus on analysing a specific energy region in-depth (see for an example: (Hoppe & Miedema, 2020).

Based on the results of the present study, the following recommendations for future research into the governance of RET are given. Attention can be paid to: the role of public values in RET; i.e. inclusiveness, energy justice (energy poverty, energy democracy, distribution of costs and benefits) (Jenkins, McCauley, Heffron, Stephan, & Rehner, 2016); the ways citizen engagement and co-creation are used (Breukers, 2007; Itten, Sherry-Brennan, Hoppe, Sundaram, & Devine-Wright, 2021; Wolsink, 2007); the ways  processes are managed (De Bruijn, 2010; van der Steen *et al.*, 2020); the role of social innovation (Hoppe & de Vries, 2019; Wittmayer *et al.*, 2020); the use of participatory and multi-modelling approaches to explore RES impact and scenarios (Cuppen, Nikolic, Kwakkel, & Quist, 2020); transition ateliers and regional transition labs (Kempenaar *et al.*, 2020; Loorbach & Rotmans, 2010); and compliance and enforcement.

Finally, based on the results of the analysis a few suggestions to policymakers can be made. This is not to suggest that energy regions – without any formal legal status – should be conceived and implemented in countries outside the Netherlands. Nonetheless some positive lessons can also be drawn from the RES approach taken. First, it is advised that policymakers consider an approach to energy transition with onshore wind and solar parks that is not only organised at the central level but also at the regional level. It is recommended to actively, pursue public participation of citizens and regional stakeholders in decision-making processes. Once wind or solar parks are constructed solid societal acceptance is a must. Here it is also advised to work with civil society movements and organisations, in particular REScoops seeking partial ownership in wind and solar parks. Second, before running a regional governance approach to energy transitions it is advised to hold regional experiments, and test participatory approaches and incentives to RET. It is important that all relevant stakeholders from the (selected) energy system are involved, and not only supply side actors. Moreover, processes in these experiments are advised to be properly managed by experienced, external process managers. Building inter-actor trust (also between central and decentralised authorities) is of eminent importance. Third, when considering a RET governance approach covering multiple energy regions in a given country it is important to develop a proper metagovernance structure, which contains the goals and frameworks that have consent from all central and decentral authorities involved. This process necessitates the involvement of experienced professionals and public officials. Lessons can also be taken from domains in which other regional governance arrangements are used. A structure that only merits central government's preferences is not to be appreciated, and will not work locally. Policymakers of decentralised authorities should also avoid that the structure is used by central government to gain more vertical control. The metagovernance structure should also comply with national and EU rules and laws. At the national level it should comply with other key policy domains that are of indispensable nature to energy transitions, like spatial policy. Fourth, the metagovernance structure should also deal with the capacities problem. Where capacities are limited capacity building efforts are required. Fifth, rules about management, (non-)compliance, distribution of effort and calculation method, monitoring, evaluation and enforcement should be made, and shared among those actors involved. A network organisation can be established to communicate and coordinate with RES actors per region.

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## APPENDIX
## ENERGY REGIONS IN THE NETHERLANDS


*Source:* NP RES (2021): De 30 RES Regio – https://www.regionale-energiestrategie.nl/documenten/handlerdownloadfiles.ashx?idnv=1333848

# *The opportunity for smart city projects at municipal scale: Implementing a positive energy district in Zorrozaurre**

**The urgency of climate change is demanding new urban energy transition processes that will be accelerated by the implementation of innovative urban solutions. This paper proposes a three-step methodology to encompass the energy transition in cities. Firstly, the design of urban spaces in accordance to Positive Energy District (PED) concept is defining a very ambitious objective that will lead the development and implementation of innovative urban approaches. Secondly, the implementation of Urban City Labs is proposed for testing and demonstrating urban innovations at real scale as reasonable approach for consolidated urban landscapes. Thirdly, energy transition is demanding new governance mechanisms where top-down and bottom-up perspectives are continually combined and harmonized. ATELIER H2020 is accelerating the demonstration of this methodology at the recently defined PED in Zorrozaurre (Bilbao, Basque Country).**

*La urgencia del cambio climático está demandando nuevos procesos de transición energética que acelerarán el desarrollo soluciones innovadoras. Este artículo propone una nueva metodología en tres pasos que acompañará procesos de transición energética. En primer lugar, el diseño de espacios urbanos de acuerdo al concepto de Distrito de Energía Positiva (DEP) define un objetivo muy ambicioso que liderará el avance de nuevas perspectivas de desarrollo urbano. En segundo lugar, se propone el concepto de City Lab para el testeo y demostración de soluciones a escala real en ciudades de estructuras urbanas muy consolidadas. Por último, la transición energética está demandando nuevos mecanismos de gobernanza donde se combinen y armonicen estrategias de largo plazo con procesos participativos bottom-up. El proyecto europeo ATELIER – H2020 acelerará la demostración de esta nueva metodología en el DEP de Zorrozaurre (Bilbao, Euskadi).*

Klima-aldaketaren larritasuna dela eta, energia-trantsizioko prozesu berriak behar dira, irtenbide berritzaileen garapena bizkortzeko. Artikulu honek hiru urratseko metodologia berria proposatzen du, energia-trantsizioko prozesuekin batera. Lehenik eta behin, Energia Positiboaren Barrutiaren (EPB) kontzeptuaren araberako hiri-espazioen diseinuak asmo handiko helburu bat definitzen du, hiri-garapenerako ikuspegi berrien aurrerapena gidatuko duena. Bigarrenik, City Lab kontzeptua proposatzen da garapen urbanoa oso finkatua duten hirietan eskala errealeko soluzioak probatu eta erakusteko. Azkenik, trantsizio energetikoak gobernantza-mekanismo berriak eskatzen ditu, epe luzeko estrategiak eta bottom-up partehartze prozesuak konbinatu eta bateratzeko. Europako ATELIER – H2020 proiektuak bizkortu egingo du metodologia berri horren erakustaldia Zorrotzaurreko EPBn (Bilbao, Euskadi).

* Spanish version available at https:/euskadi.eus/ekonomiaz.

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**Keywords:** positive energy district, smart cities, city labs, two-way governance, bottom-up collaborative approaches, quadruple helix methodology.

**Palabras clave:** distrito de energía positiva, ciudades inteligentes, gobernanza bidireccional, modelos de participación ciudadana, metodología cuádruple hélice.

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## 1. INTRODUCTION

Europe has a strongly consolidated urban structure, which is generally linked to the history of the territory, the landscape and environmental conditions, and of course, to geographical boundaries (González Medina and Fedeli, 2015). Many European cities have few opportunities to test or deploy any real-scale urban innovations that can be extended beyond the scale of individual buildings to neighbourhood or district level. At the same time, the world has become increasingly urban with the great majority of the population now living in built-up areas. It is estimated that 54.5% of the world's total population of 7.4 billion now live in urban areas, and by 2030, this proportion is projected to rise to 60% (Pérez *et al.*, 2019).

Cities now account for approximately two-thirds of global energy consumption and about 75% of worldwide $CO_2$ emissions. These emissions result in a deterioration of air quality and speed up the climate change, contributing to its detrimental effects and posing a enormous stress on cities. Air pollution causes an estimated 4.2 million premature deaths worldwide, while over 91% of the world's population is exposed to toxic air (Kusch-Brandt, 2019), (Petrillo *et al.*, 2016), (Castillo-Calzadilla *et al.*, 2018). As a consequence, over the last decade, a number of global targets have been set for cutting greenhouse gases and pollutant emissions, with a view to tackling climate change and ensuring better air quality in cities. These include the goals established in the Paris Agreement (United Nations, 2015) and more recently, in the European Green Deal (European Commission, 2019a). The European Green Deal provides a holistic framework for resource efficiency, clean and circular economy, low environmental impact and pollution reduction. Its ultimate aim is to achieve climate neutrality in the EU by 2050. The smart city concept has been developed to provide new answers for the European agenda.

Smart Cities are becoming one of the cornerstones of the push for energy neutrality, resource efficiency and high standards of well-being (European Environment Agency, 2015)major environmental challenges remain which will have significant consequences for Europe if left unaddressed. What differs in 2010, compared to previous EEA European environment – State and outlook reports, is an enhanced understanding of the links between environmental challenges combined with unprecedented global megatrends. This has allowed a deeper appreciation of the human-made systemic risks and vulnerabilities which threaten ecosystem security, and insight into the shortcomings of governance. The prospects for Europe's environment are mixed but there are opportunities to make the environment more resilient to future risks and changes. These include unparalleled environmental information resources and technologies, ready-to-deploy resource accounting methods and a renewed commitment to the established principles of precaution and prevention, rectifying damage at source and polluter pays (Martin, Henrichs and Eea, 2015. They can significantly improve energy savings, close the circle of resources (including materials and water) and foster healthier lifestyles, with open spaces becoming more abundant and connected to classic infrastructures. Smart and sustainable cities are expected to be a key feature in achieving energy transition and resource efficiency in Europe. They can potentially deliver significant energy savings and increased resource efficiency, in harmony with the cultural aesthetics of the urban and natural landscape. Technological and scientific advances –especially when integrated with one another– offer a rich pool of solutions that can help make cities a more sustainable place to live (Angelakoglou *et al.*, 2019).

At the same time, the scope of energy transition and smart city projects is increasing, with an ever-increasing use of terms such as ‘zero building blocks’, ‘zero energy buildings’, ‘zero net energy‘ and ‘zero energy districts’ (Charron, 2008); (Pandey *et al.*, 2015); (Cao, Dai and Liu, 2016); (Taherahmadi, Noorollahi and Panahi, 2020). In recent years, the ambition behind such projects has widened and Europe is now championing Positive Energy Districts as a fundamental unit for the design and planning of smart cities. The concept of the Positive Energy District (which is still under development) entails defining a set of inter-connected buildings that can together achieve a positive energy balance.

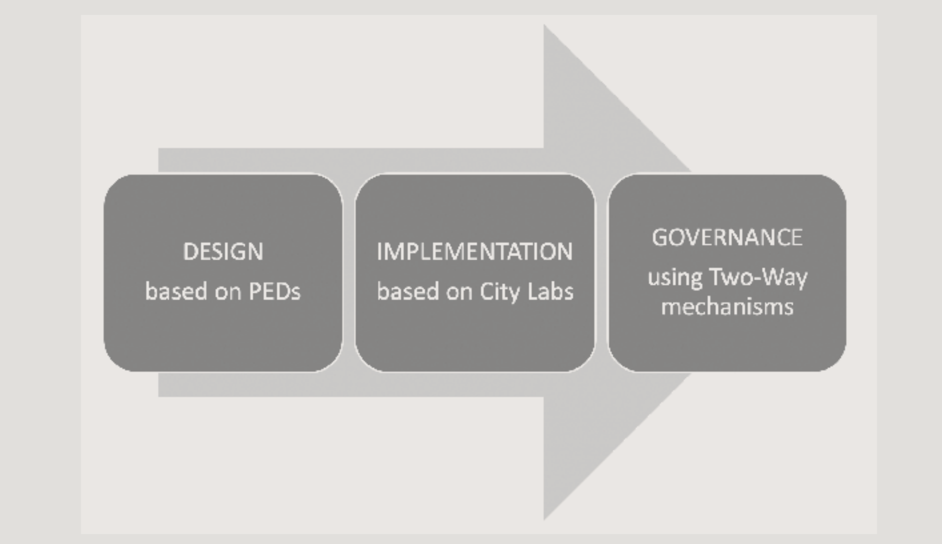
This evolution in smart city projects must go hand in hand with the definition of new strategies of governance. City governance is immensely complex, with a multifaceted and multi-level ecosystem of agencies and stakeholder groups (e.g. local governments, citizens and urban planners), often driven by conflicting interests. As a result, (smart) cities require a proper system of governance to connect all the different forces at work, enable knowledge transfer and facilitate decision-making in order to maximize their socioeconomic and environmental performance (Ruhlandt, 2018).

The main objective of the paper is to propose a new methodological approach to guide the design, implementation and governance of cities in view of leading an energy transition process. The paper includes four main sections. After introducing the main international concerns and demands, Section 2 defines the main methodological proposal that would guide future cities in leading energy transition processes. Section 3 details the case study presenting ATELIER H2020 project and the Positive Energy District proposal in Zorrozaurre island (Bilbao). Section 4 presents the main results organised according to the three methodological steps. Finally, Section 5 draws out the main conclusions of this research and provides some policy feedback in view of inspiring similar initiatives in the Basque Region.

## 2. METHODOLOGY

This paper proposes a new methodology that would pave the way transforming cities and comply with energy transition strategies. The new methodology (Figure 1) includes three main stages for the design of new urban areas, the implementation of innovative solutions and the governance of cities where citizens are at the centre. This new methodology assumes a continue calibration of citizen requirements that will be naturally embedded and articulated all along the city building process:

*Figure 1.* **THREE-STEP METHODOLOGY FOR ENERGY TRANSITION IN CITIES**




*Source:* Own elaboration.

- Design: Innovative urban designs based on the definition of Positive Energy Districts (PEDs) are defined as a group of connected and neighbouring buildings that produce more energy than required, in terms of lighting, heating, cooling and ventilation (see Section 4.1). The challenge in terms of energy efficiency, uptake of renewable energies, and integration of systems and solutions that allow energy flexibility is huge, but also required given the effects of climate change. On the other hand, the definition of PED as a main functional unit for urban development is a promising idea since PEDs may work as operational units that are completed (design of open spaces, buildings, iteration of neighbours) and easily replicable along the entire city.
- Implementation: Testing and demonstrating innovative solutions in City Labs. The deployment of smart and integrated solutions in European cities is a challenging objective given the consolidation of urban areas, the average age of the population, and the investment costs of the solutions. Urban City Labs (see Section 4.2.1) are conceived as urban laboratories where innovative solutions can be deployed and tested in relatively controlled environments because of the scale, the number of people affected, or the geographical situation of the area. This methodology presents City Labs of different scales that move from building scale to city scale, which makes the proposal valid for any city independently of the degree of urban development or urban consolidation.

- Governance: Smart collaborative schemes keep cities alive and connected. The success of any innovative urban design or development is going to be connected to the extent to which citizens are being involved all along the process of design, implementation and governance of the urban areas, i.e. they need to become active part of the solution. Cities need to combine top-down and bottom-up collaborative approaches where strategic objectives are analysed and assessed with respect to particular perspectives and feelings. At this point, we propose a two-way governance mechanism (see Section 4.3) that provides a flexible and comprehensive approach where all stakeholders can easily identify where they are, what they can do, and how they will be able to proceed.

## 3. CASE STUDY

ATELIER is an H2020 innovation action (Grant Agreement: Nº 864374) that belongs to Smart City and Communities (SCC) cluster of innovation projects. The ATELIER operative includes 30 partners from 11 countries that will collaborate and work together for a period of five (5) years. The action has a total budget of -21 million that will serve to deploy and validate new methodologies, urban designs and smart solutions that will be monitored and evaluated showing that positive energy districts are possible.

### 3.1. Smart cities and communities partnership

ATELIER has been founded by SCC1 – Smart Cities and Communities open call (of H2020 program) and therefore it becomes automatically part of the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) (Smart City Expo World Congress, 2016). This initiative is supported by the European Commission and brings together cities, industry, SMEs, banks, research facilities and other smart-city actors. EIP-SCC provides action clusters, guides and toolkits, marketplaces for investors, etc. with the ultimate goal of improving the quality of life of European citizens. The partnership builds up a wide network of European cities that share knowledge and gain support in finding solutions that will improve the social, environmental and economic performance of their cities. The SCC partnership activity is geared towards strengthening the links between existing European smart city networks and platforms, especially those that have been funded under the SCC1 H2020 programme. Table 1 lists the projects funded since 2015.

*Table 1.* **LIST OF HORIZON 2020 SMART CITIES AND COMMUNITIES SINCE 2015**

| Call ID | Call focus | Project Names | Duration | Project Website |
|---|---|---|---|---|
| H2020-SCC-2014-2015 | Solutions integrating energy, transport, ICT sectors | RemoUrban | 2015-2019 | http://www.remourban.eu/ |
| | | GrowSmarter | 2015-2019 | https://grow-smarter.eu/home/ |
| | | Triangulum | 2015-2020 | https://www.triangulum-project.eu/ |
| | | Sharing Cities | 2016-2020 | http://www.sharingcities.eu/ |
| | | SmartEnCity | 2016-2021 | https://smartencity.eu/ |
| | | Replicate | 2016-2021 | https://replicate-project.eu/ |
| | | Smarter Together | 2016-2021 | https://www.smarter-together.eu/ |
| SCC-1-2016-2017 | Solutions at district scale: smart homes and buildings smart-grids, EVs and ICT tools | RuggedISED | 2016-2021 | https://ruggedised.eu/home/ |
| | | MySMARTLife | 2016-2021 | https://www.mysmartlife.eu/ |
| | | MAtchUP | 2017-2022 | https://www.matchup-project.eu/ |
| | | IRIS | 2017-2022 | https://www.irissmartcities.eu/ |
| | | StarDust | 2017-2022 | https://stardustproject.eu/ |
| LC-SC3-SCC-1-2018-2019-2020 | Positive energy blocks/districts | CityxChange | 2018-2023 | https://cityxchange.eu/# |
| | | Making City | 2018-2023 | http://makingcity.eu/ |
| | | POCITYF | 2019-2024 | https://pocityf.eu/ |
| | | SPARCS | 2019-2024 | https://www.sparcs.info/ |
| | | ATELIER | 2019-2024 | https://smartcity-atelier.eu/ |

*Source:* Own elaboration.

## 3.2. ATELIER Innovation Action

ATELIER is a smart city project that demonstrates Positive Energy Districts (PEDs) within eight European cities with sustainability and carbon neutrality as guiding ambitions. Amsterdam and Bilbao are the Lighthouse cities that will generate an energy surplus of 1,340 MWh measured in terms of primary energy and prevent 1.7 kt of $CO_2$ and 23 t of NOx emissions. Together with district users, ATELIER will showcase innovative solutions that integrate buildings with smart mobility and energy technologies to create a surplus of energy and balance the local energy system. Bratislava, Budapest, Copenhagen, Krakow, Matosinhos, and Riga are the Fellow cities that will replicate and adapt successful solutions.

All cities will establish a local PED Innovation Atelier to co-produce locally embedded, smart urban solutions. In the ateliers (see Section 4.3.3), the local innovation ecosystem (authorities, industries, knowledge institutes, citizens) is strengthened, enhancing embeddedness and removing any obstacles (legal, financial, social, etc.) for implementation of the smart solutions. The ateliers are engines for upscaling solutions within the ATELIER-cities and replication to other EU-cities. ATELIER integrates a high degree of citizen engagement throughout the project, by actively involving local residents, local initiatives, and energy communities in activities to align the technical solutions with citizens' objectives and personal perspectives. Each of the cities will develop a City Vision 2050 (see Bilbao Bold City Vision in Section 4.2.2) that creates the roadmap for upscaling the solutions to the entire city.

ATELIER has the ambition to pave the way for «energy positive cities» in Europe. All ATELIER activities will be monitored (socially and technically), and lessons learned are systematically drawn and disseminated to relevant stakeholder groups, city networks, and innovation forums.

### 3.3. **Positive Energy District (PED) in Zorrozaurre island**

ATELIER defines two Positive Energy Districts in Bilbao and Amsterdam, respectively. The Positive Energy District of Bilbao is defined as the sum of specific interventions in Zorrozaurre, located in specific areas in the North, Centre and South of the island (Figure 2). Three sets of connected buildings will be deployed conforming the PED of Bilbao demonstration site. These three specific areas will be continually monitored in terms of energy consumption and generation, electro-mobility uptake, ICT integration, citizen participation, etc. This system represents a very special City Lab and a major step forward for the decarbonisation of the island. The outcomes of PED implementation will be scaled up to the entire city of Bilbao according to the Bilbao Bold City Vision.

The district has a 5th generation district heating based in low temperature geothermal energy, photovoltaic panels, a smart-grid, increased e-Mobility capacity, energy storage capacity, smart street furniture and smart lighting systems. New-generation smart meters will be installed in the three areas of the PED demo. Demand response solutions and energy community self-generation sharing will be implemented and validated. The aim is to continue developing functions that provide added value for clients, including services that increase flexibility and allow active demand management.

*Figure 2.* **SATELLITE VIEW OF ZORROZAURRE ISLAND SHOWING PED LOCATION**


*Source:* Bilbao City Council.

Energy flexibility will be enabled through the use of smart metering devices, Smart Building Energy Management Systems (smart BEMS) and an overarching Energy Management System (EMS) that will aggregate BEMs and other smart district consumption (public services, storage systems, heat pumps, EV operators, etc.). The EMS will work as an 'Energy Trading Coordinator', providing prosumers and energy communities with an active demand response approach that effectively coordinates and deploys local resources to balance energy supply and demand, while at the same time activating different flexibility business models.

New substations with advanced control capability will be installed. Inter alia, these will have new functions for managing a Low Voltage (LV) network, a high penetration of flexible distributed resources and new services to improve flexibility, etc. The smart secondary substation will introduce supervisory architecture and advanced control for network optimization (reduction in losses and saturation level) which will provide services for customers that give them increased flexibility.

All the actions and smart solutions to be deployed in Zorrozaurre can be summarized as seven strategic interventions (Figure 3). The first three ones refer to the deployment of the North, Centre and South areas of Zorrozaurre whereas the other four ones provide the connectivity and integration of the operational strategies that will be implemented along the entire island. In this sense, the deployment of the 5th generation of geothermal network, the inclusion of renewable energy sources, the advanced operation of the smart-grid, the electro-mobility, and deployment of smart street furniture bring an important added-value to the Zorrozaurre neighbourhood.

The PED in Zorrozaurre is defined as the sum of the deployments at the North Area, the Centre Area and the South Area in the island, which include new and retrofitted buildings; private and public buildings (own by public entities), as well as residential or public-used buildings (mostly service oriented). With this definition, ATELIER ensures an equilibrated portfolio of buildings in terms of isolation profiling, ownership and usage. The transversal interventions are implemented along the entire island. They include:

***Geothermal Network***

The geothermal network is built by 19 rings that will be connected in a flexible manner to optimize the different energy needs. The establishment of a 5th generation district heating implies a reduction in distribution losses, thanks to the possibility of using low temperature fluid network. Moreover, the district heating system is ready to be fuel by other alternative renewable energies (apart from geothermal) or waste heat. The geothermal network is formed by a mix of boreholes and groundwater wells that will be designed and implemented to provide a steady 14 ºC throughout the year. The PED (the sum of the North, Centre and South areas) are connected only by four rings.

***Smart Grid***

The smart grid integrates the following elements:

- Smart metering devices will provide new functionalities that offer added value to end-users, including the flexibility for the consumer to provide services, mainly in terms of active demand management.
- Energy storage systems will include virtual storage and second life Li-Ion batteries that will ensure energy supply to the entire neighbourhood, balancing the periods with lower Renewable Energy Sources (RES) generation.
- Smart Buildings Energy Management Systems (BEMS) will be implemented to optimise the energy flows and services at building scale. The individual systems deployed at the South, Centre and North area will be connected in view of providing an integrated and optimised management at the PED as a whole.
- Intelligent Secondary Substation for flexible distributed energy resources management will implement advanced control capabilities with new functionalities to manage a low voltage (LV) network. The secondary substation will introduce supervisory architecture and advanced control for network optimisation which includes sufficient intelligence to autonomously perform operations and optimization functions of the LV network.

***Electromobility***

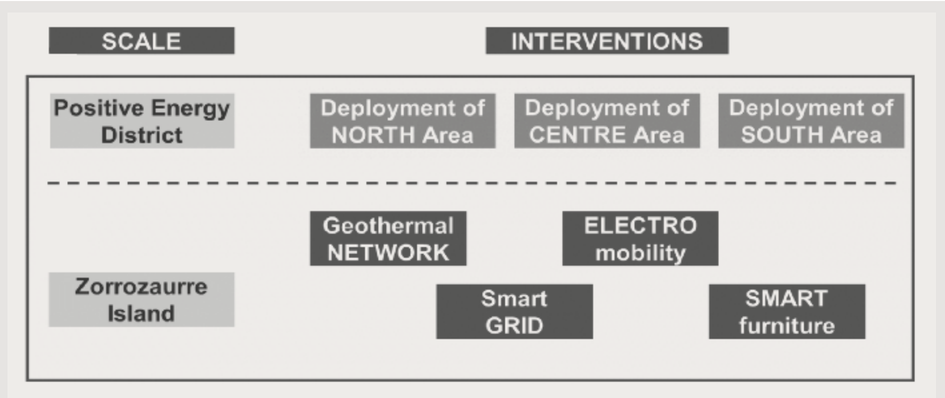
New e-mobility concepts will be integrated within the demonstration area running in parallel with the progressive elimination of surface parking areas for non-electric vehicles. The e-mobility will be facilitated by smart charging systems that include two fast rechargers (around 50 kW each) and two fast-medium rechargers (around 22 kW each); as well as an EV charger (7.2 kW) for an electric boat. The impact of EVs charging in the grid will be minimised with an adequate management of the smart grid operation and the use of energy storage systems.

***Smart furniture***

The Big Data system at Bilbao is designed under a citizen-centre approach. The Zorrozaurre City Lab will progress it by providing innovative big data mechanisms to relate energy data at municipal and district level. Indeed, the possibilities of iteration and the data commons of Bilbao will be enlarged by the deployment of:

- Smart lighting system: city light poles will be acquired and installed allowing the provision of public lighting system fully remotely and automatically monitored and controlled under energy efficiency criteria.
- Interactive bus shelter information points: bus shelters will be equipped with information points in order to inform them about the main sustainability variables (energy flows, storage, renewable generation, etc.) and provide interaction functionalities.

*Figure 3.* **STRATEGIC INTERVENTIONS TO BE TESTED AND DEMONSTRATED IN ZORROZAURRE POSITIVE ENERGY DISTRICT**




*Source:* Own elaboration.

## 4. RESULTS

This section summarizes the results obtained when applying the new three-step methodology for Energy Transition in Cities to Bilbao, and more specifically, to the already presented Case Study: the Positive Energy District of Zorrozaurre.

The results are organised in three sections accordingly to the methodology: design (and motivation) of Positive Energy Districts, implementation of PEDs as City

Laboratories, and the two-way governance mechanism as main instrument for dynamic co-design and co-implementation of the solutions.

### 4.1. **Design based on Positive Energy Districts (PED)**

The concept of Positive Energy District is a direct consequence of the new European energy strategies and commitments. However, this is a very new concept that is still under debate and will continue evolving during next years. First generation of innovation projects based on PEDs are currently being deployed and they will still need three to four years to be assessed in terms of performance, bankability of solutions, integration and collaboration of citizens, etc.

This section analyses both, the evolution of the European energy and climate policies, and the concept behind the term ‘Positive Energy District’.

#### *4.1.1. **European energy and climate policy***

From its origins as the European Coal and Steel Community (ECSC) in 1952, energy always formed part of the agenda of what was to become the European Union, although in the early years –up to the 1970s– relatively little work went into developing a common energy policy.

The two crises of 1973 and 1979 posed a serious challenge to global oil supplies and highlighted Europe’s enormous dependency on crude oil exporting nations (Mitchell, 2010). It was from that point on that the foundations for a common energy policy began to be laid, albeit not without difficulty. This new departure was bolstered by the relationship between energy and environmental policy; while many Member States considered energy to be an issue of strategic national importance, they did not hold the same view of environmental policy and the Council therefore had greater freedom to legislate in this area.

It was against this backdrop that the European Union signed the Kyoto protocol in New York on 29 April 1998 (Howell et al., 2017)and transitioning towards distributed energy systems, facilitated by advances in power system management and information and communication technologies. This paper elaborates on these generations of energy systems by critically reviewing relevant authoritative literature. This includes a discussion of modern concepts such as ‘smart grid’, ‘microgrid’, ‘virtual power plant’ and ‘multi-energy system’, and the relationships between them, as well as the trends towards distributed intelligence and interoperability. Each of these emerging urban energy concepts holds merit when applied within a centralized grid paradigm, but very little research applies these approaches within the emerging energy landscape typified by a high penetration of distributed energy resources, prosumers (consumers and producers, under which industrialised nations committed to implementing a series of measures aimed at reducing greenhouse gas emissions by an average of 5% over the period 2008–2012, compared to 1990 levels. The EU ratified the Protocol on 31 May 2002 (EU ratifies the Kyoto Protocol, 2002), committing to an 8% reduction in emissions, to be shared out among the fifteen states that formed the Union at the time. Ratification therefore entailed a dual process of commitment: on the one hand, the European Union accepted an overall, legally binding commitment; at the same time, each Member State accepted its own individual commitment in accordance with the burden-sharing agreement.

The definitive step in the development of a common energy policy came with the enactment of the Lisbon Treaty, which set the legal basis for energy to be considered as one of the 'shared competences'. From then on, the EU set itself the task of 'leading a new industrial revolution and creating a high efficiency energy economy with low $CO_2$ emissions' (Calleja and Caballero, 2014), (Pearson and Foxon, 2012) by drawing on recent thinking on the technological, economic and institutional factors that enabled and sustained the first (British, defining targets, adopting commitments and identifying priority sectors for action.

This new strategy was reflected in the 2008 'Climate and Energy Package' (European Commission, 2014) which sets the following targets for 2020, based on the Union's commitments: to reduce emissions of greenhouse gases by 20% compared to 1990 levels; to increase energy efficiency by 20% and to reach 20% of renewables in total energy consumption. In 2015 the European Union played a key role in the achievement of a new global milestone, when 195 states signed up to a binding agreement at the Paris climate conference (United Nations, 2015). The agreement represented a global plan for adopting measures to prevent global climate change reaching dangerous proportions, by limiting global warming to below 2 °C.

Arising out of these commitments, the EU's current agenda for action is based on an integrated climate and energy policy framework (European Commission, 2014) adopted by the Council on 24 October 2014 and revised in December 2018, which set the following targets for 2030:

- A reduction of at least 40% in greenhouse gas emissions compared to 1990 levels.
- An increase to 32% of the share of renewable energies in energy consumption.
- An improvement of 32.5% in energy efficiency.
- The interconnection of at least 15% of the EU's electricity systems.

In 2016, the Commission proposed a package entitled 'Clean energy for all Europeans' (European Commission, 2019b), whose aim is to keep the EU competitive as global energy markets are changed by the transition towards clean energy. This package includes eight legislative proposals in areas of governance, design of the electricity market (the Electricity Directive, the Electricity Regulation and Risk-Preparedness Regulation), energy efficiency, energy performance in buildings, renewable energy and rules applying to energy regulators.

Since 2019 the European Commission has been working on the Green Deal (European Commission, 2019a), a major project to stimulate the European economy. This ambitious strategy is intended to achieve a low-carbon economy in coming decades and places the energy transition at the centre of political action. The strategy, which planned to mobilise one trillion euros to 2027-2030, has been further accelerated by the Covid-19 crisis, affecting the recently announced post-pandemic recovery fund, which will have to conform to the targets set in the European Green Deal roadmap.

The urban areas (such as cities) of the EU account for nearly two-thirds of energy consumption and generate roughly 80% of European GDP (Kusch-Brandt, 2019). This makes cities the fields in which compliance with the political commitments acquired at a European and global level is being played out. One result was the announcement in 2008 of the Covenant of Mayors initiative (*The Covenant of Mayors initiative for local sustainable energy (E3P)*, 2020), under which local governments voluntarily committed to implementing EU climate and energy targets. To achieve this aim, signatories prepare and implement a Sustainable Energy and Climate Action Plan (SECAP) setting out the key actions they plan to undertake.

#### *4.1.2.* ***Positive Energy Districts (PED) definition and concept***

The concept of the PED can be seen as growing out of the notions of the 'zero energy building' and the 'positive energy block', which have been the subject of intense discussion in recent decades (Cao, Dai and Liu, 2016); (Hirsch, Parag and Guerrero, 2018); (REN21, 2018); (Buonomano *et al.*, 2019). The earliest definitions of zero energy buildings, were in fact for 'zero heating' buildings, such as the 1939 MIT Solar House I, which included a large solar thermal collection area and water storage, or the 1955 'Bliss House' (Taherahmadi, Noorollahi and Panahi, 2020). More recent definitions of 'net-zero energy' and 'positive energy' buildings have generally included domestic hot water, cooling, and ventilation (Montava M., 2014).

The 'positive energy block' concept developed as part of the EU Smart Cities initiative, extended the definition to groups of connected and neighbouring buildings that annually produce more energy than they require, in terms of lighting, heating, cooling and ventilation. JPI (Joint Programming Initiative) Urban Europe has further developed the definition and framework for PEDs, emphasising three principles on which they should be based: energy efficiency, renewable energy, and energy flexibility.

The JPI White Paper on a Reference Framework for Positive Energy Districts and Neighbourhoods, defines Positive Energy Districts as 'energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy. They require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and ICT systems, while securing the energy supply and a good life for all in line with social, economic and environmental sustainability.'



When it comes to setting goals and designing strategies for PEDs, and trying to align them with the proposed JPI (Joint Programming Initiative) definition, there are a number of issues that need to be considered:

- Final energy uses: A positive energy balance can be achieved for different final energy uses, both within the buildings (heating, cooling, hot water, lighting, appliances), and for services and other energy uses outside the buildings (public lighting, water and waste management, mobility).

- Boundaries of the analysis: In many cases, it can be very difficult to achieve a positive energy balance within the confines of a geographical district (particularly in high density urban areas). When defining a PED, therefore, it may be useful to establish functional PED boundaries, such a specific district heating network or micro-grid connecting the different buildings and through which a positive energy balance can be achieved. The concept of virtual PED boundaries has also been introduced in the form of contractual boundaries (EU Smart Cities Information System, 2017), for example for cases where there is some energy generation outside the district, but it is owned by –or directly supplies its output to– the district.

- Indicators used for the energy balance: A positive energy balance means that more energy is produced than used in the district. Further clarification is needed on the energy accounting used. Any final energy balance should be achieved across all the different energy carriers. With a primary energy balance, imported and exported energy are multiplied by primary energy conversion factors, thus allowing for some flexibility in the energy carriers. The total primary energy factor indicates the amount of primary energy used to generate one unit of final energy, whilst the non-renewable primary energy factor includes only the non-renewable portion of the primary energy used. A PED with a positive non-renewable primary energy balance, therefore, allows for potentially unlimited importation of renewable energy into the district, whereas a PED with a positive total primary energy balance needs to generate as much energy as is used within the defined boundaries. $CO_2$ emissions can be an additional indicator, generally closely related to the non-renewable primary energy indicator.

- Energy balancing period: The most common requisite for classification as a PED is the achievement of a positive annual energy balance. However, energy flexibility is another important characteristic of a PED that is not taken into consideration in an annual energy balance. Performing energy balances for shorter time periods can offer a better insight into the district's performance at different times of day, and over different days or months. A district might have a 'positive energy' rating solely in specific hours of the day in certain months – for example during the central hours of the day in summer in the case of a PED focusing on the use of solar energy. Storage or demand management may help increase the number of hours or days in which a positive energy balance is attained and reduce peak loads for the district. A detailed hourly or sub-hourly balance is therefore important in assessing the interactions between the district and the energy grids, and to evaluate specific strategies for increasing energy flexibility.

## 4.2. **Implementation of PED based on Urban Labs**

This section provides the context for the deployment of Zorrozaurre PED as an innovative City Lab. The city of Bilbao has deployed several city labs at different scales and therefore, the deployment of ATELIER demonstration site is not an isolated initiative but, on the contrary, perfectly exemplifies the city ambition and commitment of innovation. In this case, and thanks to the ATELIER project, the deployment of the PED directly connects with the definition of Bilbao Bold City Vision that will facilitate moving from a PED scale to a city scale.

### *4.2.1. **Bilbao Urban City labs***

Bilbao is the largest city in the Basque Country and the tenth largest in Spain, with a population of 345,000 inhabitants and a density of 8,300 inhabitants per square kilometre. Since the 1990s, it has seen major urban regeneration, with former industrial areas being turned into open areas. The process has transformed the city and its environs. The regeneration of Zorrozaurre will (probably) be the last major urban transformation project at a neighbourhood scale in the city.

Since the final Master Plan (DUSI strategy) was approved in 2012, the development has already seen completion of the Deusto Canal, making Zorrozaurre a true island, and construction and renovation of buildings at the northern and southern ends. The transformation of Zorrozaurre is in line with the smart city concept, which will be demonstrated using an inter-sectorial and trans-disciplinary approach.

Like many other European cities, Bilbao has a very consolidated and well-defined urban landscape, and the existing districts and neighbourhoods leave very little space for new innovative regeneration approaches. Moreover, the existence of an aging population is not generally conducive to major urban transformation. In this scenario, Bilbao has chosen to promote a Living-Lab approach (Figure 4) where innovative solutions are tested at different scales: building scale, set of connected buildings scale (PED), district (or neighbourhood) scale, and city scale.

*Figure 4.* **LIVING-LAB APPROACH DEVELOPED IN THE CITY OF BILBAO**


*Source:* Own elaboration.

The aim of the Living-Lab approach is to try out innovative urban solutions in a controlled and effective form that can be gradually upscaled, thus guaranteeing two premises: non-intrusiveness with city life, and economic feasibility. Bilbao City Council is committed to guaranteeing citizen wellbeing without hampering regular day-to-day life, i.e. without invading its citizens' everyday activities and without requiring any additional economic investment. Bilbao's living-labs are co-created with local stakeholders and offer an opportunity for exploring and evaluating new concepts and solutions. Pursuing the general objective of decarbonisation, energy transition and smart city development, several living-labs have been created in the city in four different scales (Figure 4):

***Scale 1: Single buildings***

An example of an action undertaken in an individual urban development is the city's new central coach station, Termibus. The 3,200 square-metre site with 4 underground levels will be climate-controlled using geothermal energy, offering greater ecological and economical savings than traditional heating/cooling systems. The geothermal pipes will provide a constant year-round temperature of 14 Cº, sharply reducing the difference that needs to be overcome to reach 20 Cº from January to December. The installation was presented in December 2019 and marks a small step forward in the city's sustainable development policy.

***Scale 2: Limited set of connected buildings (and/or PED)***

The City of Bilbao is working on the design of a Positive Energy District in which it will trial the introduction of renewable energy, the roll-out of new connectivity systems, smart monitoring of energy generation and consumption, and a model of citizen participation (see Section 4.3). The first City Lab in this second phase is being demonstrated in specific areas of Zorrozaurre where a set of well-connected actions are being undertaken from 2020 to 2024. The ATELIER project will accelerate demonstration of Positive Energy Districts and the roll-out of solutions across the entire city. The main challenge of promoting City Labs at this scale is that when connecting buildings of different nature, the inclusion of residential areas implies the participation of citizens with very sensitive aspects, as they are their dwellings.

***Scale 3: Entire districts or neighbourhoods***

The City of Bilbao is formed as the sum of 8 districts and 40 neighbourhoods, in each of which citizens have access to all municipal services: schools, libraries, sport centres, commercial areas, cultural centres, etc. Indeed, each neighbourhood is a complete unit of urban development where urban transformation follows a holistic and citizen-centred approach.

As an example, the City Council has a strategic plan (DUSI Strategy) for the Zorrozaurre area that seeks to turn a degraded industrial area into a major new neighbourhood in which businesses will share public and open spaces with new homes, public facilities and playgrounds. The strategic plan envisages the island as a consolidated area of interest for attracting business projects, investment in a new model of economy, high added-value activities, etc. Of course, the upscaling of the Zorrozaurre PED (City Lab at scale 2) will accelerate the urban development of the entire district.

***Scale 4: Bilbao City***

The intention is for the Living-Labs to be replicated throughout the different districts and neighbourhoods and ultimately upscaled to the entire city. The individual actions are not intended to be perfectly organised in time or in any geographical scale but will respond to the specific requirements of citizens and neighbourhoods. The City Council is working on a bold city vision for 2050 (Section 4.2.2), defining strategic plans that are in line with urban commitments, European strategies, and sustainable development goals.

#### *4.2.2.* ***Bilbao Bold City Vision***

In the current legislative context (see Section 4.1.1), it seems reasonable that each city must contribute responsibly (in line with their city energy vision and according to their capabilities) to meeting the decarbonization targets established at a higher (regional, national and European) level. However, defining city strategies and plans in such a way that they are aligned with the targets undertaken at a higher level is neither simple nor immediate. In many cases, a lack of connection has been identified between regional energy planning and the deployment of specific technologies and measures at city level. This makes it difficult to tell whether the aggregation of measures from different cities will enable the targets committed to at the higher level of governance to be fulfilled.

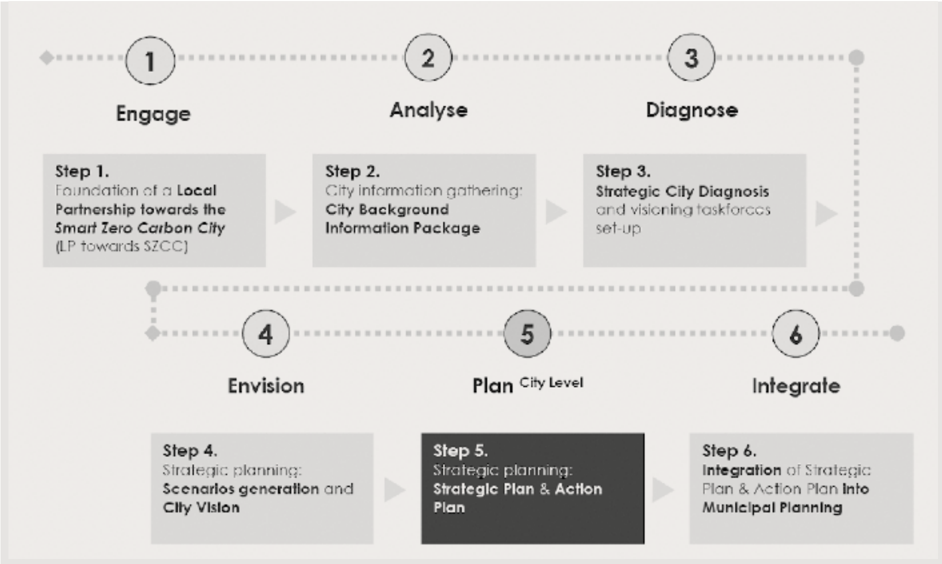
In any case, each city has to define its own energy vision and decarbonization pathway. That is to say, most cities tend to establish a series of general objectives that are complemented by a list of measures to be implemented in a distributed manner throughout the city over the following years. This approach tends to create a major disconnect between the city's general objectives and the realistic capabilities for the deployment of measures in the different zones which is basically demanding new governance mechanisms (see Section 4.3). This situation is further exacerbated by the lack of integrated (energy, economic, environmental and social) prospective methods and models to allow simultaneous evaluation of both levels, i.e. the city as a whole and the specific measures implemented at district level.

This will be a recurrent problem as cities become more complex in terms of energy use and generation in coming years. Cities will have to deal with issues such as an increasing use of energy production from local and distributed renewable sources, accompanied by a gradual 'smartening' of distribution networks. In addition, thermal and electrical storage will become more significant in distributed energy generation, which is expected to cover a significant proportion of the space currently occupied by large-scale energy generation. New integrated capabilities will therefore be required by municipalities to allow optimum analysis of their cities' energy systems. In this context, it will be essential to develop new integrated and multi-scale models and methodologies to support local authorities during the planning process by providing them with relevant quantitative data and criteria.

The city vision approach proposed in the ATELIER project takes into account the Strategic Stage, consisting of the six main sequential steps proposed by (Urrutia-Azcona *et al.*, 2020), shown in Figure 5. Starting from this general view, the various tools and methods proposed in the project seek to overcome the main difficulties mentioned above with regard to city-integrated energy planning.

In this case, the focus is mainly on the specific advances proposed in the project for Steps 3 (Diagnose) and 4 (Envision), which are those most closely related to quantitative analysis and modelling. Step 3 focuses on developing a strategic city diagnosis that will include the data collection process and a detailed analysis of the baseline situation in the different departments of the City Council. Step 4, on the other hand, focuses on an analysis of alternative long-term energy scenarios (2030/2050) that can guide the city's transition towards a low-carbon future.

*Figure 5.* **GENERAL VIEW OF THE CITY VISION APPROACH FOLLOWED IN THE ATELIER PROJECT FROM THE STEPS OF CITIES4ZERO STRATEGIC STAGE**




*Source:* Urrutia-Azcona *et al.*, 2020.

To address the analysis required in steps 3 and 4, the ATELIER project establishes an integrated methodology which seeks to guide cities by using a combination of different tools and methods that will support the integrated energy planning process. In this integrated methodology, the conventional city energy analysis is complemented by a prospective analysis (as proposed by (Arrizabalaga *et al.*, 2020)), an ex-ante impact assessment, and various methods of multiple-criteria decision analysis (MCDA) to facilitate the definition and evaluation of various future alternatives or scenarios that can guide the transition process of the city in question towards the desired low-carbon future. Additionally, the most relevant stakeholders in the city participate in the decision-making process via Innovation Atelier Bilbao.

The next stage entails modelling the city's energy demand and supply, as required by Step 3 (Figure 5). This involves an assessment of its energy situation from both a bottom-up and top-down perspective. The bottom-up part entails detailed characterisation of the city's building stock; the top-down perspective analyses energy flows from both the demand side (including all sectors of the city ranging from residential to services, transport, industry, etc.) and the generation side (conventional and distributed and/or renewable energy generation, available resources and energy imports and exports).

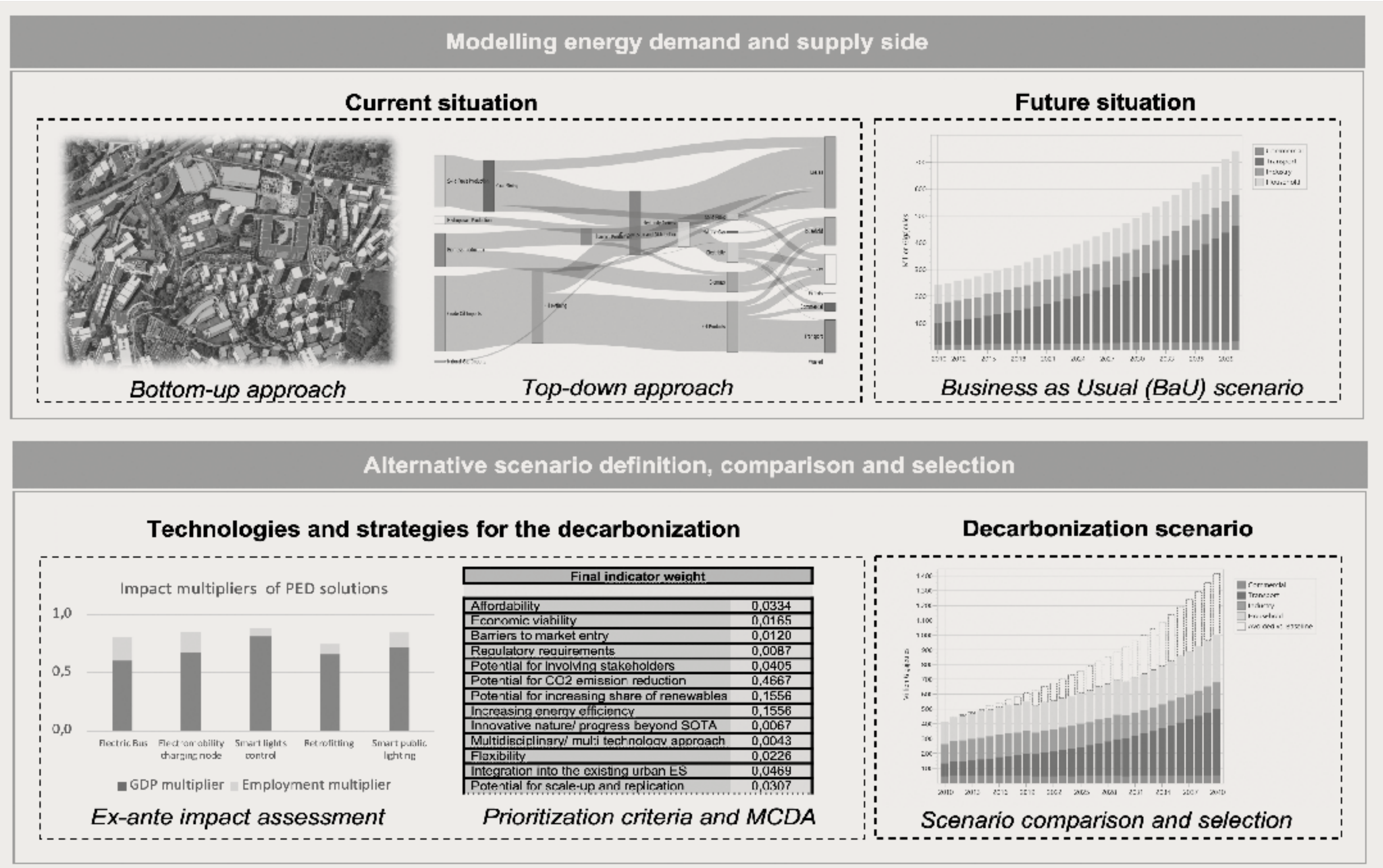
This makes it necessary to integrate tools (Figure 6) for energy characterization of building stock such as (*Enerkad*, 2019) with others for energy system modelling (ESM) such as LEAP (*LEAP*, 2020), which are generally used for larger scales. In order to ensure proper integration, differing aspects between the two perspectives must be combined. These include the sectors evaluated, the minimum resolution required, both at a spatial level (building blocks vs complete building stock) and at a temporal level (hourly-basis analysis vs annual analysis) level and the limits of the system used in each case.

Once the current situation of the city has been characterised, the way in which it may evolve in the long term can be assessed, using energy system modelling tools such as LEAP. The eventual evolution of a continuing situation can be depicted in the Business as Usual (BaU) scenario. This provides clues about the future difficulties and needs each city will face in a specific timescale (to 2050 in the case of this project). Subsequently, alternative scenarios can be defined, factoring in the deployment of certain decarbonisation technologies and strategies. These scenarios are shaped through the progressive deployment of an optimal combination of previously evaluated measures, using ex-ante impact assessment methodologies.

The assessment as a whole will be performed using innovative energy modelling approaches and the ex-ante impact assessment (environmental, energy and socio-economic). This includes a prospective energy analysis applied to cities, a life cycle perspective applied to transition scenarios, a supply-chain analysis of deployed technologies, and macroeconomic impact assessment methods such as those based on input-output theory. This will make it possible to predict the impact associated with each measure based on multiple impact indicators that will be used as criteria for prioritisation. Finally, using MCDA (Multiple Criteria Decision Analysis) theory, these measures can be prioritised to define decarbonisation scenarios that will again be modelled in the ESM tools. This process gives a large number of plausible scenarios for decarbonisation, which can be compared to determine the optimal scenario for each individual city.

At this point, in addition to the tools and methods, concepts such as Positive Energy Districts (PEDs) can help simplify the problem, provided they are properly integrated into the broader city vision. Identifying and designing districts that can provide a positive energy balance can facilitate the process of structuring the city's transformation. Replication and upscaling PEDs can contribute by aggregation to achieving the city's overall objectives. Moreover, projects such as ATELIER, which focuses on developing pilot schemes that allow different areas of cities to become PEDs, should serve as demonstrators, facilitating replication of the PED concept in other cities.

*Figure 6.* **TOOLS AND METHODS OF THE INTEGRATED MODELLING VISION OF THE ATELIER PROJECT**




*Source:* based on Arrizabalaga *et al.* (2019)

### 4.3. **Smart governance approach**

All departments of Bilbao City Council are currently promoting participatory approaches that engage with citizens from the very earliest stage in new initiatives. The development of new strategic frameworks, the design of cultural agendas, and innovative urban developments are all submitted for citizen proposals and adjustments. With regard to the agenda for urban regeneration, the city council has proposed an innovative approach based on the development of Urban City Labs (Section 4.2), with citizens and stakeholders placed at the core of the proposals.

#### *4.3.1. **Two-way governance mechanism***

Traditional models of governance use a top-down approach, with governments drafting strategic plans that guide cities (regions, or countries) on the objectives and ambitions of coming years. However, Europe is making advances in this respect, proposing more participatory bottom-up approaches in which citizens are called on to take an active part in the decision-making processes (Calzada, 2018).

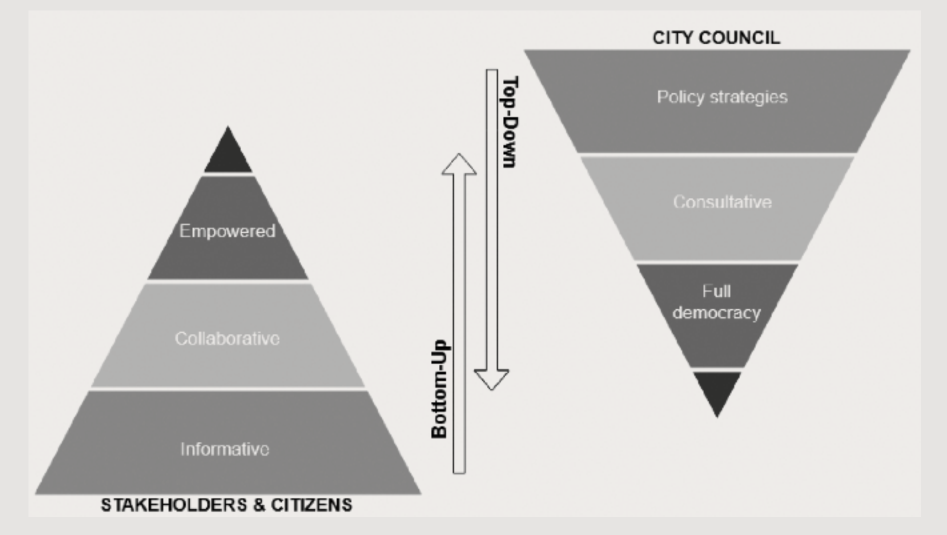
Both top-down or bottom-up approaches may be used, depending on the nature of the policy and the context in which it is being implemented. Top-down governance, in particular, entails the implementation of a policy decision (by statute, executive order, or court decision) in which decisions are taken by public authorities in order to produce certain desired effects. Bottom-up implementation, on the other hand, begins with the requirements of certain stakeholders (industries, service providers, clusters, civil associations, etc.) and citizens, who are the ultimate backers of the policies or strategic plans.

The top-down approach is a rational, comprehensive way of planning. It is consistent with overhead democracy, strategic plans, and policies, and is generally well-connected to higher level transversal policies and legislations. The decision-making process can be very efficient, innovative, and disruptive, depending on the visionary perspectives involved. On the downside, top-down policy making may be disconnected from the perspective, feelings, and desires of the community and as a result, may not enjoy support from citizens.

The bottom-up approach builds from citizen perspectives and ideas up to strategic plans by delivering scattered drops of well-connected needs, requirements, and desires. The bottom-up model is, by definition, closely connected to the general public's actual perspective but it may fail to generate cutting-edge proposals that make the leap into a long-term perspective.

The Two-Way Governance mechanism has been developed naturally by combining elements from both the top-down and bottom-up models (Figure 7). It is not an ex-ante static governance model; rather, it is continually and dynamically self-calibrated with elements combining the highest-level perspectives and demands (SDGs, EU legislation, SEAP plans, etc.) and citizen-driven co-generation of solutions. This innovative instrument combines interdisciplinary and transdisciplinary working mechanisms that structure the generation of urban communities, definition of strategic visions, co-implementation of innovative energy systems, integration of ICT tools, empowerment of communities working as prosumers, etc.

*Figure 7.* **TWO-WAY GOVERNANCE MECHANISM**




*Source:* Own elaboration.

The implementation of such as innovative City Lab, as it is the Positive Energy District of Zorrozaurre, demands the articulation of two-way governance mechanisms that ensure its long-term acceptance and success. The ATELIER project accelerates the implementation of this governance approach in an implicit manner. On the one hand, the design of top-down strategies is articulated thanks to the design of Bilbao Bold City Vision (Section 4.2.2). This strategic document will define the planning framework, methodological vision and roadmap for the coming years providing the long-term ambitions in terms of energy transition. On the other hand, the implementation of the PED in Zorrozaurre and the Roadmap for the entire city should be accompanied by bottom up mechanisms that facilitate the dialogue among all the stakeholders.

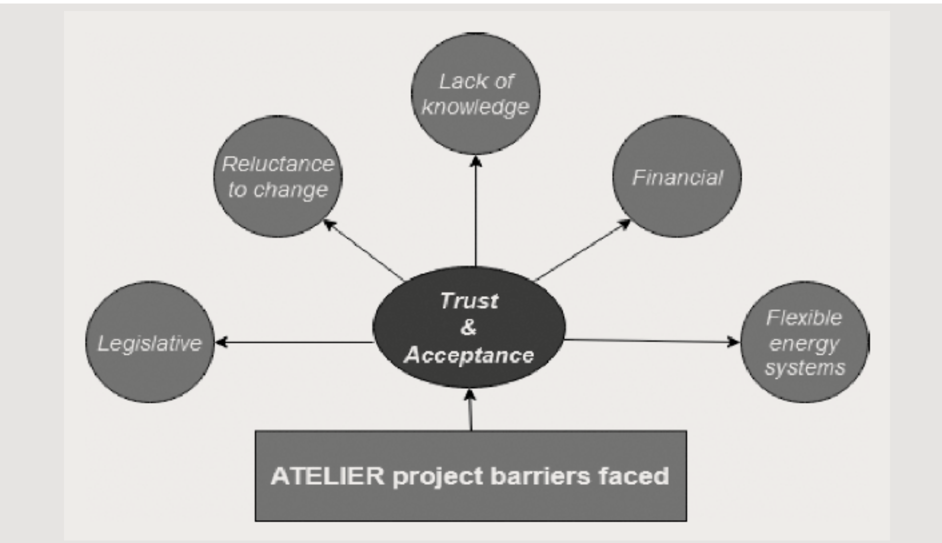
ATELIER supports the generation of a dynamic urban participatory strategy called 'innovation ateliers'. Currently, the innovation ateliers are working on the smooth deployment of the PED in Zorrozaurre. However, the ambition is that they were self-sustainable and maintained their activity after the project life (after 2024) so that they would support many other innovative City Labs that the municipality would lead in accordance with the implementation of the Bilbao Bold City Vision.

#### *4.3.2. **Main barriers faced for the deployment of PED City Lab***

The deployment of the Positive Energy District (see Section 3.3) implies very ambitious interventions (see Section 3.3) that come together with important challenges. Indeed, the PED is a new concept that needs to be tailored to the local situation and context. Moreover, the associated benefits cannot be fully known beforehand but require some research. As with many innovations, the deployment of the PED faces many uncertainties and risks, and many obstacles. The development of new decision-making instruments and participatory mechanisms is the most promising way of overcoming them.

On the one hand, a general lack of experience in designing, engineering, building, and operating highly energy efficient buildings, technologies and energy systems means that many chain-partners do not have enough familiarity or expertise to make well informed decisions in the process of implementing a PED project (Figure 8). At the same time, end-users tend to be reluctant to change. The uncertainty surrounding any new commodity or in-house facility engenders a significant degree of inertia, which affects attitudes towards the adoption of new solutions. In addition, there is a significant risk associated with investment in innovation, as there can be no guarantee that more efficient solutions may not emerge in the short term.

*Figure 8.* **MAIN BARRIERS FACED BY THE ATELIER PROJECT**




*Source:* Own elaboration.

Therefore, the most important barriers identified so far are related to social acceptance of and trust in smart solutions. These are directly connected to the lack of knowledge, reluctance to change, adoption of more flexible energy systems, design of new legislations or new financial structures, etc.

*4.3.3.* ***Innovation ATELIERS as smart governance process***

Given their systemic nature, PEDs require support from the local innovation ecosystem in tailoring and implementing smart urban solutions. Many European cities still do not have the 'governance capacity' (capacity of local actors to work together on a societal challenge and implement solutions) required for smooth implementation of innovative solutions. It therefore needs to be boosted.

In ATELIER smart city project, the design of new participative mechanisms is based on the Quadruple Helix methodology (Figure 9), an inter-sectoral approach where governance, academia, industry, and citizens build up new decision-making processes.

*Figure 9.* **INNOVATION ATELIERS FOLLOW QUADRUPLE HELIX METHODOLOGY**


*Source: Värmland Country Administrative* Board, 2018.

Bilbao Innovation Atelier was created as a forum for local, regional and related stakeholders with a clear vocation for innovation and continuity beyond the lifespan of the H2020 project and as an instrument of collaboration with other cities and areas of government beyond Bilbao city and the ATELIER innovation action.

The objectives were as follows:

- To create a forum for ATELIER Bilbao partners and the local stakeholder community to foster open innovation in PEDs
- To disseminate progress on the development of ATELIER smart urban solutions and showcase its results
- To involve the local innovation ecosystem (quadruple helix) in tailoring and implementing the solutions in Bilbao, by:

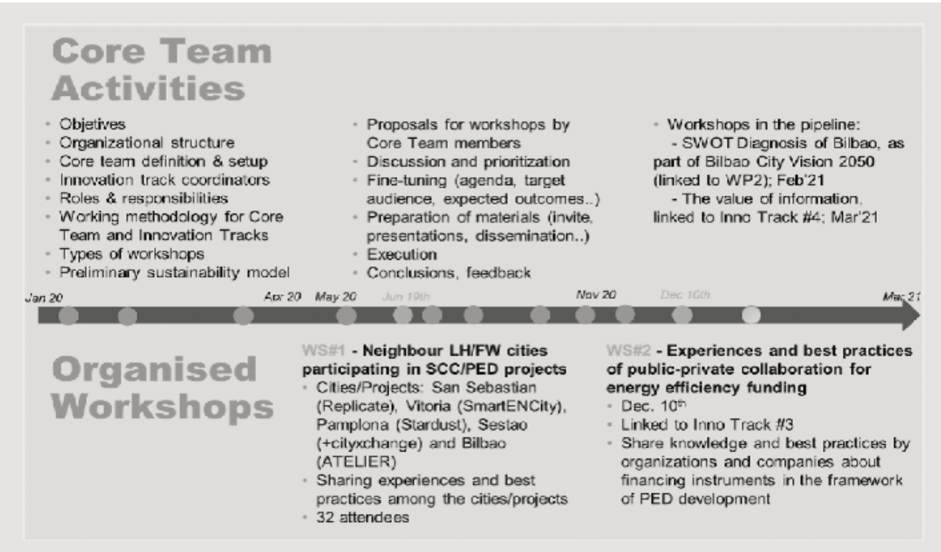
  – Identifying local particularities and barriers and potential solutions
  – Exploring and fine-tuning business models for the innovations proposed

- To share knowledge and gain experience in four thematic tracks: #1 Integrated energy systems and e-mobility; #2 Governance, Integrated Planning and Law; #3 New financing instruments; #4 Data, privacy and data platforms
- To deliver useful feedback and best-practices to upscale the solutions to other districts of Bilbao and other cities in the Basque region and to support replication elsewhere in Europe.



The core group of the innovation ateliers meets regularly for the organisation of the workshops, which will always answer a research question, would identify the stakeholders to be involved, and would design the type of workshop (number of participants, type of participation, etc.). The innovation ateliers were stablished in Bilbao. Two workshops have been organised from the beginning of the project (from November 2019 to December 2020) (see Figure 10). The objective is to increase the intensity of the activity and to organise around five workshops per year.

*Figure 10.* **ACTIVITY OF INNOVATION ATELIERS IN BILBAO**




*Source:* Own elaboration.

***Workshop 1: Neighbour LH/FW cities participating in SCC/PED projects***

The first Innovation Atelier was held in June 2020. The aim was to draw on the experience of other Basque smart-city projects (Lighthouse and Fellow cities) to pool knowledge, experiences and best practices from their H2020 projects, and thus identify potential collaboration opportunities.

The Basque region has enormous potential as a smart city region since there are five SCC1 funded smart city projects. A panel of representatives from REPLICATE (Donostia-San Sebastian), SMARTENCITY (Vitoria-Gasteiz), STARDUST (Pamplona), +CITYXCHANGE (Sestao) and ATELIER (Bilbao) projects presented their smart vision of their respective cities, sharing many of the experiences, best practices and lessons learned in their H2020 projects to foster a joint understanding of the roll-out and take-off phases. The session allowed all the participants to reach a common understanding of the projects and initiatives proposed and implemented in the five cities. It also facilitated an exchange of experiences, lessons learned and recommendations on a series of subjects in an open and fruitful discussion between panellists and participants. The three main lines of debate focused on the governance model and tools made available in each city for the initiatives of the projects, how the best technical solutions were defined in each case, and the citizen communication strategy and participation mechanisms put in place.

In terms of the principal strengths, a good communication and citizen engagement strategy was seen as being key to achieving support from neighbourhood communities in adopting the solutions designed under the projects. A great effort must be made —even before the project is begun— to deliver clear, simple and accurate messages on planned actions and their expected benefits, including door-to-door campaigns, tailored to wide-ranging groups of citizens in an understandable way, avoiding too much technical detail and fostering an environment of trust.

Some difficulties were also raised, such as the complexity of harmonizing and coordinating work between different municipal areas and services, each of which has different objectives, teams and working schedules. A flexible and efficient governance model would be helpful, with a clear commitment from all municipal areas involved to meet project targets and execution milestones.

Most of the panellists agreed on the advisability of defining and implementing on-site pilot schemes or demonstrations in the neighbourhoods, following a bottom-up strategy, since this is the most practical way of showing the different technologies in place and the benefits of the selected solutions. This kind of action could be extremely helpful in making citizens understand the impact of the projects' results in terms of energy efficiency, sustainability, and comfort, thus encouraging the communities to adopt them. As a result of this workshop, the panellists were quite positive about establishing a collaborative framework between the five projects and cities to build on the issues discussed, analyse others of common interest and identify joint initiatives to be undertaken within the framework of Bilbao Innovation Atelier.

***Workshop 2: Financing energy saving: experiences and alternatives***

The second innovation workshop took place on the 10th of December 2020, under the topic «Financing energy saving: experiences and alternatives», organized by Deusto Business School (DBS). The workshop featured an outstanding panel of representatives from the Basque Government: Ignacio de la Puerta Rueda. Director of Territorial Planning, Urbanism and Urban Regeneration, Greenward: Fernando de Roda. Founder & Managing Partner, Stratenergy, Velatia: Alejandro Sánchez Palomo. Managing Director, Triodos Bank: Daniel Pascual Pascual. Director of the Basque Country, Smart Energy-Iberdrola: Jose Ignacio Leonet. Product Manager. Smart Solar, GoiEner: Jokin Castaños González. Generation Area Coordinator, EVE: Luis de Velasco. Department of Studies and Planning and the participation of ATELIER «Opengela» experience was shared. It was focused on partners. The workshop was attended and participated by a total of 25 people.

The seven panellists addressed the issue of financing energy saving and $CO_2$ emission reduction projects from their respective organizations. The main conclusions were:

- The decarbonisation challenge set for 2050, which involves an intervention in nearly 1,100,000 homes in the Basque Country. Financing is key and is part of the solution and must be 1) Easy to access 2) Affordable and 3) Fair and generate 4) Trust. The presenter shares the «Opengela» experience that focuses on intervention in the most vulnerable neighbourhoods.
- Financing is an important barrier, especially in the most vulnerable neighbourhoods. It is important to simplify the information, make it easy to communicate. An example of good practice is related to the «Opengela» project and the «Neighbourhood Offices».
- It is important to talk about energy saving, but it is also important to talk about improving the quality of life of citizens and the right to have a decent home in terms of light, energy, heating, etc.
- Public-private collaboration is essential in building rehabilitation projects. The public part should offer guarantees to the private sector (i.e. clear rules and regulations). As an example, it should be possible to extend the repayment terms of loans for financing energy savings (15-25 years) to make it affordable for the most vulnerable people.
- The role of ESCOs as motivator/facilitator of the energy transition process was highlighted. Example of good practice of public-private collaboration in TxominEnea in Donostia was presented by Stratenergy.
- New financing formulas through PPAs services (Smart Solar-Iberdrola case), energy cooperatives for self-generation and self-consumption projects (Goiener case) were presented.

There are no public resources to subsidize 70-80% of the retrofitting/renovation projects. It would be necessary to refine the recipients of the aid, who are those who really need it. The challenge would be for public funding to cover people who are not eligible by the private sector.

## 5. CONCLUSIONS AND POLICY FEEDBACK

This article presents an innovative three-step methodology that will pave the way for energy urban transition in cities. It combines: an innovative design approach based on the definition of Positive Energy Districts, a real-scale implementation using the City Labs, and the definition and implementation of new governance mechanisms that combine long-term strategic perspectives with bottom-up participatory schemes. ATELIER H2020 project has accelerated the demonstration of this innovative methodology that has already provided the following results:

- The definition of Positive Energy District (PED) is still under debate; however, it seems to be an appealing concept that is very well suited to the requirements of the integrated climate and energy policy framework (European Commission, 2014). A PED is defined in Zorrozaurre including specific areas at the North, Centre and South of the island.
- The implementation of the Positive Energy District in Zorrozaurre is not seen as an isolated initiative but, on the contrary, it is one of the City Labs promoted by the council of Bilbao. It will serve to define and illustrate the Bilbao Bold City Vision, the strategic plan for urban transition that defines the roadmap for 2050.
- The success of new urban developments motivated by energy transition requirements depends on citizens and all stakeholders: the acceptance of the solutions, the difficulty that poses the resistance to changes, the trust on the community, etc. will be clue elements for the integration of measures and the success of integrated developments. Innovative governance mechanisms that boost bottom-up participatory approaches have been recently adopted in Bilbao, they have been called innovation ateliers and will work on four thematic tracks: integrated energy systems and e-mobility; governance, integrated planning and law; new financing instruments; and data, privacy and data platforms.

The Basque region has great potential to be a reference in Europe with respect to the energy transition and smart-city region development. The Positive Energy District supported by ATELIER – H2020 innovation project will provide new insights for policymaking. The support of Smart Cities and Communities (SCC) as well as the experience of the Basque smart cities will facilitate the rapid roll out of solutions all along the Basque Region.

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# *Fostering green financing at the subnational level. The case of the Basque Country*[*]

**Although the role of the public sector in developing green financing has been analyzed, there is a gap in the literature regarding the specific funtions of subnational (or regional) governments to facilitate financing of clean technologies and sustainability projects. This research aims to contribute to the academic literature on the specific channels and mechanisms through which a regional government can facilitate green financing. To answer this question, this paper studies the role of the public sector at various administration levels (supranational, national and subnational) in facilitating the financing of sustainable investments to delineate best practices. It develops a framework to assess strategies to foster green finance, with a focus on the regional level, and applies it to the specific case of the Basque Country.**

*Si bien se ha analizado el papel del sector público en el desarrollo de la financiación verde, existe un vacío en la literatura sobre las funciones específicas de los gobiernos sub-nacionales (o regionales) para facilitar el financiamiento de tecnologías limpias y proyectos de sostenibilidad. Esta investigación tiene como objetivo contribuir a la literatura académica sobre los canales y mecanismos específicos a través de los cuales un gobierno regional puede facilitar la financiación verde. Para responder a esta pregunta, este trabajo estudia el papel del sector público en los distintos niveles de la Administración (supranacional, nacional y sub-nacional) para facilitar la financiación de inversiones sostenibles y diseñar las mejores prácticas. Asimismo, el trabajo desarrolla un marco de evaluación de estrategias de fomento de las finanzas verdes, con un enfoque regional, y lo aplica al caso concreto del País Vasco.*

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* Spanish version available at https:/euskadi.eus/ekonomiaz.

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**Keywords:** green financing, sustainable finance, green bonds, role of governments, subnational governments.

**Palabras clave**: financiación verde, finanzas sostenibles, bonos verdes, papel de los gobiernos, gobiernos sub-estatales.

**Jel codes:** G12, G18, G28

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## 1. INTRODUCTION

The transformation of the energy system and, more generally, the economy as a whole, to achieve sustainability goals will necessarily imply large volumes of investment in new, low-carbon technologies, including renewable generation, energy storage and network infrastructure.

Energy investment stabilized in 2018 at over $1.8 trillion[1] after three consecutive years of decline. According to the International Energy Agency (IEA), average annual investment in the Stated Policies Scenario will rise to almost $2.7 trillion per year over the period to 2040, and to an annual average of $3.2 trillion to 2040 in the Sustainable Development Scenario (IEA, 2019a). Specifically, meeting the Paris Agreement challenge of limiting global warming to well below 2ºC and pursuing efforts to limit it to 1.5°C could represent an opportunity of $12.1 trillion worth of investments in renewable power generation over 25 years ($485 billion/year on average) (Zindler, 2016).

[1] *Billion = $10^9$ and trillion = $10^{12}$.*

Such levels of investment effort will imply new financing needs and requirements. Green financing[2] (or sustainable financing) refers to the use of specific financial instruments (including securities, yieldcos, green investment funds and green loans, to name a few) to finance investments in clean (green and sustainable) technologies and low-carbon, environmentally sustainable projects throughout all economic sectors (Lindenberg, 2014; European Commission, 2017).

The interest in sustainable finance has grown steadily in recent years, following the Paris Agreement (Deschryver *et al.*, 2020). In the post-Covid world, sustainable finance is recognized to be a key lever for implementing the European Green Deal and the European Union's recovery strategy, in its quest for increased resilience and environmental, social and economic sustainability (EU Technical Expert Group on Sustainable Finance, 2020a).

Although bank and corporate financing has traditionally been an essential source of funding for low-carbon projects, which involve, at the initial stages, low returns, higher risks and depend heavily on policies and regulations (Sartzetakis, 2020), the intervention of the public sector will be required to meet the significant investments needed to carry out the energy transition. Until now, the academic literature has addressed a large number of topics related to green financing from various points of view, such as its relationship with sustainable economic growth (Stojanović & Ilic, 2018; Wang & Zhia, 2016), the development of green financing instruments (Lund Larsen, 2019; Jiguang & Zhiqunb, 2011), green bonds as an instrument to finance the low-carbon transition (Sartzetakis, 2020; Dou & Qi, 2019) or the relation between green bonds and financial markets (Reboredo, 2018; Tolliver *et al.*, 2019).

The role of governments in developing green financing has also been analyzed by scholars (Taghizadeh-Hesary & Yoshino, 2019, 2020). However, there is a gap in the literature regarding the specific mechanisms through which subnational (or regional) governments may facilitate green financing. They can contribute to this end because they are well positioned to create a favourable environment for economic activity at the local level (Porter, 2008), focusing on the strengths and specificities of each territory to foster their competitive advantages (Hoppe & Miedema, 2020) and better fulfill functions such as mobilizing local networks, engaging external partners and their resources appropriately and playing a leadership role (Ketels, 2017).

This paper aims to contribute to the academic literature by helping to bridge this gap. Analyzing what are the specific channels and mechanisms through which a regional government can facilitate green financing is the central question addressed in this article.

[2] Even if there are distinctions between the terms 'green', 'sustainable', 'climate' and 'low-carbon' finance, in this article the terms 'green financing' and 'green finance' are used to include these concepts.

The remainder of this paper is organized as follows. Section 2 presents the methodology applied in the analysis. Section 3 briefly describes the main green financing mechanisms. Section 4 proposes an analytic framework for assessing the role of regional governments in fostering green finance. Section 5 applies this framework to the specific case of the Basque Country. The last section presents some conclusions and identifies avenues for further research.

## 2. METHODOLOGY

In order to answer the proposed research question, a non-systematic literature review on green financing instruments is conducted first. The goal is to identify a representative base of articles that, although not intended to be comprehensive, will account for the most relevant theoretical (and practical) perspectives and approaches.

The ResearchGate, Science Direct and Google Scholar engines are used to survey the literature by searching the following terms: 'sustainable financing', 'green financing', 'low-carbon financing', 'climate finance', 'green financial instruments', and 'green bonds'. The focus of the search is set initially on peer-reviewed articles; although sectoral publications that analyze current trends in green financing from International Capital Market Association (ICMA), International Finance Corporation, Climate Bonds Initiative (CBI) and Organisation for Economic Co-operation and Development (OECD), among others, are also considered.

A literature review is then carried out of the role of the public sector at various administration levels (supranational, national and subnational) in facilitating the financing of investments in clean assets and technologies and sustainable projects. The results help to identify key insights and trends in green financing around the world and delineate best practice. Based on these and other references from ICMA, Sustainable Banking Network, International Renewable Energy Agency (IRENA) and CBI, to name a few, a framework to assess strategies for the development of green financing and filling the 'financing gap' is developed, with a focus on the subnational/regional level.

The resulting analytical framework is then used to analyze the specific case of the Basque Country and derive policy implications.

## 3. GREEN FINANCING INSTRUMENTS

Green financing involves the use of a large variety of market-oriented mechanisms, channels, financing structures and products (Wang & Zhia, 2016).

The review of the literature suggests that the universe of green finance instruments can be broadly characterized by (1) the destination of the funds within the life-cycle of innovation activities or projects (i.e., upstream or downstream) (Polzin, 2017; Polzin & Sanders, 2019); (2) the origin of the resources (i.e., the private sector or the Government and public administrations) (GEF, 2015); and (3) the rights and obligations associated with the reception of the funds (equity, debt or grants).

Basic and common green finance instruments are based on equity and debt financing (Owen *et al.*, 2018). Additional sources of funds include grants (whether from individuals, corporations or government entities), the cash flows of projects in project finance and alternative financing schemes, including, for instance long-term contracts (e.g., power purchase agreements, PPA), on-bill and PACE (Property Assessment Clean Energy) financing structures, green mortgages, energy performance or services contracts, policy and regulatory instruments such as subsidies, tax incentives, feed-in tariffs, quota-based schemes, etc.

Besides, various instruments have been developed to reduce the risk of investments in green projects, including insurance or guarantee schemes and other contingent claim instruments (catastrophe bonds, contingent credits or nature-linked securities, weather derivatives, etc.). Technical assistance platforms and initiatives that connect project developers and financing providers should also be mentioned. Table 1 reviews all these instruments.

*Table 1.* **GREEN FINANCE INSTRUMENTS**

| Instrument types | Comments |
|---|---|
| EQUITY FINANCING | |
| Seed capital | • Supports the creation of start-ups and low-TRL R&D activities.<br>• Typically used in smaller projects with relatively high-risk and high-return.<br>• May come from a variety of private and non-commercial sources (family and friends, crowdfunding, business angels, corporations, public institutions…). |
| Venture or risk capital | • Provided in early stages of projects by investors requiring high expected returns, usually after a round of initial seed funding.<br>• Typically used in smaller projects with low capital requirements.<br>• May come from private (individual investors and family offices, etc.) or public institutions. |
| Growth capital | • A type of private equity investment in relatively mature companies that are looking for capital to expand or restructure operations, enter new markets or finance acquisitions. |
| Investment funds | • Pooled capital in the form of mutual funds, hedge funds, private-equity funds, pension funds or insurance funds.<br>• Green investment funds specialize in green, sustainable projects. |

…/…

| DEBT FINANCING | |
|---|---|
| Bank loans | • Green loans are provided to green projects complying with guidelines (e.g., ICMA guidelines, EU taxonomy, etc.).<br>• They are often accompanied by green credit guarantee schemes (GCGS).<br>• Sustainability-linked loans (SLL) link parameters on Environmental, Social and Governance (ESG) ratings or other ESG-related indicators.<br>• Green promissory note loans are offered to potential investors in the early stages of projects and are subject to less-stringent reporting requirements. |
| Structured banking finance and new services | • Leases, invoice factoring, supply-chain finance (e.g., purchase-order, warehouse financing), structured products, off-balance sheet financing, new financial services (e.g., new payment and working capital schemes). |
| Loans from governments and multilateral institutions | • Provide funds to green projects to attract additional private capital.<br>• Concessional loans are usually offered below market rates with features such as extended repayment schedules or interest rate flexibility during the life of the loan.<br>• Non-concessional loans are offered at near market rates to finance large projects (i.e., infrastructures).<br>• Credit lines and subordinated debt by multilateral development banks (e.g., World Bank, European Investment Bank, etc.).<br>• Debt-for-climate swaps cancel external debt in less-developed countries in exchange for investments in green projects. |
| Green bonds | • There is a variety of green bonds, including sovereign bonds, subnational and local government bonds, supranational bonds (e.g., issued by the World Bank), corporate bonds, project bonds, asset-backed bonds and financial sector bonds, among others.<br>• Comply with international guidelines, such as the ICMA's Green Bond Principles.<br>• Can be traded on public markets.<br>• Ample flexibility to provide tailor-made financing solutions (flexible payment schedules, credit-extension provisions, leverage options, cost-reducing benefits, etc.).<br>• Basis for complex bond-based financing schemes such as PACE (Property Assessed Clean Energy), whereby municipal bonds support loans for renovations in commercial or domestic bulidings. |
| GRANTS | |
| Grants | • Common in early stages of green projects (usually linked to non-revenue generating R&D activities and capacity building), can be provided by private, corporate or government agents or institutions.<br>• Convertible grants become debt or equity once certain milestones of the project are achieved. |

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| OTHER TYPES OF FINANCING ARRANGEMENTS AND INSTRUMENTS | |
|---|---|
| Project finance | • A way to finance green projects via a 'special-purpose vehicle' (SPV) based on their expected cash flows and/or the operation of an asset or group of assets.<br>• Used in combination with equity and debt financing.<br>• Usually characterized by high debt-to-equity ratios, facilitating investments not backed by balance sheets. |
| Yieldcos | • Affiliated companies where a parent company spins off assets that generate stable cash flows.<br>• Selling yieldco stocks or issuing green bonds out of it allows the parent company to raise additional funds. |
| Power-purchase agreements and long-term contracts | • Long term arrangements between a project's developers and users of energy that generates a stream of predictable, stable revenues over time. |
| On-bill financing and other contracting structures | • On-bill financing of energy investments allows utilities to update the infrastructures and equipment of end consumers and recover the investment costs via their energy bills over a period of time.<br>• Green mortgages support home renovations and investments.<br>• Municipal PACE schemes help to finance building renovations. |
| Energy services and energy performance contracts | • Under a typical contract, energy services companies (ESCOs) finance the up-front costs of investments in energy efficiency via expected (agreed) energy savings.<br>• Energy services agreements (ESAs) are similar, except that services are paid through charges based on realized savings. |
| Policy and regulatory instruments | • These include subsidies, tax incentives, feed-in tariffs for renewable electricity production, quota-based schemes and other policy instruments aimed at fostering innovation in green technologies. |
| Risk-reducing schemes | • Insurance or guarantee schemes and other contingent claim instruments and schemes, such as catastrophe bonds, contingent credits or nature-linked securities and market risk-reducing or risk-hedging instruments, such as weather derivatives or similar.<br>• Blended finance transactions (co-financing structures or on-lending structures) among providers of capital (institutional investors, developers, commercial banks, as well as multilateral, supranational and national development banks) provide an effective sharing of risks and returns among the parties. |
| Project facilitation initiatives | • Technical assistance platforms and initiatives that connect project developers and financing providers. |

*Source:* own elaboration.

## 4. THE ROLE OF GOVERNMENTS IN DEVELOPING A GREEN FINANCING MARKET

Globally, sustainable investments stood at $30.7 trillion at the start of 2018, a 34% increase in two years, reaching a market share of 18% in Japan and 63% in Australia and New Zealand (Global Sustainable Investment Alliance, 2019). Despite this, reaching sustainable scenarios in the long run will require a significant increase in the rate of investments in low-carbon assets and technologies (IEA, 2019b; IRENA, 2019).

The 'green financing gap' concept refers to the inability of current energy and financial markets to materialize the high levels of investments in low-carbon assets and projects that are required to meet energy and climate policy objectives (Polzin & Sanders, 2019; Sachs *et al.*, 2019; Hafner *et al.*, 2020).

Traditional ways of funding (e.g., balance-sheet financing, project finance) are not sufficient to induce the required levels of investment. They will need to be coupled with new public and/or private sources of capital, including institutional investors (e. g., government agencies and institutions, trust funds, pension funds, insurance companies) and other non-institutional investors (Jones, 2015; Taghizadeh -Hesary & Yoshino, 2020).

In general, the literature on the green financing gap identifies barriers related to a variety of factors, including technology, regulatory and commercial risks, relatively high Capex requirements, higher transaction costs and interest rates, information asymmetries, lack of analytical capacity and knowledge, difficulty of internalizing environmental externalities, lack of clarity in the definition of «green» or «sustainable» activities and limited development of the green financial market (Polzin, 2017; Geddes *et al.*, 2018; Stojanović & Ilic, 2018; Hafner *et al.*, 2019; Hyung & Baral, 2019; Yoshino *et al.*, 2019; Hafner *et al.*, 2020; Taghizadeh-Hesary & Yoshino, 2020; Jones *et al.*, 2020).

In order to solve the green financing gap and facilitate the flow of private capital towards green projects and activities, it will be necessary to reduce the aforementioned barriers and create an adequate environment that includes business laws, rules[3] and standards, an efficient investment regime, voluntary guidelines, financial and regulatory incentives and coordination mechanisms between all actors involved (Berensmann and Lindenberg, 2019). The role of financial system regulators should be highlighted to avoid inadequate management and guarantee the coordination

[3] The regulatory framework under development in the EU within the implementation of the European Green Deal will focus on facilitating the reorientation of financial flows towards achieving carbon neutrality by 2050, with targets and obligations for public or private financiers and investors (European Commission, 2020b).

with supervisors and central banks (The de Larosière Group, 2009; Carney, 2015; Larreina, 2015; Bolton *et al.*, 2020).

### 4.1. **The role of the governments in developing green finance**

Private entities tend to invest suboptimally in R&D activities related to clean technologies and green projects (Hannon & Skea, 2014) because of the high probability of failure to reach the commercialization and dissemination phase (Gallagher *et al.*, 2012; Wilson *et al.*, 2012; Hannon & Skea, 2014). Thus, the role of governments in fostering investments in markets with high technological uncertainty and risk or externalities has been thoroughly studied in the academic literature.

In this context, governments can act as risk-bearing agents (Stiglitz, 1993; Mazzucato, 2018; IRENA, 2020a, 2020b, 2020d). They can induce and stimulate investments in high social return projects by providing guarantees or public funding (Jomo *et al.*, 2016), incorporating sustainability aspects for investments and placing the low-carbon transition at the core of their strategies (IRENA, 2020b). Governments play a critical role in reducing barriers for investments (adopting initiatives to simplify and standardize renewable energy project documentation), enabling adequate policy frameworks (including monetary and fiscal policies; IRENA 2020d), with clear, supportive and comprehensive policies (IRENA, 2020b).

Governments aiming to foster transitions should consider designing, implementing and assessing finance-related policy interventions (Geddes & Schmidt, 2020)[4]. They may intervene directly in the capital markets by creating and regulating financial institutions, offering loans and correcting market failures associated with costly information in credit markets, imperfect competition and certain externalities (Stiglitz, 1994). Governments can create green standards and certifications and align them with leading international best practice. They can foster the creation of domestic green bond markets with demonstration issuances (IRENA, 2020c), also offering technical assistance and economic incentives (IRENA, 2020d).

Braga (2020) argues that governments' interventions in credit markets help to reduce credit constraints and induce socially beneficial investments in a context of high uncertainty and risk. This is in line with the view in Mazzucato (2015) and Mazzucato & Semieniuk (2018) about how the public sector helps to de-risk investments with high technological uncertainty (such as green investments) by funding basic research and creating new markets for these technologies.

Governments may also reduce the cost of financing investments via equity and bond issuances, due to its capacity to bear and manage credit risk (Arrow & Lind, 1970; Holmström & Tirole, 1998; Grant & Quiggin, 2003). This also holds for pro-

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[4] The British Government, for instance, defined a Green Finance Strategy in 2019 to stimulate sustainable activities (HM Government, 2019).

jects with social benefits (such as green projects) under uncertainty (Arrow and Lind, 1970). An optimal level of public debt is also found to not entirely crowd out private lending (Azzimonti & Yared, 2019).

By supporting the development of a holistic green financing ecosystem, policymakers can also help to ensure that the process of achieving the Sustainable Development Goals (SDGs) is just and equitable, maximizing socio-economic and environmental benefits (IRENA, 2020d).

There is, therefore, ample evidence favouring a significant role of governments in developing green financing markets and helping to close the green financing gap by strengthening the green market infrastructure, stimulating private investment flows and promoting synergies with private investors (Gabbi *et al.*, 2016; Climate Bonds Initiative, 2018b, 2019b; Taghizadeh-Hesary & Yoshino, 2020).

All this suggests that governments should adopt an entrepreneurial role in the transition to a sustainable economy and implement policy mixes designed to affect both the quantity and quality of green financing and to create effective institutions and adequate credit market conditions that help to fill the green financing gap (Lamperti *et al.*, 2019).

### 4.2. **The role of subnational governments in developing green financing**

The question arises as to whether there is a differential; distinctive role subnational (or regional) governments can play in developing green financing at the regional level. The answer partly depends on factors such as the degree of decentralization and political autonomy of the regions and their capacity to design and implement fiscal and financial policies.

In addition to designing integrated strategic plans for economic development and growth and creating appropriate structures for governance, subnational governments help to create a favourable environment for economic activity. They support local businesses and industries, help to develop human capital of local actors, foster demand, induce the optimal degree of competition and cooperation between companies and collaboration by other institutions (Porter, 2008) and play a leadership role in mobilizing local networks and engaging relevant external partners (Ketels, 2017). In 2016, more than 50% of public investments were made at the subnational level in 36 countries, and even 65% in high- and upper-middle-income economies (OECD/UCLG, 2019).

The local and regional dimension of the transition to a sustainable economy is also relevant. Balta-Ozkan *et al.* (2015) and Grillitsch & Hansen (2019) review the relevance of the local context in the development of the 'green industry' and Mattes *et al.* (2015) analyze the ties between energy transition at the regional level and innovation, stressing the role of individual and organisational actors as well as institutions at the local level in shaping the transition processes.

This implies that regional sustainability strategies must focus on the specific characteristics of the local firm fabric and the sociopolitical environment and its potential for developing sustainable competitive advantages (Hoppe & Miedema, 2020). A single solution will not fit all nor a set of standard tools to achieve the goal of zero net emissions in the economy exists, as local conditions matter (Grillitsch & Hansen, 2019; Mattes *et al.*, 2015).

Lamperti *et al.* (2019), in turn, argue that developing a multi-level and cross-sectoral system of governance of the energy transition will facilitate the green transition. This will require the coordination of the various layers of governments across policy instruments with an impact on multiple sectors, including the energy and financial sectors, and innovation and R&D activities. Owen *et al.* (2018), for instance, claim that a finance ecosystem approach should be taken to ensure that the diverse, complementary forms of finance for low-carbon investments are connected at the subnational, national and international levels.

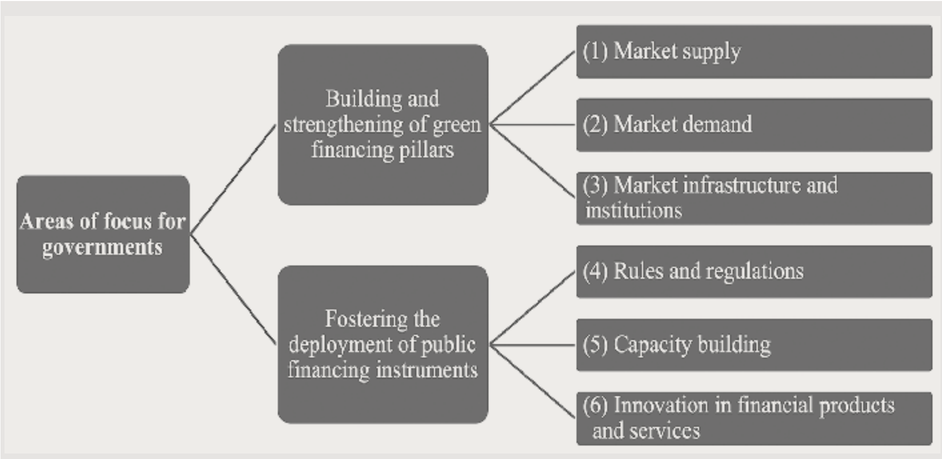
Additionally, the academic literature shows that when proper institutional arrangements and capacities are in place subnational governments play a relevant role in fiscal governance and could be crucial to the development of a sound financing environment and adequate regulations at the local level (Litvack *et al.*;1998; Bird, 2011; Oates, 2005; Vo, 2010; Liu & Pradelli, 2012; Faguet, 2014; Baskaran *et al.*, 2016).

### 4.3. **A framework for analyzing the role of governments**

To understand how governments can spur green financing, an analytic framework is developed around six key dimensions where they should focus, which have been reviewed in the literature (ICMA, 2018a, 2018b; Sustainable Banking Network, 2018; Climate Bonds Initiative, 2018b; Mazzucato & Semieniuk, 2018; IRENA, 2020a, 2020c, 2020d) (Figure 1).

(1) The Government can facilitate the supply of green financing via various mechanisms. Direct intervention as a supplier of green funds can take the form of equity investments, grants (e.g. Santa Monica in California and Wellington, New Zealand, offer grants to fund and support local initiatives to mitigate climate risks and adapt for climate change) or government loans offered by public banks or governmental development finance agencies. These are generally targeted to specific R&D activities and specific groups of companies (e.g., SMEs), to support investments or cash-flow needs. The issuance of green bonds is another way to channel funds to green investments and has also taken place in the past at the regional and local level (e.g., Landesbank Baden-Württemberg, Germany, with participation of the regional government and the City of Stuttgart, has executed several issuances of green bonds since 2017).

*Figure 1.* **THE SIX DIMENSIONS OF GREEN FINANCING WHERE GOVERNMENTS SHOULD FOCUS**




*Source:* own elaboration.

Specialized funding agencies or other private aggregation vehicles may also help to pool resources from institutional and non-institutional investors. In order to increase the flow of capital towards green investments from institutional investors such as pension funds, mutual funds or risk capital companies, for instance, their internal capacities, incentives, management and operating practices and investment strategies should be aligned with sustainability and green investment goals. Cooperation between investors through different vehicles and fora (e.g., Institutional Investors Group on Climate Change, IIGCC) will facilitate the diffusion of best practice in green finance, knowledge about climate-related assets and financial instruments and the development of corporate responsibility related to sustainability.

Public policies can help to reduce the risk associated with green investments. For instance, tax incentives or rebates, improving credit information and credit profiles of project developers will help to reduce financial risks and may create incentives to issue debt (IRENA, 2016; Groenewegen & Wierts, 2017). Providing public green credit guarantees on loans will reduce credit risk (IRENA, 2016). In addition, establishing new local- or community-based trust funds and addressing specific green investment risks via financial and policy de-risking tools will help to unlock capital resources (Yoshino *et al.*, 2019; Taghizadeh-Hesary & Yoshino, 2020). Project development risk may be reduced by streamlining siting, permitting and other administrative requirements and simplifying specific regulations (e.g., related to grid access or construction and other standards) (IRENA, 2020b). Technology risks may be addressed via grants supporting R&D activities, public-private co-financing, risk-sharing across agents and other tools.

(2) The demand side of the market can be stimulated by stable, transparent policies that foster the deployment of clean, sustainable technologies and the adoption of more efficient and sustainable production and consumption processes. Tax advantages for green investors (e.g., income, corporate or wealth tax rebates) will spur private green investments. Governments may also engage in active ownership regarding the ESG goals of public companies (Dimson *et al.*, 2015) or directly act as consumers of green financial services. Deleidi *et al.* (2020) find that public investments not only have a positive but also a larger effect on private investment flows than feed-in tariffs, taxes or renewable portfolio standards, thus providing evidence that no significant crowding-out effects occur. In addition, a clear identification of green sustainable economic activities and projects (such as the EU Taxonomy of sustainable activities[5] or the Climate Bonds Initiative) will help to reduce the uncertainty faced by investors (Climate Bonds Initiative, 2018a, 2018b; IRENA, 2020a; European Parliament, 2020). Specific policies and instruments also create incentives for investment, such as using spillover tax revenues from energy supply to increase the rate of return of green projects.

(3) The creation and establishment of sound market infrastructure and institutions is also a key pillar for the development of green financing markets. In the case of green bond markets, for instance, the development of indices and an active role by actors such as exchanges will facilitate access to the market by smaller issuers and national or international investors. Other stakeholders, such as rating agencies, the various types of financial institutions, government agencies and retail investors also play a critical role in strengthening the market for green financial products.

Clear disclosure rules for companies and investors and detailed regulations of the green bond market (for instance, related to project selection and evaluation or management of bond proceeds) will help to generate confidence in the nascent green financing market (IRENA, 2020c). Market oversight is another critical function that should be carried out by governments or an appointed entity subject to strict independence-preserving rules.

(4) The regulatory framework will establish boundary conditions that, if well designed, may help to foster the development of green financing. In the case of green bonds markets, for instance, harmonized definitions of green and sustainable bonds, alignment with international best practice and development of common ap-

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[5] The EU Taxonomy was approved in 2020. It considers an activity as environmentally sustainable if it contributes to at least one of the following objectives: a) climate change mitigation and adaptation; b) sustainable use and protection of water and marine resources; c) transition to a circular economy; d) pollution prevention and control, and e) protection and restoration of biodiversity and ecosystems (European Parliament, 2020; EU Technical Expert Group on Sustainable Finance, 2020b). The criteria for the climate change mitigation and adaptation objectives are expected to be applicable from the end of 2021. The criteria for the rest of the objectives will be developed and applicable by the end of 2022 (European Commission, 2020a).

proaches, such as through regional collaboration, may accelerate the development of local green financing and investment (i.e. the City of Stockholm in Sweden developed a system of co-financing for transport projects). Specific rules and guidance for project selection, evaluation and reporting will lower the risk of 'greenwashing' and provide investors with more certainty about the nature of the projects and the management of proceeds (Sustainable Banking Network, 2018).

Sound regulations and standards will help to reduce information asymmetries and transaction costs and to solve problems related to incomplete markets. Moldogaziev *et al.* (2018) argue that capacity of a system to solve information asymmetries through transparency, disclosure and regulation, or ensure contractability between borrowers and lenders, controlling for the existing economic, financial and market, political, and legal institutions, is critical for the development of subnational credit markets. The resolution of information problems is particularly relevant in the case of investments in infrastructures and, specifically, in the case of green investments (Sharma & Knight 2016; Clark, 2018).

(5) Additionally, both the increase of supply and demand for green financing will be closely related to the skills and capacities of the actors involved in this market. Governments can induce the growth of the green financing market by stimulating the participation of other stakeholders, such as rating agencies, think tanks and other organizations that foster awareness and capacity building about sustainability, green assets and projects or new financing instruments. It can also help to disseminate information on best practice, guidelines and innovation in green finance markets, regulations and products, providing or inducing specialized training services for investors, technical advisors and policymakers and promoting fora where relevant stakeholders can share information and market intelligence. Chambers of commerce, associations in the financial sector and cluster associations can also contribute to capacity building, as can universities and technical education institutions through specialized programs.

(6) In addition to supporting R&D related to new financial products and services by, for instance, financial start-ups, governments can use new financing schemes and economic incentives such as funding of demonstration issuances, grants to offset issuance and reporting costs or the provision of seed capital for new financing vehicles. Alternative innovative financing instruments by governments and/or private entities based on grants, equity, debt, crowdfunding or community-based schemes also help to foster investments in low-carbon technologies (Owen *et al.*, 2018; Yoshino *et al.*, 2019). Table 2 summarizes all the above.

*Table 2.* **THE ROLE OF GOVERNMENTS IN CREATING A WELL-FUNCTIONING GREEN FINANCE MARKET**

| Goal | Specific policies and measures to foster green financing | Impact on the development of the market |
|---|---|---|
| (1) Market development: supply | • Public green financing (lending, equity, de-risking instruments).<br>• Offer tailor-made instruments.<br>• Facilitate aggregation and joint issuance of debt and bonds to reduce costs.<br>• Engage relevant stakeholders.<br>• Public policy instruments (incentives, taxes, monetary policies, etc.). | • Increase the flow of funding and capital resources.<br>• Stimulate the supply of capital from the private sector.<br>• Better address the needs of project developers.<br>• Increase competition. |
| (2) Market development: demand | • Policies enabling the development of clean, green or sustainable projects.<br>• Governments as users of green financing instruments and services.<br>• Application of taxonomy of green, sustainable projects.<br>• Facilitate aggregation initiatives.<br>• Public policy instruments (incentives, taxes, etc.).<br>• Facilitate funding in the early stage of sustainable projects. | • Increase the leverage of public investment.<br>• Identification of a pipeline of eligible green, sustainable projects.<br>• Build lender and investor confidence.<br>• Increase competition.<br>• Induce innovation in financial products and services. |
| (3) Market infrastructure and institutions | • Development of green indices and participation of exchanges.<br>• Engage specialized financial institutions.<br>• Disseminate information.<br>• Developing reporting and compliance standards, etc.<br>• Implementation of a market oversight function.<br>• Promote cooperation among stakeholders. | • Facilitate the pricing and trading of green instruments in the secondary market.<br>• Facilitate the matching of supply and demand needs and requirements.<br>• Increase market transparency.<br>• Preserve market integrity and credibility. |
| (4) Rules and regulations | • Implementation of supranational and national legislation.<br>• Development of a green finance strategy.<br>• Alignment with international best practice.<br>• Introduction of tax deductions for investments in new clean technologies (e.g., income tax, corporate tax, etc.). | • Build lender and investor confidence and green awareness.<br>• Increase market transparency.<br>• Increase the effectiveness of incentives.<br>• Facilitate connections with international markets. |

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| | | |
|---|---|---|
| (5) Capacity building | • Establish knowledge-creating institutions.<br>• Disseminate information and intelligence on green investments and green financing instruments.<br>• Specific training for company managers and staff, technical advisors and government agencies.<br>• University and technical education programs. | • Access to the market by smaller project developers, investors and potential lenders.<br>• Facilitate the creation of new specialized companies.<br>• Facilitate innovation in financing products and services. |
| (6) Foster innovation in products and services | • Issuance of new products (e.g., green bonds) by public institutions.<br>• Support alternative financing schemes (e.g., provision of seed capital, demonstration issuances, public-private schemes, etc.).<br>• Channel R&D funds to innovative projects and start-ups. | • Induce investment by reducing the risk of green projects.<br>• Strengthen the supply side of the market. |

*Source:* own elaboration.

## 5. GREEN FINANCING AT THE REGIONAL LEVEL: THE CASE OF THE BASQUE COUNTRY

### 5.1. Basque energy and environmental policies and measures

The Basque Country (BC) in Spain has a devolved government that exercises major powers over critical public services. It has its own tax system and has full authority to manage, levy and collect practically all taxes. It contributes with an agreed quota to finance the services that the Spanish Government provides in this region the so-called Economic Agreement (Concierto Económico). It is structured across three layers of government (municipal, province-level and BC as a whole). Province-level governments (called Diputaciones) set and collect taxes. The Diputaciones transfer 70% of their tax revenues to the Basque Government, which has most of the revenue allocation power in the BC.

Since the eighties, the BC has been transitioning towards a low-carbon, sustainable economy via various strategies and policies. The successive Basque energy strategies, for instance, have tackled the challenges faced by an industry-based economy (23.9% of gross added value in 2019; Eustat, 2020), such as the substitution of coal and oil products in most industrial uses for gas and electricity or the improvement of overall energy efficiency.

Regarding innovation, technology and industrial development, the Basque smart specialization strategy (RIS3) focuses on three key sectors: energy, biosciences and advanced manufacturing[6]. Specifically, in energy, the RIS3 implementation strategy (energiBasque) aims to position the Basque Country as a market leader in certain low-emission technologies (e.g., offshore wind and smart grids) and take advantage of the industrial and commercial opportunities generated by the transition to an environmentally sustainable economy (Clúster de Energía, 2019).

Environmental and sustainability goals are defined by the strategy Klima 2050 (which sets long-term emissions reduction targets), the 2030 Basque Agenda (which focuses on the United Nations' SDGs) and Basque Law 4/2019 on the energy sustainability of the BC, which focuses on reducing the energy consumption of the administration and establishes obligations regarding energy efficiency. The Circular Economy Strategy 2030 sets goals regarding the efficient use of materials and recycling and offers the opportunity to develop a competitive business ecosystem around the circular economy.

All these energy and climate strategies are currently under review to adapt them to the European Climate Law and the European Green Deal. Since 2019, a group of experts has the mandate to draft the Basque Energy Deal, a roadmap to achieving net-zero emissions in 2050.

Despite the progress made in the past three decades, much remains to be done, especially regarding emissions in buildings and transport, but also in the industrial sector. Achieving the above-mentioned energy and environmental objectives will imply significant volumes of green and sustainable investments over the next few years.

## 5.2. **Green financing in the BC**

### ***Key public financing institutions***

Since the eighties, the Basque Government has established several institutions and put in place and designed a number of programs and instruments to help overcome the challenges of industrial companies and, notably, small and medium enterprises (SMEs), as the Basque business ecosystem is mainly populated by this type of companies (Figure 2).

Key Basque public institutions providing resources to the industrial sector to support the creation of companies, their internationalization and investments in new technologies and R&D activities include the Basque Economic and Industrial Development Agency (SPRI), the Basque Institute of Finance, Risk Capital Management Euskadi, Basque Trade and Investment, and Elkargi (Figure 3). Usual support instruments include loans, credit guarantees and investments in equity in both government and private companies.

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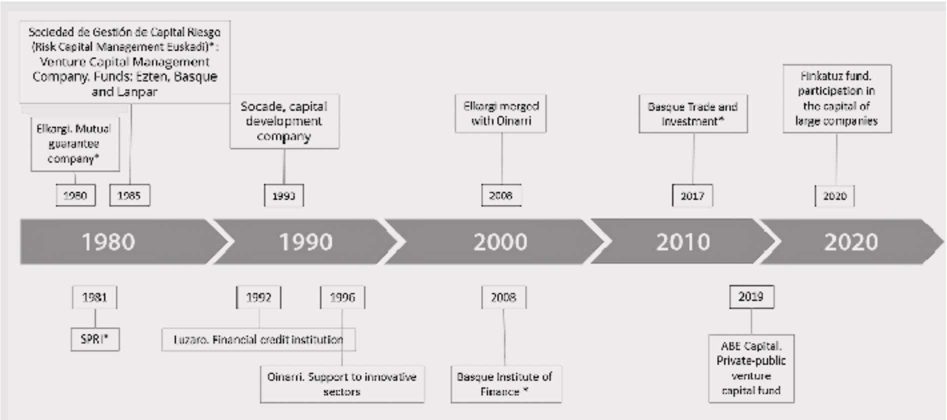
[6] Since 2019, the specialization areas of the RIS3 Strategy are under review following the European methodology and have been influenced by the megatrends, especially the three transitions: the technological-digital, energy-environmental and demographic-social. Therefore, the new three strategical priorities of the RIS3 will probably be health, cleaner energies and smart industry (Gobierno Vasco, 2019).

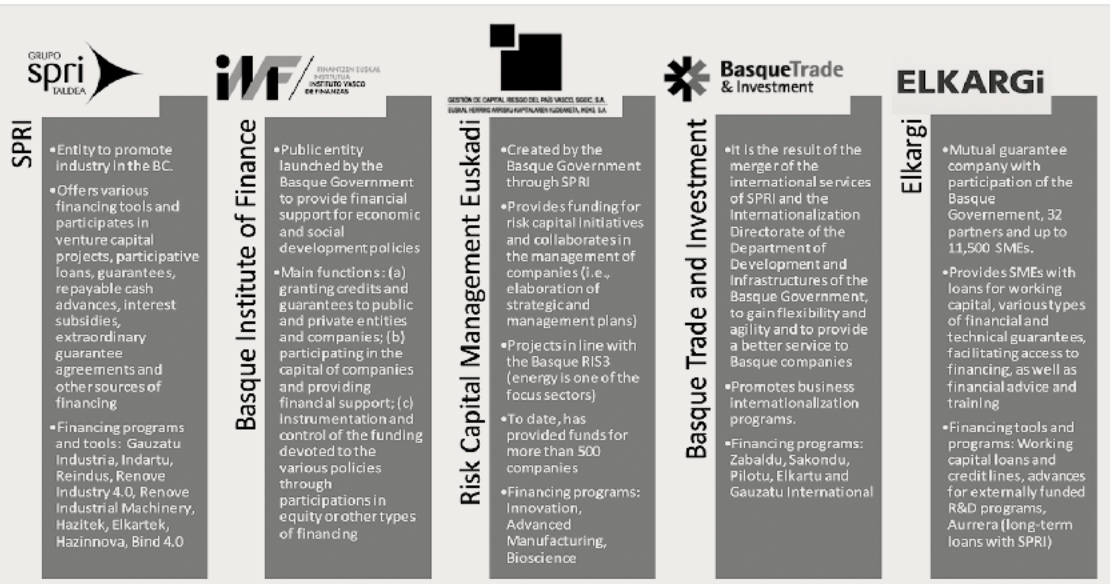
*Figure 2.* **FINANCING INSTRUMENTS AND MECHANISMS FOR SMEs IN THE BASQUE COUNTRY**




*Source:* own elaboration.

SPRI also designed the Bind 4.0 program, a public-private business accelerator program that provides financing (and other) resources to start-ups in the energy, advanced manufacturing, health and food sectors to facilitate the transition to the so-called «industry 4.0».

*Figure 3.* **MAIN BASQUE PUBLIC COMPANIES FINANCING GREEN AND SUSTAINABLE ACTIVITIES**




*Source:* own elaboration.

In the areas of energy and the environment, two public agencies of the Basque Country Government (the Basque Energy Agency, EVE, and the Basque Environmental Agency, Ihobe) play a relevant role in the financing of green, sustainable investments and projects.

***Equity investments and grants from the Basque Energy Agency***

Even though its main activities focus on promoting energy R&D and providing advice to the Basque Government on energy policy and planning, the EVE supports the development of new infrastructure projects and the creation of companies specializing in new technologies via equity investments and grants.

In the past, it has invested in companies developing infrastructures in the natural gas sector (e.g., Naturgas, Bahía Bizkaia Gas and Itsas Gas) and wind energy (Eólicas de Euskadi). It later divested some of its public equity participations. It still holds shares in companies such as Telur (geothermal energy), BEC Solar (solar energy), CADEM (energy efficiency and new energies), BioArtigas and Zabalgarbi (biomass), Aixeindar (wind energy), several local mini-hydro companies and other energy technology development companies such as Ibil (electric charging technologies).

In addition, the EVE has ample experience in providing grants to companies and end consumers in areas ranging from energy efficiency, deployment of renewable energies or sustainable mobility. It also participates and provides financing to demonstration projects and infrastructures related to renewable energy sources, such as marine technologies (Bimep).

***Grants from the Basque Environmental Agency***

Ihobe was established to support the Basque Government in the design of the environmental policy and to promote sustainability, efficient environmental management and protection of the environment in the BC. The main financing instrument used by Ihobe are grants supporting specific activities related to environmental sustainability and the circular economy.

***Other grants for green activities from the Basque Government***

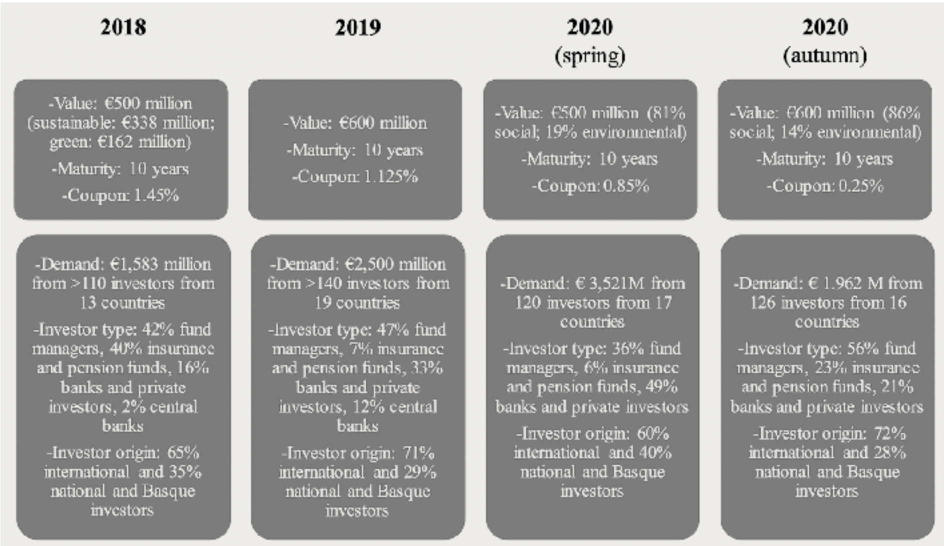
The Basque Government Decree 202/2015 regulates subsidies to companies that make investments aimed at protecting the environment. These grants are oriented to financing innovative investments and projects that focus on going beyond environmental EU standards, early adaptation to future EU standards, recycling and reuse of waste generated by third parties, land decontamination and covering other costs (i.e., environmental studies).

***Green government bonds***

In recent years, the Basque Government has been playing an essential role in the development of a sustainable bonds market in the BC by executing since 2018 four issuances of government-backed sustainable bonds that follow the steps of earlier issuances of sustainable or green bonds by Iberdrola (starting in 2014) and Kutxabank (starting in 2015). This is part of a more comprehensive strategy to create a green financing ecosystem that helps to address the environmental, economic and social challenges of the region.

To facilitate the viability of the Basque bond issuances, the Basque Government first developed a sustainable bonds guide in 2018 (Gobierno Vasco, 2018), aligned with the Green Bond Principles («GBP»), the Social Bond Principles («SBP») and the Sustainable Bond Guidelines 2017 (Sustainalytics, 2018). The four issuances to date were listed in the Bilbao Bourse, with increasing success in terms of the volume of revenues, demand and the heterogeneity of investors (Figure 4).

*Figure 4.* **BASQUE GOVERNMENT SUSTAINABLE AND GREEN BOND ISSUANCES**




*Source:* own elaboration.

### 5.3. **Other green financing instruments and tools**

***The Basque List of Clean Technologies***

In 2004, the Basque Government approved the List of Clean Technologies, with advanced technologies (e.g., industrial equipment and other technologies) with a direct impact on energy efficiency and the reduction of resource consumption and emissions in the commercialization phase that generate corporate tax deductions of 30% of the total investment.

***The 2020 Basque Country green public procurement and contracting program***

This program, approved in 2016, establishes a framework for the Basque Administration to internalize the environmental dimension in their purchases and public contracting, using EU standards and setting quantitative objectives for a large number of product categories.



### 5.4. Discussion and policy implications: The role of the Basque Government in fostering a local green market

The experience accumulated by the Basque Government in recent decades in establishing institutions, deploying public-private initiatives and demonstration projects and putting in place financing programs and schemes to foster industrial activity and facilitate innovation in the Basque Country proves to be a good starting point to consolidate a competitive Basque green finance ecosystem.

The second column of Table 3 describes, based on the analytical framework described previously, the current situation of the green finance market in the BC and the degree of involvement of the Basque Government and other institutions. Most of these institutions, initiatives and support programs already have a presence and impact in areas closely related to green financing, as seen before. Also, a number of pioneering and innovative green finance developments (for instance, in the area of bond issuances) have taken place in the BC in recent years.

Additional strengths in the area of green finance in the BC include an array of detailed governmental energy, environmental, technology and innovation strategies and policies oriented towards making an effective transition to a net-zero emissions economy and a culture of public-private collaboration that brings together government and private actors, science, research and academic institutions and even the civil society in different fora in order to tackle challenges relevant to the Basque economy.

There is, however, a lack of a broad green finance government strategy (for instance, similar to the aforementioned, UK Green Finance Strategy) that clearly aligns the goals, incentives and actions of all interested stakeholders in the direction of fostering a competitive local green finance market. This shows, for instance, in the absence of specialized institutions, a limited amount of specialized local actors on the supply side (institutional investors, services companies) and limited activity by potential project developers and local governments (municipalities and province-level) in deploying green projects.

Such a strategy would help to strengthen the market on both the supply and demand sides and create the right institutions to facilitate the flow of public and private capital to projects that are relevant for reaching the Basque Country's sustainability goals.

The number of areas where the Basque Government can act to create a well-functioning, competitive green finance market is large (third column of Table 3).

They range from the introduction of new public green finance instruments (for instance, publicly-backed innovative investment funds) to facilitating aggregation on the demand side to lower the transaction costs faced by borrowers. Engaging all stakeholders on both the supply and demand sides of the market is also relevant to facilitate the flow of capital to sustainability projects.

The creation of new green finance institutions, or the reorientation and adaptation of the roles of the existing ones (e.g., the Basque Institute of Finance and Elkargi) that improve collaboration across actors and help to build know-how and new sets of financial skills and capacities, disseminating relevant information across the market and, in general, fostering innovation in financial schemes, products and services are also key areas where the Government can have a sizeable effect.

A promising course of action for the Basque Government would be to facilitate investment vehicles, fiscal policy tools and funding and R&D programs in the BC to include specific aspects related to green financing. This would foster the creation of a sophisticated financial cluster in the Basque Country, in line with earlier suggestions by Gómez-Bezares *et al.* (2001) and Larreina & Gómez-Bezares (2007).

*Table 3.* **THE ROLE OF THE BASQUE GOVERNMENT IN FOSTERING THE GREEN FINANCE MARKET IN THE BC**

| Goal | Current situation in the Basque country | Actions to improve the green finance ecosystem |
|---|---|---|
| Market development: supply | • Long tradition of public loan vehicles and programs to foster innovation and investments in all sectors, especially industrial sectors and in SMEs.<br>• 40-year-old mutual guarantee company (Elkargi) with presence in the Basque industry with both government and private participation.<br>• Pioneer sustainable and green bond issuances by the Basque Government, Kutxabank and Iberdrola over the past few years.<br>• Limited amount of specialized local actors (institutional investors, services companies) | • Engage public sector stakeholders (e.g., government agencies and institutions, municipalities, province-level governments).<br>• Engage private-sector stakeholders at the local level (fund and asset managers, insurance companies, etc.).<br>• Foster the creation of new, highly specialized start-ups with a focus on green financing and green financial services (legal, accounting, climate risk assessment, consulting, etc.).<br>• Adapt Elkargi's experience to the green finance market.<br>• Focus a specific line of activity on green financing within the Basque Finance Institute.<br>• Facilitate aggregation vehicles for investors (especially small, private investors).<br>• Launch new specialized public green investment funds (for equity and debt financing and grants) to leverage private supply of capital (mission-oriented, with technical assistance, etc.).<br>• Conduct international roadshows to attract foreign capital, foreign place-makers and export specialized green financial services. |

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| Goal | Current situation in the Basque country | Actions to improve the green finance ecosystem |
|---|---|---|
| Market development: demand | • Focus of territorial strategies (e.g., energiBasque) on deploying renewables and low-emission technologies.<br>• Strength of public-private investment and R&D initiatives in new clean and sustainable technologies, backed by well-established Basque science, technology and innovation network.<br>• Tax deductions for investments in new clean technologies.<br>• Extensive grant programs for R&D activities.<br>• Specialized vehicles for start-up financing (Bind 4.0)<br>• Limited services market for investors.<br>• Some activity by potential project developers and local governments (municipalities and province-level) around innovative green, sustainable projects. | • Dissemination of the EU taxonomy of sustainable activities and EU fund programs across potential project developers.<br>• Dissemination of information on energy efficiency, clean technology adoption, new materials, circular economy actions and environmental programs for homes, primary and tertiary sector businesses, industry and transportation sector.<br>• Develop habitat banking and carbon credit programs to foster investment in conservation, biodiversity and forest development and other climate change adaptation and mitigation actions.<br>• Foster the creation of local green finance hubs to identify high-benefit green and sustainable projects.<br>• Foster aggregation of borrowers to reduce transaction costs and increase the scale of financing needs.<br>• Foster the development of data tools (e.g., on climate) and technical assistance services for companies to facilitate assessment of green and sustainable project opportunities.<br>• Strengthen Bind 4.0 objectives regarding green and sustainable projects. |
| Market infrastructure and institutions | • The Bilbao Bourse lists the Basque Government's Sustainable Bonds.<br>• Limited specialized activity by main Basque financial institutions.<br>• Limited legal capacity to develop a market oversight function.<br>• Basque Cybersecurity Centre. | • Coordinate approach with Bilbao Bourse and main banking and institutional investors to increase the liquidity of green bonds, launch of new products (ESG exchange-traded funds, yieldco shares) and development of sustainability indices.<br>• Foster the communication with financial entities and companies and dissemination of green financing mechanisms possibilities.<br>• Develop a platform to connect developers of green projects with potential providers of capital. |
| Rules and regulations | • The Sustainability Bonds Framework paves the way for a better understanding of sustainable financial products and bonds and increases alignment with international best practice. | • Develop a green finance strategy.<br>• Set-up a specialized task force to coordinate a green financing strategy.<br>• Adapt EU's Green Deal strategies and regulations to the BC context.<br>• Set-up a specialized task force to coordinate regulatory approach with Spain's and EU's regulators.<br>• Disseminate best-practice on reporting standards and codes and adoption by public institutions.<br>• Disseminate best-practice codes, guidelines and standards for investors and financial services organisations in line with Spain's and EU's legislation. |

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.../...

| Goal | Current situation in the Basque country | Actions to improve the green finance ecosystem |
|---|---|---|
| Capacity building | • Corporate and government experience with bonds (Iberdrola, Kutxabank, Basque Government)<br>• No specific government-run programs to disseminate knowledge and build capacities related to green finance.<br>• Specialized courses on ESG and sustainable finance at the University of Deusto (Deusto Business School) | • Set-up a public-private research and training institute specialized in green financing with green finance certification programs (e.g., similar to the Green Finance Institute in the UK)<br>• Foster the creation of green-finance focused knowledge networks and fora (e.g., on climate risks, reporting, accounting, de-risking tools, corporate governance, etc.)<br>• Facilitate the creation of a green-finance business association representing all types of investment institutions and service companies.<br>• Strengthen specialized education programs and disseminate them to attract human capital. |
| Foster innovation in products and services | • Basque Government green bonds.<br>• Some support for alternative financing schemes (e.g., provision of seed capital, demonstration issuances, public-private schemes) | • Coordinate with the Bilbao Bourse to foster the market for exchange-traded green funds.<br>• Elkargi's experience could be used to develop new de-risking instruments specifically adapted to green finance.<br>• Channel R&D funds to innovative projects and start-ups.<br>• Launch specialized green-finance product and services innovation contests.<br>• Coordinate with banks and utilities to develop green mortgage and on-bill, pay-as-you-save financing schemes and energy-efficiency savings recycling instruments to induce investments in energy efficiency of homes and buildings. |

*Source:* own elaboration.

## 6. CONCLUSIONS AND FURTHER RESEARCH

This article has explored the role of governments and, specifically, subnational or regional governments, in fostering a well-functioning green financing market.

The process of transition to a sustainable economy from the economic, environmental and social perspectives will necessarily require large volumes of investment, as shown, for instance, by the European Green Deal and the Covid-19 economic recovey packages. This implies the need to unlock significant volumes of capital and new ways of financing green, sustainable projects.

In this regard, new instruments to mobilize capital, such as NextGenerationEU, a temporary financing program within the EU Recovery Plan that will complement the European Green Deal financing scheme, will play a key role in unlocking private investment in sustainable projects, by creating an enabling framework for investors where the EU taxonomy will provide a common understanding on green investments and environmentally sustainable activities.



Investments in green technologies and projects face substantial technology, regulatory, commercial and credit risks. This has led to the development of innovative financing instruments and schemes specifically designed to cover these risks and induce greater levels of public and private investment, including green bonds. Despite these developments, a 'green financing gap' exists and the financial markets have difficulties in facilitating a steady flow of private capital towards green projects and activities.

In this context, governments can implement policies that increase both the quantity and quality of green financing and create effective institutions and adequate credit market conditions that help to fill the green financing gap. This may involve developing legislation, regulation, standards, institutions and policies that favour investment decisions by both public and private agents, inducing lending by providing a safe business environment and facilitating innovation in financing instruments and financial practices. The Government will also have to play an active role in increasing the supply of capital to finance green investments. In sum, governments might improve green financing by acting as a risk-bearing agent, an active market facilitator and a driver of financial innovation.

The research conducted in this article shows that subnational governments may play a differential, distinctive role in developing green financing at the regional level, especially in contexts with a high degree of decentralization and political autonomy. This is mainly because they are best placed to support local businesses and industries, develop human capital and the skills and capacities of local actors, foster local demand and induce competition and cooperation between local companies and collaboration across a variety of institutions, in addition to carrying out a large share of public investments and managing a variety of tools to induce economic growth and competitiveness at the local level, including research and innovation policies and tax and financial tools.

Additionally, the local and regional dimension of the energy transition is also relevant. Energy transition strategies at the regional level must focus on the specific strengths and specificities of each region and the characteristics of the local firms and institutions and the sociopolitical environment when designing the most appropriate policies, including those aiming to facilitate the financing of green, sustainable investments.

In this article, an analytic framework has been developed to assess the ways in which a government may induce better functioning of the green financing system. Six key dimensions where governments should focus to foster green finance are identified: (1) market supply, (2) market demand, (3) market infrastructure and institutions, (4) specific rules and regulations, (5) capacity building and (6) innovation in financial products and services. How specific policies and measures along each of these dimensions may have an impact on the development of the market is also addressed in the article.

This framework is then applied to the case of the Basque Country. The analysis in this article suggests that the development of a holistic, comprehensive green finance strategy by the Basque Government may consolidate a competitive green finance sector. Specific policies and actions that may be conducted by the Basque Government to effectively implement such strategy are also identified.

Future research lines on this topic may focus on developing the analytic framework presented here. This may imply studying the specific channels through which public green financing instruments and schemes and public-private collaboration schemes affect investments in innovative low-carbon technologies. In addition, the analytic framework may be complemented by quantitative indicators to assess the degree of development of a (regional) green financing market and highlight areas where government policies should focus. Moreover, a quantitative framework may help to carry out comparative assessments of various regions and countries.

Additionally, analyzing governance and collaboration models in the green finance sector between local, subnational and national governments may shed light on how to best design financial policies to spur the transition to a sustainable economy. Future work could also examine in depth the specific actions taken to improve the green finance ecosystem in the Basque Country, for instance, by setting a roadmap to their implementation, or analyzing potential new business models that may emerge in the area of green finance.

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# *Best practices to mitigate $CO_2$ operational emissions: A case study of the Basque Country energy ecosystem[*]*

**This work reviews the best practices to reduce $CO_2$ emissions in energy intensive organizations and energy value-chains by highlighting the synergy that can be built with like-minded organizations via collaborations; taking the Basque Country as a case study. An academic review covers how corporate strategies are attempting to curtail emissions in a systematic manner. The study is then complimented by findings obtained from interviews of key stakeholders in the Basque Country responsible for playing an important role in implementing a green agenda. The interviews allow us to highlight flagship projects and assess the collaborative framework strengths and challenges. Results indicate that organizations are well underway in implementing and researching low carbon solutions, but issues surrounding governance, strategy, and regulatory challenges can slow progress of goals.**

*Este trabajo resume las mejores prácticas en reducción de $CO_2$ en organizaciones con una gran huella de carbono y su respectiva cadena de valor al resaltar la sinergia que se puede dar a través de colaboraciones; utilizando como caso de estudio al País Vasco. El resumen detalla estrategias corporativas para reducir emisiones de una forma sistemática. El trabajo es complementado resaltando las perspectivas obtenidas por medio de entrevistas con actores clave en el País Vasco responsables de implementar una agenda verde. Las entrevistas mencionan proyectos primordiales y enfatizan las fortalezas y retos del trabajo en colaboración. Los resultados indican que las organizaciones están avanzando en implementar sus iniciativas, pero aspectos de gestión, estrategia y regulación pueden dificultar el lograr objetivos.*

Lan honek laburbiltzen ditu karbono-aztarna handia uzten duten erakundeetan CO2 murrizteko egin beharreko jardunbide onenak eta euren balio-katea, lankidetzaren bidez eman daitekeen sinergia nabarmentzen baitu; eta Euskal Autonomia Erkidegoa azterketa-kasu gisa erabiltzen da. Laburpenak isurketak sistematikoki murrizteko estrategia korporatiboak zehazten ditu. Lana osatzeko, agenda berde bat ezartzeko ardura duten Euskal Autonomia Erkidegoko funtsezko aktoreekin egindako elkarrizketen bidez lortutako perspektibak nabarmendu behar dira. Elkarrizketetan funtsezko proiektuak aipatzen dira eta elkarlanaren indarguneak eta erronkak nabarmentzen dira. Emaitzen arabera, erakundeak aurrera egiten ari dira beren ekimenak ezartzen, baina kudeaketa-, estrategia- eta erregulazio-alderdiek helburuak lortzea zaildu dezakete.

* Spanish version available at https:/euskadi.eus/ekonomiaz.

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**Keywords:** carbon mitigation, decarbonisation, environmental policy, low carbon technologies, sustainability best practice.

**Palabras clave:** descarbonización, mejores prácticas medioambientales, políticas medioambientales, reducción de carbono, tecnologías bajas en emisiones.

**JEL codes:** Q20, Q28, Q30

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## 1. INTRODUCTION

Carbon intensive organizations have the imperative need to decarbonise and implement best practices in their day to day operations. The United Nations Framework Convention on Climate Change (UNFCCC) in 2015 managed to agree a landmark climate pledge to combat global warming. 195 countries signed the Paris Climate Agreement at COP21, aiming to limit global temperature increase to 2 °C, relative to pre-industrial temperatures (United Nations Climate Change, 2016). This legally binding global climate change accord aiming to strengthen countries' ability to deal with the impacts of climate change and support them in their efforts is creating shockwaves across carbon management concepts and strategies for both profit and non-profit organizations (Zhou, 2020). COP21 has accelerated the transition to a low-carbon economy, across all sectors, but particularly within energy intensive organisations who are becoming more transparent and meticulous in their greenhouse gas (GHG) emissions reporting as exemplified in the Carbon Disclosure Project (CDP) initiative (CDP, 2020).

Meanwhile, almost 500 companies have already committed to implementing science-based targets, this initiative supports organisations in counteracting political short-termism by setting a glidepath towards long-term emissions reduction. Science based targets are in line with the level of decarbonisation set by climate science while future-proofing growth, as described in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5) (Science Based Targets, 2017). Furthermore, a handful of countries have showed leadership and set a net-zero target by law (*e.g.* Denmark, France, New Zealand, Sweden, and the UK); making these nations climate targets fully aligned to COP21.

The advantages of setting ambitious environmental targets is that leading companies and governments will collaborate in developing innovation in sustainable energy generation and supply solutions while also evaluating policies that support their implementation (Rissman *et al.*, 2020). Solutions from the supply-side can range from low-carbon electrification, bioenergy, synthetic fuels, carbon capture, and zero-carbon hydrogen. Alternatively, important demand-side mitigation options include championing energy efficiency, on-site energy generation, the replacement of high-carbon materials for low-carbon materials and circular economy practices. A combination of all these solutions should ensure the competitiveness of key industries in a future where governmental policies will most likely set carbon pricing and energy efficiency standards, while achieving net zero emissions in the required timeframe set by the Paris agreement without sacrificing human and economic development (Hickel, 2020).

Although organizations have environmental targets, they all have their own business models and have the desire to be financially viable well into the future. Therefore, increasing profitability or reducing operational costs are key objectives in any organization. This financial goal consequently needs to be aligned with carbon management business drivers, such as innovation, stakeholder value, and future-proofing supply-chain risks. This combination of factors should create a virtuous cycle in the organization proactively seeking cost-effective ways to reduce carbon emissions and in turn defeat short-termism and uncertainty avoidance that results in sustainability inaction (Slawinski *et al.*, 2017).

Although nations are slowly enacting climate legislation for-profit organizations are moving faster to adapt and change their business practices in which sustainability is at the core of their decision-making. For instance, «big brand» carbon intensive organizations such as Amazon (Amazon, 2020), Microsoft (Microsoft, 2020), Repsol

(Repsol, 2020a), among many others are making pledges to become net zero in operations in the coming decades by 2050. As organisations from all economic sectors make zero carbon pledges, their corporate energy policies will face substantial challenges in undertaking cost-effective investments that both align in delivering value to shareholders but keep them on-track to meet their sustainability targets (Finnerty *et al.*, 2018).

Developing comprehensive tools to devise optimal investment strategies to mitigate GHG emissions is not straightforward and requires abundant knowledge of the activities and systems that originate the carbon and the technologies or measures that can address them (Ayoub *et al.*, 2020). However, unless organizations have specific expertise and extensive financial resources, most will lack in-house expertise for adequate decision-making to make informed decisions on how best to address their sustainability challenges (Campbell-Árvai *et al.*, 2019). The power of partnerships and collaboration is key to drive innovation and accelerate the transition towards a low carbon economy.

Implementing the solutions for a cost-effective transition towards a low carbon economy is not straightforward and this paper attempts to summarise and portray the best practices in decarbonisation and sustainability initiatives to help us become net zero. Emphasis is given to corporate carbon strategies and decarbonisation pathways. These best practices are then complimented by depicting the collaborative approach and initiatives a progressive ecosystem of organisations in the Basque Country are taking to mitigate carbon emissions. This paper allows key stakeholders to become aware on a range of sustainability best practices but also allows them to gain clarity on productive collaborative frameworks as they undertake tangible actions towards sustainable operations. The questions this paper is trying to answer is identifying the best practices being applied in the Basque Country in terms of solutions and collaborative vehicles, highlighting the strengths and challenges.

This paper is structured as follows. Section 2 provides a literature review covering sustainability best practices that organizations need to consider driving effective environmental change. Section 3 gives context to the Basque Country innovation ecosystem and explains the interview approach undertaken to inform the case study. Section 4 presents the results obtained from the interviews and discusses them against the findings from the literature review. Lastly, Section 5, offers concluding remarks from this work.

## 2. LITERATURE REVIEW IN SUSTAINABILITY BEST PRACTICES

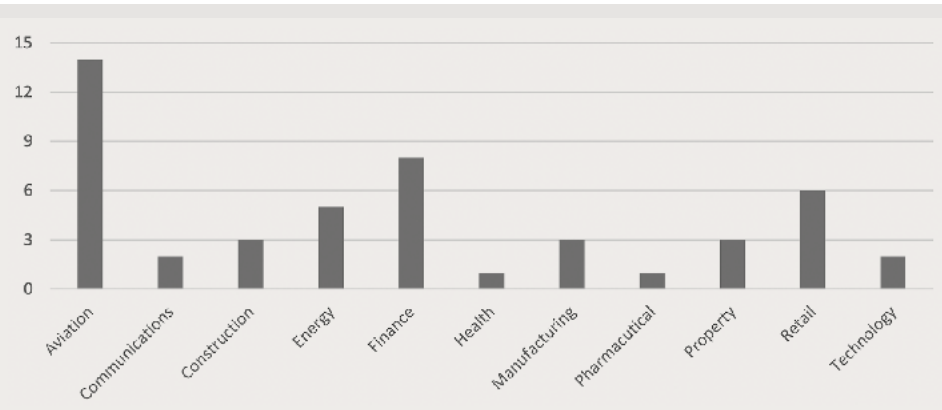
The process consisted in identifying key literature from 2016 onwards, after the Paris Climate Agreement had been signed to list the progress and innovation that has occurred in the last few years. Peer reviewed literature on corporate energy strategies to achieve carbon emissions reductions is not abundant, especially depicting holistic long-term approaches. In a similar fashion a literature review of technology solutions that are supporting the transition towards a low carbon economy was investigated. Thus, the literature review focused on summarising progress in the following areas regarding «carbon strategies in organizations”:

- Net zero pledges;
- Governance;
- Mitigation approaches;
- Energy management;
- Energy policy post Covid-19;
- Fostering R&D;
- Decarbonization solutions.

### 2.1. **Net zero pledges**

Net zero refers to achieving a balance between the amount of greenhouse gas emissions produced and the amount removed from the atmosphere. There are two different routes to achieving net zero, which work in tandem: a) reducing existing emissions and b) actively removing greenhouse gases (Institute for Government, 2020). Targets are indeed ambitious and due to the intrinsic differences of the economic sectors companies operate in, the solutions will vary for each organization, however tangible progress is mandatory, and it must also stand up to scrutiny. The journey of how a company gets to net zero is just as important as simply getting there. As of May 2020, a diverse group of 50 companies have officially announced their net zero ambitions by 2050 (at the latest) and have started to align their strategy and brand accordingly.

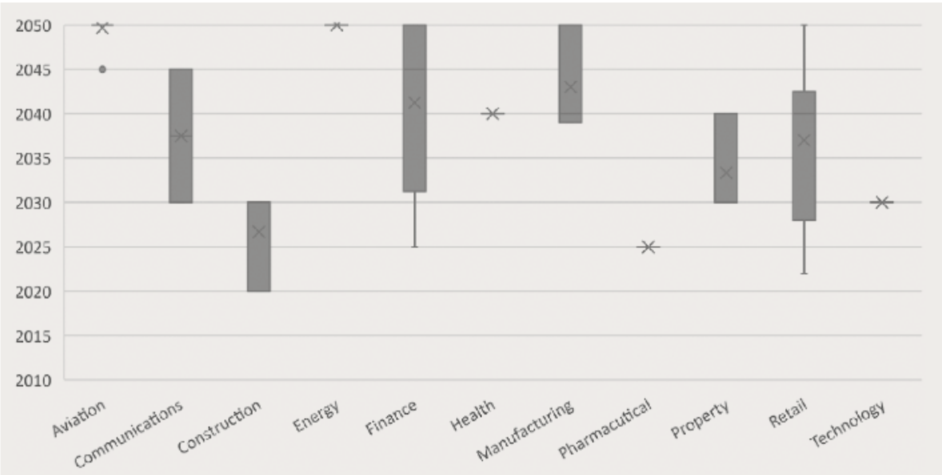
*Figure 1.* **NUMBER OF NET ZERO PLEDGES FROM COMPANIES BY ECONOMIC SECTOR**




*Source:* Carbon Intelligence, 2020.

However, there is a race to reach net zero as quickly as possible and some organizations are showing a great degree of ambition, see Figures 1 and 2 illustrating how net zero pledges vary by economic sector (Carbon Intelligence, 2020). Mace, a construction company stands out as committing to net zero by 2020 via energy efficiency and by offsetting all outstanding emissions (Mace, 2020). Also, it is worth highlighting some organizations such as Microsoft and AstraZeneca have gone a step further and committed to become carbon negative. Whichever target is established, setting a net zero target implies a business needs to do exhaustive work across its business units to develop a clear roadmap and governance structure that produces a credible and cost-effective pathway to reduce its GHG emissions. As Figure 2 indicates companies are taking an ambitious and proactive approach to the challenge and most of them are hoping to meet their environmental targets well before 2050.

*Figure 2.* **NET ZERO TARGET YEAR SET BY COMPANIES IN VARIOUS ECONOMIC SECTORS**




*Source:* Carbon Intelligence, 2020.

## 2.2. **Governance**

Carbon governance refers to an organization's managerial capabilities of dealing with risks and opportunities related to climate change mitigation and resulting governance mechanisms. Carbon governance can be broken down into various corporate activities that need to be championed by institutions; however, the following are deemed the most important to convert wishful thinking into reality (Caritte *et al.*, 2015):

- Organizational involvement: A company can assign roles and responsibilities for climate change issues to staff at different organizational levels, shifting the culture to raise awareness about climate change and to promote climate-friendly behaviour, offer monetary and non-monetary incentives and engage employees in innovation processes for emission reductions (Damert & Baumgartner, 2017);

- Alignment of incentives: Despite increasing pressure to deal with climate change, firms are usually slow to respond with effective action because of excessive short-termism and avoidance of risk or uncertainty due to corporate culture and regulatory inadequacy. In the short run, such decisions are generally not consistent with executive incentives and generally regarded as not maximizing profits. Therefore, firms need to incentivise boards, directors, and managers so they align their sustainability strategy to increase the long-term value of the companies they lead (Aggarwal & Dow, 2012).

## 2.3. **Carbon mitigation approaches**

There are two elements to a net zero pathway: a reductions pathway and a removals pathway. Organizations should not become complacent and try to implement both approaches in parallel, but the priority should be on the reduction pathway. The carbon mitigation approaches can be grouped into four categories (Carbon Intelligence, 2020):

- Decarbonization: Reducing emissions on an absolute basis through efficiency improvements or via low carbon solutions (*e.g.* converting to renewables) with regards to the sourcing, management, and disposal of resources;
- Removals: Balancing remaining emissions by sequestering carbon through activities that happen within the value-chain of the company;
- Carbon credits: Balancing emissions with carbon credits from carbon removal projects or carbon avoidance projects;
- Avoided emissions: Balancing emissions with emissions avoided by selling products or services.

The carbon mitigation approach championed by organizations needs to be transformational. This principle implies that the approach followed by a company to reach net zero emissions should inform long-term strategies and investments while also providing certainty to investors, and other stakeholders, that the business model of the company will continue to be viable in a net zero carbon economy. This means companies need to build a strategy and pipeline of projects to inform their investment programme for carbon reduction or removal. To meet this pressing requirement novel modelling frameworks are being proposed by the research community; providing a blueprint to enable organizations to develop their bespoke low carbon roadmap strategies. Ayoub *et al.* (2020) presents a reductions pathway modelling framework to develop cost-effective decarbonisation investment programs that address electricity and heat carbon emissions in organisations with multiple properties by 2050. Similarly, Hart *et al.* introduces a data-driven modelling framework for optimal investment strategies supporting the food retail industry to transition from hydrofluorocarbon (HFC) refrigeration systems to lower GWP systems by 2030, in line with EU legislation (Hart *et al.*, 2020). Works such as these offer valuable insights into some of the complexities and techno-economic attributes low carbon roadmaps require to meet the scrutiny of key decision-makers.

### 2.4. Energy management practices

Implementing best energy management practices is pivotal in the global agenda to improve energy performance and GHG reduction in organizations. Organizational processes and actions in energy and environmental management can be comprised of two key areas that improve business competitiveness: strategy and operations (ISO, 2020).

Naturally, there are barriers that even the most proactive and engaged organizations need to face and overcome to implement effective energy management practices. Researchers have published extensively in this field and their reviews suggest the following barriers are the most common in industry (Finnerty *et al.*, 2018):

- Low availability of capital: Due to a lack of vision or a different order of priorities organizations do not allocate sufficient resources to energy related investments as they might deem them too risky or with a low return on investment;
- Risk of disruption in production or trading activities: The threat of a loss in revenues from implementing an energy related project can derail promising initiatives;
- Lack of support: A lack support from regulation to incentivise consumers via policy mechanisms to champion energy efficiency and reduce GHG emissions can slow down innovation.

### 2.5. Energy policy post Covid-19

Naturally, companies do not act in a vacuum and require the support from governments via progressive policies to enable them to implement carbon mitigation solutions. In May 2020 over 150 global companies aligned to Science Based Targets urged world leaders for a net-zero recovery from Covid-19 (Science Based Targets, 2020). Ignacio Galán, Chairman & CEO, Iberdrola, said: «The world must be united to tackle the current health crisis. And, as we emerge from this crisis, we must focus economic recovery on activities aligned with key priorities, such as the fight against climate change, and reactivating economic activity and employment quickly and sustainably. Pursuing environmental sustainability will be essential for long-term economic recovery.» The statement comes as governments around the world are preparing financial stimulus packages to help economies recover from the impacts of the Covid-19 pandemic, and as they prepare to submit enhanced national climate plans under the Paris Agreement.

The IEA recently stated: «Covid-19 does not change the elements of the net-zero emissions innovation policy package, but some of the elements deserve immediate attention as governments prepare policies to repair, stimulate and recover economic activity. The central role of government in supporting energy innovation is well established, especially in relation to the public good nature of R&D and tackling the greenhouse gas externality is widely agreed to need strong government action over the coming decades. Energy innovation offers an opportunity to boost economic activity damaged by the Covid-19 pandemic and at the same time to help with the transition to net-zero emissions.» In other words, a lack of investment in energy innovation and sustainable transitions would have grave consequences and complicate meeting the Paris Climate Agreement (IEA, 2020). Table 1 depicts the IEA recommendations to foster both short-term and long-term investment in sustainable solutions across the developed and developing countries.

*Table 1.* **POLICY ACTIONS FOR A SUSTAINABLE ENERGY RECOVERY POST COVID-19**

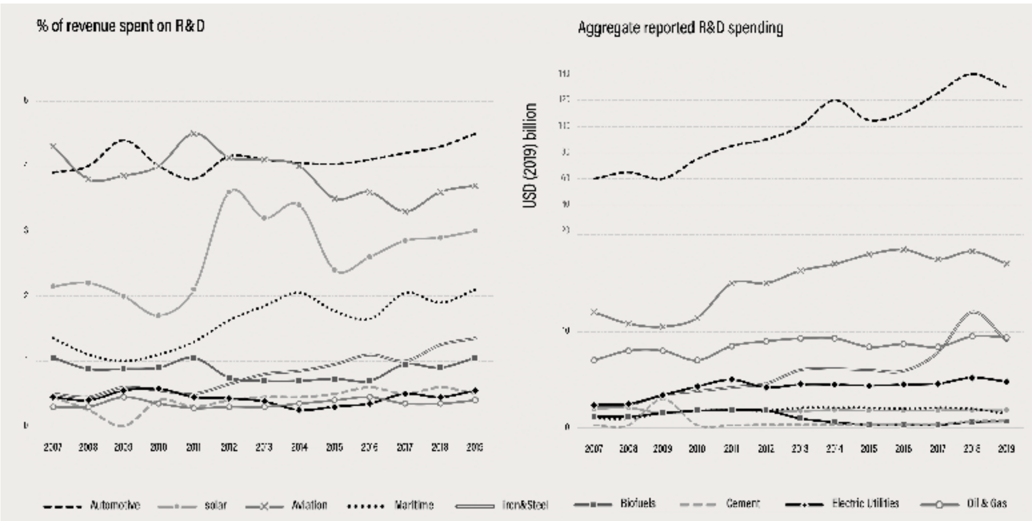
| Sector | Measure |
|---|---|
| Buildings | – Implement large-scale retrofit programmes for public buildings, provide subsidised financing for private retrofits.<br>– Implement appliance turnover schemes to replace inefficient appliances, install heat pumps and renewable energy systems that use solar water heaters and biomass boilers.<br>– Support clean cooking access by offering modern stoves, and developing advanced biomass and liquefied petroleum gases delivery systems. |
| Transport | – Implement vehicle turnover schemes to accelerate efficient car and electric vehicle adoption.<br>– Boost high-speed rail and incentivise the purchase of new efficient trucks, airplanes and ships.<br>– Accelerate deployment of recharging networks for electric vehicles, upgrade public transport, and improve walking and cycling infrastructure. |
| Industry | – Incentivise industrial energy efficiency, especially light-industry electric motor and process heat pumps upgrades.<br>– Improve waste collection and recyclable material recovery rates, especially where waste collection processes are informal.<br>– Upgrade to efficient agricultural pumps. |
| Electricity | – Invest in electricity network upgrades, particularly distribution system strengthening and modernisation.<br>– De-risk and fast-track new wind and solar PV deployment.<br>– Extend lifetimes for nuclear plants near their end of life and repower existing hydropower facilities. |
| Fuels | – Support for biofuel industries if they meet appropriate sustainability criteria.<br>– Implement methane leak detection programmes to address fugitive methane from upstream oil and gas operations.<br>– Reform inefficient fossil fuel subsidies without increasing end-use prices. |

*Source:* IEA, 2020.

## 2.6. **Fostering R&D**

Companies active in renewable energy technologies have increased their R&D spending faster than other energy technology sector companies: they increased their expenditure on R&D by 74% between 2010 and 2019, adding over USD 2.5 billion to efforts to improve their technologies. Companies have continued to increase their spending in recent years, with government policies and competitive pressures leading them to focus more on energy efficiency and electric vehicles, as illustrated in Figure 3 by the analysis made by the IEA depicting R&D spending in key energy sectors. Other sectors – notably cement, biofuels, electric utilities, and iron and steel – invest much less in R&D as a proportion of their revenue. Electric utilities and heavy industrial companies are generally consumers of technology, typically engaging in technology development via partnerships with suppliers.

*Figure 3.* **GLOBAL CORPORATE R&D SPENDING BY SECTOR FROM 2007 TO 2019**




*Source:* IEA, 2020.

## 2.7. **Decarbonization solutions**

A variety of low carbon technologies, product design choices, and operational approaches can rapidly and cost-effectively reduce energy consumption and GHG emissions across a broad range of industries (Kramer & Haigh, 2009). Furthermore, all these technologies and interventions can be enhanced by integrated systems design. So very large reductions in industrial GHG emissions are possible by focusing on a limited set of product and process improvements. This section presents a brief overview of the solutions and developments that are expected to enable viable solutions by 2050; both on the supply side and on the demand side – outlined in Table 2. These solutions need to be supported by strategic, well-designed policies that accelerate innovation and provide incentives for technology deployment (Griffin & Hammond, 2019). High-value policies include carbon pricing with border adjustments or other price signals; robust government support for research, development, and deployment; and energy efficiency or emissions standards (Rissman *et al.*, 2020). Technologies will likely be deployed in waves, with demand-side interventions and already commercialized efficiency technologies dominating through 2035, structural shifts becoming more pronounced from 2030–2050, and nascent technologies such as hydrogen becoming important thereafter.

*Table 2.* **SOLUTIONS FOR CARBON MITIGATION EXPECTED BY 2050**

| Theme | Key solutions for carbon mitigation |
|---|---|
| Supply-side: Materials and carbon capture | – Reduce process emissions from cement.<br>– Reduce thermal fuel-related emissions from cement.<br>– Reduce carbon emissions from steel production.<br>– New chemical production technologies avoiding fossil fuels.<br>– Use of biomass feedstocks and recycled chemicals.<br>– Biomass and hydrogen value-chains.<br>– Reuse of CO2 for chemicals production.<br>– Chemical separations.<br>– Carbon capture and storage (CCS/CCU) to address residual CO2.<br>– Retrofit of buildings to passive house level. |
| Supply-side: Energy | – Renewable energy generation via wind, solar, tidal, and geothermal power.<br>– Energy generation from waste resources (AD), biogas, biomass, and biomethane.<br>– Efficient steam and heat recovery processes.<br>– Electrification of key services such as heating and transport.<br>– Integrated distributed energy systems for local energy districts supporting heating, cooling, and transport.<br>– Zero carbon hydrogen production and use.<br>– Sustainable production of ammonia, methane, and methanol. |
| Demand-side: Interventions | – Improvements in energy efficiency for heating, cooling, and other services in industry, commercial and domestic buildings.<br>– Implementing advanced control strategies to shift demand using dynamic energy prices and weather forecasts.<br>– Machine learning applications for energy efficiency and controls.<br>– Replacement of fossil fuel transportation systems.<br>– Additive manufacturing for industry 4.0 (3D Printing).<br>– Low embodied carbon materials.<br>– Circular economy practices: longevity, transfer, refurbish, recycle. |

*Sources:* (Acha, 2013), (Acha, 2013), (Delangle *et al.*, 2017), (Efstratiadi *et al.*, 2019), (Chakrabarti *et al.*, 2019), x (Bustos *et al.*, 2014), (Bustos *et al.*, 2015), (Bustos *et al.*, 2016), (Langshaw *et al.*, 2020), (Acha *et al.*, 2016), (Gonzato *et al.*, 2019), (Cedillos *et al.*, 2016), (Mariaud *et al.*, 2017), (Acha *et al.*, 2018), (O'Dwyer *et al.*, 2019), (Olympios *et al.*, 2020), (Rissman *et al.*, 2020), (Sunny *et al.*, 2020), (Tapia *et al.*, 2019), (Sarabia *et al.*, 2019), (Maouris *et al.*, 2019), (Acha *et al.*, 2020).

## 3. THE BASQUE COUNTRY ENERGY ECOSYSTEM CASE STUDY

This section depicts the different players and collaboration vehicles that have made the Basque Country a leading industrial European hub and explains the interview approach undertaken to implement carbon mitigation initiatives and their collaborative framework.

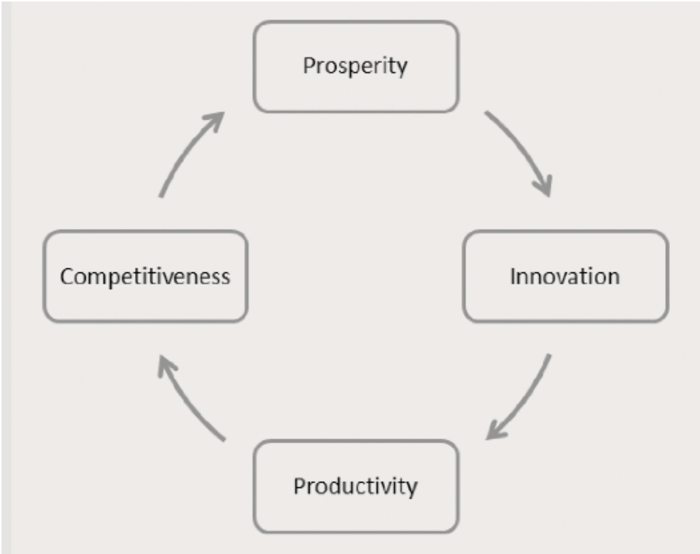
### 3.1. Basque Country entrepreneurial ecosystem

After a struggling economic period with high unemployment and low productivity in the 1970s and 1980s, due to an outdated manufacturing and industrial sector, the Basque Country reinvented itself in the 1990s by setting up technology clusters and industrial parks sparking innovation and knowledge creation that made the most of their strong engineering know-how (Grupo SPRI Taldea, 2020a). This refocus was derived from strategic technology planning devised by government, industry, and chamber of commerce experts. By frequently reviewing the technology plan, goals are closely aligned in their effort to maximise economic potential for the region, creating a win-win situation for business growth, employment, and societal well-being.

As depicted in Figure 4, the entrepreneurial ecosystem thrives on enhancing innovation capabilities to power productivity and competitiveness which results in prosperity. Competitiveness ultimately depends on improving the microeconomic capability of the economy and the sophistication of local competition (Pressman, 1991). This policy framework over the years has yielded economic growth and aided Basque companies' in becoming important players in key sectors such as energy (*e.g.* Iberdrola, Petronor, Velatia Ormazabal), telecommunications (*e.g.* Euskaltel), manufacturing (*e.g.* Gestamp, Siemens-Gamesa), and aeronautics (*e.g.* ITP). These strategic technology plans have been complimented by bespoke policy that supports their implementation and consist of the following elements:

- Basque Economic Agreement featuring autonomy in financing, taxation, and policy (Bizkaia Foru Aldundia Diputación Foral, 2020);
- Integrated and balanced structure;
- Adaptable to economic conditions;
- Strong support in spurring industry development;
- Industrial ecosystem with a focus on R&D, clusters, financing, and entrepreneurship;
- Long-standing policy support through tax incentives for business investment;
- Ongoing public-private collaboration.

*Figure 4.* **DETERMINANTS OF COMPETITIVE ADVANTAGE OF INDUSTRIES**




*Source:* Pressman (1991).

### 3.2. Basque Country energy stakeholders

The SPRI Group at the Development and Infrastructure Department of the Basque Government has been a key pillar in driving the technology plans and helping companies obtain access to resources so they can innovate and stay at the forefront in their sectors (Grupo SPRI Taldea, 2020b). The SPRI Group coordinates 22 clusters in the Basque Country, facilitating communication of their action plans with hundreds of profit and non-profit organizations. The evolution of these clusters has seen its actions oriented towards the gradual development of the pyramid of cooperation on their strategic areas of action. Its goal is to promote cooperation between its members in addressing the strategic challenges of each cluster with a preferred approach of strengthening SMEs. This cluster support across areas such as energy, advanced manufacturing, automotive, and aeronautics is pivotal in driving competitive advantage.

In particular, the Basque Energy Cluster is made up of the leading companies in the energy sector located in the Basque Country (*i.e.* energy operators, component and equipment manufacturers), agents of the Basque Science, Technology and Innovation Network and public administration bodies involved in the energy field (Cluster Energia, 2019). The Cluster is a non-profit organisation which was set up at the end of 1996 within the framework of the Basque Government's policy to foster the competitiveness of the industrial sector. It is currently made up of over 160 companies and entities active in the energy sector leveraging its ability to invigorate partnerships and promote the visibility of the sector both locally and internationally.

Members belong to five major groups:

- *Driver companies* defined as end-users and potential clients that steer solutions;
- *Large enterprises* are businesses of a significant size withing the value-chain and R&D capacity;
- *SMEs* are small companies and start-ups championing innovation and seeking growth;
- *Knowledge agents* are organizations either in academia or research centres that can provide know-how and independence to advances in research and specialised training;
- *Government agencies* with the role of supporting the cluster (*e.g.* EVE, SPRI, etc.).

In its most recent technology plan «EnergiBasque» detailing the industrial development and technology strategy of the «Energy Cluster» the following strategic areas have been highlighted: a) wind power, b) solar power, c) wave power; d) oil and gas, e) smart grids, f) electromobility, and g) energy efficiency and advanced energy services. These areas cover the whole value-chain (*i.e.* generation, transport and distribution, and consumption) and the latest technologies championing digitalisation, circular economy, and materials, etc. The strategy is implemented via working groups which are formed from a small group of businesses/agents interested in developing initiatives or projects in cooperation with others in response to seeking shared challenge.

### 3.3. **Interview approach and themes discussed**

Through a set of comprehensive interviews from key stakeholders driving best practices in the Basque Country energy value-chain perspectives have been captured and synthesised. These interactions allow us to outline the plans, challenges and initiatives organizations are facing to support the transition towards a low carbon economy; either by reducing their own carbon footprint or by providing services or products to energy intensive end-users or sectors. Findings from the interviews allow us to identify the problems being faced on the ground by stakeholders as they pursue a green agenda, while also highlighting the collaborative frameworks they embark upon as they seek to unlock know-how via collaborations. Understanding what drives the collaborative process and the value it provides has the purpose of exemplifying how healthy ecosystems can thrive.

Figure 5 depicts some of the most representative organizations in the Basque Country energy ecosystem. Core findings from the interviews present the diversity of thought and approaches or initiatives being devised for a quicker progression in carbon mitigation solutions. Emphasis is given to their respective perspectives while also highlighting the benefits partnerships and collaborations provide under a cluster framework. The stakeholders interviewed fall under the following categories:

- Energy agencies, the energy cluster, and other government bodies;
- Energy generation and supply companies;
- Energy infrastructure and service providers and SMEs;
- Research centres and universities.

Due to the challenging conditions derived from Covid-19 all interviews conducted were done remotely via videoconference. The set of interviews conducted with over 10 organizations in the Basque Country have the goal of depicting the findings from open and inclusive discussions that portray the narratives and distinct perspective each stakeholder faces. All the interviews followed a similar structure but were slightly adapted to understand the viewpoint of each stakeholder. The themes discussed in the interview were posed as open-ended questions covering the following subjects:

- Role of organizations in the sustainability transition;
- A perspective of the challenges being faced by industry;
- Sustainable flagship projects in the energy value-chain;
- The collaborative ecosystem in the Basque Country.

*Figure 5.* **ORGANIZATIONS OF THE BASQUE COUNTRY ENERGY ECOSYSTEM**


*Source:* Own elaboration.

## 4. RESULTS OF THE BASQUE COUNTRY CASE STUDY

The findings from the interviews portray the perspectives of each stakeholder and are presented under distinct themes. The role organizations have in the sustainability transition is discussed first, followed by flagship projects being undertaken. After these aspects are detailed a summary section highlights areas of strength and opportunity, while a discussion sections gives further thoughts on how the Basque Country energy ecosystem can take learnings from actions occurring abroad.

### 4.1. Role of organizations in the sustainability transition

The Basque Country energy ecosystem relies on key organizations that have acted as pillars thanks to the backing from the Basque Government despite the political cycles every few years.

At its core, the Basque Energy Agency (EVE) coordinates with the Basque Government and is responsible for laying the foundations of the energy strategies and policies of the territory with an emphasis on energy efficiency, uptake of renewables, smarter infrastructure, demand side management, distributed generation, and electromobility as well as playing a major role in supporting sustainability projects where public involvement may be required. One of the biggest virtues of EVE is that it funds its activities through the revenues generated in the projects it undertakes with companies. EVE by acting as an anchor to facilitate the execution of innovative projects provides a solid springboard so private organizations can develop new business energy models. Once these public-private partnerships grow, mature, and become sustainable is the moment at which EVE exits the venture and sells its stake.

EVE is supported by organizations that enact and support their agenda. As described in Section 3, the SPRI Group and the Energy Cluster are two key organizations that attempt to support private organizations to strengthen their competitive advantage by funding or supporting activities that enhances their know-how. SPRI seeks to help companies align their activities to sustainable best practices, shifting their corporate strategy to a «green agenda», while also helping them to gain exposure at an international level. But most important of all, SPRI has a priority to foster collaboration between large companies (*e.g.* Iberdrola) and SMEs/start-ups who seek to shake-up the industry. Through these activities the SPRI Group attracts companies to sign-up to the Energy Cluster and makes them appreciate the benefits from collaboration. The Energy Cluster is then responsible to support its members in funding calls and other collaborative opportunities so SMEs, start-ups, and research-oriented organizations can enhance their business models and become fully fledged business. By obtaining funds to undertake activities the stakeholders and knowledge ecosystem benefit by invigorating the sector, developing know-how, and improving their internationalisation prospects.

Another noteworthy mention supporting EVE in its sustainability mission is the Ihobe organization. Ihobe is a public company of the Basque Government, supporting the Ministry of Economic Development, Sustainability and Environment by implementing environmental policy and in collaborating with stakeholders to drive the sustainability agenda in private and public organizations; effectively establishing a network of alliances (Ihobe, 2020).

From a more autonomous viewpoint, it is worth highlighting the three territorial provinces of the Basque Country (Araba, Bizkaia, and Gipuzkoa) are committed to the EVEs strategy through its various public institutions and municipalities by enacting the «Sustainable Energy» law (Eusko Jaurlaritza – Gobierno Vasco, 2019). This law sets the tone and mandatory actions for public facilities and public transport units to be audited and pushes them to make concise efforts to reduce their demand, transition to electric fleets, and source 100% of their energy via green PPAs. Such a regulation inadvertently creates a market for low carbon solutions. Table 3 details the role of the private industry in supporting the sustainable transitions.

*Table 3.* **ROLE OF PRIVATE ORGANIZATIONS IN THE SUSTAINABILITY TRANSITION OF THE BASQUE COUNTRY**

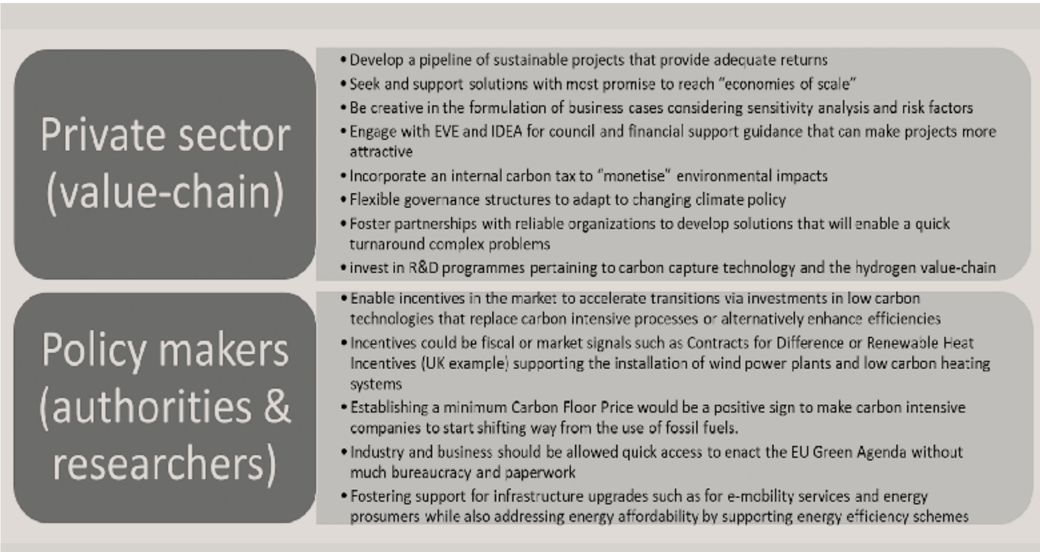
| Sector | Measure |
|---|---|
| Energy suppliers | – Decarbonise operations and energy provision to customers by 2050.<br>– Investment in renewable technologies such as wind power, photo-voltaic (PV) and photo-voltaic thermal (PVT) systems.<br>– Support R&D in green hydrogen, biomethane, and synthetic fuel projects.<br>– If fossil fuel is still to be used, employing CCS and CCU technology will be pursued to secure the carbon emissions are contained. |
| Energy service providers | – Provide services that are zero carbon by fulfilling the potential of digital services while reducing the carbon footprint associated to products in their supply-chain. |
| Consultancy firms | – Guide and enable customers to align their sustainability strategies with effective solutions and financing opportunities to foster such change. |
| SMEs | – Play a catalyst role in their niche market they are trying to address be it smart grids, electromobility, or renewable energy projects, etc. |
| Consumers | – Although have not committed to net zero yet, they are working on robust frameworks that facilitates them to reduce their carbon footprint. These actions include championing operational excellence, setting ISO 14001 standards and goals aligned to the UN 2030 Agenda for Sustainable Development and the European Green Deal. |
| Research centres | – Committed to a collaborative relationship with industry and government; sharing a technological strategy to achieve the highest value-adding proposals/funding and know-how to boost competitiveness and benefit society via educational, publications, and/or R&D activities. |

*Sources:* (Gestamp, 2019), (Vidrala, 2019), (BC3, 2020), (Orkestra, 2020), (Fundacion Tecnalia Research and Innovation, 2018).

### 4.2. **A perspective of the challenges being faced by industry**

The challenges are many. From government agencies and public bodies, the main task is keeping the collaboration ethos fluid, dynamic, and moving forward despite the economic difficulties Covid-19 brings to the budgets of public organizations and private companies. For instance, EVE continues to evaluate innovative projects and is considering which ones are worth embarking upon. In addition, EVE is making sure the 3E2030 plan is progressing adequately in terms of energy efficiency and renewable energy goals and is currently in discussions to devise a more ambitious plan aligned to Paris Climate Accord. Meanwhile, SPRI is actively working on supporting its clusters under the pandemic storm, while driving the «EnergiBasque» agenda that is supporting the development of competitive industries: a) wind power, b) solar power, c) wave power; d) oil and gas, e) smart grids, f) electromobility, and g) energy efficiency and advanced energy services. Furthermore, SPRI is also supporting efforts in biosciences and industry 4.0 activities. Naturally, SMEs and start-ups are the ones which require more support and an opportunity can be made from the pandemic crisis with the momentum of the EU Green Agenda; developing cutting-edge energy products and/or services. Figure 6 lists some the issues that need to be addressed to foster a sustainable transition in the Basque Country energy ecosystem; these have been provided by industry and policy makers.

*Figure 6.* **LIST OF ACTIONS AND APPROACHES TO FOSTER A SUSTAINABLE ENERGY TRANSITION**




*Source:* own elaboration.

### 4.3. Sustainable flagship projects in the energy value-chain

There are many encouraging signs that the collaborative ecosystem in the Basque Country is yielding positive results. During the interviews key projects that are on-going or that are in the pipeline were outlined; most of these are available in the public domain. In this section we make mention of the most promising ones; summarised in Table 4.

*Table 4.* **COLLABORATIVE PROJECTS FOR CARBON MITIGATION BEING DEVELOPED BY ORGANIZATIONS IN THE BASQUE COUNTRY ENERGY ECOSYSTEM**

| Project | Lead | Partners | Scope |
|---|---|---|---|
| Net zero emission fuels (Part 1) | Petronor | EVE, Aramco | One of the world's largest plants to manufacture net zero emissions fuels (e.g. synthetic), using CO2 captured and also producing green hydrogen with renewable energy. |
| Net zero emission fuels (Part 2) | Petronor | EVE, Aramco | Plant for generation of biogas and biomethane from urban waste which replaces traditional fuels used in Petronor's production process. |
| Green hydrogen | Iberdrola | Fertiberia | The hydrogen Puertollano plant (in south of Madrid) will consist of a 100 MW photovoltaic solar plant, a lithium-ion battery system with a storage capacity of 20 MWh and one of the largest electrolytic hydrogen production systems in the world (20 MW); a futuristic project requiring an investment of 150€ million. Fertiberia will update its ammonia plant to be able to use the green hydrogen produced to manufacture green fertilisers. |
| EV fast charging services | IBIL | EVE, Petronor | Example of how a public-private partnership has grown into a full-fledged business is the story of Ibil, an organization focused on facilitating a fast charging EV network and electromobility services. Ibil now has partnerships with Santander and collaborating on projects such as E-Via Flex-E, CIRVE. |
| AIGeCo | Petróleos del Norte | Ingeteam, IBIL, Basque Government, EU, Petronor, Euskaltel, Tecnalia, Izertis | Intelligent aggregator project to encourage active generation and demand participation. Local energy system value-chain R&D activities covering aggregation services, smart charging, power electronic devices and software development. |

…/…

…/…

| | | | |
|---|---|---|---|
| eMovLab | Petronor | Begas Motor, IBIL, Ingartek, Ingeteam, Ekide, Masermic, Ziv, Tecnalia, Energy Cluster | eMovLab has as its aim to conceptualise and develop innovative technologies and businesses, enabling Basque industry to adapt to future scenarios in sustainable mobility and energy. eMovLab has a budget of €5M and is funded by the Basque Government's Hazitek Programme, with support from the EU Regional Development Fund. |
| Basque Electrical Laboratories Alliance | Velatia-Ormazabal | Arteche, Tecnalia, Energy Cluster | This collaboration has the aim to do R&D and tests to improve the competitiveness of T&D equipment. Products developed will be certified and market ready for deployment. |
| Energy Intelligence Center (EIC) | Basque Government and Biscay Provincial Government | Iberdrola, Petronor, Siemens Gamesa, Sener, Ingeteam, Ormazabal, Arteche, Zigor, Cegasa, Solarpack | Public-private R&D hub that will specialize in innovative hydrogen, smart grid, wind generation and oil and gas technologies. Furthermore, industry 4.0 and advanced manufacturing concepts will be tested and developed. |
| Bidelek Sareak | Iberdrola Distribution | EVE, Velatia-Ormazabal, ZIV, Arteche, Tecnalia, Elecnor, Schneider Electric | This project aims to deploy Smart Grids in both cities and towns to increase the security and efficiency of the electric energy supply. |
| Territorial competitiveness (various) | Orkestra | SPRI, EVE, Iberdrola, Euskaltel, Petronor, Tecnalaia | Multidisciplinary projects between research and academic institutions to conduct studies influencing policy and informing about the nature of successful techno-economic and environmental transitions that promote economic growth and societal well-being. |
| Battery storage research | CIC energiGUNE | Energy cluster, Ingeteam, Solarpack | Multi-disciplinary research projects covering the value-chain of electrochemical and thermal energy storage systems as well as the power conversion and control devices that can enable their uptake. |
| Basque Research & Technology Alliance (BRTA) | Basque Network of Science | 16 research centres supported by the Basque and Provincial Governments | BRTA has the mission to create collaboration vehicles to leverage resources to address industrial challenges. Also, this alliance allows a greater capacity to attract funding as the skillsets of various research centres create synergies and facilitates knowledge transfer. |
| Climate Change Research | Basque Centre for Climate Change (BC3) | Ikerbasque, Ihobe, UPV, Basque Government, Excelencia Maria de Maeztu | BC3 is a research centre on the causes and consequences of climate change. It produces multidisciplinary knowledge to support decision making towards sustainable development at the international level. BC3 is a world leader in supporting the significant parts of the lifecycle of transdisciplinary climate change research. |

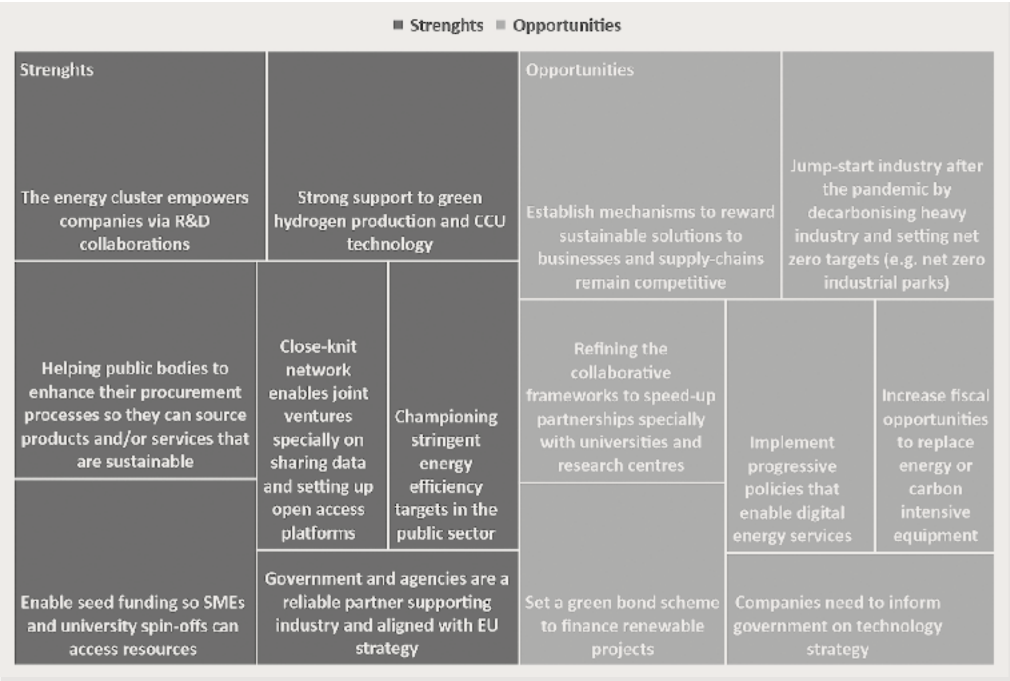
*Sources:* (Repsol, 2020b), (Iberdrola, 2020), (Ibil, 2020), (Ingeteam, 2019), (CIC energiGUNE, 2019).

### 4.4. Strengths and opportunities for the Basque Country energy ecosystem

Although the virtues of the collaborative ecosystem in the Basque Country are many, the system has elements that can be improved upon. Figure 7 outlines the most frequently mentioned strengths and opportunities identified by the stakeholders.



*Figure 7.* **STRENGTHS AND OPPORTUNITIES PORTRAYED IN THE INTERVIEWS WITH BASQUE COUNTRY ENERGY ECOSYSTEM STAKEHOLDERS**




*Source:* Own elaboration.

As the figure above suggests the stakeholders seem to be in general agreement that the main ingredients collaborative framework set by the Energy Cluster, SPRI, EVE and the Basque Government has many positive elements. Particularly the alignment with local authorities (see Table A.1), industry, and SMEs to develop a strong value-chain that delivers the solutions required. However, the areas of opportunities indicate the post-pandemic policies need to be well targeted to revitalise industry that champion competitiveness. Also, it is stressed progressive policies are enacted and green bond schemes set to finance innovation; just like Scandinavian and USA local or regional authorities have done with considerable success. Some noteworthy comments made by the interviews also stated the following:

- Strengths
  - Persist in incentivising energy service companies and large consumers to invest in energy efficiency technology and/or renewable technologies via EVE or IDEA to support the market, making it less difficult to burden organizations with the capital such investments have on balance sheets.
  - Communication channels that enable companies to be well informed on activities made by competitors and changes to regulatory processes in the countries where operations are taking place needs to continue and become embedded as best practice.
  - The province of Bizcay is offering support to start-ups, such mechanisms need to be refined and increased to foster innovation and local economic growth.
- Opportunities
  - Many organizations delay investments as such works disrupt key operations and create a loss in revenues, can a mechanism be introduced to alleviate this loss in production?
  - Promote best «corporate sustainability report» (CSR) practices across the Basque companies so they report the environmental impact from their activities and develop carbon mitigation pathways.
  - Governments need to give greater powers to regulatory bodies that do not have enough power to enact a sustainability agenda, otherwise delay in investments will occur.
  - Review land use policies and refurbishment of infrastructure that could increase the feasibility of renewable energy projects.
  - The Energy Cluster could re-consider its strategy by including hydrogen and bioenergy production to reduce reliance on fossil fuels, digitalisation of energy services to increase end-user engagement, review transmission infrastructure at high-voltage levels to seek high power capacity interconnectors from where renewable energy could be sourced.

### 4.5. **Discussion**

Private and public organizations must play their role to prevent the worst impacts of climate change, but solutions are very complex. Robust internal decision-making processes and solutions are required by supporting technology development and through collaborative frameworks with 3$^{rd}$ parties (*e.g.* governments, regulatory bodies, SMEs, etc.) to drive innovation and implement cost-effective solutions.

As this research has shown net zero pledges are in vogue and it is a matter of time for key stakeholders to ask if the results from many promising investments are matching the rhetoric. Developing adequate decision-making tools that allow us to identify the right time to invest, where to invest, and what to install is fundamental for each organization. Another point worth highlighting is the tricky nature of how organizations will mitigate emissions they cannot reduce directly. Careful due diligence is needed to reassure that carbon credits, offsets, or removal solutions applied do not have unattended consequences that erase the carbon savings they claim. Therefore, embedding sustainability best practices, carbon awareness, and a committed working culture of having a positive environmental impact is paramount to drive organizational change. This last point gathers more weight as the world recovers from the economic fallout generated from Covid-19. Now more than ever governments, institutions, and companies need to lead with support from the public to enact a green recovery that unlocks economic growth and simultaneously reduces carbon emissions.

A promising example of leadership is being done particularly by those countries enacting legislation to reach net zero targets by 2050. Of those countries, the UK is the one who is articulating the range of technology solutions that will enable a «green revolution» (Afry, 2020). Such advocacy and clarity are appreciated by stakeholders as it gives direction of travel and confirms the net zero legislation will drive flagships projects soon. Albeit such announcements do not detail the supportive policies that will be enacted to drive the «revolution», but it can help to drive grant and investment for niche technologies. For the UK the decarbonization strategy will most likely support the development of the following technologies:

- Off-shore and on-shore wind farm projects;
- Hydrogen generation, infrastructure, and market;
- Large and small-scale nuclear power plants;
- Electric vehicles, batteries, and fast-charging infrastructure;
- Public transport, cycling and walking;
- Aviation and greener maritime;
- Refurbishment of homes and public buildings and upgrading its heating systems;
- Carbon capture and sequestration in fossil fuel power plants;
- Massive tree-planting programmes;
- Green financing.

The above solutions should kick-start an entrepreneurial journey in the UK that fosters collaboration and R&D programmes to refine solutions that are fit for purpose, implementable, effective, and scalable. Indeed, the UK collaborative cluster of public, private, and academic organizations will be tested. In a very similar fashion, such as in the Basque Country, governments and regions around the world will be required to enact funding programs and legislation to support the green agenda. Public policy is to play a key role to enable and accelerate this transition to net zero.

The stakeholders interviewed in the Basque Country showed a sensible degree of optimism at the future ahead as they believe the inertia towards sustainability is unstoppable. The decarbonization challenge needs to be converted into a great opportunity to propel the know-how developed thus far and used for cutting-edge sustainable solutions that will make organizations competitive and cement their position as leaders in their field; securing economic growth that benefits the wider society.



Making the most of the EU Green Deal is a must, acting as a springboard to drive innovation and serving to leapfrog current best practices. The Basque energy ecosystem needs to be ready to embrace this opportunity by embarking on stimulating collaborative projects and showing it is possible to develop business models that do not rely on fossil fuels. Attracting investment to the Basque region from multiple sources is also key to enable the flourishment of sustainable solutions that provide economic growth. Either through fiscal incentives or green financing mechanisms, authorities and companies need to find winning formulas that put innovation at the heart of the energy ecosystem in the Basque Country.

Energy transitions are not easy due to their disruptive nature and foreseeing unattended consequences should also be priority. Perhaps providing support for financing investments or reducing the loss generated from lower productive output would make companies accelerate their transition towards net zero. Furthermore, the speed at which a transition can take place - its timing, or temporal dynamics - is a critical element of consideration. If we analyse previous transitions from technologies developed since the industrial revolution it could be argued that meeting climate goals by 2050 will be very challenging indeed as socio-technical, sociology, regulation, and political trends need to be aligned (Sovacool, 2016).

Many stakeholders interviewed expect the Basque Government through the EVE will soon set ambitious carbon mitigation goals aligned to the Paris Climate Accord – articulating the various pathways, mechanisms, and approaches available to make a net zero future viable is desired. Maybe a carbon tax, fossil fuel duties or a carbon floor price can be implemented with the support of EU authorities to send a clear signal.

Enabling a more competitive environment through net zero innovation seems to make a lot of sense for the Basque Country and preaching with flagship projects would signal organizations are ready to meet the challenge head on. A great example would be to invest and develop net zero industrial (*i.e.* green) clusters in the areas where many companies have their operations such as petrochemical plants, manufacturing clusters, and technology parks; benefitting not only the energy intensive users but also the value-chain of companies providing products and services. Reaching such goals via collaboration and partnerships would be very positive as they have the effect of transforming governance and are inclusive which improves the capacity to resolve complex problems at scale (McAllister & Taylor, 2015).

## 5. CONCLUSION

Private and public organizations must play their role to prevent the worst impacts of climate change by reducing their greenhouse gas emissions to meet the Paris Climate Accord. In recent times many nations have enacted climate legislation, while also many private organizations have either committed to net zero emission targets or are following Science-based target frameworks. The positive inertia to for a «green revolution» seems palpable and we must act upon it. Expectations need to be carefully managed and tangible results delivered otherwise there would be a breach of trust and positive sustainability inertia gathered will lose steam and support. Consequently, organizations need to implement lean and progressive decision-making processes to ensure their investments programmes are aligned with their long-term roadmap strategy. Getting the temporal dynamics of this transition is not an easy endeavour, especially for those organizations with a high carbon footprint distributed across many facilities and with large and complex supply-chains.

This work reviewed the best practices to reduce $CO_2$ emissions in energy intensive organizations and energy value-chains by highlighting the synergy that can be built with like-minded organizations via collaborations; taking the Basque Country as a case study. An academic review covers how corporate strategies are attempting to curtail emissions in a systematic manner. The study is then complimented by findings obtained from interviews of key stakeholders in the Basque Country responsible for playing an important role in implementing a green agenda. The interviews allowed us to outline the key organizations driving the sustainability transition, highlight flagship projects and assess the collaborative framework strengths and challenges. Results indicate that organizations are well underway in implementing and researching low carbon solutions, but issues surrounding governance, strategy, and regulatory challenges can slow progress of goals. Some projects such as the ones from Petronor and Iberdola already indicate the shift towards exploring next generation solutions such as green hydrogen, while other companies are fostering know-how by public-private partnerships in transport electrification and digital energy services.

Although challenges remain the Basque Country energy ecosystem is aligned to EU environmental targets and it is expected that key stakeholders such as EVE will set a clear strategy to strive for net zero goals by 2050. Setting up an adequate regulatory and incentive framework will be no easy task but the collaborative relationship between public-private organizations puts the Basque Country in a great position to succeed in making the region an exemplar in net zero solutions in the upcoming decades. Becoming a regional industrial powerhouse that runs on low carbon energy is an ambition worth aiming for to enact transformative change, develop a competitive advantage, and generate economic prosperity. It is the case that for the Basque industry a shift towards net zero would put them at the forefront against other European regional hubs, making their products and services a desired commodity elsewhere.

# APPENDIX

## Local Authorities

*Table A1.* **ENERGY POLICIES INSTRUMENTS AVAILABLE FOR LOCAL AUTHORITIES IN THE BASQUE COUNTRY**

| Political instruments available to local authorities | Private buildings | | | Public buildings | | |
|---|---|---|---|---|---|---|
| | New | Renovated | Existing | New | Renovated | Existing |
| Regulations on minimum energy efficiency | ++ | ++ | - | + | + | - |
| Tax incentives and credits | ++ | ++ | + | + | + | - |
| Information and training | ++ | ++ | ++ | ++ | ++ | ++ |
| Promotion of good practice | ++ | ++ | + | ++ | ++ | + |
| Demonstration buildings | ++ | ++ | - | ++ | ++ | - |
| Promotion of energy audits | - | ++ | ++ | - | ++ | ++ |
| Regulations and urban development plans | ++ | + | - | ++ | + | - |
| Increase in rate of rehabilitation | - | ++ | - | - | ++ | - |
| Energy taxes | + | + | + | + | + | + |
| Coordination of policies with authorities at different levels | ++ | ++ | ++ | ++ | ++ | ++ |

Note: ++ Very relevant + Relevant - Not very relevant
*Source:* EVE, 2017.

## Abbreviations

| | |
|---|---|
| AD | Anaerobic digestion |
| AR5 | $5^{th}$ Assessment report |
| BC3 | Basque Centre for Climate Change |
| BEIS | Business, Energy & Industrial Strategy |
| BELA | Basque Electrical Laboratories Alliance |
| BRTA | Basque Research & Technology Alliance |
| CAPEX | Capital expenses |
| CCS | Carbon capture and sequestration |
| CCU | Carbon capture unit |

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.../...

| | |
|---|---|
| CDP | Carbon disclosure project |
| CHP | Combined heat and power |
| COP21 | 2015 United Nations Climate Change Conference |
| CO | Carbon monoxide |
| $CO_2e$ | Carbon dioxide equivalent |
| CPPA | Corporate power purchase agreement |
| ECA | Enhanced capital allowance |
| EVE | Energy Basque Agency |
| GDP | Gross domestic product |
| GHG | Greenhouse gas |
| HFC | Hydrofluorocarbon |
| IPCC | Intergovernmental Panel on Climate Change |
| ISO | International Organization for Standardization |
| KPI | Key performance indicators |
| Ktoe | Kilo tonnes of oil equivalent |
| LNG | Liquified natural gas |
| LSE | London School of Economics |
| MW | Megawatt |
| $NO_x$ | Nitrogen oxides |
| PV | Photo-voltaic |
| PVT | Photo-voltaic thermal |
| RIS3 | Regional innovation smart specialization strategy |
| R&D | Research and development |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UPV | University of the Basque Country |

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# *How are O&G companies contributing to the energy transition? A novel analytical framework for assessing sustainability strategies**

**Oil and gas (O&G) companies are progressively developing and adopting sustainability strategies in response to regulatory and market pressures embedded in the energy transition process. The UN's Sustainability Development Goals (SDGs) are strongly linked to energy transitions and key to achieving successful sustainability strategies. A novel analytical framework to evaluate sustainability strategies is proposed and applied to the case study of Petronor, a refining company in the Basque Country (Muskiz, Bizkaia). The analysis helps to assess how O&G companies contribute to the energy transition by focusing on the SDGs. This first application of this framework suggests that a comprehensive understanding of an O&G company's sustainability efforts is needed to fully evaluate its role in the energy transition.**

Las empresas de petróleo y gas (O&G) están desarrollando y adoptando progresivamente estrategias de sostenibilidad en respuesta a las presiones regulatorias y de mercado contempladas en el proceso de transición energética. Los Objetivos de Desarrollo Sostenible (ODS) de la ONU están estrechamente vinculados a las transiciones energéticas y son clave para lograr estrategias de sostenibilidad exitosas. Se propone un novedoso marco analítico para evaluar estrategias de sostenibilidad y se aplica al caso de estudio de Petronor, una empresa de refino del País Vasco (Muskiz, Bizkaia). El análisis ayuda a evaluar cómo las empresas de O&G contribuyen a la transición energética al centrarse en los ODS. Esta primera aplicación de este marco sugiere que se necesita una comprensión integral de los esfuerzos de sustentabilidad de una empresa de O&G para evaluar completamente su papel en la transición energética.

*Petrolio- eta gas-enpresak (O&G) iraunkortasun-estrategiak garatzen eta hartzen ari dira pixkanaka, trantsizio energetikoaren prozesuan aurreikusitako erregulazio- eta merkatu-presioei erantzuteko. NBEren Garapen Iraunkorreko Helburuak (GIH) oso lotuta daude trantsizio energetikoekin, eta funtsezkoak dira iraunkortasun-estrategia arrakastatsuak lortzeko. Esparru analitiko berri bat proposatzen da iraunkortasun-estrategiak ebaluatzeko, eta Petronorren azterketari aplikatzen zaio, Euskal Autonomia Erkidegoko fintze-enpresa bati (Muskiz, Bizkaia). Analisiak laguntzen du ebaluatzen O&G enpresek nola laguntzen duten trantsizio energetikoan, GIHetan zentratzen direnean. Esparru horren lehen aplikazio horrek iradokitzen du beharrezkoa dela osorik ulertzea O&Gko enpresa batek egiten dituen iraunkortasun-ahaleginak, trantsizio energetikoan betetzen duen rola erabat ebaluatu ahal izateko.*

* Spanish version available at https:/euskadi.eus/ekonomiaz.

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**Keywords:** energy transition, oil and gas, petroleum industry, sustainable development goals, sustainability strategies, clean energy technologies, low-carbon technologies.

**Palabras clave:** transición energética, gas y petróleo, industria del petróleo, objetivos de desarrollo sostenible, estrategias de sostenibilidad, tecnologías de energía limpia, tecnologías bajas en carbono.

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## 1. INTRODUCTION

A common challenge in the energy transition processes is reducing greenhouse gas emissions from the combustion of fossil fuels (Grubler, 2012; Clews 2016; IEA, 2020a), positioning oil and gas (O&G) companies under increasing market and regulatory pressure to adapt their businesses and processes. This adaptation will have profound environmental, economic and social implications, especially in locations where O&G companies account for a relevant share of economic activity.

These factors suggest a trade-off between moving fast towards a low- or zero net-emissions economy and the development of sound sustainability strategies by the O&G companies. Any approach to sustainability can hardly ignore the existing call to businesses around the globe to integrate the United Nations' Sustainable Development Goals (SDGs) into their strategies (Kingo, n.d.; UN Global Compact, n.d.; SDG Compass, n.d.). Identifying those SDGs that are most relevant to an O&G company may be a useful first step in building robust sustainability strategies.

The aim of this paper is to develop a novel analytical framework that helps to identify, classify and arrange in order of importance the activities of an O&G company regarding their contribution to the SDGs, by linking them to low-carbon technologies. In order to do so, this work addresses the approaches to energy-related SDGs by international organizations like the United Nations Development Programme (UNDP) or the International Energy Agency (IEA). This purpose is guided by the following research question: *how can an O&G company contribute to the energy transition by implementing a sustainability strategy?*

As a first application of this tool, the analysis in this article focuses on a specific case study around Petronor, the only refinery in the Basque Country.

This paper is structured as follows. Section 2 conducts a non-systematic literature review on the relationship between energy transitions and the SDGs and how O&G businesses adapt to the changing environment. Section 3 describes the proposed analytical framework regarding the fulfilment of the SDGs. In Section 4, Petronor's sustainability strategy and related activities are assessed under this framework. The last section presents conclusions and avenues for further research.

## 2. LITERATURE REVIEW

### 2.1. Relationship between energy transitions and the SDGs

Although no universally accepted definition exists, the concept of energy transition is generally understood in the academic literature as a shift away from low-cost, centralized, mostly fossil-based energy systems or the change to a more sustainable energy and economic system (Verbong & Loorbach, 2012).

It is a process that involves transformation along many dimensions towards meeting economic, social and environmental goals, implying changes in the generation and use of energy and other resources for production processes or final consumption. It is also characterized by technological and institutional changes, innovation dynamics and other societal and economic trends (e.g., regarding urbanization, population, interactions between various stakeholders, social issues, politics and institutions, etc.) (Grubler, 2012; Araújo, 2014; Li *et al.*, 2015; Defeuilley, 2019; Lee and Yang, 2019; Sorman *et al.*, 2020).

The concept of sustainability lies now at the heart of the energy transition. This arises from the view that sustainable development means overcoming several energy challenges, related to issues such as emissions and climate change, air pollution, energy security, energy poverty, water, food or the use of land and forests (McCollum *et al.*, 2011; Bazilian *et al.*, 2011). The synergies between objectives such as tackling climate change, increasing energy security and reducing air pollution and related health impacts lead to the need to take an integrated perspective and approach to designing and implementing energy and climate change policies (McCollum *et al.*, 2011; Waage *et al.*, 2015) and assessing energy transition pathways (Hammond *et al.*, 2013; Barton *et al.*, 2018; Child *et al.*, 2018).

The SDGs were developed to guide changes in the world's economies and societies, including a response to global energy and climate change challenges. The academia has studied the relationship between the various SDGs and found that the economic, social and environmental targets are deeply intertwined and can be considered an indivisible whole, with positive and significant cross impacts (Griggs *et al.*, 2013; Griggs *et al.*, 2014; Le Blanc, 2015; Waage *et al.*, 2015; Stafford-Smith *et al.*, 2017; Nilsson *et al.*, 2018). Furthermore, significant benefits can accrue from integrated policies and strategies that appropriately account for synergies between SDGs (Scharlemann *et al.*, 2020).

The relationship between energy- and climate-change-related goals and other SDGs is also being studied by scholars. von Stechow *et al.* (2015; 2016), Jakob and Steckel (2016) and Riahi *et al.* (2017) address the relationships and trade-offs between climate-change policies and non-climate SDGs across variables such as air pollution, energy security, land and water use, energy poverty or employment. Fuso Nerini *et al.* (2017) review the synergies and trade-offs between SDG 7 (affordable and clean energy) and the other SDGs, arguing that energy systems are key to social and economic development and have a decisive effect on the delivery of all other SDGs.

In a similar fashion, McCollum *et al.* (2018) show that positive interactions between SDG 7 and the other SDGs outweigh the negative ones, which leads to the conclusion that energy policy must be designed in a way that accounts for the effects and potential spillovers across other sustainability dimensions.

### 2.2. **O&G strategies within the energy transition**

The academic literature has scrutinized the ongoing shifts in the strategies of O&G companies resulting from growing pressure to increase their environmental sustainability from different angles and in a heterogeneous way. Different attempts to develop new business models can be identified in the decades following the 1973 oil crisis. Although many of them were unsuccessful, they are relevant precedents and had an influence on national energy policies (Boon, 2019).

Weijermars *et al.* (2014) identify the rise of hydrocarbon extraction costs as an incentive for accelerating the transition to renewable energy investments in recent decades. However, in the last few years many other several factors appear to be accelerating the changes in O&G company strategies. According to Csomós (2014), investments in the renewable energy sector made by the largest public oil companies may respond to reputational factors and to advertising strategies and their perception about the extent to which market and demand forecasts support the continuity of conventional O&G business models. Additionally, García *et al.* (2014) claim that a differentiating factor for energy firms' approach to sustainability could be their ability to tackle social concerns beyond climate change, for instance by engaging with the local community to build entrepreneurial skills.

More recently, a growing number of authors have focused on the identification of O&G activities in the evolving energy landscape. Pickl (2018) classifies the major O&G companies into «renewable leaders» or «laggards» depending on their strategies regarding investments in renewable energy. According to Peng Yun *et al.* (2019) these strategies may also be driven by a shift towards gas production, or collaboration with peers. These divergences may be clearer among oil majors' strategies in Europe and the US and have been illustrated as a 'trans-Atlantic divide' (Andreasson, 2018), which may also apply to a circular economy perspective (de Selliers & Spataru, 2020).

Despite recent research, there is still a thin body of academic literature focusing on this issue and heterogeneous approaches to characterizing the companies' strategies are taken. This may be justified on the basis of the novelty of the strategies and the consequent lack of data to evaluate their success (Zhong & Bazilian, 2018). This 'under-examination' of O&G company strategies in the literature applies particularly to state-owned companies and developing countries (Chaiyapa *et al.*, 2018).

This leads to complement the academic knowledge with 'grey' literature, since some relevant international organizations have paid attention in recent years to the challenge of decarbonizing the O&G sector. For example, IEA (2020a) questions whether O&G companies should be viewed not only as part of the climate change problem but also as part of the solution, while UNDP *et al.* (2017) focus on the SDGs.

Some authors have taken this last approach and have tried to relate the SDGs and the O&G sector (Ekiugbo and Papanagnou, 2017; Williams, 2018; Hamzah, 2019). However, a deeper level of analysis would be desirable, given the growing importance of sustainable development approaches.

## 3. METHODOLOGY AND DEVELOPMENT OF AN ANALYTICAL FRAMEWORK

### 3.1. Case study methodology

The aim of this paper is to introduce an analytical framework that helps to improve the understanding about how an O&G company contributes to SDGs. For this purpose, the methodology of case study research is chosen (Villarreal, 2016), given the absence of well-defined theoretical frameworks and as a prior step before more precise further research.

Proponents of this methodology argue that case studies that focus on single settings like corporations do actually cover a variety of items that, via the study of repeated observations, can lead to generalizations (Eisenhardt, 1989, 1991; Dyer & Wilkins, 1991).

The selection of cases should focus on situations with transparently observable interest (Eisenhardt, 1989) and, in single-case studies, as is the case of this article, the object of analysis should be considered to have enough importance and significance to be critical (Villarreal, 2016). The purpose of this work fits well within this approach.

Taking this into account, Petronor (Petróleos del Norte, S.A.) has been chosen as pilot case for introducing and testing the proposed analytical framework for a number of reasons that highlight its relevance as object of study. First, it is the only refinery in the Basque Country, it accounts for a significant share of the economic activity in the region and will play a critical role in the region's energy transition.

Moreover, Petronor's main shareholder is Repsol (with a stake of 85.98%) (PWC, 2020), and the company is fully integrated into its downstream business as one of the Repsol group's five refineries in Spain. The fact that Repsol became in 2017 the first O&G company to commit to achieving net-zero emissions by 2050 (Repsol, 2019a; OGCI, n.d.) increases the interest of studying the case of Petronor. As part of Repsol's sustainability strategy, Petronor is attracting to the Basque Country key innovative decarbonisation projects and initiatives.

### *3.1.1.* ***Sustainability actions as units of analysis***

According to Villarreal (2016), the «unit of analysis» within each case study must be clearly defined in order to trace the boundaries and the core of the research work. In this article, the analysis of Petronor's sustainability strategy focuses on its «sustainability actions», which are treated as units of analysis. The advantage of centring the analysis on sustainability actions is that they drive the company's approach to fulfilling the SDGs along specific, detailed paths.

Petronor's annual Sustainability Plans (Petronor, 2016; 2017; 2018; 2019a; 2020a) are used as primary information sources in this study. Each of these documents identifies a series of detailed activities, labelled as «actions» by the company, that conform the firm's sustainability strategy.

The SDGs appeared for the first time in Petronor's Sustainability Plans in 2016, mentioned in a general way. In 2017, the most relevant SDGs for Petronor were identified, but still not related to specific sustainability actions by the company. Since 2018, however, Petronor's Sustainability Plans have related each sustainability action to selected SDGs, according to the company's own view.

At the same time sustainability actions are the unit of analysis of the case study of Petronor, the SDGs represent the boundaries of the study. The relevant SDGs, chosen by the company, reflect Petronor's sustainability priorities, as described in the Sustainability Plans[1] and other corporate documents (both Petronor's and Repsol's).

In line with Repsol's corporate approach to the SDGs, Petronor identifies seven key SDGs and classifies them into a primary and a secondary focus group (Repsol, 2019b; 2019c; Petronor, 2019a; 2020a). This work is centred on the primary group, which is directly related to the energy transition and the company's response to the climate change challenges (specifically SDGs and 7 and 13), but also to working conditions and economic growth (SDG 8). This identification serves as the delimitation of the boundaries of the analysis, following Villarreal (2016).

### 3.2. **Development of a framework for analysing the contribution to the SDGs**

In this subsection, two different frameworks for analysis are introduced. The combination of both frameworks constitutes a proposal of a novel approach to assess the sustainability strategy of O&G companies (see Subsection 3.2.3).

The first one describes the channels of contribution to the SDGs by companies in the O&G sector and was developed by the United Nations Development Programme (UNDP) and other organizations (see Subsection 3.2.1). This is complemented with the use of a second analytical framework based on a database on new low-carbon technologies developed by the International Energy Agency (IEA) (see Subsection 3.2.2).

The resulting process of analysis may be seen as an approximation to the «case study protocol», advisable for single case studies (Villarreal, 2016). Here, the proposed framework aims to standardize the application to a case study, as it is based on external information, is replicable and includes a pilot case (Petronor). The final stage of the analysis seeks to find generalizations and present new, perhaps «frame-breaking», insights, as Eisenhardt (1991) claims.

#### *3.2.1.* ***The UNDP Atlas***

The first framework applied in the analysis follows UNDP *et al.* (2017). This identifies different paths for an O&G company to address and engage with the SDGs (called «areas of contribution to sustainability» in this article), either by integrating a targeted SDG into the company's core business or by collaborating with other stakeholders in supporting sustainability efforts. It is conceived as an «Atlas» or tool to be used by businesses to better understand their sustainability targets. Following this, this report is referred to here as «the Atlas».

The Atlas sets a series of steps for companies in the O&G sector undertaking a thorough analysis of how to address the SDGs, including (1) the identification of the most relevant SDGs to the company's activities, (2) engaging with stakeholders, par-

[1] In the case of Repsol, this refers to the Global Sustainability Plans.

ticularly governments, to identify overlapping development priorities and (3) collaborating with stakeholders to develop a shared understanding of the company's role in supporting the SDGs.

Step 1 depends on a company's own initiative to relate its activities to SDGs. Petronor has done so in its Sustainability Plans from 2018 to 2020. Such correspondence is used in this work as the starting point for using the Atlas to characterize Petronor's sustainability strategy (as explained in Subsection 3.1.1).



For example, if in one of Petronor's Sustainability Plans a given sustainability action is related to SDG 7, then this action is classified into one of the areas of contribution to sustainability that UNDP *et al.* (2017) establish for this SDG. It may also fit in areas of contribution within other SDGs. This way, the analysis consists of finding the areas of contribution within the Atlas where each of the sustainability actions by Petronor would best fit in.

Applying the Atlas to Petronor's sustainability actions helps to identify the specific channels through which each action contributes to the SDGs, thus reinforcing the company's reasoning behind linking individual sustainability actions with certain SDGs. It also facilitates classifying other activities by the company that were not included in the Sustainability Plans but appear in other sources. Hence, this framework helps to identify of gaps or missing pieces in a company's sustainability approach (according to the SDGs) and facilitates the replicability of the analysis in different case studies.

### *3.2.2. **The IEA's ETP-CET Guide***

The second framework follows the approach to the SDGs described in IEA (2020b). According to this, SDGs 3, 7 and 13 are critical for reaching energy-related and sustainability goals and, in order to meet them, the evolution of the (global) energy sector should be guided by the so-called Sustainable Development Scenario (SDS).

The SDS is the spotlight of the IEA's Energy Technology Perspectives (ETP) reports (IEA, 2020c; 2020d), which highlight the importance of technology innovation in meeting sustainability goals. The IEA has developed an interactive database called «ETP Clean Energy Technology Guide» (IEA, 2020e), referred to in this paper as «ETP-CET Guide», which includes information on the level of maturity of up to 433 technology solutions (in this paper, referred as «key technologies») that are applicable in different segments of the energy system and that contribute to achieving the goal of net-zero emissions in 2070 embedded in the SDS.

The purpose of applying this framework in this study is to identify whether there are key technologies included in the ETP-CET Guide that may be linked to Petronor's sustainability actions. By relating key technologies and sustainability actions (which, in turn, are related to the SDGs), the contribution by Petronor to the innovation process can be assessed, by looking at two specific parameters assigned by the ETP-CET Guide to each technology:

- The Technology Readiness Level (TRL), which uses IEA's own 1-11 scale.
- The «importance for net-zero emissions», which describes the IEA's view regarding the market share of that technology in the net-zero emissions SDS in 2070. The ETP-CET Guide divides the list into three groups, depending on their forecasted role in the 2070 SDS scenario: «very high», «high» and «moderate» importance. This variable refers to an estimated market share, so a «lower importance» score does not mean that a technology is less or not at all needed to achieve the SDS.

These two parameters are used to define a relevance order for the various key technologies associated to the sustainability strategy of Petronor, based on two criteria.

The first criterion is that the higher the TRL is, the less time it takes for the key technology (hence, the sustainability action) to contribute to the targeted SDGs and, therefore, a higher relevance order should be set.

The second criterion is that the more important the key technology is for net-zero emissions according to IEA's view, the more aligned it is with global technology trends and the higher relevance order it should have. This is consistent with the idea that, from a potential return-on-investment point of view, it would be preferable for a company to develop or adopt a technology that is applied in larger markets and value chains where innovation spillovers could take place (Acemoglu & Linn, 2004; Nieto & Quevedo, 2005; van Praag & Versloot, 2007).

### *3.2.3.* ***Combining the two analytical frameworks***

By combining the two frameworks described above (based respectively on the Atlas and on the ETP-CET Guide), an analytical tool can be developed to evaluate how the actions of an O&G company contribute to the SDGs. The combination of both frameworks requires to identify the SDGs that can be analysed, to define how the process of analysis is structured and, additionally, to define codes for ease of analysis.

#### ***Limitation of which SDGs the analysis can focus on***

In order to delimit the number of SDGs that can be addressed in this work, two approaches are considered:

- UNDP *et al.* (2017) cover all the SDGs, but each company chooses what the main goals for its business priorities are. As shown in Subsection 3.1.1, Petronor's sustainability strategy is focused on Goals 7, 8 and 13.
- As described in Subsection 3.2.2, the ETP-CET Guide follows the IEA's SDS, which focuses on Goals 3, 7 and 13.

This means that a common approach linking both frameworks should be based on SDGs 7 and 13, as SDGs 3 and 8 are not addressed by the two of them. The main limitation of this tool is then related to the energy-centred approach of the IEA's SDS. Its main advantage is that it complements the analysis of the energy dimension of SDGs with a technological focus that appears to be key to define the path to a net-zero emissions horizon.

***Structure of the process of analysis***

The process of studying Petronor's sustainability strategy is based on three main blocks of analysis:

- Sustainability actions. As defined in 3.1.1, these are each of the specific activities that make up the company's Sustainability Plans. In Petronor (2018; 2019a; 2020a), each sustainability action targets specific SDGs. Sustainability actions are the starting point of the analysis.
- Areas of contribution to sustainability. These are the different paths that UNDP *et al.* (2017) identify for contributing to each SDG (as described in 3.2.1) and are used here to classify the sustainability actions, using the authors' judgment. This step validates the sustainability actions and helps to identify additional relevant ones not included in the company's Sustainability Plans.
- Key technologies. These are the various technologies that are listed in the ETP-CET Guide (as explained in 3.2.2). They are used here to establish a technological linkage for each sustainability action, where this is possible. This helps to assign each sustainability action a TRL score and an «importance for net-zero emissions» category.

Two more items are introduced in the analysis to facilitate the discussion of the results. These two additional pieces are outputs of the analysis tool.

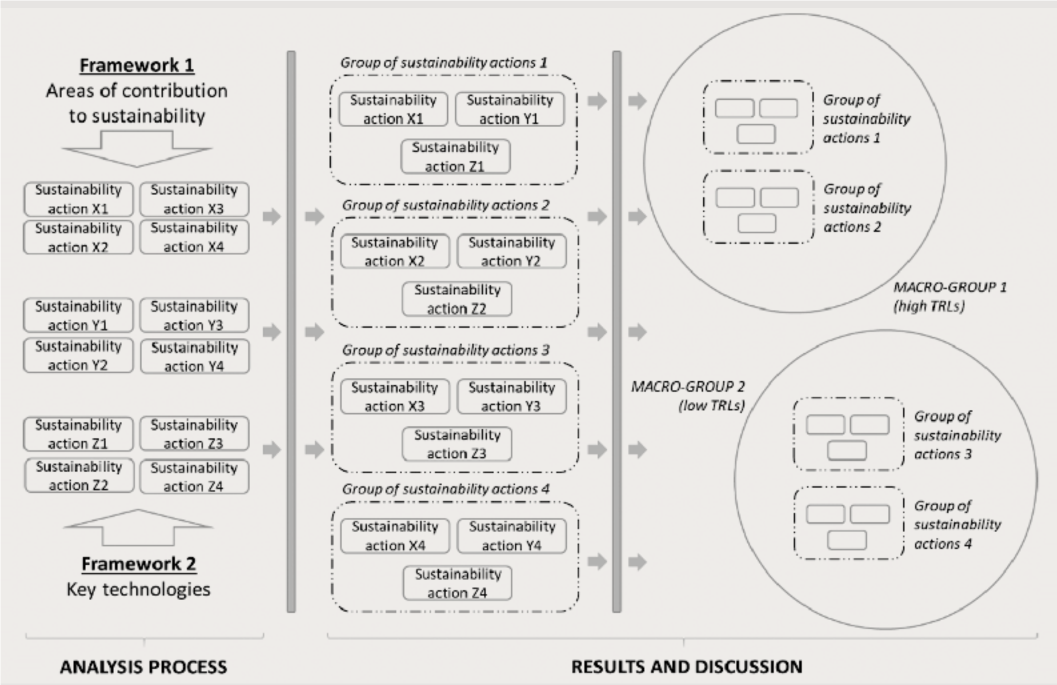
- Groups of sustainability actions. Based on the linkages between sustainability actions and key technologies, these groups gather different sustainability actions (once they are associated with key technologies) when they share a same purpose[2]. When the group includes more than one sustainability action or key technology, the criteria used to characterize each group is to identify it by the highest TRL within it, as well as its corresponding «importance for net-zero emissions» score. This assumes that the most advanced technology in the innovation ladder is the leading technology within the group. On the basis of the assigned TRLs, firstly, and of the importance for net-zero emissions, secondly, the resulting groups of sustainability actions are ordered hierarchically from highest to lowest relevance.
- Macro-groups. Based on the resulting order of the groups of sustainability actions, those that show proximity of TRLs are gathered in larger groups called here macro-groups. These help to characterize the main results in a more simplified manner and are used to draw generalizations (in line with the case study methodology) and derive conclusions.

Figure 1 depicts the relationship between these five pieces of analysis that, together, help to conduct the analysis within the proposed framework. As it can be seen, the analysis starts with sustainability actions (given by the company's sources)

[2] For example, various different technologies for producing hydrogen from electrolysis, could be gathered under a common group called «electrolysis».

and ends by organizing them in large macro-groups, from which general conclusions may arise. This tool is applied to the specific case of Petronor in Section 4. It is important to underline the replicability of this approach to analyse this and other case studies of O&G companies' contribution to SDGs.

*Figure 1.* **EXAMPLE OF THE PROPOSED FRAMEWORK FOR ANALYSING THE TECHNOLOGICAL CONTRIBUTION TO SDGS BY AN O&G COMPANY**




*Source:* own elaboration.

### *Nomenclature (codes)*

In order to facilitate the treatment of sustainability actions as the basic units of analysis, each sustainability action is labelled with a code.

Sustainability actions related by Petronor to SDGs 7 and 13 are assigned codes «A7» and «A13», respectively, and are ordered chronologically in the way they appear in Petronor's Sustainability Plans (i.e., A7.1, A7.2, etc.). Additionally, actions that are related to other SDGs by Petronor but that could conceptually be linked to SDGs 7 and 13 are assigned code «A0» (resulting in specific codes A0.1, A0.2, etc.). Relating «A0» actions to SDGs 7 and 13 is carried out under the authors' own judgment, as described in Section 4.

Finally, the review of different corporate documents (both Repsol's and Petronor's) yielded the identification of other activities carried out by Petronor that contribute to sustainability, as defined in the Atlas, but that are not included in the companies' Sustainability Plans. These additional activities are assigned the letter «B» and classified within SDG 7 (actions B7.1, B7.2, etc.) or 13 (actions B13.1, B13.2, etc.). Their inclusion in the analysis is also based on the authors' own judgment on the basis of the discussion in Section 4.

## 4. ANALYSIS OF THE CONTRIBUTION TO SDGS BY PETRONOR

### 4.1. Application of the proposed analytical framework to the case of Petronor

In this section, the framework described previously is applied to the case of Petronor's approach regarding sustainability, which follows that of its parent company, Repsol. As previously stated, the analysis carried out in this paper focuses on SDGs 7 and 13 and, accordingly, Petronor's sustainability actions (from its Sustainability Plans) are assigned codes A7.X, A.13.X or A0.X. Table 1 presents the list of identified sustainability actions by Petronor in 2018-2020.

*Table 1.* **SUSTAINABILITY ACTIONS CLASSIFIED BY PETRONOR AS CONTRIBUTIONS TO SDGS 7 AND 13 AND TO OTHER SDGS BUT WITH STRONG LINKS WITH SDGS 7 AND 13**

| 2018 | 2019 | 2020 |
|---|---|---|
| SDG 7 (Code A7.X) | | |
| | A7.1. Execute investments in refinery equipment and processes to reduce $CO_2$ emissions (repeated in A13.3)<br>A7.2. Organize informational and awareness activities focused on energy sustainability and accessibility | A7.3. Optimize the process for obtaining hydrogen (repeated in A13.7) |
| SDG 13 (Code A13.X) | | |
| A13.1. Implement measures to improve energy efficiency and reduce greenhouse gas emissions<br>A13.2. Participate in international verification processes for the analysis of greenhouse gas emissions | A13.3. (same as A7.1 for SDG 7).<br>A13.4. Participate in international verification processes for the analysis of greenhouse gas emissions | A13.5. Reduce the waste generated during stoppages and sent to landfill sites<br>A13.6. Promote voluntary work in schools related to environmental issues<br>A13.7. (same as A7.3 for SDG 7) |
| 2018 | 2019 | 2020 |
| Other SDGs (Code A0.X) | | |
| A0.1. Launch innovative activities from Petronor Innovation (a Petronor subsidiary) | A0.2. Start operating the pilot project «Smart aggregator for generation and consumption» at Petronor's Training Centre in Somorrostro (Bizkaia) | A0.3. Improve energy efficiency in acid water treatment<br>A0.4. Promote renewable power generation and km 0 consumption |

*Source:* own elaboration based on Petronor (2018; 2019a; 2020a).

In the same way, additional activities that can be classified as sustainability actions (but not included in the Sustainability Plans) are assigned codes B7.X or B13.X, as shown in Table 2.

*Table 2.* **SUSTAINABILITY ACTIONS BY PETRONOR THAT CAN CONTRIBUTE TO SDG 7 AND SDG 13 BUT NOT INCLUDED IN PETRONOR'S SUSTAINABILITY PLANS**

| Additional sustainability actions | Assigned codes |
|---|---|
| Creation of Edinor (developer of distributed generation and energy communities) | B7.1 |
| Agreement with natural gas distributor Nortegas to supply CNG for transportation | B7.2 |
| Production of synthetic fuels with hydrogen production and carbon capture | B7.3 |
| Pyrolysis treatment plant | B7.4 |
| Project eMovLab (electric mobility) | B7.5 |
| Think Tank #VEHICLES7YFN (on sustainable, connected and autonomous mobility) | B7.6 |
| Commitment to be a net-zero emissions company by 2050 | B13.1 |
| Collaboration with the RESET-KLIMATEK project (adaptation of energy infrastructures to climate change) | B13.2 |
| Collaboration with agents in the Basque science and technology network (for digitalization and energy storage technologies) | B13.3 |
| Involvement in the EIC (Energy Intelligence Center, a R&D and knowledge hub) and Basque Hydrogen Corridor projects | B13.4 |

*Source:* own elaboration based on Petronor (2018; 2019a; 2020a).

In the next two subsections, Petronor's contributions to SDGs 7 and 13 are assessed by using the analytical framework developed in Section 3.

### 4.2. Petronor's contribution to SDG 7 («Ensure access to affordable, reliable, sustainable and modern energy for all»)

Table 3 presents the full list of Petronor's sustainability actions that contribute to SDG 7 (included in Tables 1 and 2), classified by area of contribution (as defined by the UNDP Atlas; see the first column of the table).

Each of the sustainability actions presented in the second column of the table is assigned a corresponding key technology (within the ETP-CET Guide), shown in the third column. The fourth and fifth columns of the table present, respectively, the technology's corresponding TRL and its «importance for net-zero emissions», also according to the ETP-CET Guide.

*Table 3.* **SUSTAINABILITY ACTIONS BY PETRONOR CONTRIBUTING TO SDG 7**

| Main areas of contribution to SDG 7, as defined by UNDP *et al.* (2017) | Sustainability actions (codes in Tables 1 and 2) | Related technology from the ETP-CET Guide | TRL | Importance for net-zero emissions |
|---|---|---|---|---|
| Improve access to energy services through shared infrastructure | A0.1<br>A0.2 | Open automated demand response | 7 | High |
| | A0.1<br>A0.4 | Direct current microgrid system | 7 | High |
| | B7.1 | Virtual net metering - Community Scale Solar | 8 | Very high |
| | | Transactive energy | 4 | Moderate |
| Grow the share of natural gas in the energy mix[a] | B7.2 | Hydrogen blending in natural gas network | 6-7 | Moderate |
| Main areas of contribution to SDG 7, as defined by UNDP *et al.* (2017) | Sustainability actions (codes in Tables 1 and 2) | Related technology from the ETP-CET Guide | TRL | Importance for net-zero emissions |
| Increase the share of alternative energies and technologies in the global energy mix | B7.3 | Liquid fuels from hydrogen and $CO_2$ | 5-7 | Very high |
| | | Electrolysis (alkaline) | 9 | Very high |
| | | Electrolysis (polymer electrolyte membrane) | 8 | Very high |
| | | Electrolysis (solid oxide electrolyser cell) | 6-7 | Moderate |
| | | Gasification and hydrogen enhancement and Fischer-Tropsch | 3-4 | High |
| | | Hydrogen refuelling station | 9 | Moderate |
| | B7.4 | New recycling techniques with reduced downcycling | 9 | Moderate |
| Improve energy efficiency in operation and production | A7.1 | Fluid catalytic cracker in combination with post-combustion capture or oxy-fuelling capture | 5 | Moderate |
| | A7.3 | Hydrogen production at refinery | 3-4 | Moderate |
| | A0.3 | N/A | - | - |
| An integrated, multi-stakeholder approach to energy poverty[b] | A7.2<br>A0.1<br>B7.5<br>B7.6 | Battery electric vehicle / Fast charging | 9 / 8 | Very high / High |

*Source:* own elaboration. Note: N/A = not applicable. [a] It is interpreted that the existence of natural gas infrastructure will pave the way for the consumption of hydrogen in a sustainable scenario. [b] In this analysis, the idea of «energy poverty» is interpreted broadly, in the sense of «energy social challenges». See subsection 4.2.5.

Although Table 3 is intended to be self-explanatory, some details are clarified in each area of contribution to SDG 7, especially regarding actions labelled with letter «B» (not included in the Sustainability Plans) or those that are not included in the analysis due to a lack of linkage with key technologies from the ETP-CET Guide.

Each of the main areas of contribution (first column of Table 3) is then discussed in more detail.

### *4.2.1.* ***Improve access to energy services through shared infrastructure***

Sustainability action B7.1 implies the creation in 2020 of a Petronor subsidiary called Edinor to develop distributed generation and energy community systems (UNEF, n.d.; Petronor, 2020b). Regarding actions A0.1 and A0.4, which introduce microgrids into the sustainability strategy, it should be noted that these are infrastructures that can have more designs than the «direct current» model included in the ETP-CET Guide (see Table 3) (Arif & Hasan, 2018).

### *4.2.2.* ***Grow the share of natural gas in the energy mix***

Sustainability action B7.2 encompasses an agreement signed in 2020 between Repsol and Nortegas Green Energy Solutions (part of Nortegas, a gas distribution company) to promote compressed natural gas (CNG) supply for transportation through the Repsol group's network of petrol stations (Nortegas, 2020; Petronor, 2020c).

None of the key technologies cover CNG supply for transportation, but this action can be related to the technology «hydrogen blending in natural gas network»[3] since petrol stations are a basic element for hydrogen end-use in road transportation and, therefore, part of the infrastructure required for hydrogen distribution within the natural gas network. Both Nortegas (Nortegas, n.d.) and Petronor have interest in hydrogen technologies (see next item).

### *4.2.3.* ***Increase the share of alternative energies and technologies in the global energy mix***

Sustainability action B7.3 represents Petronor's plans to develop a major project for a synthetic fuels (efuels) plant based on hydrogen production and carbon capture in the port of Bilbao[4] (Petronor, 2020d; 2020e; $BH_2C$, 2020).

Additionally, sustainability action B7.4 represents a second large project announced by Petronor for the development of a pyrolysis treatment plant to convert solid urban waste into biogas in order to partly substitute the natural gas consumed by the refinery[5] (Petronor, 2020f).

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[3] As indicated in Table 3, it is interpreted that the existence of natural gas infrastructure will pave the way for the consumption of hydrogen in a sustainable scenario.

[4] Together, the Petronor's efuels plant and electrolysis facilities imply a 58.6 M€ investment. A production of fifty daily barrels is expected to be reached by 2024.

[5] This represents a 21.3 M€ investment.

#### *4.2.4.* ***Improve energy efficiency in operation and production***

Sustainability action A0.3 aims to improve energy efficiency in acid water treatment, but no corresponding key technology could be identified. This area of contribution is related to actions A13.1 and A13.5 (see Subsection 4.3).

#### *4.2.5.* ***An integrated, multi-stakeholder approach to energy social challenges***[6]

Energy social challenges can include a large variety of issues, from energy poverty, lack of access to essential services, premature mortality due to air pollution, etc. Petronor's sustainability actions focused on transportation issues are related to some of these challenges and, at the same time, have an evident multi-stakeholder dimension.

This is the case of various initiatives. First, the eMovLab is one of the company's main R&D projects (labelled as sustainability action B7.5), Petronor is the leader of this consortium of different actors in the industrial and technological value chains in mobility in the Basque Country (Petronor, 2020g). Second, Petronor participated in a series of multi-stakeholder working groups focused on analysing the short-term evolution of mobility promoted by Spanish ICT business association under the brand Think Tank #VEHICLES7YFN (Ametic, 2019). These complement Petronor's collaboration with the City Council of Bilbao in the organisation of a Sustainable Mobility Congress and an eco-rally for electric vehicles (SUM Bilbao, 2019; FIA-ERRC, 2019) or Petronor Innovación's (a subsidiary of Petronor) work on sustainable mobility (respectively actions A7.2 and A0.1).

This results in a large and varied coverage of issues and stakeholders, among which company Ibil[7] stands out as a key Petronor stakeholder, owing to its close linkage to Repsol and its transversal presence in the aforementioned actions, sharing Repsol's and Petronor's goals on electric mobility (Petronor, 2020h). This is the reason for linking these sustainability actions to the «battery electric vehicle» and «fast charging» key (generic) technologies.

### 4.3. **Petronor's contribution to SDG 13 («Take urgent action to combat climate change and its impacts»)**

Table 4 presents the full list of Petronor's sustainability actions that contribute to SDG 13 (second column), classified by area of contribution in the UNDP Atlas (first column) and with the associated technology within the ETP-CET Guide (third column) and its related TRL and «importance for net-zero emissions» level, also according to the ETP-CET Guide (columns four and five). As is the case of Table 3 in the previous section, the aim of Table 4 is to be self-explanatory, but some details are clarified in each area of contribution to SDG 13.

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[6] In UNDP *et al.* (2017) this contribution area originally refers to «energy poverty», instead of «social challenges». The analysis in this article adopts a broader perspective.

[7] Ibil is a technological company founded by Repsol and the Basque Government's energy agency EVE with the purpose of developing electric vehicles charging technology and infrastructure.

*Table 4.* **SUSTAINABILITY ACTIONS BY PETRONOR CONTRIBUTING TO SDG 13**

| Main areas of contribution to SDG 7, as defined by UNDP et al. (2017) | Sustainability actions (codes in Tables 1 and 2) | Related technology from the ETP-CET Guide | TRL | Importance for net-zero emissions |
|---|---|---|---|---|
| Plan strategically for a net-zero emissions future | B13.1 | N/A | - | - |
| Self-assess carbon resiliency | | | | |
| Strengthen resilience and adaptive capacity to climate change impacts | A13.6<br>B13.2 | N/A | - | - |
| Mitigate emissions within oil and gas operations | A13.1 | N/A | - | - |
| | A13.5 | Waste gasification | 3-5 | Moderate |
| | A13.3 (same as A7.1)<br>A13.7 (same as A7.3) | Fluid catalytic cracker in combination with post-combustion capture or oxy-fuelling capture and hydrogen production at refinery (see Table 3) | - | - |
| Partner in research and development and education outreach | A13.2<br>A13.4 | N/A | - | - |
| | B7.3<br>B7.4 | Various synthetic fuels production and electrolysis technologies (see Table 3) | - | - |
| | B13.3 | N/A | - | - |
| Support effective policy measures | B13.4 | N/A | - | - |
| Help consumers lower their emissions | A0.1<br>B7.1<br>B7.3<br>B7.5<br>B7.6 | Various low-emissions technologies like demand response; microgrids; energy communities; production of synthetic fuels and hydrogen; electric vehicle; etc. (see Table 3) | - | - |

*Source:* own elaboration. Note: N/A = not applicable.

#### *4.3.1.* ***Plan strategically for a net-zero emissions future / Self-assess carbon resiliency***

Sustainability action B13.1 is a global corporate target that follows the fact that, in 2017, Repsol became the first O&G company to commit to achieving net-zero emissions by 2050 (Repsol, 2019a; OGCI, n.d.). Every downstream unit within the group must contribute to this strategic planning, including Petronor. At the same time, this necessarily involves the «Self-assess carbon resiliency» area of contribution by assessing investments, decision-making, risk evaluation and adaptation strategies and processes regarding climate change impact on business.

#### *4.3.2.* ***Strengthen resilience and adaptive capacity to climate change impacts***

Sustainability action B13.2 refers to a programme called Klimatek, supported by the Basque Government's Environment Agency (Ihobe), that analysed the potential effects of climate change in the Basque Country. Within this programme, project RESET focused on the resilience of critical energy infrastructure (Ihobe, 2020; Basque Government, 2020). Due to its geographical position, Petronor participated in the project and both the refinery and other O&G infrastructure were included in the list of critical energy assets.

Additionally, Petronor's action A13.6 also addresses the company's facilities' environmental footprint through nature-based solutions such as the reforestation of degraded land. No key technologies could be identified for both sustainability actions.

#### *4.3.3.* ***Mitigate emissions within oil and gas operations***

Sustainable action A13.1 seeks the certification of its energy management system under standard ISO 50.001:2011[8] in order to improve energy efficiency and reduce emissions. This goes together with reducing waste from operations that is sent to landfill sites (action A13.5). None of them could be specifically linked to a key technology; A13.5 may be related to «waste gasification», but only if oriented to converting unrecyclable plastic waste into electricity or hydrogen[9].

#### *4.3.4.* ***Further partnerships and synergies***

«Partner in research and development and education outreach», «Support effective policy measures» and «Help consumers lower their emissions» are the remaining areas of contribution to SDG 13. Sustainability actions that fit into these areas have in common a partnering and collaborative approach rather than technological, so no linkages with key technologies could be found.

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[8] This has been replaced by ISO 50001:2018 (ISO, n.d.).

[9] See the Waste2tricity example in Fuel Cells Bulletin (2020).

This is the case of sustainability actions A13.2 and A13.4, which consist of participating in international verification activities with recognized foreign organisations and laboratories to contrast the rigour of Petronor's greenhouse gas analysis.

Other actions also show synergies with areas of contribution to SDG 7. For example, sustainability action B13.3 represents Petronor's collaborations with agents from the Basque network of science and technology (SPRI, n.d) to promote the digitalization of the refinery's operations or foster energy storage for mobility (Tecnalia, 2018; Cidetec, 2018; Petronor, 2019b; n.d.).

In particular, sustainability action B13.4 involves Petronor's collaboration with the Provincial Council of Biscay in the projected Energy Intelligence Center (EIC), a technological R&D hub that will specialize in innovative technologies for hydrogen, smart grids, wind generation and O&G. This support is partly driven by the company's leadership of the hydrogen area, which is a milestone in the development of the so-called Basque Hydrogen Corridor and a new sustainable mobility value chain in the Basque Country ($BH_2C$, 2020). But also, by its announced intention to relocate its corporate headquarters and its subsidiary Edinor at the EIC facilities (Petronor, 2020i).

Since many other industrial companies from the aforementioned fields are backing the EIC initiative, this may give place to broader R&D and technology collaboration between Petronor and this business ecosystem; for instance, in relation to Petronor's projects in energy communities, power aggregation or microgrids, and particularly in sustainable mobility. In general, this can be a potentially fertile context for developing innovative solutions for end uses or final consumers, with synergies regarding SDG 7 and addressing value-chain or Scope 3 emissions (Greenhouse Gas Protocol, 2011; Ramaswami *et al.*, 2008; Huang *et al.*, 2009), which is a critical area in achieving an effective corporate strategy for net-zero emissions.

### 4.4. **Results and discussion**

Following the framework described in Section 3, in order to assess Petronor's sustainability strategy on the basis of the analysis carried out in the previous subsections and summarised in Tables 3 and 4, the different sustainability actions are clustered into groups of sustainability actions according to shared technological purpose (Table 5).

This way, each group may include several sustainability actions, as well as more than one specific technology within the ETP-CET Guide (for instance, «Electrolysis» in Table 5 refers to a number of electrolysis technologies in the Guide).

All identified Petronor sustainability actions are classified into 12 groups of sustainability actions (second column of Table 5) and these are ordered in terms of their relevance, as defined in Section 3.2.2 (i.e., using the TRL ranking first and then the «importance for net-zero emissions» score). Each group of sustainability actions is characterized by the TRL and «importance for net-zero emissions» score of the most advanced technology within the group (higher TRL, always according to the ETP-CET Guide criteria).

To facilitate the interpretation of the results obtained, these 12 groups of sustainability actions are further reclassified into four macro-groups that describe major lines of activity or value chains (fifth column in Table 5).

The first one (the «Cutting Edge» group) includes the first four areas of contribution, characterized by technologies with the highest TRL (9). Electrolysis and electric mobility are expected to have very high presence in the net-zero emissions scenario in 2070. Hydrogen supply for transportation and biogas production by pyrolysis treatment, on the other hand, are expected to have moderate importance in that scenario. This macro group represents activities in which Petronor has the largest potential for contributing to sustainability in the nearest future, as shown by the high TRLs.

*Table 5.* **MAIN CONTRIBUTIONS TO SUSTAINABILITY BY PETRONOR**

| Relevance order | Groups of sustainability actions, TRLs and «importance for net-zero emissions» | SDGs | Sustainability actions (in Table 1 and 2) | Macro-groups |
|---|---|---|---|---|
| 1-2 | Electrolysis (TRL 9; VH) | 7; 13 | B7.3 | Cutting Edge |
| 1-2 | Electric mobility (TRL 9; VH) | 7; 13 | A7.2; A0.1; B7.5; B7.6 | |
| 3-4 | Hydrogen supply for transportation (TRL 9; M) | 7; 13 | B7.3 | |
| 3-4 | Biogas production by pyrolysis treatment (TRL 9; M) | 7; 13 | B7.4 | |
| 5 | Energy communities (TRL 8; H) | 7; 13 | B7.1 | Electricity Value Chain |
| 6-7 | Power aggregation (TRL 7; H) | 7; 13 | A0.1; A0.2 | |
| 6-7 | Microgrids (TRL 7; H) | 7; 13 | A0.1; A0.4 | |
| 8 | Collaboration with natural gas DSO (TRL 6-7; M) | 7 | B7.2 | Alternative Fuels for Transportation |
| 9 | Synthetic fuels production (TRL 5-7; VH) | 7; 13 | B7.3 | |
| 10 | Refinery's $CO_2$ emissions reduction (TRL 5; M) | 7; 13 | A7.1/A13.3 | Advanced Refinery Processes |
| 11 | Refinery's internal waste reduction (TRL 3-5; M) | 13 | A13.5 | |
| 12 | Refinery's hydrogen production optimization (TRL 3-4; M) | 7; 13 | A7.3/A13.7 | |

*Source:* own elaboration. Note: The TRL is indicated in brackets for each field of contribution, as well as the «importance for net-zero emissions» score: very high (VH), high (H) and moderate (M).

A second macro-group («Electricity Value Chain») refers to areas of contribution to sustainability that include Petronor's innovative activities in the electricity value chain. Energy communities (TRL 8) and power aggregation with microgrids (both TRL 7) reach a high importance for net-zero emissions. This macro-group can be strongly linked to the electric mobility and electrolysis groups of actions in the Cutting Edge macro-group.

A third macro-group (labelled as «Alternative Fuels for Transportation») includes groups of sustainability actions that share a focus on alternative transportation fuels. One of these consists of Petronor's collaboration with the natural gas DSO (higher TRL within this group but moderate importance for net-zero emission) and the other refers to synthetic fuels production (lower TRL but very high importance). Both are based on assets or resources related to Petronor's traditional business, such as adapting existing petrol stations for natural gas supply or capturing $CO_2$ from the refinery operations to feed the synthetic fuels production. At the same time, they pave the way for innovation activities related to greener fuels.

The list of macro-groups is completed with one including three groups of sustainability actions that pursue improvements of the refinery's internal processes: $CO_2$ reduction, waste reduction and hydrogen optimization. This is the «Advanced Refinery Processes» group.

Generally, it can be observed in the sample of activities included in Table 5 that the lower the TRL is for a given technology (i.e., the further from the commercialisation phase it is), the lower the importance for net zero emissions is as well. This is due to the fact that the SDS is based on technology-adoption paths that account for the degree of matureness of the various technologies.

However, three fields of contribution do not abide by this logic: (a) hydrogen supply for transportation, (b) biogas production by pyrolysis treatment (which have moderate importance but are in high positions in the list) and (c) synthetic fuels production (which has a very high importance but is in a middle-low position). This leads to the following implications:

- The moderate importance of hydrogen supply for transportation means that hydrogen commercialization should probably focus first on feeding the production of synthetic fuels, and only later on supplying end-uses in areas that span beyond road mobility.
- The use of pyrolysis treatments to produce biogas is a relevant tool for the implementation of circular economy processes, but the focus of this group of sustainability actions is on displacing natural gas consumption in the refinery's internal processes and not on end-use applications. This justifies its moderate importance for net-zero emissions, as this product is not intended to be commercialized.
- Synthetic fuels production has a very high importance score and therefore may have a large market share globally in the 2070 SDS. At the same time, it

is the first driver of hydrogen production by electrolysis. The low TRL of this technology should therefore be improved by intensive R&D effort.

The overall order of macro-groups and the former implications can be interpreted jointly as follows. On the one hand, the groups of sustainability actions in the Cutting Edge macro-group should be the focus of Petronor's business development in order to achieve the largest contribution to sustainability, according to the framework presented in this article.



On the other hand, these groups of actions at the vanguard of the company's contribution to sustainability should not be considered in isolation but actually backed by the rest of the identified macro-groups. Petronor's work on electric mobility and electrolysis (and therefore, on hydrogen supply) can hardly be understood without the company's goal to develop activities in the electric sector (Electricity Value Chain macro-group). Additionally, this is more broadly linked to Repsol's work on these groups of sustainability actions through its subsidiary energy retailer Repsol Electricidad y Gas and by the group's EV charging technology company Ibil.

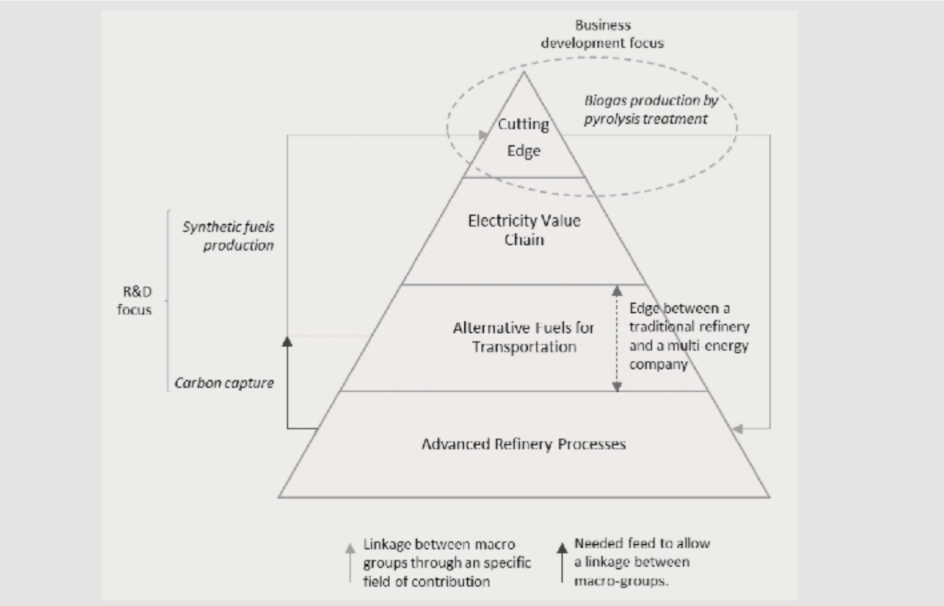
Also, the implications described above indicate that the Cutting Edge macro-group could be completed by one group of sustainability actions in the Alternative Fuels for Transportation macro-group; i.e., synthetic fuels production. At the same time, this activity is closely linked to the carbon capture process in the Advanced Refinery Processes macro-group. Both of them have relatively low TRLs, which suggests that the R&D effort of the company should pay special attention to these technologies in order to increase their matureness in as short time as possible in order to reap the benefits derived from the synergies between all these activities.

Finally, the Cutting Edge macro-group is directly linked to the Advanced Refinery Processes macro-group by the biogas production from pyrolysis treatment technology. This reduces the use of fossil fuels in refining, and together with the other fields of contribution related to the refinery processes, constitute critical actions in order to improve energy efficiency and competitiveness of the company's conventional business. This may help to support Petronor's bet over the long term on R&D and business models involving technologies in the Cutting Edge and Electricity Value Chain macro-groups, thus unlocking greater potential to contribute to sustainability.

This interpretation suggests that Petronor's contribution to sustainability through the Cutting Edge macro-group is somehow the «tip of the iceberg» of the company's actual contribution to sustainability (Figura 2).

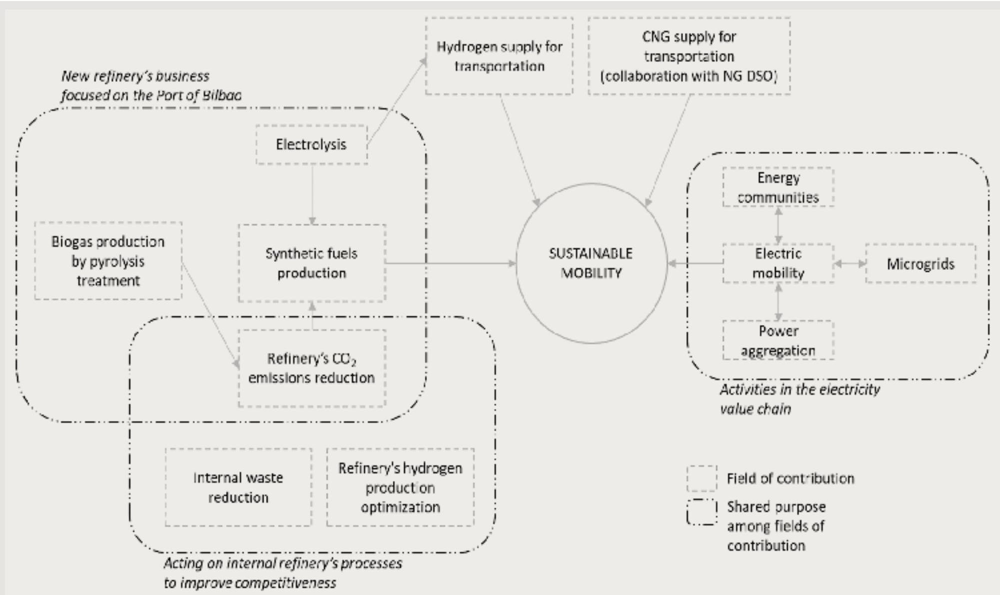
This shows a transversal relationship between the various macro-groups of sustainability actions that drives the process of developing a multi-energy company such as Petronor (and Repsol). This transition, heavily dependent on the development and adoption of new technologies, needs to be supported on a solid base of industrial capacities. Such relationship ultimately drives the bet on the activities in the Cutting Edge macro-group (hydrogen production from electrolysis and supply to

*Figure 2.* **AN ICEBERG CONCEPTION OF PETRONOR'S MACRO-GROUPS OF CONTRIBUTION TO SUSTAINABILITY**




*Source:* own elaboration.

*Figure 3.* **AN INTEGRATED VIEW OF PETRONOR'S CONTRIBUTION TO SDGS AROUND SUSTAINABLE MOBILITY**




*Source:* own elaboration.

transportation, electric mobility and, once its TRL is increased, synthetic fuels production). Although the precedent discussion argues that hydrogen production should not only be focused on (sustainable) mobility, the ambition to develop the latter is shared among these activities. This suggests that sustainable mobility could act as a common pivotal point around which Petronor's innovation activity and contribution to SDGs may spin, as shown in Figure 3.



Lastly, there are several identified sustainability actions for which a related technology in the ETP-CET Guide could not be found. However, their concordance with the areas of contribution to sustainability defined by UNDP *et al.* (2017) strongly suggest that they help to contribute to SDGs 7 and 13 as well. These can be seen as complementary actions to those in Table 5 and sustainability synergies between them may be exploited. For example, the application of ISO standards or participating in international associations and projects could lead to improvements inducing better operating performance and competitiveness of the Petronor refinery, while other actions like reforestation programmes may be aligned with nature-based solutions within the company's carbon capture objectives.

## 5. CONCLUSIONS AND FURTHER RESEARCH

The identification by an O&G company of those SDGs that are most relevant to its business, and how it is linked to them, is a useful first step in building a sound sustainability strategy. This is a necessary, but not sufficient, condition for the development of good sustainability policies at the firm level.

Such identification has to be carried out through the application of conceptual frameworks that allow a company to verify whether its self-analysis is correctly justified. This includes checking that no activity or action that can contribute to achieving the SDGs is left aside. But also understanding that different activities and technologies contribute to sustainability in different ways and that they should be prioritised, given that a company's resources are limited. This is relevant not only for the individual O&G company's business and its adaptation to a low-carbon economy, but also for the surrounding business ecosystem and the governments, in order to establish optimal sustainability and innovation policies both at the firm and at an economy-wide level.

In this article, a novel analytical framework is presented that facilitates the assessment of an O&G company's sustainability actions by using the SDGs as a benchmark. The proposed tool uses information provided by international organizations (essentially UNDP and the IEA) to characterize the sustainability strategy of a company as a series of sustainability actions linked to specific technologies. This way, a company's focus on the different SDGs can be evaluated and assessed in terms of the maturity of the employed technologies.

When studying the particular case of Petronor by applying the proposed framework, it is found that the company is well positioned to make relevant technological contributions to SDGs 7 and 13, but that this potential is underestimated in its Sustainability Plans.

The analysis conducted on the basis of the new tool helps to identify the most relevant areas of contribution to SDGs 7 and 13 by Petronor and organize them hierarchically. The vanguard of the company's contribution to these SDGs focuses on its current work on cutting-edge, innovative fields such as electric mobility, hydrogen production and pyrolysis treatment for supplying biogas to Petronor's refinery's internal processes. Increased R&D activity would be needed to include in this group the production of synthetic fuels.

An integral view of Petronor's sustainability efforts can also be generated by using this tool. The conclusion of the analysis is that these «cutting-edge» contributions to SDGs 7 and 13 by Petronor cannot be understood by just looking at the corresponding specific sustainability actions as an isolated group.

Indeed, Petronor's «cutting-edge» sustainability activities may be seen as the tip of an iceberg of a much larger, wide-scope strategy to develop a multi-energy, sustainable company based on a solid industrial base. The pivotal point driving innovation and contribution to SDGs in this strategy is sustainable mobility. The analysis in this article also highlights that the capacity to build a multi-energy company that contributes to SDGs 7 and 13 relies on a multi-stakeholder business ecosystem in which synergies and innovation spillovers can lead to a much broader contribution to the SDGs and to greater firm competitiveness.

This all suggests that the existence of an O&G company carrying out high-impact sustainability activities in a particular geographical area can act as a catalyst for effective decarbonisation policies, rather than an obstacle. But this leading role can only be played through an extensive bet on innovation and diversification of activities in a multi-energy context, with focus on multiple value chains. Otherwise, the diversification efforts may result in insufficient ambition and the company's sustainability efforts may be at risk of being seen as part of a greenwashing strategy.

While the analysis in this article includes some quantitative indicators (i.e., sustainability actions are ranked according to the associated technologies' TRLs and their importance to net-zero emissions scenarios, according to the IEA's ETP-CET Guide), it offers no insights on how energy companies contribute to sustainability in terms of measurable variables such as avoided $CO_2$ emissions by technology, investment levels in specific technologies and other socioeconomic factors. This issue and the strong limitation of the number of SDGs covered by this analysis constitute the main weaknesses of the proposed analytical framework.

Further research along these lines may help to better understand and value the impact of a company's sustainability policies and how beneficial investments in new technologies may be from a company's point of view and from the point of view of global sustainability. The framework described in this article may also be applied to compare sustainability strategies across O&G companies and to assess the evolution of a company's sustainability strategy and efforts over time.

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# *Impacto de las políticas de autoconsumo y recarga del vehículo eléctrico en comunidades energéticas**

## *Impact of self-consumption and electric vehicle recharging policies on energy communities*

**El autoconsumo es una herramienta fundamental para integrar energías renovables y fomentar la participación activa de los consumidores en el sector energético. Para ello, la regulación del autoconsumo debe expandirse, incorporando figuras como el autoconsumo compartido, las comunidades energéticas, el almacenamiento y los vehículos eléctricos. En este artículo se presenta un problema de optimización del coste energético de una comunidad que considera diferentes políticas de autoconsumo compartido y gestión del vehículo eléctrico. El problema se aplica a una comunidad de energía compuesta por cinco consumidores domésticos para escenarios de uso del vehículo eléctrico con diferentes horarios de trabajo y consumos diarios. Los resultados muestran que las políticas involucradas tienen mayor impacto en el precio de la comunidad que el uso dado a los vehículos eléctricos.**

*Autokontsumoa funtsezko tresna da energia berriztagarriak integratzeko eta energiaren sektorean kontsumitzaileen parte-hartze aktiboa sustatzeko. Horretarako, autokontsumoaren erregulazioa hedatu egin behar da, autokontsumo partekatua, komunitate energetikoak, biltegiratzea eta ibilgailu elektrikoak barne hartuz. Artikulu honetan autokontsumo partekatuko eta ibilgailu elektrikoaren kudeaketako hainbat politika aintzat hartzen dituen erkidego baten kostu energetikoa optimizatzeko arazo bat aurkezten da. Arazoa etxeko bost kontsumitzailek osatutako energia-komunitate bati aplikatzen zaio, ibilgailu elektrikoaren erabilerarako, lan-ordutegi eta eguneko kontsumo desberdinak dituztenean. Emaitzek erakusten dute inplikatutako politikek eragin handiagoa dutela komunitatearen prezioan ibilgailu elektrikoei emandako erabilerak baino.*

Self-consumption is a key element to integrate renewable energies and foster consumer participation in the energy sector. To expand it, self-consumption regulation needs to incorporate policies such as shared self-consumption, energy communities, storage and electric vehicles. In this article, an optimization problem for the total cost of an energy community considering different self-consumption and electric vehicle management policies is presented. The problem is applied to a set of electric vehicle usage scenarios with diverse work schedules and daily consumptions. Results show that the involved policies have a greater impact on the community's energy cost than the usage of the electric vehicles.

* Dedicado a la memoria de nuestra compañera Julia Merino Fernández.

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## *Índice*



**Palabras clave:** autoconsumo compartido, comunidad energética, vehículo eléctrico, fotovoltaica, V2B.
**Keywords:** shared self-consumption, energy community, electric vehicle, photovoltaic, V2B.

**Nº de clasificación JEL**: Q21, Q41, Q50

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## 1. INTRODUCCIÓN

La transición energética, entendida esta como la descarbonización del sistema energético, es un proceso crucial en la lucha contra el cambio climático. En el año 2018, el sector de la energía seguía siendo el sector que generaba más emisiones de gases de efecto invernadero de la Unión Europea, con el 27 % de las emisiones totales[1] (European Environment Agency, 2020). En España, la contribución de este sec-

[1] Incluyendo el transporte internacional y excluyendo el UTCUTS (uso de la tierra, cambio de uso de la tierra y la silvicultura, LULUCF en singlas del inglés).

tor a las emisiones totales era menor, del 20 %. El sector energético ha hecho un gran esfuerzo por descarbonizarse, reduciendo sus emisiones desde el año 2000 en un 23 % (Europa) y 30 % (España) respectivamente. Aun con este esfuerzo, el IPCC (2018) señalaba que es necesario acelerar esta descarbonización para evitar los escenarios más severos del cambio climático en las próximas décadas.

La principal prioridad para alcanzar la neutralidad en carbono es la electrificación de la demanda y el empleo de fuentes de energía renovables, para lo cual los gobiernos han dispuesto un amplio abanico legislativo y medidas de apoyo que han fomentado el despliegue de un número creciente de instalaciones de generación renovable a pequeña y gran escala. Estos trabajos requieren una importante movilización de recursos y suponen un fuerte impacto económico y social, por lo que, para el éxito de la transición energética, es imprescindible involucrar a la sociedad (Lowitzsch, 2019).

Los modelos de propiedad compartida, en los que los usuarios comparten los costes y beneficios asociados a una instalación o servicio se han mostrado como una parte eficiente de implicar a la sociedad (Acquier, Daudigeos y Pinkse 2017). Aunque los modelos de propiedad compartida de energías renovables son aún escasos en España, en otros países europeos como Alemania son mucho más habituales y han contribuido a aumentar el peso de la generación distribuida sobre el parque de generación total (Dóci y Gotchev, 2016; Yildiz *et al.*, 2019). Esta vía de participación ciudadana se ha ido cerrando en los últimos años con la entrada de grandes empresas, que con sus menores costes han desplazado a estos pequeños propietarios. Esto pone en riesgo la aceptación social de la transición energética, la cual favorece y acelera los cambios económicos y sociales necesarios para su éxito (Romero-Rubio y de Andrés Díaz, 2015), y obliga a buscar nuevas formas de participación social activa (Tews, 2018).

El autoconsumo aparece aquí como una de las posibles vías para fomentar la participación activa de los consumidores, ya que cuenta con una experiencia previa exitosa y una regulación bastante asentada (Álvaro Hermana *et al.*, 2018). El autoconsumo individual ha sido regulado en la mayoría de países y ha contado con diferentes políticas de apoyo en su despliegue. Estas políticas pueden dividirse en dos categorías principales: las relativas a la financiación de la instalación y las relativas a la remuneración de los excedentes del autoconsumo que se inyectan a la red principal.

El siguiente paso en el desarrollo del autoconsumo es abrirlo a un mayor número de ciudadanos, para lo que es fundamental la regulación del autoconsumo compartido (Fina *et al.*, 2020). Esta forma de autoconsumo está presente en pocos países, entre ellos España, y, en general, está aún muy limitada, con sistemas de reparto fijos de la generación entre los diferentes propietarios que no aprovechan las dinámicas que pueden surgir del conjunto. En este sentido, la Unión Europea espera que el desarrollo de estos grupos de productores-consumidores, denominados comunidades de energías renovables, sean parte de la columna vertebral de la transición energética en las ciudades, como se refleja en la Directiva 2018/2001 del Parlamento Europeo y del Consejo (2018).

Para el éxito de estas propuestas es necesario además que haya una regulación que pueda potenciar sus ventajas sin que suponga un coste excesivo para el resto de elementos del sistema eléctrico. En Alvaro-Hermana *et al.* (2019) se analizó, mediante un problema de optimización, el impacto que tenían las políticas de autoconsumo en los ahorros que podía lograr una comunidad energética con paneles fotovoltaicos y baterías. El presente trabajo profundiza en el desarrollo realizado previamente, incorporando a la comunidad un almacenamiento dinámico mediante los vehículos eléctricos en sustitución de las baterías estáticas presentes en el trabajo previo. Esto permite analizar cómo afecta, en el coste energético de la comunidad, el uso dado a dichos vehículos eléctricos, así como el efecto de la política de la conectividad vehículo-edificio, además de poder estudiar el impacto cruzado entre el autoconsumo y la recarga de los vehículos eléctricos. Complementa así trabajos anteriores que han explorado las ventajas que aportan los vehículos eléctricos y la conectividad vehículo-edificio para la integración de renovables y fomentar el autoconsumo (Barone *et al.*, 2020, Bartolini *et al.*, 2020).

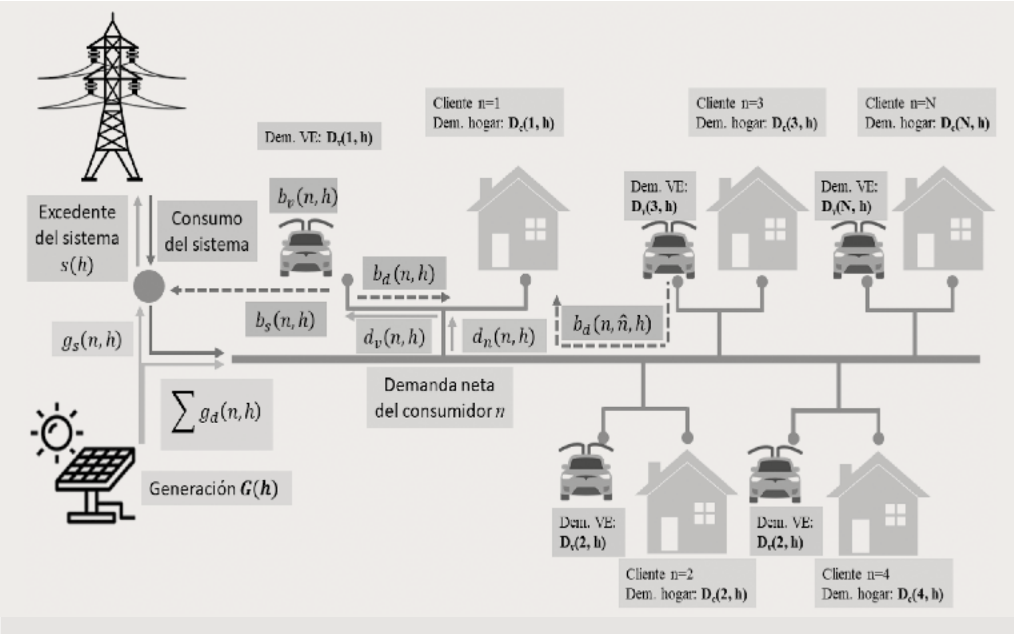
El resto del artículo se estructura como sigue. En el apartado segundo se presentan el sistema de estudio y los datos básicos empleados para realizar el análisis. En el tercer apartado se describen los diferentes escenarios analizados y las variables de interés que les afectan, fundamentalmente de carácter regulatorio y también de utilización de los vehículos eléctricos por parte de los usuarios. En el apartado cuarto se detalla el problema de optimización definido, donde se adaptan las restricciones para las diferentes políticas de vehículo-edificio y reparto de la generación fotovoltaica. En el quinto apartado se muestran los principales resultados del estudio, con cuyas conclusiones cierra el apartado sexto.

## 2. DESCRIPCIÓN DEL SISTEMA Y LOS DATOS ANALIZADOS

### 2.1. Descripción del Sistema

El problema de optimización presentado en este trabajo es de aplicación para cualquier periodo de tiempo y para todo tipo de comunidad energética que cuente con una o varias fuentes de generación eléctrica, varios puntos de consumo y puntos de recarga de vehículo eléctrico, según se resume en el Gráfico nº 1. Para analizar el impacto regulatorio se ha optado por particularizar este problema para el caso de un año y una comunidad energética con cinco viviendas, cada una con un vehículo eléctrico, y a las que da suministro una instalación fotovoltaica común.

*Gráfico nº 1.* **ESQUEMA DE LA COMUNIDAD ENERGÉTICA**




*Fuente:* elaboración propia. Para un mejor comprensión y seguimiento, ver la Nomenclatura en el recuadro siguiente.

## NOMENCLATURA

- Índices:

  *c*: índice de consumidor
  *h*: índice de hora

- Constantes:

  $B_{cap}$: capacidad de la batería
  $D_c(n,h)$: demanda bruta de la vivienda del consumidor *n en la hora h*
  $D_v(n,h)$: demanda del vehículo del consumidor *n en la hora h*
  $E_v(n,h)$: estacionamiento del vehículo del consumidor *n* en la hora *h*
  $G(h)$: generación fotovoltaica en la hora *h*
  *H:* número total de horas
  *N*: número total de consumidores
  $P_{carga}$: potencia máxima de carga y descarga del vehículo eléctrico
  $P_d(h)$: precio de la energía horaria proveniente de la red en la hora *h*
  $c_s$: coeficiente del excedente de electricidad
  $\mu$: rendimiento de la carga/descarga del vehículo

…/…

.../...

- Variables reales positivas:

  $b_d(n,h)$: electricidad inyectada desde el vehículo del consumidor *n* al consumo neto de su hogar (consumidor *n*) en la hora *h*

  $b_d(n,\hat{n},h)$: electricidad inyectada desde el vehículo del consumidor *n* al consumo neto del hogar del consumidor $\hat{n}$ en la hora *h*

  $b_s(n,h)$: electricidad inyectada desde el vehículo del consumidor *n* a la red asignada como excedente del sistema en la hora *h*

  $b_v(n,h)$: energía almacenada en el vehículo del consumidor *n* en la hora *h*

  $d_n(n,h)$: demanda neta del consumidor *n* en la hora *h*

  $d_v(n,h)$: demanda del VE del consumidor *n* en la hora *h*

  $g_d(n,h)$: electricidad desde la generación asignada al consumidor *n* en la hora *h*

  $g_s(n,h)$: energía desde la generación asignada al consumidor *n* al excedente del sistema en la hora *h*

  $s(h)$: excedente del sistema en la hora *h*

A continuación, se describen brevemente los datos del sistema.

## 2.2. Consumo de los usuarios

Los datos de consumo empleados provienen de la base de datos IPTC-SISDAC, que contiene datos anonimizados de una distribuidora eléctrica española con consumos de más de 100.000 usuarios repartidos por toda España. Se ha seleccionado el consumo anual de cinco consumidores del entorno de Bilbao (Vizcaya, España) con un perfil de consumo parejo. El consumo total anual de los usuarios se sitúa entre 2,70 MWh y 3,05 MWh, con una punta horaria de entre 4,75 kWh y de 8,48 kWh. El número de horas anuales con un consumo inferior a 100 Wh está entre 2.853 y 3.516.

En comparación con las demandas de los vehículos eléctricos propuestas en el subapartado 3.5 (5 kWh al día, 10 kWh y 20 kWh), el consumo de los vehículos eléctricos puede suponer, aproximadamente, aumentar un 50 %, duplicar o triplicar el consumo medio anual de cada uno de los miembros de la comunidad.

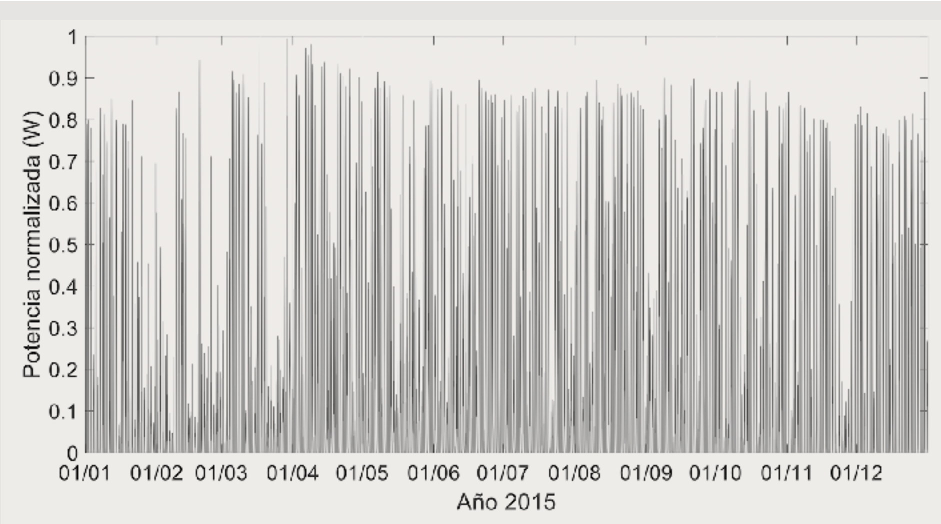
## 2.3. Generación fotovoltaica

Los datos de generación fotovoltaica se han tomado para la ciudad de Bilbao, correspondiente a las coordenadas 43,279º, -2,967º, para el año 2015 a partir de Huld, Šúri, Dunlop, Albuisson y Wald (2005). Se ha seleccionado un montaje fijo con unos ángulos de inclinación y azimut (orientación) optimizados.

Respecto a la potencia fotovoltaica instalada, en este trabajo se comparan entre sí diferentes escenarios de consumo de los vehículos eléctricos. Como se comparan los resultados según el coste total para la comunidad, de tomarse esta energía de la red los resultados de los escenarios con mayor demanda de los vehículos eléctricos llevarían a costes mayores con independencia de la gestión de la energía. Para evitar distorsión, en este análisis se ha decidido que, para cada uno de los diferentes escenarios, el total anual de la generación fotovoltaica coincida con la demanda total del sistema (vivienda y vehículo). De esta manera, se mantiene la relación entre ambas magnitudes, de forma que el resultado final, el coste global del sistema, dependerá únicamente de su desempeño en las condiciones dadas.

La potencia normalizada (punta de 1 W) a lo largo de un año de un panel fotovoltaico en la zona bajo estudio se presenta en el Gráfico nº 2.

*Gráfico nº 2.* **POTENCIA HORARIA NORMALIZADA (W) DE UN PANEL FOTOVOLTAICO EN LA LOCALIZACIÓN DESCRITA PARA EL AÑO 2015**



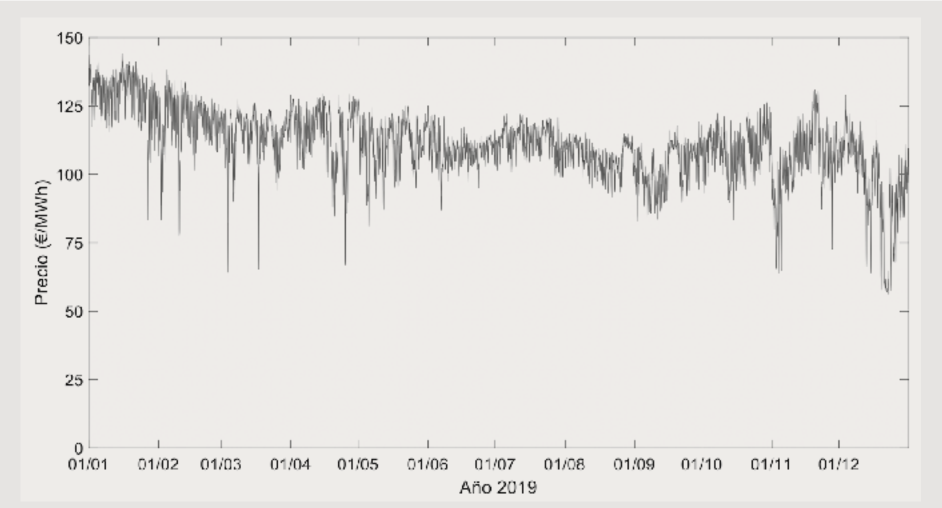

*Fuente:* elaboración propia.

## 2.4. **Precio de la electricidad**

Como precio de la electricidad de la red se ha considerado el término de energía del Precio Voluntario para el Pequeño Consumidor (PVPC), publicado por Red Eléctrica de España (2020), para el año 2019. El PVPC es la tarifa regulada a la que pueden acogerse los consumidores con una potencia contratada no superior a 10 kW, según lo establecido en el Real Decreto 216/2014, de 28 de marzo. El PVPC emplea un sistema de fijación del precio de la energía eléctrica que toma como referencia el precio de la energía en el mercado mayorista, entre otros componentes.

El término de energía del PVPC medio a lo largo del año 2019 fue de 110,4 €/MWh con una varianza de 153,6. Estos valores son inferiores a los de los dos años anteriores, con una media de 119,0 €/MWh para el año 2017 y de 123,3 €/MWh con unas varianzas de 190,4 y 171,2 respectivamente.

*Gráfico nº 3.* **PRECIO DE LA ENERGÍA CONSUMIDA DE LA RED PARA EL AÑO 2019**




*Fuente:* elaboración propia.

La componente de potencia de la tarifa PVPC es fijada por el Ministerio de Industria y su coste es proporcional a la potencia demandada por el consumidor. Estos costes, más relacionados con la instalación que con la actividad de la misma, no se han considerado de cara al problema de optimización ya que el sistema no considera posibles cambios en la tarifa contratada como parte de la gestión de la recarga del vehículo eléctrico.

## 3. REGULACIÓN Y OTROS FACTORES ANALIZADOS

La metodología empleada en este trabajo consiste en un análisis de todos los diferentes escenarios que pueden darse a partir de los factores que se describen en este apartado. Estos factores se pueden dividir en dos partes: aquellos relacionados con la regulación existente y aquellos relacionados con las características de los usuarios. Los primeros están compuestos por los factores relativos a la instalación de autoconsumo (cómo se valoran los excedentes y la forma en la que se reparte la energía entre los miembros de la comunidad) y la relación del vehículo con el resto de la comunidad (como carga activa o como almacenamiento individual o compartido). Los segundos están compuestos por el uso que hacen del vehículo eléctrico los usuarios: qué cantidad de energía consumen en su jornada diaria y qué horario tiene esta jornada. Con tres posibilidades por cuatro de los factores y cuatro posibilidades para uno de ellos (para el reparto de la generación), esto conforma un total de 324 escenarios a analizar.

*Cuadro nº 1.* **FACTORES CONSIDERADOS Y VARIANTES EMPLEADAS PARA LA CONSTRUCCIÓN DE ESCENARIOS**

| Factores | Tipo | Variantes |
|---|---|---|
| Valoración de excedentes de energía ($c_s$) | Regulación | 0, 1/3, 1 |
| Reparto de la generación fotovoltaica | Regulación | Libre, equilibrado (semanal y mensual), fijo |
| Interacción vehículo-edificio | Regulación | V1B, V2B, V2B2 |
| Horario de aparcamiento | Comportamiento de los usuarios | Mañana, tarde, noche |
| Demanda diaria de los vehículos (kWh) | Comportamiento de los usuarios | 5, 10, 20 |

*Fuente:* elaboración propia.

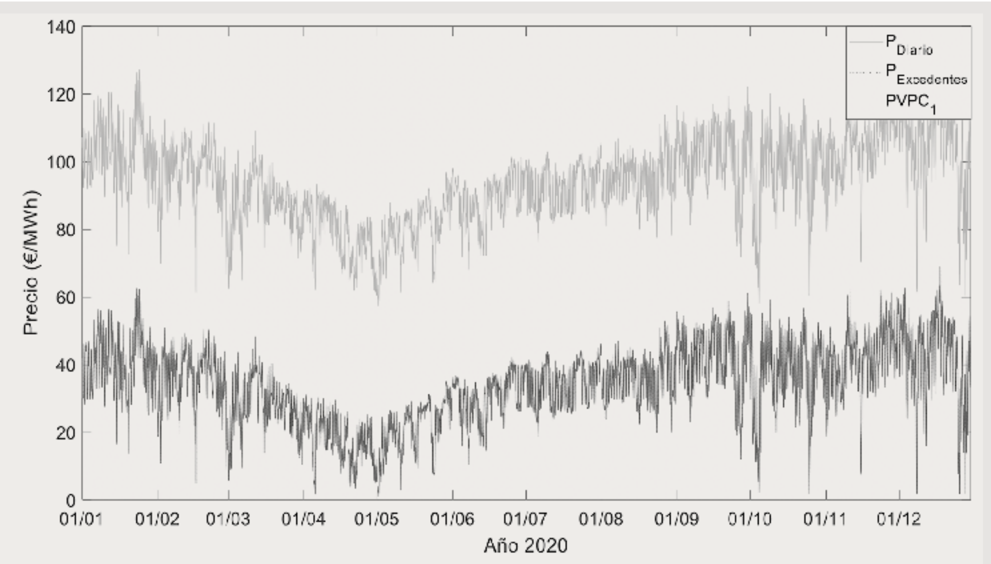
### 3.1. **Excedentes de energía**

La forma en la que se remuneran los excedentes de energía es uno de los aspectos clave en cualquier marco normativo que afecte a las instalaciones de autoconsumo. Además de sus repercusiones en los costes del conjunto del sistema, esta remuneración tiene un gran impacto en los tiempos de recuperación de la inversión y, en última instancia, en el comportamiento de los autoconsumidores. Cuanta menor diferencia haya entre el precio de la red y el precio que perciben los usuarios por los excedentes, menor valor se pierde en desplazar la energía consumida de la red (con mayor coste promedio) y menor será el interés de los consumidores por adaptar su consumo a su generación y por la inclusión de sistemas de almacenamiento (en el caso estudiado, el uso de los vehículos eléctricos), esto último también influido por la variabilidad en el precio de la red.

Para este estudio se han considerado tres políticas de valoración de estos excedentes de energía: medida neta, factura neta y sin excedente, que se reflejan en el problema de optimización del apartado cuarto mediante el coeficiente $c_s$, ratio entre el precio horario de los excedentes y el precio horario de la energía de la red. En el caso de la medida neta, el precio de la energía vertida a la red coincide con la proveniente de esta ($c_s$ = 1); para la factura neta, la energía vertida se valora como una parte del precio de la red (en este caso se ha tomado $c_s$ = 0,3; de manera que se prima mucho más el autoconsumo que el vertido de excedentes a la red) y para la política sin excedentes, no tiene valor alguno ($c_s$ = 0). En este trabajo se considera un precio horario para la energía proveniente de la red y la vertida a la misma, aunque en algunas legislaciones se evalúa la diferencia entre las mismas de manera diaria o mensual considerando un precio medio.

La elección de estas políticas de valoración de los excedentes no busca reflejar la situación concreta de un país, en este caso España, sino mostrar el impacto que tiene en la comunidad de energía el precio al que se valoran los excedentes vertidos de la red. En el caso de España, el Real Decreto 244/2019 establece que el precio de los excedentes de autoconsumo se calcula como la suma de los precios de la energía en los mercados diario e intradiario menos la gestión de desvíos. Para el año 2020, como se muestra en el Gráfico nº 4, su precio es casi parejo al del mercado diario y lejos del coste del término de energía en el precio PVPC visto en la subapartado 2.4, lo que se aproxima al caso de la factura neta descrito en el párrafo anterior. El PVPC también está calculado tomando como referencia el precio de los mercados diario e intradiario más diferentes conceptos incluidos el término de energía del peaje de acceso y cargos de la red, según se determina en el Real Decreto 216/2014. Finalmente, puede señalarse también que en el mercado libre es posible encontrar más diversidad de precios para la energía consumida y los excedentes vertidos a la red.

*Gráfico nº 4.* **PRECIO DEL MERCADO DIARIO, DE LOS EXCEDENTES Y DEL PVPC DE UN PERIODO PARA EL AÑO 2020**




*Fuente:* elaboración propia.

### 3.2. Reparto de la generación fotovoltaica

El reparto de la generación fotovoltaica es la forma en la que toda la generación producida y compartida por todos los usuarios se divide entre cada uno de ellos. Este reparto puede estar fijado por la ley vigente o por una obligación contractual entre los usuarios.

En este artículo se han seleccionado tres de los modelos de reparto de la generación fotovoltaica estudiados en Alvaro-Hermana *et al.* (2018): reparto libre, reparto equilibrado (con variante semanal y mensual) y reparto fijo.

El reparto libre es una política en la que no hay definida una obligación determinada en la forma en la que la energía generada se reparte entre los diferentes usuarios. Este sistema de reparto es el que otorga una mayor flexibilidad y, por tanto, mayores beneficios económicos para los usuarios, pero requiere definir de forma clara los términos en los que se realiza la gestión de la energía de la comunidad y sus miembros.

Esta gestión puede realizarse de maneras muy diversas. Por ejemplo, una forma simplificada sería repartir la energía de forma equitativa entre los usuarios hasta que alguno iguale su demanda, repartiendo el resto de la energía entre el resto de usuarios y prosiguiendo el proceso hasta cubrir toda la energía generada por la instalación. Sistemas de reparto más complejos, que incluyan el uso de almacenamiento compartido, requerirán seguramente de la participación de un tercer agente, como, por ejemplo, un agregador, que gestione dinámicamente este reparto y divida los beneficios del sistema entre los consumidores de la manera acordada. En este trabajo se va a suponer que esta entidad busca optimizar la gestión del sistema según la disponibilidad de la generación y los vehículos eléctricos, dejando el reparto de este beneficio en un segundo plano. Esto es igualmente aplicable al caso del reparto equilibrado, ya que, aunque se entregue la misma energía a todos los usuarios, su valor varía con el tiempo en función del precio de la red.

En el caso del reparto fijo, al entregarse la misma cantidad de energía a todos los usuarios en todo momento, no es necesario ningún acuerdo (salvo en el caso de introducir el V2B2, visto en el subapartado 3.3, donde los vehículos eléctricos actúan como una suerte de reparto complementario entre usuarios).

El reparto equilibrado es una política en la que la legislación permite que se reparta libremente la energía entre los diferentes usuarios siempre y cuando al final de un determinado periodo de ajuste (por ejemplo, un mes o un año) se garantice que los usuarios hayan percibido una determinada cantidad de energía. En Alvaro-Hermana *et al.* (2019) se estudió el impacto del tiempo para realizar este reparto para un sistema de generación fotovoltaica compartida con batería estática centralizada, con el resultado de que no había un impacto global respecto al reparto libre en los casos en los que se contaba con suficiente tiempo para asignar la energía (sin impacto cuando se disponía de un mes, un impacto mínimo para una semana y algo más apreciable para un día). En este trabajo se van a considerar dos periodos de reparto con distinto margen temporal, para comprobar que se repite el impacto visto en Alvaro-Hermana *et al.* (2019): de un mes y de una semana.

Finalmente, el reparto fijo es aquel en el que no se da ninguna flexibilidad a los consumidores, repartiendo la energía generada según unos coeficientes de manera constante en cada franja de tiempo (típicamente, quince minutos o una hora). Este sistema es el menos complejo técnica y legislativamente, dándose en legislaciones como la española, aunque es el que ofrece menos beneficios económicos a los usuarios. Para este trabajo se considera un reparto equilibrado entre los diferentes usuarios, de manera que cada uno de ellos perciba la misma cantidad de energía en cada franja de tiempo con independencia de que esta vaya destinada al propio usuario (al hogar o al vehículo) o vertida a la red bajo la asignación a dicho usuario; excedentes por los que percibirá en su cuenta una compensación.

### 3.3. **Interacción vehículo-edificio (V1B, V2B y V2B2)**

El impacto de los vehículos eléctricos en la demanda de las instalaciones se prevé que sea muy significativo a medio plazo cuando, debido a normas anticontaminación europeas cada vez más restrictivas, fomenten el despliegue significativo de este tipo de vehículos Muratori (2018). Estos vehículos supondrán un importante aumento del consumo eléctrico de los hogares que cuenten con un garaje propio, así como en otras localizaciones como centros de trabajo y centros comerciales. Gracias a la amplia disponibilidad de tiempo para recargar estos vehículos durante el tiempo en que permanecen aparcados y la flexibilidad de potencia con la que pueden realizar dicha recarga, los vehículos eléctricos pueden gestionarse para disminuir el coste de la recarga. Esta carga controlada aparece en la literatura como V1G, en contraposición con la posibilidad de devolver energía a la red de un esquema más avanzado tipo “vehículo-a-red” (*vehicle-to-grid*, V2G). Al estar hablando en este subapartado de gestión de demanda de edificios, en este trabajo la recarga controlada se denominará V1B.

De manera similar a como el V2G como la posibilidad de devolver energía a la red, el V2B (*vehicle-to-building*, vehículo-a-edificio) introduce la posibilidad de enviar energía desde el vehículo al edificio, para disminuir su consumo de la red, reduciendo los costes del mismo. Este sistema introduce así la posibilidad de cargar el vehículo desde la red eléctrica o empleando los excedentes de la generación fotovoltaica para poder emplear esta energía almacenada posteriormente, haciendo funcionar al vehículo como una batería, con dos únicas particularidades. En primer lugar, el vehículo no está disponible todo el tiempo, sino que solo lo está el tiempo que permanece aparcado. Y, en segundo lugar, el vehículo se descarga durante el tiempo que está en circulación y debe mantener un cierto nivel de energía antes de volver a salir, lo que restringe su uso como almacenamiento. Todo ello se compensa con la reducción de costes que supone para el hogar no tener que asumir la adquisición de una batería estacionaria dedicada, aspecto que no se evalúa en este trabajo.

Finalmente, se puede considerar que, al igual que se puede repartir la energía de la generación comunitaria entre los diferentes usuarios, también se puede repartir la energía almacenada en los vehículos, de manera similar a como puede hacerse con una batería común para la comunidad (aspecto estudiado en Alvaro-Hermana *et al.* (2019)). Este sistema se denominará en este trabajo como V2B2.

### 3.4. **Horario de aparcamiento**

La disponibilidad de los vehículos eléctricos para su conexión en la red tiene un impacto importante en las interacciones vehículo-edificio descritas en el subapartado anterior. Un mayor tiempo de aparcamiento y una menor demanda conllevan más flexibilidad para elegir cuándo cargar el vehículo y, si está habilitado, cuándo ceder energía al edificio o verterla a la red. Esta flexibilidad puede aprovecharse más cuanto más variable es el precio de la red y cuando hay una mayor disponibilidad de la generación propia.

En este estudio se va a analizar los impactos en coste energético para los usuarios de vehículos eléctricos de tener distintas jornadas laborales: de mañana, de tarde o de noche. Para ello, se han considerado tres jornadas tipo de características similares, con un horario continuo de ocho horas durante los días laborales de una semana (lunes a viernes) más una hora adicional de descanso/almuerzo. El horario de mañana es 08:00 a17:00 horas; el horario de tarde, de 16:00 a 01:00 horas; y el de noche, de 00:00 a 09:00 horas. Si se le añade una hora de trayecto, esto implica que el coche durante el horario de mañana está fuera de su plaza desde las 07:00 a las 18:00 horas; en el horario de tarde, de 15:00 a 02:00 horas; y en el de noche, de 23:00 a 10:00 horas. Los diferentes horarios considerados se resumen en el Cuadro nº 2.

*Cuadro nº 2.* **FRANJAS HORARIAS EN LAS QUE ESTÁN LOS VEHÍCULOS FUERA DEL APARCAMIENTO**

| Horario | Mañana | Tarde | Noche |
|---|---|---|---|
| Inicio | 8 (07:00-08:00) | 16 (15:00-16:00) | 24 (23:00-24:00) |
| Fin | 18 (17:00-18:00) | 2 (01:00-02:00) | 10 (09:00-10:00) |
| Precio medio (€/MWh) | 109,50 | 109,43 | 110,49 |
| Varianza normalizada del precio $(€/MWh)^2$ | 172,52 | 162,55 | 147,82 |

*Fuente:* elaboración propia.

Estos horarios de aparcamiento implican que los vehículos eléctricos de los diferentes escenarios analizados disponen de unos precios de red diferentes, aunque con medias similares, para poder recargar su energía. A esto hay que añadir que una mayor varianza en el precio, como en la mañana, permitirá mayores ahorros a los usuarios que aprovechen para realizar una recarga inteligente y, si está habilitado, devolver energía a la red en las franjas en las que el precio de la energía eléctrica sea mayor.

### 3.5. Demanda diaria de los vehículos eléctricos y potencia de recarga

Se ha supuesto que las baterías de los vehículos eléctricos cuentan con una capacidad de 30 kWh y, para este estudio, se han supuesto tres casos de demanda en cada día laborable de los vehículos eléctricos: 5 kWh, 10 kWh y 20 kWh (que corresponden a unas distancias medias diarias de 33 km, 66 km y 133 km, tomando un consumo medio de 15 kWh/100 km). Esto supone un consumo anual de cada uno de los vehículos eléctricos de 1,3 MWh, 2,6 MWh y 5,2 MWh, respectivamente. Como se ha dicho anteriormente, esto supone un 50 %, un 100 % y un 200 % del consumo de las viviendas. Aparte, salvo para el último de los casos, los vehículos pueden permanecer varios días sin recargar, lo que aporta más flexibilidad.

De cara a integrar la demanda de los vehículos en el modelo, aunque esta se distribuye en dos viajes idénticos a lo largo de la jornada, es equivalente desde el punto de vista del sistema considerado a una única demanda que se produzca en la franja anterior al regreso del vehículo, siendo esta la opción elegida para simplificar el sistema.

Respecto a los cargadores, se ha supuesto que cuentan con una potencia de recarga de 3,4 kW y con un rendimiento de carga/descarga del vehículo del 95 %. Esto implica que, como el problema emplea franjas de tiempo de una hora, los vehículos requieren de al menos dos, cuatro y siete franjas horarias para recargar las baterías del total de trece franjas diarias que el vehículo pasa aparcado.

## 4. PROBLEMA DE OPTIMIZACIÓN

En este apartado se describe el problema de optimización empleado para el análisis de la comunidad de energía descrita anteriormente. Este problema es aplicable a un amplio abanico de comunidades de energía con distintos esquemas de regulaciones del autoconsumo y distintos comportamientos de usuarios y movilidad. Para desarrollar este modelo de optimización, se requiere partir del caso base descrito en el subapartado 4.1 (recarga inteligente y reparto libre) e introducir o modificar las restricciones expuestas, para definir el resto de escenarios, presentados en los subapartados posteriores.

### 4.1. **Caso base. Recarga inteligente (V1B)**

La recarga inteligente es el problema que emplea un menor número de variables y restricciones, por lo que se ha escogido para mostrar el problema completo de la forma más simplificada. El problema incorpora el coeficiente $c_s$ para considerar la política con la que se valora la energía excedente y, al no incluir restricciones relativas al reparto de la generación, implica que se trata como una política de reparto libre.

La función objetivo a minimizar (1) es la suma del coste de la demanda neta de cada uno de los usuarios, $d_n(n,h)$, menos los beneficios generados por los excedentes de la generación fotovoltaica y las baterías de los vehículos eléctricos, $s(h)$. Estos beneficios dependen de cómo se valore la energía vertida a la red, aspecto que describe el coeficiente $c_s$ usando como base el precio de la red, $P_d(h)$, y que toma los valores comentados en el subapartado 3.1.

$$\min \sum_{h=1}^{H} \left( P_d(h) \cdot \left( \sum_{n=1}^{N} d_n(n,h) - c_s \cdot s(h) \right) \right) \tag{1}$$

En este caso base, en el que la interacción entre los usuarios y los vehículos eléctricos se limita a que los usuarios realicen una recarga activa de estos, las restricciones quedarían de la siguiente forma:

$$G(h) = \sum_{n=1}^{N} \left( g_s(n,h) + g_d(n,h) \right) \ \ \forall h \tag{2}$$

$$d_n(n,h) = D_c(n,h) - g_d(n,h) + d_v(n,h) \ \ \forall n, \forall h \tag{3}$$

$$b_v(n,h) = b_v(n,h-1) - D_v(n,h) + \mathrm{m} \cdot d_v(n,h) \ \ \forall n, \forall h \tag{4}$$

$$s(h) = \sum_{n=1}^{N} g_s(n,h) \ \ \forall h \tag{5}$$

$$b(n,h) \leq B_{cap} \ \ \forall n, \forall h \tag{6}$$

$$d_v(n,h) \leq P_{carga} \cdot E_v(n,h) \ \ \forall n, \forall h \tag{7}$$

La restricción (2) define que la energía eléctrica horaria generada por la instalación fotovoltaica común a todos los consumidores, $G(h)$, se reparte entre los N consumidores. Esta puede verterse directamente a la red a cuenta de uno de los consumidores, $g_s(n,h)$, o emplearse para cubrir la demanda del hogar o del vehículo eléctrico, $g_d(n,h)$.

La restricción (3) obtiene la demanda neta horaria de cada uno de los consumidores, $d_n(n,h)$, como la demanda bruta de su hogar, $D_c(n,h)$, menos la energía proveniente de la instalación fotovoltaica, $g_d(n,h)$, más la energía demandada por su vehículo eléctrico, $d_v(n,h)$.

La restricción (4) contiene el balance de energía de la batería del vehículo eléctrico entre dos tiempos sucesivos. Esta batería debe cubrir la demanda del propio vehículo al circular (habitualmente durante el horario de trabajo), $D_v(n,h)$. Sin pérdida de generalidad, se asume que el consumo realizado por el vehículo se realiza en el último intervalo horario antes de regresar a casa y conectarse a la red. Una vez que el usuario ha regresado a su hogar, la batería del vehículo puede cargarse, en función de la optimización del sistema, $d_v(n,h)$.

La restricción (5) calcula cuál es el excedente del sistema, que proviene únicamente de la generación fotovoltaica, $g_s(n,h)$. Dado que se calcula el beneficio total del sistema, no es necesario calcular un excedente concreto para cada usuario.

Por último, las restricciones (6) y (7) se refieren a las restricciones técnicas de la batería del vehículo eléctrico. En (6) se especifica la capacidad máxima que puede almacenar la batería del vehículo eléctrico. La restricción (7) define la capacidad máxima de carga de la batería en función de la potencia del cargador, $P_{carga}$, disponible siempre y cuando el vehículo esté aparcado en casa, según indica la constante binaria $E_v(n,h)$ (1: aparcado; 0: no aparcado).

## 4.2. **V2B y V2B2**

### 4.2.1. *Vehículo-a-Edificio (Vehicle-to-Building, V2B)*

En caso de que se pueda extraer energía del vehículo, será necesario añadir nuevas variables al modelo para poder así ampliar las opciones disponibles, lo que lleva a incorporar nuevas restricciones y modificar las ya existentes. Debe añadirse una nueva restricción relativa a la energía que puede extraerse de la batería del vehículo, que puede destinarse tanto a disminuir el consumo neto del hogar, $b_d(n,h)$, o como excedente al sistema, $b_s(n,h)$, para reducir la factura energética en caso de percibir remuneración por la energía vertida a la red.

$$b_d(n,h) + b_s(n,h) \leq P_{carga} \cdot E_v(n,h) \;\; \forall n, \forall h \tag{8}$$

Adicionalmente, es necesario modificar las restricciones (3-5) para introducir estas dos nuevas variables. Quedarían respectivamente como:

$$d_n(n,h) = D_c(n,h) - g_d(n,h) + d_v(n,h) - m \cdot b_d(n,h) \;\; \forall n, \forall h \tag{9}$$

$$b_v(n,h) = b_v(n,h-1) - D_v(n,h) + \mathrm{m} \cdot d_v(n,h) - b_d(n,h) - b_s(n,h) \quad \forall n, \forall h \tag{10}$$

$$s(h) = \sum_{n=1}^{N} \left(g_s(n,h) + \mathrm{m} \cdot b_s(n,h)\right) \;\; \forall h \tag{11}$$

donde en las restricciones (9) y (11) se ha añadido el excedente de los vehículos eléctricos considerando el rendimiento asociado, $\mu$. En el balance de la batería del vehículo eléctrico, (10), se ha añadido que la batería también se puede descargar en función de la optimización del sistema.

### 4.2.2. *Vehículo-a-edificio compartido (Shared Vehicle-to-Building, V2B2)*

Finalmente, si se abre la posibilidad de que los vehículos puedan intercambiar energía con otros usuarios además de su propietario, el término $b_d(n,h)$, que define la energía saliente del vehículo hacia el local del consumidor, debe cambiarse por la suma de energías salientes del vehículo hacia todos los locales de los consumidores, $b_d(n,\hat{n},h)$, donde $n$ denota al consumidor propietario del vehículo y $\hat{n}$ al consumidor receptor, pudiendo ambos consumidores ser el mismo ($n = \hat{n}$), como en el caso anterior. De esta forma, partiendo del caso V2B, las restricciones (8-10) quedarían respectivamente como:

$$d_n(n,h) = D_c(n,h) - g_d(n,h) + d_v(n,h) - \mathrm{m} \cdot \sum_{\hat{n}=1}^{N} b_d(n,\hat{n},h) \quad \forall n, \forall h \qquad (12)$$

$$b_v(n,h) = b_v(n,h-1) - D_v(n,h) + \mathrm{m} \cdot d_v(n,h) - \sum_{\hat{n}=1}^{N} b_d(n,\hat{n},h) - b_s(n,h) \quad \forall n, \forall h \qquad (13)$$

$$\sum_{\hat{n}=1}^{N} b_d(n,\hat{n},h) + b_s(n,h) \leq P_{carga} \cdot E_v(n,h) \quad \forall n, \forall h \qquad (14)$$

## 4.3. **Reparto de la generación fotovoltaica**

Desde el punto de vista del problema de optimización antes planteado, la forma en la que se decida repartir la generación fotovoltaica implica introducir nuevas restricciones a las ya definidas. No obstante, dependiendo del reparto en concreto, el problema puede simplificarse modificando alguna de las restricciones ya existentes, como se verá para el caso del reparto fijo.

En este análisis se han seleccionado tres de los modelos de reparto de la generación fotovoltaica estudiados en Alvaro-Hermana *et al.* (2019): reparto libre, reparto equilibrado mensual y reparto fijo. El reparto libre, al considerarse la forma más abierta, no necesita plantear restricciones adicionales. Por ello, en este subapartado solo se describirán las particularidades de las restantes formas de reparto.

El reparto equilibrado mensual supone que cada usuario recibe, de la generación fotovoltaica, la misma cantidad de energía a lo largo del mes. En Alvaro-Hermana *et al.* (2019), al contar el sistema con una batería central para todos los usuarios, el reparto de esta generación debía tener en cuenta qué cantidad de energía se extraía de la misma para cada usuario. En este caso, al disponer de una batería descentralizada para cada usuario, constituida por sus vehículos eléctricos, la formulación de la restricción se simplifica. La generación fotovoltaica debe ser idéntica para cada usuario en cada uno de los periodos de tiempo acordados, *H'*, que, en este caso, son los correspondientes a cada mes. Esta generación se asigna directamente a cada uno de los usuarios, pudiendo verterse a la red ($g_s(n,h)$ en (2)), destinarse a reducir la demanda neta del usuario (a través del término $d_n(n,h)$) o emplearse para recargar su vehículo (considerando el término $d_v(n,h)$). Ambas opciones están recogidas en el término $g_d(n,h)$ en (3).

$$\sum_{h=1}^{H'}\left(g_s(n_1,h)+g_d(n_1,h)\right)=\sum_{h=1}^{H'}\left(g_s(n_2,h)+g_d(n_2,h)\right)$$
$$\forall H' \subseteq H\,, \forall\,(n_1,n_2)\in(N,N) \qquad (15)$$

En el caso del reparto fijo, puede optarse por añadir una nueva restricción que indique que la energía suministrada a cada usuario debe ser igual en cada franja, en línea con lo anterior.

$$g_s(n_1,h)+g_d(n_1,h)=g_s(n_2,h)+g_d(n_2,h)$$
$$\forall h, \forall(n_1,n_2)\in(N,N) \qquad (16)$$

No obstante, resulta más práctico modificar la restricción (2), fijando la forma en la que se realiza el reparto de la generación fotovoltaica de manera equilibrada, *G*(*h*).

$$\frac{G(h)}{N}=g_s(n,h)+g_d(n,h)\ \ \forall n,\forall h \qquad (17)$$

## 5. RESULTADOS

En este trabajo se han analizado 324 casos correspondientes a las diferentes combinaciones de factores considerados[2]: política con la que se valoran los excedentes de la generación fotovoltaica ([Excedente], pudiendo ser: medida neta [MN], factura neta [FN] y sin excedentes [SE]), la forma en la que se reparte la energía generada por la instalación fotovoltaica común ([Reparto FV]: Individual [Indiv], Equilibrio semanal [Eq_sem], Equilibrio mensual [Eq_mes], y [Libre]), la política de interacción de los vehículos eléctricos con el edificio ([Política VE]: recarga inte-

[2] Entre corchetes, la abreviatura usada en las tablas para los diferentes factores y sus casos. Si coincide con el caso, como en la demanda de los vehículos, únicamente aparecen los corchetes.

ligente [V1B], *vehicle-to-building* [V2B] y *vehicle-to-building* compartido [V2B2]), el horario de aparcamiento de los diferentes usuarios ([Aparca]: 18:00-07:00 [Mañana], 02:00-15:00 [Tarde] y 10:00-23:00 [Noche]) y la demanda de los vehículos eléctricos ([Demanda]: [5] kWh, [10] kWh y [20] kWh).

En primer lugar, se estudia el impacto de cada uno de estos factores por separado. El Cuadro nº 3 muestra el promedio del coste global para la comunidad de usuarios para cada uno de los identificadores de los casos analizados.

*Cuadro nº 3.* **COSTES PROMEDIOS PARA LA COMUNIDAD DE LOS CASOS POR FACTOR INDIVIDUAL (€)**

| | | | | |
|---|---|---|---|---|
| Excedente | Sin excedentes SE | Factura neta FN | Medida neta MN | |
| Coste | 1.707,4 | 1.511,4 | 1.033,4 | |
| Política VE | V1B | V2B | V2B2 | |
| Coste | 1.470,7 | 1.390, 8 | 1.390,8 | |
| Demanda | 5 | 10 | 20 | |
| Coste | 487,8 | 1.115,0 | 2.592,4 | |
| Aparca | Mañana | Tarde | Noche | |
| Coste | 1.641,9 | 1.294,7 | 1.315,6 | |
| Reparto FV | Indiv | Eq_sem | Eq_mes | libre |
| Coste | 1.447,4 | 1.408,3 | 1.406,9 | 1.406,9 |

*Fuente:* elaboración propia.

Como se puede apreciar, hay dos factores en los que hay un coste igual o muy similar entre dos políticas propuestas: Política VE y Reparto FV.

En el caso de la relación vehículo-edificio (Política VE), la interacción del vehículo con la demanda del edificio tiene un importante impacto en los costes de los usuarios cuando se permite que puedan emplear las baterías de sus vehículos para reducir su demanda (V2B), frente a la mera recarga activa de los mismos (V1B), obteniendo un 5 % de descenso en el coste promedio de los casos analizados. Por el contrario, flexibilizar este uso permitiendo un uso compartido de este recurso para el resto de la comunidad (V2B2) no genera ningún impacto cuando todos los usuarios cuentan con un horario idéntico. Es de esperar que sí se obtengan beneficios adicionales cuando haya variabilidad entre los diferentes usuarios y, especialmente, cuando haya usuarios que hagan un uso ocasional de su vehículo, ya que el impacto entre poder usar o no esta batería (V1B y V2B) es muy significativo.

En el caso del reparto de la generación fotovoltaica (Reparto FV), se observa que este resultado es coherente con los resultados obtenidos en estudios previos (en Alvaro-Hermana *et al.;* 2019), donde se vio que era necesario reducir el periodo de ajuste a una semana para que tuviera un mínimo efecto sobre el ahorro del sistema y a un día para que fuese un impacto significativo. Esta política solo genera un impacto medio del 3 % entre el caso en que no se habilite ningún reparto de la generación y el resto de casos en los que sí se permite.

El factor con una importancia más destacada es la energía demandada por los vehículos (81 % de diferencia entre la media de los casos de 5 kWh y 20 kWh). Dado que se incrementa la generación fotovoltaica cuando aumenta la demanda, esto quiere decir que el impacto de una mayor demanda puede obedecer a dos causas: la menor flexibilidad del sistema (el vehículo debe estar mayor tiempo cargando) y el desfase entre la generación y la demanda, lo que, en general, eleva los costes del sistema.

La política con la que se valoran los excedentes del sistema también tiene un impacto importante en el coste global del sistema, destacable en la comparación entre las políticas sin excedentes y factura neta (11 %) y con mayor diferencia aún para la medida neta (39 %). Esto se debe en buena parte al hecho de disponer de una generación fotovoltaica anual igual a la demanda anual del conjunto de usuarios, lo que conlleva a que, en muchos casos, con esta remuneración se reduzca mucho el coste de la energía para el conjunto del sistema[3].

El último factor, el horario de aparcamiento, tiene un impacto menor que los dos anteriores. La diferencia más acusada se tiene para el horario de mañana, con un coste medio de la energía para los usuarios entre un 20 % y un 21 % mayor que para la media de casos en los que los usuarios tienen un horario de tarde o de noche.

A continuación, se analizan los pares de factores más significativos. Debido a que no ha habido diferencias entre los casos V2B y V2B2, solo se va a considerar uno de ellos para evitar sobrerrepresentar estos casos. En el caso del reparto de la generación fotovoltaica, se van a descartar los casos con Equilibrio mensual, ya que no ha habido diferencias entre este y el reparto Libre. Esta criba deja un total de 162 casos a analizar en el resto de este apartado.

[3] El valor mínimo se tiene para los casos con factores de Medida Neta, horario de mañana, demanda de 5 kWh y Política VE V2B o V2B2 (con independencia del reparto de la generación fotovoltaica). Aunque se obtiene un valor ligeramente negativo, -577 -, en el caso de la legislación española solo se admiten costes de la energía positivos, con lo que la instalación fotovoltaica estaría levemente sobredimensionada.

*Cuadro nº 4.* **COSTES PROMEDIOS PARA LA COMUNIDAD PARA LAS DIFERENTES COMBINACIONES DE HORARIO DE APARCAMIENTO Y DEMANDA DE LOS VEHÍCULOS (€)**

| Aparca \ Demanda | 5 | 10 | 20 |
|---|---|---|---|
| Mañana | 687,7 | 1.390,7 | 2.876,2 |
| Tarde | 506,1 | 1.003,0 | 2.431,6 |
| Noche | 479,8 | 1.027,4 | 2.505,8 |

*Fuente:* elaboración propia.

La interacción entre la energía demandada y el horario de aparcamiento, mostrada en el Cuadro nº 4, permite destacar la importancia de la disponibilidad del vehículo y su alineamiento con la generación fotovoltaica. Mientras que la combinación de una baja demanda y trabajo nocturno (aparcamiento entre las 10:00 y las 23:00, prácticamente coincidente con la generación fotovoltaica) obtiene el menor coste promedio, cuando la demanda es máxima se es más dependiente de la red (con precios más elevados, como se vio en el subapartado 3.4) y la posibilidad de generar beneficios con los excedentes (beneficio proporcional al precio de la red) disminuye, resultando en que, para una demanda de 20 kWh, el coste del sistema es menor con un horario de tarde.

Esto es coherente con la relación observada entre la política asociada a los VE y la demanda de los mismos: a medida que aumenta la demanda, la capacidad de aprovechar las ventajas del V2B disminuye y más se acerca al resultado para el V1B.

*Cuadro nº 5.* **COSTES PROMEDIOS PARA LA COMUNIDAD PARA LAS DIFERENTES COMBINACIONES DE REGULACIÓN VEHÍCULO-EDIFICIO Y DEMANDA DE LOS VEHÍCULOS (€)**

| Política VE \ Demanda | 5 | 10 | 20 |
|---|---|---|---|
| V1B | 640,5 | 1.167,1 | 2.615,5 |
| V2B | 475,2 | 1.113,7 | 2.593,5 |

*Fuente:* elaboración propia.

Y también es coherente con relación entre el horario de aparcamiento y la política de valoración de los excedentes de energía, donde se aprecia que la ventaja de disponer de un mayor tiempo del vehículo eléctrico durante las horas de generación fotovoltaica se anula por completo en el sistema de medida neta, donde no es necesario realizar una gestión activa de la instalación fotovoltaica y pasa a tener más importancia el precio de la red en el momento de cargar.

La aparente contradicción entre esto último y la ventaja en el horario de mañana frente al horario de tarde cuando hay una política de medida neta se explica por el impacto de la energía demandada por el vehículo. Como se vio anteriormente, cuando la disponibilidad de la batería es alta (baja demanda) el sistema puede alcanzar un menor coste, hasta el punto de casi no tener costes de energía en el caso de mínima demanda y medida neta. Por el contrario, una alta demanda dificulta el uso de la batería y no se puede obtener tanto beneficio de una política de excedentes más favorable para los autoconsumidores.

*Cuadro nº 6.* **COSTES PROMEDIOS PARA LA COMUNIDAD PARA LAS DIFERENTES COMBINACIONES DE VALORACIÓN DE LOS EXCEDENTES DE ENERGÍA Y HORARIO DE APARCAMIENTO (€)**

| Aparca \ Excedente | Mañana | Tarde | Noche |
|---|---|---|---|
| SE | 2.149,8 | 1.520,1 | 1.532,4 |
| FN | 1.789,0 | 1.393,0 | 1.405,8 |
| MN | 1.015,8 | 1.027,6 | 1.074,8 |

*Fuente:* elaboración propia.

*Cuadro nº 7.* **COSTES PROMEDIOS PARA LA COMUNIDAD PARA LAS DIFERENTES COMBINACIONES DE VALORACIÓN DE LOS EXCEDENTES DE ENERGÍA Y HORARIO DE APARCAMIENTO PARA DEMANDA DIARIA DE LOS VEHÍCULOS DE 5 kWh Y 20 kWh (€)**

| Demanda | 5 | | | 20 | | |
|---|---|---|---|---|---|---|
| Aparca \ Excedente | Mañana | Tarde | Noche | Mañana | Tarde | Noche |
| SE | 1.193,5 | 846,7 | 784,4 | 3.368,7 | 2.548,8 | 2.630,2 |
| FN | 831,2 | 623,1 | 580,1 | 3.008,3 | 2.479,0 | 2.549,2 |
| MN | 38,5 | 48,5 | 74,8 | 2.251,5 | 2.267,0 | 2.338,0 |

*Fuente:* elaboración propia.

La interacción entre la política de valoración de excedentes y la política de interacción de los vehículos eléctricos con el edificio también subraya la importancia del almacenamiento. Se aprecia que el impacto de disponer de V2B es mayor para la política sin excedentes que para la política de factura neta. Esto se debe a que el V2B permite valorizar los excedentes de generación en la propia demanda de la casa, lo que genera un beneficio mayor que al verterse directamente en la red. Cuando el valor de los excedentes es alto (caso de la medida neta), el valor de la disponibilidad del vehículo pasa a residir en revender la energía de la red, cargando el vehículo en momentos de precios bajos y devolviendo energía a la red durante episodios de precios altos.

*Cuadro nº 8.* **COSTES PROMEDIOS PARA LA COMUNIDAD PARA LAS DIFERENTES COMBINACIONES DE REGULACIÓN VEHÍCULO-EDIFICIO Y VALORACIÓN DE LOS EXCEDENTES DE ENERGÍA (€)**

| Excedente\ Política VE | SE | FN | MN |
|---|---|---|---|
| V1B | 1.795,6 | 1.570,3 | 1.057,2 |
| V2B | 1.672,6 | 1.488,2 | 1.021,6 |

*Fuente:* elaboración propia.

Finalmente, en este estudio vuelve a verse la misma relación entre la política de valoración de los excedentes de energía y la política de reparto de la generación fotovoltaica que ya apareció en Alvaro-Hermana *et al.* (2019). La medida neta no solo ofrece un ahorro muy importante (el coste de la medida neta es un 42 % inferior que el coste sin excedentes cuando hay un reparto fijo de la generación fotovoltaica [Indiv]), sino que anula por completo las políticas de reparto de la generación fotovoltaica, al no promover una mayor ratio de autoabastecimiento por parte de los usuarios.

*Cuadro nº 9.* **COSTES PROMEDIOS PARA LA COMUNIDAD PARA LAS DIFERENTES COMBINACIONES DE REPARTO DE GENERACIÓN Y VALORACIÓN DE LOS EXCEDENTES DE ENERGÍA (€)**

| Excedente \ Reparto FV | SE | FN | MN |
|---|---|---|---|
| Indiv | 1.782,6 | 1.562,4 | 1.039,4 |
| Eq_mes | 1.710,9 | 1.513,3 | 1.039,4 |
| Libre | 1.708,8 | 1.512,1 | 1.039,4 |

*Fuente:* elaboración propia.

Analizando los resultados por política aplicada, se observa que el impacto de pasar de una política de factura neta a una política sin excedentes se aminora con una regulación del V2B frente al V1B, donde impacta menos este cambio de valoración de los excedentes. Este hecho muestra el gran potencial que tiene aplicar políticas que favorezcan el autoabastecimiento, y que para ello debe abrirse el sistema eléctrico a facilitar el uso del vehículo eléctrico como parte activa de la demanda.

*Cuadro nº 10.* **COSTES PROMEDIOS PARA LA COMUNIDAD PARA LAS DIFERENTES COMBINACIONES DE REPARTO DE GENERACIÓN, VALORACIÓN DE LOS EXCEDENTES DE ENERGÍA Y REGULACIÓN VEHÍCULO-EDIFICIO** (€)

| Política VE | V1B | | | V2B | | |
|---|---|---|---|---|---|---|
| Excedente \ Reparto FV | SE | FN | MN | SE | FN | MN |
| Indiv | 1.848,0 | 1.605,8 | 1.057,2 | 1.717,3 | 1.518,9 | 1.021,6 |
| Eq_sem | 1.769,5 | 1.552,6 | 1.057,2 | 1.652,3 | 1.474,0 | 1.021,6 |
| Libre | 1.769,2 | 1.552,5 | 1.057,2 | 1.648,4 | 1.471,8 | 1.021,6 |

*Fuente:* elaboración propia.

## 6. CONCLUSIONES

La política de valoración de los excedentes es el factor que mayor importancia tiene en el coste energético que perciben los usuarios de las comunidades energéticas en las condiciones estudiadas. Aunque hay un impacto importante entre las políticas sin excedentes de energía y de factura neta, es al aplicar la medida neta donde su influencia es máxima. Esto se debe a que deja de ser necesario alinear la producción fotovoltaica con el vehículo eléctrico, bien como carga gestionable en el caso de V1B, bien como almacenamiento de energía en el V2B. Esto da una flexibilidad muy importante al sistema, que unido a la mayor remuneración de los excedentes, supone el impacto más destacado de entre los factores estudiados, siendo el único factor con el que se llega a obtener precios próximos a cero aprovechando las diferencias horarias en los precios de la red.

El impacto en el precio del resto de factores analizados también depende de la flexibilidad que proporcionan a la comunidad. La mayor demanda, junto con una potencia de recarga limitada por tratarse de una carga lenta, contribuye a que el vehículo tenga que dedicar más tiempo a cubrir la necesidad de movilidad del usuario y menos a reducir el coste de su energía (aun cuando se disponga de más generación fotovoltaica para cubrir, en su suma anual, la mayor demanda del vehículo). También la política de interacción de los vehículos eléctricos con el edificio tiene un impacto importante al pasar de V1B a V2B, si bien el V2B2 apenas reduce costes al haber considerado un horario idéntico para todos los consumidores. Es de esperar que, en un caso de funcionamiento real, donde además de una mayor diferencia de horarios diarios habría que considerar a aquellos conductores que realizan un uso ocasional del vehículo y los efectos del calendario (como las vacaciones, los festivos, etc.), este mecanismo contribuya a disminuir los costes del sistema.

El peso del reparto de la generación fotovoltaica está muy condicionado por la retribución de los excedentes. La medida neta deja sin efecto el reparto de la energía y da un mayor peso a la red eléctrica, mientras que la factura neta permite que el reparto pueda empezar a dar beneficios al sistema. Nuevamente, en el caso más realista donde los miembros de la comunidad tuvieran una mayor diversidad de horarios, sería de esperar que el reparto de la generación tuviera un impacto más destacable.

Finalmente, el horario de aparcamiento de los vehículos eléctricos no es un factor determinante en el coste total de la comunidad energética. Su influencia se correlaciona más con su interacción con el resto de factores que con el peso del precio de la red. Así, si la energía demandada es poca y el valor de los excedentes no es elevado, se puede conseguir una mayor tasa de autoabastecimiento (porcentaje de la generación que consume directamente el usuario) cuanto más tiempo están aparcados los vehículos coincidiendo con las horas de mayor generación fotovoltaica y, con ello, lograr un mayor ahorro. Por el contrario, si la demanda es alta y el valor dado a los excedentes es elevado, el autoabastecimiento se impulsa menos y se fomenta más la venta de energía al sistema.

En conclusión, aunque el coste de la energía en las comunidades energéticas se ve afectado por las características de uso del vehículo de la comunidad, las diferentes políticas que confluyen en las mismas, relativas a la generación fotovoltaica y los vehículos eléctricos, tienen un impacto mayor. Para evitar que estas tengan un impacto gravoso en el resto de agentes del sector eléctrico, debe optarse por aquellas que favorezcan un mayor autoabastecimiento por parte de la comunidad, como las medidas de reparto flexible de la generación fotovoltaica y la integración del vehículo en la gestión activa del edificio, tanto como carga flexible como almacenamiento reversible.

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# *Climate change, energy transition and carbon neutrality recommendations**



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## 1. INTRODUCTION

This policy letter will focus on how new climate change, clean energy and carbon neutrality policies may be conducive to economic growths in an industrial economy such as the Basque region. These will be based on relevant global experience, especially the latest policy recommendations to the G20 Global Leaders. We have adapted these to offer some key policy recommendations for the Basque government which should support them developing relevant new policies on meeting their international commitment to achieve carbon neutrality by 2050 or earlier.

## 2. CLIMATE CHANGE GLOBAL ISSUES

Climate change, energy transition, carbon neutrality, climate-resilient infrastructure and water are among the most pressing global issues with drastic impacts worldwide. Climate studies and scientific data have indicated that these climate risks will continuously increase in the foreseeable future. Their impacts will grow in a non-linear manner with disastrous impacts globally. Coping with climate risks and achieving carbon neutrality will require countries committing to new mitigating actions plus providing predictable and effective policy frameworks.

Carbon neutrality should be accelerated and achieved by countries globally in the second half of the century and preferably by 2050. This is in line with the Paris Agreement goal of «holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature

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increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change».

To mitigate further climate change and global warming consequences, governments worldwide should formulate new policies to advance, scale and deploy low carbon technologies, energy efficient processes. They should promote innovations, especially on clean energies and carbon recycling, so as to facilitate their transformation into low emission and carbon neutral economies soon.

Carbon neutrality and sustained economic growths can only be accomplished if many multiple policy levers are activated jointly by governments and societies worldwide. In addition to promoting technology and innovations, governments globally must also make use of new effective enabling policy frameworks, including carbon pricing or taxes plus the elimination of inefficient fossil fuel subsidies, for a just climate transition which will combine environmental sustainability with creating a more equal and inclusive economy.

Infrastructures globally are critical for economic activities and extremely vulnerable to the impacts of climate change. Major climate events in recent years have destroyed critical infrastructures such as roads, bridges, power networks, and human dwellings. In a time of rapid climate change and intensifying natural hazards, infrastructure systems are under pressure to deliver resilient and reliable services. Therefore, there are high needs for various governments and business communities to improve the climate resilience of infrastructures globally via better building design standards, risk assessments and financing vehicles. These are key enablers for climate change control, economic development and improving the quality of life for people globally.

Water is at the source of life but also key for economic activity. The protection of freshwater systems and the ocean globally are critical to ensure human well-being, economic growth and biodiversity. Globally, growing water demands and climate change have seriously affected water supplies and have resulted in water scarcity. Similarly, the ocean is at great risk due to rising temperatures, vast amounts of marine litter and pollution, overfishing, and unsustainable urban development of coastal regions. All countries should put in place new policies that safeguard their freshwater systems and the ocean via national and international regulations and governance mechanisms.

The global COVID-19 pandemic has served as a serious wake-up call plus a strong reminder of the urgency and importance of these new climate and carbon neutrality policies and actions. In the post-COVID-19 economy, promoting alternative low carbon technologies and carbon neutrality will be sound economic strategies. These are expected to boost the number of new jobs created by the green energy and finance sectors whilst reducing carbon emissions. In essence, we must strive to leverage COVID-19 recovery to build back better, improve resilience, promote the green agenda and improve global sustainability.

## 3. BASQUE ECONOMY, CLIMATE & CARBON OUTLOOKS

The Basque region is Spain's fifth largest regional economy, with a gross domestic product GDP accounting for around 7 percent of the total national GDP of Spain. The region's exports are more or less evenly balanced between the rest of Spain and markets beyond Spanish borders. It also has the lowest unemployment rates in Spain.

The Basque region is one of the most important industrial regions in Spain. The Basque Country's economy has been strongly manufacturing-based since the beginning of the 20th century. Manufacturing is accounting for over 25% of total GDP of the region. The industrial production is diverse. All of the activities derived from metal, including the production of steel and machine-tools, are very important for the local economy. However, other sectors such as the chemical and petrochemical sectors and refineries are also noteworthy, accounting for a very significant part of the region's GDP. The strongest industrial sectors of the Basque economy are machinery, aeronautics and energy. New technologies plus research and development (R&D) initiatives are becoming very relevant, and the same applies to technology parks. Basque companies are manufacturing a wide variety of capital goods, durable goods and other intermediate products for domestic consumptions and exports.

The Basque Government has declared their strong commitments to Climate Change, reducing carbon emissions and developing new Net Zero Carbon Pathways. They have entered into the global Climate Ambition Alliance. This is an international network bringing together regions, cities and companies from around the world that are committed to fighting climate change. The alliance brings together the countries, regions and cities that are working toward achieving net-zero CO2 emissions by 2050 or earlier, in line with the Paris Agreement. The Basque Country has joined the global network of 65 countries, 10 regions, 102 cities, 93 companies and 12 investors that have already joined the global Climate Ambition Alliance.

The Basque Government has also taken part in the meeting of the Steering Committee of the Under2 Coalition, of which Basque has been a member since the coalition was founded. The Under2 Coalition is a global community of state and regional governments committed to ambitious climate actions in line with the Paris Agreement. It brings together more than 220 governments representing over 1.3 billion people and 43% of the global economy. Its members are committed to keeping global temperature rises to under 2ºC and to increasing their efforts to reach 1.5ºC, along with achieving net-zero greenhouse emissions by 2050.

Basque Government has also declared publicly their commitment to tackling the climate crisis. They have announced that they are establishing a legislative framework to set carbon neutral targets for 2050 or earlier. Basque government has been working on its own climate change strategy, KLIMA2050 since 2015. Furthermore, external auditors of the UN IPCC panel of experts had been in the Basque region to assess the Basque greenhouse gas emissions inventory. This is an audit that the Basque Country has undertaken voluntarily.



## 4. POLICY RECOMMENDATIONS

Looking ahead, the Basque government and companies will have to develop their new Climate Change and Net Zero Pathways so as to meet their carbon neutrality target by 2050 or earlier. Global experience has showed that these new climate change, clean energy and carbon neutrality policies will also promote social and economic growths in an industrial economy such as the Basque region. Relevant policy recommendations will be given based on latest global research and developments. In particular it will include our recent work with the G20/B20 Global Advisory Taskforce plus our latest policy recommendations to the G20 Global Leaders and the B20 International CEOs. Relevant conclusions from the author's recent books titled «Climate Change and Clean Energy Management: Challenges and Growth Strategies» and «Renewable Energy Management in Emerging Economies» will also be incorporated. We have adapted these to offer relevant new policy recommendations for the Basque Government plus key actors in the Basque industrial sector and Basque innovation eco-system. We hope that these will support high level policy formulation and developments. The key policy recommendations are summarised below:

Energy transition and clean energy growth will be critical to ensure the success of the new energy and climate policies. It is important for Basque government to commit to firm policies and actions on accelerating the Basque region energy transition away from fossil fuels and moving towards carbon neutrality. The government should provide predictable, effective policy frameworks to achieve carbon neutrality. Sustainability is key and it is most apparent in the sustainable use of energy, local resources, environment, freshwater systems and the ocean. Climate, and the anthropogenic changes to it, calls for strong mitigation actions but it also requires us to strengthen climate resilient infrastructures and services.

The Basque government and companies should all now commit to achieving carbon neutrality by 2050 or preferably earlier, as they have announced previously. They have to accelerate new policy formulation and implementation towards this important goal. This is in line with the Paris Agreement goal of «holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. This should significantly reduce the climate risks and the global warming impacts to the region. If no actions are taken then global temperatures could rise by 4°C by 2100 which could then result in 30-40% destruction of the local and global GDPs which will have disastrous consequences.



New policies on promoting the new circular carbon economy (CCE) will be important. These should revolve around optimising various closed-loop regional systems and will be vital to achieve the Paris Agreement goals. CCE policies will encourage efforts to reduce carbon accumulation in the atmosphere through the «4Rs». These include: Reduce the amount of carbon entering the economy; Reuse carbon without chemical conversion; Recycle carbon with chemical conversion; and Remove excess carbon from the atmosphere. Likewise, Carbon-mitigating technology and energy efficient processes are critical to achieving the balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases.

Basque government and companies should promote and deploy suitable low carbon technologies and energy efficient processes. They should promote innovation, especially on carbon recycling, so as to transform it's economy into a new low emission carbon neutral economy soon. New policies should be introduced to create an enabling environment for the deployment of relevant low carbon technologies. New low carbon technologies should be advanced via effective public policy supports, including supports for research and development plus international collaborations.

Global experiences have shown that new policies to promote various natural based solutions and circular economy concepts should have additional environmental, economic and social benefits. It is recognised that the Basque region and companies may have different requirements and timelines to achieving carbon neutrality based on their national or local circumstances. Hence it is recommended that the Basque government, inline with other countries globally, should develop new plans and policies to support innovative carbon technologies and carbon pricing. These will include Carbon Capture Utilization and Storage CCUS plus other energy efficiency processes together with a Carbon Emission Trading System (CETS) inline with international standards. The various new low carbon technologies together with a modern carbon emission trading system CETS should be central pillars of the Basque environmental masterplan and carbon neutrality roadmap to make good their commitments on the Paris Agreement. It is appreciated that different regions and companies will have to take into account differing local and individual requirements, maturity levels and sector relevance on developing their own specific local policies and action plans. Hence it is very important that the Basque government should coordinate and drive all these new policies and actions so as to enable the Basque region to achieve their international commitment to achieve carbon neutrality by 2050 or earlier.

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# *Setting a higher carbon price in the EU*[*]

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With the adoption of the *Green Deal,* the European Union (EU) is flagging ambitious targets for Green House Gas (GHG) emission reduction: 55% by 2030, and carbon neutrality by 2050. A growing number of scientific reports, from the Intergovernmental Panel on Climate Change (IPCC) and numerous other sources, point to the accelerating pace of anthropogenic climate change (Carbon Brief, 2020) and its devastating consequences on human health and well-being (Watts *et al.*, 2020), on biodiversity, etc. On December 3, 2020, the European Court of Human Rights has solemnly summoned 33 European states to demonstrate that they are effectively acting to fulfill the commitments taken in Paris in December 2015. And in spite of the fact that these commitments don't add up to a reduction sufficient to keep global warming below 2°C by the end of the century, the latest *Emissions Gap Report* (UNEP, 2020) clearly shows that the world is globally not on track to fulfill them (Carbon Brief, 2020).

### *Insufficient efforts so far*

The EU is, so far, but the next steps will require a serious effort: whereas EU total territorial emissions have been reduced by 23% since 1990, and probably more with the sanitary crisis and its economic consequences, in some sectors (especially transport) emissions are still rising; and consumption emissions –which include carbon emitted abroad to produce and transport imports, less carbon emitted to produce exports– have been reduced much less (UNEP, 2020), pointing to a major flaw in the current European climate policy.

Along with emission standards on light vehicles and some eco-conditionality on EU budget expenditures as well as, more recently, on loans from the European In-

* Spanish version available at https:/euskadi.eus/ekonomiaz.

vestment Bank –renamed «Climate Bank»–, the main climate policy instrument at the EU level has been the imposition of emissions quotas to large GHG emitters (utilities, cement, heavy industry and waste treatment factories, essentially, accounting for about 11.000 plants in the EU and about 45% of total emissions), coupled with the Emissions Trading Scheme (EU ETS, or European Carbon Market), set up in January 2005 in application of the Kyoto Protocol (1997).

The rationale for this «cap-and-trade» system is to set an annual limit on total emissions from these plants via emissions quotas distributed to them, and let them trade these quotas on a market so that a carbon price emerges. Of course, the market price of carbon thus entirely depends on supply and demand of emission permits, so that setting the cap right is crucial. With hindsight, it appears that the ETS has been ill-managed, so that over its 15 years of existence, the carbon price has, most of the time, been extremely low –less than 10 €/tCO2–, too low to effectively incentivize significant emissions abatement from the sectors submitted to the quota system. Although emissions have indeed subsided, the pace and magnitude of reduction are clearly not up to what is required in the next decade to reach the new targets.

In 2017, after years of negotiations in the Council and EU Parliament, the Commission has enacted a reform of the EU ETS that sets the annual pace of reduction of the cap at 2.2% starting in 2021, instead of 1.74% previously, and increases the amount of permits that may be set aside to stabilize the carbon price in cases of unexpected falls in emissions, such as the one currently observed since the beginning of the Covid crisis as a consequence of the deep economic recession. As a result, the carbon market price has recovered since the beginning of 2018 and is currently close to 30 €/tCO2.

### *Green Deal: a fresh start?*

With the enhanced ambitions set for emissions reduction by 2030, and the goal of carbon neutrality by 2050, the cap will have to further tightened, so that the carbon price reaches higher levels –many analysts considering that it should be set between 33 and 66 €/tCO2 in 2020 and reach between 41 and 82 €/tCO2 by 2030 (Stern and Stiglitz, eds., 2017). It probably also will be necessary to submit more GHG emitters to the ETS, or alternatively to strengthen carbon taxation in the EU member states, so that the carbon price is effectively raised for all, or most emitters. And recent economic analyses (in particular, Saussay, *et al.*, 2018, Stiglitz, 2019, and Hepburn, Stern, and Stiglitz, eds., 2020) suggest that pricing instruments will not suffice and that the new ETS price stabilization mechanism may not work as expected.

Notwithstanding the political and social obstacles in the way of such a bold move, setting a higher carbon price in the EU may generate a competitiveness problem if the rest of the world is not following suit. Indeed in the past, the mere existence of a positive carbon price in the EU, in a context where many other areas of the world had not introduced carbon pricing, has fueled the fear of possible «carbon leakages», i.e. competitiveness effects that may trigger decisions by firms to relocate in countries with no carbon emissions restrictions. Although there is little if any empirical evidence so far of such effects (Verde, 2018), the growing discrepancy between the EU territorial emissions and «carbon footprint» (consumption emissions, i.e. emissions attributable to the production and transport of all what is consumed in the EU, see UNEP, 2020) constitutes indirect evidence that a fraction of EU consumption-related emissions has been shifted abroad, so that the reduction in global emissions has been less than EU emission reduction.

In order to remedy this carbon price gap between the EU and other regions of the world, it may prove necessary to introduce of carbon border levy on imports from those countries/regions that do not price carbon or price it much less than in the EU. This new instrument is now recommended for adoption by the EU Commission in the framework of the *Green Deal* (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12228-EU-Green-Deal-carbon-border-adjustment-mechanism-), the objective being to submit a new directive in the second quarter of 2021; in November 2020, the EU Parliament has expressed its support. This EU carbon border levy would also serve as a new own resource for the European budget, a welcome addition to service the newly created EU debt. But of course, such a project raises much opposition, both within and outside the EU, and it remains to be seen whether it will be adopted.

So far, progress in pricing carbon has been slow almost everywhere, and among the 70 countries participating in the UN Summit meeting held in London on December 12, 2020 on the 5$^{th}$ anniversary of the Paris Agreement, only Canada announced a target price for carbon: 170 $/tCO2 by 2030.

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# *Mozkin asmoagatik ez bada, zein da ba asmoa? Ekintzailetza sozial kooperatibora-ko adierazle sistema baten proposamena*

## *If not for profit for what? Proposal of a system of indicators for cooperative social entrepreneurship*

**Lan honetan ekintzailetza sozial kooperatiboaren asmo soziala elikatu eta gidatzen lagundu dezakeen adierazle sistema baten proposamena aurkezten da. Batetik, adierazle sistema eta ekintzailetza sozial kooperatiboaren elementuekin analisia burutzen da, hauen motibazio eta indarrei erreparatu nahi baitie, ekintzailetzaren «jokabideen teorian» ikerketa ildoan (behavioral theory) beste aletxo bat jarriz. Proposamen hau bestetik, Ekintzailetza Sozialaren eta Ekonomia Sozial Eraldatzailearen (ESE) teoriari, eduki eraldatzaile konkretuagoak eranstera dator. Proposamena Koopfabrika deritzon ekonomia sozial eraldatzailea eta ekintzailetza kooperatiboa sustatzeko programaren dinamizazioan diharduen Olatukoop sareko kooperatibetako kideekin elkarlanean burutu da. Ikerketa Ekintza Partehartzaileen ikuspegi metodologikora gerturatu nahian, adierazle sistema hau modu kolektiboan eta balioztatze dinamika ezberdinen bitartez eraiki da. Modu honetara, ESEaren paradigmari zenbait inplikazio praktiko eta teoriko egiteko aukera sortu da, ekonomia egiteko bestelako errealitateak egikaritzeko.**

*En este trabajo se presenta la propuesta de un sistema de indicadores que ayuden a alimentar y guiar la voluntad social del emprendimiento social cooperativo. Por un lado, se lleva a cabo un análisis del sistema de indicadores y de los elementos del emprendimiento social cooperativo que pretende atender a las motivaciones y fortalezas de estos, aportando un nuevo grano de arena en la línea de investigación de la «teoría de la conducta» (behavioral theory) del emprendimiento. Esta propuesta, por otra parte, incorpora contenidos transformadores más concretos a la teoría del Emprendimiento Social y la Economía Social Transformadora (EST). La propuesta se ha llevado a cabo en colaboración con los miembros de la red de cooperativas de OlatuKoop, dedicada a la dinamización del programa de promoción de la economía social transformadora y del emprendimiento cooperativo, KoopFabrika. Con el fin de acercarnos al enfoque metodológico de la Investigación Acción Participativa, este sistema de indicadores se ha elaborado de forma colectiva y mediante diferentes dinámicas de valoración. De esta forma, se ha generado la posibilidad de realizar determinadas implicaciones prácticas y teóricas al paradigma de la EST, para ejecutar otras realidades de hacer economía.*

This paper proposes a system of indicators that can help guide the social objective of cooperative social enterprises and to make its contribution to its transformative dimension. First, the focus is put on the motivations and forces that could underlie, contributing to the research of the «behavioral theory» in social entrepreneurship. Second, concrete elements of transformation are incorporated into the theory of Social Entrepreneurship and Transformative Social Economy (TSE). The proposal was developed in collaboration with members of the Olatukoop cooperative network involved in the revitalization of the Koopfabrika program, which seeks to promote social economy and cooperative entrepreneurship. In order to bring the study closer to the methodological approach of Participatory Action Research, we collectively built the system of indicators, with proposal and validation dynamics. In this way a series of practical and theoretical implications are created on the paradigm of TSE to execute other realities of making economy.

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## *Aurkibidea*



**Hitz gakoak:** ekintzailetza soziala, ekonomia sozial eraldatzailea, adierazle sistema.

**Palabras clave:** emprendimiento social, economía social transformadora, sistema de indicadores.

**Keywords:** social entrepreneurship, transformative social economy, system of indicators.

**JEL sailkapena:** J54, L26.

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* Egileok eskerrak eman nahi dizkiegu ebaluatzaile anonimoei, haien iruzkinek artikuluaren bertsioak nabarmen hobetzen lagundu baitute. Eskerrak ere eman nahi dizkizuegu adierazle sistemaren proposamen hau eraikitzen lan egin eta parte hartu duzuen erakunde eta pertsona guztiei, ezagutzaren eraikuntza kolektiboko prozesu honetan elkarrekin aritzeak guri bederen eskaini digun ikasbide eta ahalduntze aukeragatik. Eskerrik asko danoi!

## 1. SARRERA

Jarraian aurkezten den lanean ekintzailetza sozial kooperatiboen asmo soziala gidatzen lagun dezakeen adierazle sistema baten proposamena egiten da. Adierazle sistema bera ekintzailetza sozial kooperatiboa ulertzeko eta praktikatzeko modu batetik eraikia izan da, beraz, ekintzailetza sozial kooperatiboaren dimentsio soziala elikatu eta gidatzeaz gain bere horretan oinarri ere bada. Oinarri eta ipar izateko tresna izan daiteke proposatzen den adierazle sistema.

Ikerketa galderari dagokionez, erdigunean jarri den ekintzailetza sozial kooperatiboaren adierazle sistemarekin zuzen lotzen da: Ekintzailetza sozial kooperatiboek zein elementu izan behar dituzte ekonomia sozial eraldatzailearen baitan? Zeintzuk lirateke orduan mota honetako ekintzailetzak martxan jartzeko pizgarri suertatzen diren motibazio iturriak? Aurkezturiko proposamenaren helburu nagusia, beraz, ekintzailetza mota horien protagonisten artean aurki genitzakeen motibazioen eta helduleku teorikoen karakterizazioa burutzeko lehen hurbilketa bat egitea da.

Proposaturiko adierazle sistemak, modu honetan, motibazio horiek identifikatu, helburuen arabera antolatu, eta horiek neurgarri egiteko irizpide eta adierazle sorta bat eskaintzea du xede. Era berean, adierazle sistema honek bere aplikagarritasun praktikoaz harago, maila teorikoan ekonomia sozialaren eta ekintzailetza sozialaren ingurumarian agertzen diren eztabaida teorikoetan ere ekarpena egitea bilatzen du. Zentzu horretan eta artikulu honetako laugarren puntuan jasotzen da eztabaida horretan adierazle sistemak egiten duen ekarpen teorikoa, Ekonomia Sozial Eraldatzailea ulertzeko eta praktikatu ahal izateko oinarriak eta aldi berean iparra zehaztuz.

Hurbilketa teorikoari dagokionez, helburu horiek erdietsi nahian, adierazle sistemaren hurbilketa teorikoa hiru erpinetatik bideratu nahi izan da: ekintzailetza sozialen «jokabideen teoria» ildoan sakondu da lehenik Youngen ekarpenetan sakonduz (Young, 1983 eta 2013); ekonomia soziala, ekonomia solidarioa eta ekonomia sozial eraldatzailea proposamenek mahai gaineraturiko eztabaida teorikoen testuinguruan kokatu da, paradigma horien bilakaera xehetuz; eta azkenik, tresna honen ekarpen metodologikoaren inguruan ere zenbait zehaztapen egin nahi izan dira, proposaturiko tresna ekintzailetzen emaitza sozialen ebaluazioa egiteko baino, erakundeetan barne eraldaketa prozesuak sustatzeko helduleku gisa sortua izan baita.

Laburbilduz, gizarte ekintzaileentzat ekonomia sozial eraldatzailearen paradigmak finkatzen dituen helburuetara hurreratzeko iparrorratz bat eskaintzeko helburuz proposatzen da jarraian aurkezten den adierazle sistema. Bere aplikagarritasun praktikoari begira, ekintzailetza horien barne prozesu eraldatzaileak zein gizartearekiko eta inguruarekiko elkarlanean dimentsio eraldatzailedun prozesuak dinamizatzeko baliabide gisa pentsatua izan da.

Proposamena eraikitzeko metodologia, Koopfabrika ekintzailetza sozial kooperatiboak sustatzeko programaren dinamizazioan diharduen Olatukoop sareko kooperatibetako kideekin elkarlanean burutu da. Horretarako, Ikerketa Ekintza Partehartzaile ikuspegi metodologikora gerturatu gara, adierazle sistema hau kooperatibistekin modu kolektiboan eraiki da, proposamen eta balioztatze dinamika ezberdinen bitartez.

Erreferentzia metodologikotzat izan da Jara (2012). Izan ere, autore honek ebaluazioa ez du emaitzen neurketa huts moduan soilik ulertzen. Ebaluazioaren prozesuak berak beste prozesu batzuk aktibatu eta barnebiltzen ditu: Ekintza hezitzaile bat da ebaluazioan parte hartzaileentzat eta era berean, hobetzeko lerro proposamenak eginez amaitzen da praktika konkretuak zehaztuz hobetu ahal izateko.

Beraz, ekarpen honekin, maila praktikoan, ekintzailetza sozialen barne eraldaketa prozesuak gidatzeko tresna bat eskaintzen da; maila teorikoan, ekonomia sozial eraldatzailea zehatzago definitzen laguntzen duten helburu eta irizpideen proposamen xehatuagoa burutzen.

## 2. EKINTZAILETZA SOZIAL KOOPERATIBOAREN ETA ADIERAZLE SISTEMAREN EZAUGARRITZE TEORIKOAK

### 2.1. Ekintzailetza sozialaren «jokabide teoriarik» ba al da ekintzailetza sozial kooperatiboarentzako?

2013. urtean EMES Network erakundeak, enpresa sozialen azterketan espezializaturiko nazioarteko ikerketa sareak, Liejan antolaturiko 4. Nazioarteko Konferentziak esaera hauxe hartu zuen goiburutzat: *If not for profit, for what? And how?* (Mozkin asmoagatik ez bada, zertarako? Eta nola?). Modu honetan, 30 urte lehenago Dennis Young (1983) ikerlariak argitaraturiko obra seminalaren berreskuratze deliberatuaren bitartez, abiapuntu hartako galderaren egokitasuna berresteaz gain, bigarren galdera batekin osatu zen lehena: eta nola?

Dennis Youngen (1983) lehen ekarpen hark, mozkin asmorik gabeko erakundeen teorizazio ekonomikoaren esparruan bide berri bat zabaldu zuen, eskaintzaren ikuspegia jorratu zuen lehen ekarpena izan baitzen. Ordura arteko lehen saio teorikoek, mozkin asmorik gabeko erakundeen aldeko hautua egiten zuten kontsumitzaileen arrazoibideetan arakatu zuten, halako moduz ze ikerketa galdera nagusiak formulazio honetan hartzen baitzuten oinarri: kontsumitzaileek zergatik jotzen dute mozkin asmorik gabeko erakundeetara beren beharrizanak modu arrazionalean asetzeko? (Etxezarreta eta Pérez de Mendiguren, 2018). Galdera horri erantzuten saiatu ziren hirugarren sektoreari buruzko teoria neoklasikoaren lehen ekarpenak, Weisbord-en (1975) estatuko akatsen teoria, Hansman-en (1980) kontratu akatsen teoria, Salamon-en (1987) boluntario akatsen teoria, etab.

Young-en (1983) ekarpenak bide berri bat ireki zuen, bestelako begiratua proposatzen baitzuen: ekintzaile batek hirugarren sektoreko erakunde bat abian jartzeko zein indar eta motibazio izan ote zitzakeen galdetuz heldu zion gaiari, lehen aldiz, «eskaintzaren ikuspegiko» (*supply side*) ikerlerroa zabalduz. *If not for profit for what?* galdera itxuraz tolesgabe xamarra formulatuz, mozkin asmorik gabeko erakundeen «Jokabide Teoria» (*Behavioral Theory*) bat osatzeko oinarri batzuk finkatu zituen lehen aldiz.

Gaurtik begiratuta, lan horri «ekintzailetza sozialaren» aurkikuntza egin izana aitortzen zaio aditu ezberdinen aldetik (Bacq eta Jansenn, 2011; Dees eta Anderson, 2006; Spear, 2006). Formulaturiko galderak eta emaniko lehen erantzun saioek, beraz, egun ekintzailetza sozialaren korpus teorikoaren abiapuntua okupatzen dute oraindik orain (Dees, 2013; Defourny eta Nyssens, 2010).

Young-en hastapeneko galderak ez du gaurkotasun izpirik galdu. Galderari, ordea, ez zaio eredu ekonomiko bakar batekin erantzuten, Young-ek orduko aurreratzen zuen gisan (2013:XIII): «*we may never have a simple economic model of a non-profit organization*»[1]. Lehen lan hartan aurreratu zuen erantzuna, mozkin asmorik gabeko erakundeen artean beha zitekeen aniztasun handiaz jabeturik, ekintzailetza mota ezberdinen kategorizazio saio bat egiten saiatu baitzen, estilo eta estereotipo ezberdinak zenbait aldagai azaltzailerekin gurutzatuz (emandako zerbitzuaren izaera, profesionalizazio maila, industria kontzentrazio maila, lehentasun sozialen izaera) (Frumkin, 2013). Estilo estereotipikoak faktore baldintzatzaileekin gurutzatuz teoria bateratu eta oro azaltzaile (*comprehensive*) bat eraiki asmo izan zuen, nahiz eta ekintzailetza bakoitzak bere preferentziekin egokien doitzen den «antolakuntza gida» (*organizational vehicles*) hartzen zuela ondorioztatu zuen (Young, 2013).

Aniztasunaren aitortza horrek, aldiz, bete betean talka egiten du teoria mikroekonomiko klasiko osoaren premisa fundazionalarekin: mozkin asmodun erakundeen helburu nagusia (bakarra ez denean) mozkinen maximizazioa bada, aldagai horrek azaldu behar luke beste ezerk baino zehatzago bere jokabidearen nolakoa. Eskola neoklasikoaren arrakastaren (eta gaitasun azaltzaile apalaren) azalpenetako bat etor liteke bere sinplifikatze gaitasunetik. Jokabide teoria horrek, ordea, ezin azal dezake mozkin asmodun enpresa guztien helburu eta jokabidea. Begiratu mugatu horren ertzetan geratuko dira, ziur aski, egungo kapital enpresa txiki eta ertain gehien gehienak, eta baita, nola ez, bestelako asmoekin sorturiko enpresak ere.

Young-ek bere liburu seminalaren 2013ko berrargitalpenean (Young, 2013) aitortzen du, berak hasieran formulaturiko zenbait hipotesik sakoneko berrikusketa eskatzen dutela egun. Horien artean hiru azpimarratuko genituzke, lan honen bitartez aurkezten den proposamenaren muinean aurkitzen baitira hiruok: bata, ekintzailetza soziala fenomeno indibidual gisa ulertzea okerrekoa dela dio, lidergo sendoko ekintzaile «heroikoa»ren mitotik oso urrun aurkitzen direla ekintzailetza sozial gehienak. Hain zuzen ere, talde lanean edo zentzu kolektiboan aurkitzen baitute motibazio iturri nagusienetako bat (de Bruin *et al.*, 2015). Bi, ekintzailetza sozialak hirugarren sektoreari loturiko logika hertsian kokatzeak, enpresa publiko eta pribatuen logiketatik kanpo, gaur egun zentzu handirik ez duela dio, geroz eta hibridazio maila handiagoak sumatzen baitira erakunde berrien artean, logika publiko, sozial eta enpresarialak bat egiten dutelarik horien jardute moduetan. Eta, hiru, ekintzailetza sozialen hazkunde estrategiek federazioaren, elkarlanaren, saretzearen logikei eusten dietela gehituko du azkenik, lehian oinarrituriko estrategiari bainoago.

[1] Ez dugu inoiz mozkin asmorik gabeko eredu ekonomiko sinplerik izango (egileen itzulpena).

Hiru elementu giltzarri horiek agertuko dira aurrerago aurkeztuko den emaitzan, baina ez dezagun pausu hori aurreratu, aurreragokoak diren zenbait galderari heldu baino lehen: mozkin asmoagatik ez bada, zertarako sortzen dira ba ekintzailetza sozialak? Zein dute ba beren asmo nagusia? Mozkin asmoari kontrajartzen zaion adiera nagusia da helburu sozialaren lehentasunarena, baina helburu sozialarekin zer ulertzen da? Denok ulertzen al dugu gauza bera?

## 2.2. Ekonomia sozialaren paradigmatik Ekonomia Sozial eraldatzailearen paradigmara

Mozkin asmoagatik ez bada helburu sozial batengatik izan bedi, beraz. Baina zein helburu sozial? Ba al da besteen gainetik gailentzen den helburu sozialik? Eta zein gizarte ereduren peskizan finkatzen da lehentasunezko helburu sozial hori? Galderak formulatze hutsak agerian uzten du lehen unetik afera hau ebatzita egotetik zein urrun dagoen. Helburu sozialak gizarte eraldaketa proiektu zabalagoei loturik baitoaz, eta horiek modu herabe edo ausartagoan proposatu baititzakete egungo sistemaren alternatibak: sistemak baztertzen dituen pertsona eta kolektiboak birgizarteratzetik sistema poskapitalista baterako oinarriak jartzera, gradazio maila oso ezberdinetako alternatibak eta helburu sozialak egon badirela ezin bistatik galdu, beraz.

Helburu sozial horiek finkatze aldera, ekintzailetza sozialen izaera eta elementu bereizgarriei buruz teorizatu izan duten kontzeptu ugari agertu dira literatura akademikoan azken hamarkadatan: mozkin asmorik gabeko erakundeak, hirugarren sektorea, sektore boluntarioa, ekonomia soziala, enpresa soziala, ekonomia solidarioa, eta ekonomia sozial eraldatzailea (ESE aurrerantzean), zerrenda honetan berriena. Lehenago aurkeztu izan dira kontzeptu horiek argitzen saiatuz zenbait lan (Perez de Mendiguren, Etxezarreta eta Guridi, 2009; Perez de Mendiguren eta Etxezarreta, 2015; Etxezarreta, Perez de Mendiguren eta Morandeira, 2014; Etxezarreta eta Perez de Mendiguren, 2018;) eta kasu honetan ESE deitzen den proposamenaren kokapen teorikoa ematera baina ez da mugatuko lan hau.

Ekonomia soziala, kontzeptu juridiko gisa, helburu soziala lehenesten duten enpresa mota ezberdinen multzo bat da. Honi loturiko figura juridikoek (kooperatibak, lan elkarteak, laneratze enpresak, enplegu zentro bereziak, fundazioak, elkarteak, mutualitateak) beren logika propioak izateaz gain, denen artean partekaturiko ezaugarri batzuk izan badituztela defendatzen da ekonomia sozialaren proposamenarekin.

Ugariak izan dira azken urteetan ekonomia soziala zedarritzeko helburuz garaturiko deklarazio instituzional, lege garapen eta ikerketa akademikoak (Chaves eta Monzón, 2018; Monzón, 2016). Erakunde horiek guztiek partekatzen dituzten ezaugarriak fintze aldera erreferentziazkoa izan liteke 2002an *Social Economy Europe* (Europako Ekonomia Soziala) Europar Batasunean kooperatibek, mutualitateek, fundazioek eta elkarteek duten ordezkaritza organo gorenak zerrendaturiko printzipio multzoa[2]. Horien artean lehenak bete betean heltzen dio gure eztabaidagaiari: pertsona eta helburu sozialen lehentasuna kapitalaren aurretik. Helburu sozial hori zertan egikaritzen den jarraian zehazturiko printzipio zerrendak itxuratzen du: borondatezko atxikipen librea, bazkideen kontrol demokratikoa, bazkide erabiltzaileen interesen eta interes orokorraren bateratzea, erantzukizun eta elkartasun printzipioen defentsa eta ezarpena, autonomia kudeaketan eta botere publikoekiko independentzia, eta mozkinen gehiengoa garapen iraunkorra, bazkideen zerbitzuen interesa eta interes orokorraren aldeko helburuetara bideratzea[3].

Ekonomia sozialaren proposamenak, beraz, helburu sozialaren hurbilketa propioa egiten du, nagusiki (ez soilik) erakundeen barne egituraketari loturiko funtzionamendu moldeei erreferentzia eginez (demokrazia, elkartasuna, autonomia,…) eta helburu sozial horien derrigorrezkotasun izaera azpimarratuz, enpresa horien gizarte helburuaren (*objeto social*) eginbeharretan txertaturik baitaude helburuok[4].

Baina Ekonomia sozialeko helburuen izaera dinamikoari jarraituz, eta helburu sozial horiei sakoneko berrikusketa bat eginez, azken bi hamarkadetan paradigmaren bilakaeran bi proposamen agertu dira: ekonomia solidarioarena lehenik, eta ekonomia sozial eraldatzailearena, ondoren.

### *2.2.1. **Ekonomia Solidarioaren bitartez Ekonomia Soziala berrikusten***

Ekonomia solidarioak ekonomia sozialaren proposamenarekin dituen lotura, bat etortze, haustura eta eztabaidez literatura zabala dago (Laville, 2015; Coraggio, 2016; Drapery, 2013; Levesque, 2003; Monzón eta Chávez, 2016; Pérez de Mendiguren *et al.*, 2009; Pérez de Mendiguren eta Etxezarreta, 2015). Laburbilduz, ekonomia solidarioak hiru dimentsio erantsiko dizkio ekonomia sozialaren proposamenari: lehenik, antolakuntza-ereduari dagokionez, ekonomia solidarioak irizpide juridikoa gainditzen duen prisma hobetsiko du, erakundeon izaera «hibridoan» jarriz arreta nagusia; bigarrenik, dimentsio politikoari loturik, ekonomia sozialaren funtzio politikoaren inguruko optika zabalduko du, gizarte-mailako eraldaketa prozesu zabalagoen baitan kokatuz; azkenik, dimentsio teorikoari lotuta, ekonomia solidarioak praktika berri horiek ekonomia sustantibo eta pluralaren interpretazio markoaren pean teorizatuko ditu (Wanderley *et al.*, 2016; Etxezarreta eta Pérez de Mendiguren, 2018).

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[2] http://www.socialeconomy.eu.org/

[3] http://www.socioeco.org/bdf_organisme-478_en.html

[4] Elementu honek bereizten du, ekonomia sozialaren proposamena Enpresaren Gizarte Erantzukizuna edo Enpresa Soziala bezalako adieretatik, lehenak helburu sozialen derrigorrezkotasuna ezartzen baitu barne estatutuen bitartez, besteek borondatezko helburu desiragarri gisa planteatzen dituzten bitartean.

Proposamen berri honen bitartez, ekonomia sozialaren helburu sozialean behar besteko arreta eskaini ez zaien bi aspektu nabarmentzen dira (Laville, 2015; Wanderley *et al.*, 2016): alde batetik erretorika eta praktika errealaren arteko amildegi geroz eta handiagoa, ekonomia sozialeko erakundeen praktika errealak, mota ezberdineko isomorfismo prozesuen bitartez, beren ingurunean hegemonikoak diren erakundeen jardute logiketara (publiko zein pribatu) hurbildu baititu, kasik azken horietaz ezin bereiztera eramanez; eta, bestalde, ekonomia sozialaren dimentsio politikoa albo batera utzia izan dela aipatzen da, bai erakundeen barne-mailan, bai eta ingurunearekiko konpromiso-mailan ere. Barne-mailan, demokrazia eta berdintasuna maila formal batean ziurtatuta izan arren, praktika errealean egikaritzeko mekanismoen eta kontrol neurrien gabezia edo indargabetzea azpimarratzen da. Kanpora begira, ekonomia sozialaren funtzio eraldatzailearen inguruko ikuspegi estrategiko propioaren gabezia da nabarmentzen dena.

Laburbilduz, hortaz, bi ideia gailentzen dira ekonomia solidarioak eginiko berrikusketan: helburu soziala betetzeko, ekonomia sozialeko erakundeek berezkoak zaizkien printzipioak operatibizatzeko borondate, estrategia eta tresna konkretuen gabezia sumatzen da, alde batetik; eta bestalde, gizarteari begira erakundeok planteatzen duten gizarte eraldaketa eredu argi baten gabezia ageri da, bestelako enpresa eredu ez kapitalistak sustatzeaz harago. Bi elementu horiek justifikatzen dute, hein handi batean, lan honetan aurkezten den adierazle sistema propio baten eraikuntzaren zergatia.

### *2.2.2.* ***Ekonomia Sozial Eraldatzailearen bitartez proposamen sozial eta solidarioak irauli***

Ekonomia Sozial Eraldatzailearen (ESE) proposamena, denboran berriagoa dena, ekonomia solidarioaren koordenada ideologiko gertukoetan kokatzen da, nahiz eta ñabardura batzuk antzematen diren praktika konkretu batzuen interpretazio politikoan eta baita sare horietako bakoitzak lehenetsitako ekintza lerroetan ere.

Nekez aurki liteke, gaur gaurkoz, ESEren inguruko teorizazio lanik (Villalba, Egia eta Perez de Mendiguren, 2019), alde batetik proposamena oso berria delako denboran, eta bestetik, gorpuzten eta forma propioa hartzen ari den praktika baten gainean eraikitzen ari delako. Nazioarte mailan gaur gaurkoz ekonomia sozial eta solidarioa (edo ekonomia sozial solidarioa) deiturarekin izendatzen dira erakundeen federazio, instituzio eta nazioarteko programa gehienak (Pérez de Mendiguren eta Etxezarreta, 2015). Hala ere, «eraldatzaile» terminoa geroz eta onarpen zabalagoa lortzen ari dela dirudi, bai Espainiar estatu mailan (Andaluzian[5], Euskal Herrian[6]

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[5] http://autonomiasur.org/wp/

[6] Terminologiari dagokionez, hainbat eragileen terminologi propioa izateaz gain, 2016an Bilbon REASek antolaturiko kongresuaren azken adierazpenean ere jasoa geratu zen berau https://www.economiasolidaria.org/noticias/declaracion-de-bilbao-por-una-economia-social-y-solidaria-transformadora.

zein Katalunian[7] nagusiki) sortzen ari diren sare eta proposamen berriei kasu eginez gero, eta baita nazioarteko mailan agertzen ari diren beste ekimen batzuengatik ere[8].

Paolillok argitzen duenez (2018), ESEren proposamena ekonomia sozial eta solidarioaren esparru zabalean kokatzen da, baina eraldaketa proposamenaren planteamendu zehatzago batekin. Honela, autore honek berak ezaugarri hauexek ezartzen ditu ESEren proposamenaren oinarrian: praktiketatik abiaturiko proposamen teorikoak dira, sistema kapitalista gainditu eta ordezkatzeko helburu argia dutenak, burujabetza ekonomikodun alternatiba komunitarioak eraikiz, lurralde mailako bestelako eragile ekonomiko eta sozialekin saretuz eta bestelako korronte kritiko eta eraldatzaileekin elkarrizketa eta lankidetza emankorra izanez.

Posizio hartze politiko propio honetan, ESE proposamenak eragin nahi luke bere irudiko eraldatzaileak ez diren ekonomia solidarioko zenbait praktiketan (hirugarren sektoreko logika asistentzialistak gainditu eta ahalduntze prozesuak sortuz), baina baita kooperatibismo tradizionalean ageri diren praktika ez eraldatzaileetan ere, nagusiki merkatu eskakizunei men eginez izpiritu kooperatiboa galdu duten esperientziak interpelatuz (Autonomia Sur, 2017).

Beste ezberdintasun bat suma liteke praktikan sare bakoitzaren agenda propioan ere, ESEren proposamenak ezarritako lehentasunezko ildo nagusiak hauexek baitira: ekintzailetza kooperatiboaren sustapena, memoria kooperatibo alternatiboa indartuko duen errelatoaren eraikuntza eta sarearen baitako erakundeen arteko interkooperazioan sakontzeko egitura mutualisten sorrera (Fernandez, 2019)[9]. Lehen lerro horri loturik agertzen da –behin bilakaera paradigmatikoa mahai gaineratuta– jarraian aurkezten den adierazle sistemaren planteamendua ere.

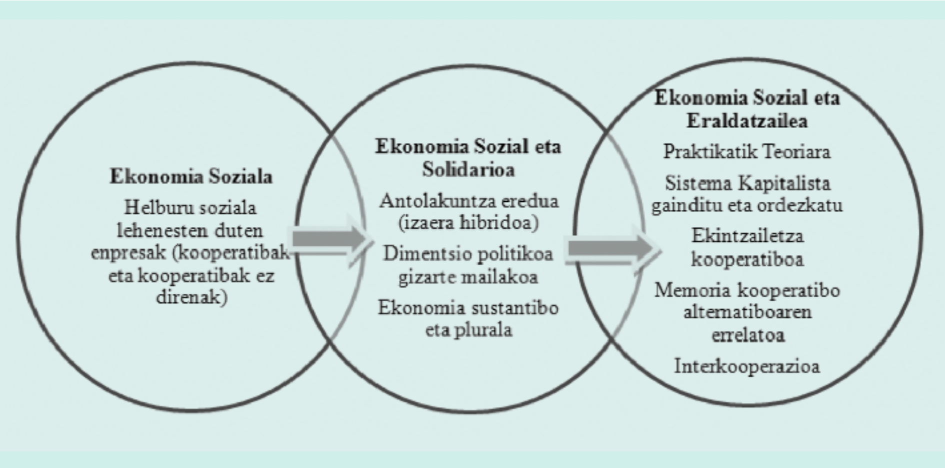
Atal honetan jorratutako hariari amaiera emateko  hurrengo irudiaren bitartez Ekonomia Sozialetik ESEra eginiko mataza kontzeptuala jasotzen da:

[7] https://bcn.coop/aprenem/; http://xes.cat/; https://ajuntament.barcelona.cat/economia-social-solidaria/ca/el-comissionat

[8] Azken bateratze prozesu bat ere antzematen ari da azkenaldion ekonomia solidarioa eta ekonomia eraldatzaile terminoen artean, bigarren honen indar hartze baten isla dena. Horren adierazle argia da 2020 urtean Bartzelonan antolatu den Munduko Foro Soziala, zeinak Ekonomia Eraldatzaileak baitarama goiburu: bertan bat egiten dutelarik ekonomia solidarioko nazioarteko eragileek, ekonomia feministaren, mugimendu agroekologikoaren eta ondasun komun natural, hiritar eta digitalen mugimenduarekin https://transformadora.org/es/2020

[9] Lehentasunezko lan lerro horiek bat egiten dute zenbait kasutan hainbat erakundeen lan ildo nagusiekin, besteak beste, REAS Euskadi eta REAS Navarrakin adibidez (ikus: https://www.economiasolidaria.org/reas-euskadi eta https://www.economiasolidaria.org/reas-navarra). Dena den, REAS-en baitan azken urteetan jorratu diren lan lerro nagusietako batzuk, merkatu sozialaren eraikuntzan, tokiko politika publikoen lanketan, erakundeen kudeaketan ikuspegi feminista txertatzean edo lan honekin zerikusi zuzena duen auditoria sozialaren egitasmoan oinarritu izan dira. Olatukoopen lerro estrategikoek nolabait osatu ditzakete REAS-en agendako zenbait hutsune: mutualizaziorako egituren lanketaren bidez edo ekintzailetza kooperatiborako programa egonkorrak eskainiz, Koopfabrika kasu (www.koopfabrika.eus).

*1. Irudia.* **EKONOMIA SOZIALEKO PARADIGMATIK ESE PARADIGMARA**




*Iturria:* Egileek egina.

## 2.3. Ekintzailetza sozial kooperatiborako adierazle sistemaren proposamen metodologikoa

Iruten ari garen hari diskurtsiboaren azken matazari helduz, zera litzateke orain askatu beharreko korapiloa: mozkin asmoa ez bada ekintzailetza sozial kooperatiboak bultzatzen dituen indar nagusia, eta ontzat harturik ESEren paradigmak eskaintzen duela ekintzailetza horien erreferentzia teoriko eta politikoa, nola gerturatu orduan helburu horietara? (*and how?*- eta nola?). Nola ezaugarritu eta xehatu ESEren paradigmatik eratortzen diren helburu eta praktika konkretuak? Eta zein bitarteko jarri helburu horien operatibizaziorako? Galdera horiei erantzun asmoz abiatzen da adierazle sistema propio bat modu kolektiboan eraikitzeko egitasmoa. Zentzu horretan, beharrezkoa egiten da adierazle sistemaren ekarpenaren zorroztasun metodologikoa eraikitzeko, bere esanahia eta baliagarritasuna zehaztea, eta, horretarako, beste proposamen batzuekin –zehazki auditoretza soziala edota Ikerketa-ekintza-partehartzaileen ikuspegiarekin– partekatzen dituenak eta ez dituenak azaltzea.

Erantzun batzuk josten hasteko: ESEk ekintzailetza sozial kooperatibo berrien paradigma osatu nahi badu, adierazle sistemaren tresnak iparrorratz funtzioa bete nahi luke, ekintzailetza horiei zerumuga ikusgarri bat jarri eta haranzko ibilbidea errazteko seinale eta xendak proposatzeko. Hortaz, *and how?* (eta nola?) galderari eman dakiokeen erantzun posibleetako bat da, adierazle sistemaren tresna: ekintzailetza sozial kooperatiboak ESEren paradigmara hurreratzen joaten laguntzeko iparrorratza.

Definizio zehatzagoa eskaintze aldera, adierazle sistema bat garai tarte jakin batean biltzen diren datu edo datu multzoak dira, zeintzuk erakunde batek edo erakunde bateko talde batek aurrez finkatutako helburu batzuen lorpen edo joera maila neurtzen duten (Begiristain, 2016). Adierazle sistemak, beraz, erakundeen praktika errealetatik horiek ezarritako helburu sozialetara gerturatzeko trantsiziorako tresna bat eskaintzen du, ibilbide orri bat, nahi bada.

Helburuen lorpen edo joera mailak neurtzeaz ari garelarik, ekonomia sozial eta solidarioan aurkitzen den eztabaidagai konkretu batekin topo egiten da: erakunde horien «balio soziala» edo «efikazia soziala» neurtu eta jakinarazi beharraren aferarekin, hain zuzen ere. Adierazle sistemaren funtzioa ezartzerakoan ez gara juxtuki ebaluazioaren gaiaz mintzatzen ari, baina bai neurri batean ebaluazioaren inguruan sorturiko eztabaidaren marko teorikoaz. Eta honi loturik agertzen dira ekonomia sozialean planteatu diren tresna eta adiera ezberdin andana: ziurtagiri sozialak, zigiluak, auditoria edo balantze sozialak, kontabilitate soziala, inbertsioen itzulkin soziala (*social return*), iraunkortasun txostenak, GRI txostenak (*Global Reporting Initiative*), ISOak eta abar.

Gaia bere inguruabar partikularrean kokatze aldera: ekonomia sozialaren bueltako eragile guzti guztiek barneratua dute, nork bere erara, praktika errealen neurketa eta kontu ematearen gaia (Díaz *et al.*, 2012; Stievenart eta Pache, 2014; Marcuello, 2015; Retolaza *et al.*, 2016; Bassi eta Vincenti, 2015).

Adierazle sistema baten funtzionalitatea, helburu sozial gisa jarritako ezaugarriak erdiesteko tresna izatea da, horietara heltzeko trantsizio bide edo prozesu bokazio izatearena, hain zuzen ere. Ebaluazioaren gaineko ikuspegi ezberdinen arteko eztabaida, funtsean, Jarak (2012) ezartzen duen oinarrizko galderatik erator liteke: ebaluazio ariketa batek zer neurtzen ditu, prozesuak ala emaitzak?

Jarak (2012) argiro ezartzen du metodologia bakoitzaren funtzioa: ebaluazioaren egitekoa ez da prozesuak interpretatzea, lorturiko emaitzen lorpen maila baloratzea baizik, hastapenetan eginiko diagnostikotik eratorritako helburuak lorturiko emaitzekin zein punturaino bat datozen baloratzea, preseski. Autore honentzat, ordea, ebaluazio ez da emaitzen neurketa hutsa, eta era berean, beste prozesu batzuk aktibatzen ditu: ekintza hezitzaile bat da ebaluazioan parte hartzen duten parte hartzaile guztien ikasbide dena, eta era berean, ekintza lerro batzuen proposamenean amaitzen da, praktika konkretuak hobetze aldera.

Adierazle sistemaren tresnak ere ez du prozesurik interpretatzen (esperientzien sistematizazioak egiten duen legez) nahiz eta prozesu ezberdinak aktibatzeko lagungarri den. Ez du, orobat, emaitzen neurketa egitea bilatzen nagusiki. Bere xede nagusia ez baita inolaz ere ziurtagiri sozialen logikan jardutea, ez eta kanpo erakunde batek aitorturiko zigilu bat lortzera begira jardutea ere. Tresna honen helburua erakundeen baitan eraldaketa prozesuak xaxatzea da, prozesuak dinamizatzearen ideia gailentzen da emaitzen lorpenaren gainetik. Prozesu horien bitartez maila ezberdinetako helburuak lor litezke: hausnarketa kolektiborako esparruak sortzea, iparrorratz funtzioa betetzen du lortu asmo diren helburuetarantz igarotzen laguntzeko, auto-ebaluaziorako tresna interesgarria izan daiteke baina baita prozesuen sistematizaziorako, proiektuen exekuzioa hobetzeko, ezagutza berriak sortzeko, lan taldean garatu eta lan taldearen gaitasunetan sakontzeko, identitate partekatuak sendotzeko, jasotzen joaten diren datuekin borrokak legitimatzeko, etab. (Begiristain, 2016).

Hortaz, hori guztia aintzat hartuta, adierazle sistema bat ezartzea ez da ebaluazio ariketa soil bat proposatzea. Zentzu horretan ekonomia solidarioko erakundeek eginiko auditoretza sozialeko dinamika eta logiketatik edaten badu ere, beste bide batzuk eskaintzen ditu.

Bestalde, adierazle sistema baten eraikuntza teorikoa eta aplikazio praktikoa egin liteke ikerketa-ekintza-parte hartzaile metodoen (Fals-Borda eta Rahman, 1991) bitartez ala ez, nahiz eta lehenaren filosofiak gertutasun handia duen bigarrenaren ikerketa ikuspegiarekin. Izan ere adierazle eraikuntza eta praktika prozesua erreflexiboa, sistematikoa eta kontrolatua izan daiteke, eta ekintza ere ezagutza iturri izan daiteke non komunitateko kideek subjektu gisa parte hartuz garatu daiteke (Fals-Borda eta Rodrígues-Brandao, 1987; Jara, 2012 eta 2018; Streck eta Jara, 2015). Dena den, prozesu hauek eskatzen duten lanketa sakona onartu behar da, eta horrek adierazle sistema ariketa tresna soil bat izatetik harago ulertzea eskatzen du.

Jarraian zehaztuko den adierazle sistemaren eraikuntza prozesuak ikerketa-ekintza-parte hartzaileko prozesu bat jarraitu du teoriko mailan. Bere osotasunean garatzeko maila praktikoan balioztatu eta horrek komunitatearen parte hartzearekin sortu ahal dituen eraldaketak identifikatu eta lantzea eskatuko luke. Beraz, lehen hurbilpen bat gauzatu dela esan daiteke, ikerketa eginez, ekintzak gauzatuz eta modu parte hartzailean jorratuz, horrelako prozesu batek eskatzen dituen irizpideak zainduz. Etorkizunean, adierazle sistemaren neurketa ezberdinak egingo dira balioztatzea egiteko.

## 3. EKINTZAILETZA SOZIAL KOOPERATIBORAKO ADIERAZLE SISTEMA: KNOW-HOW-A LANTZEN GIPUZKOAKO KOOPFABRIKAKO KASUTIK ABIATUTA

### 3.1. Ekonomia Sozial eraldatzailearen eta ekintzailetza sozial kooperatiboaren testuingurua Gipuzkoan

Ekonomia sozial eraldatzailearen paradigmara hurbiltzeko ekintzailetza sozial kooperatiboentzako baliagarria izan nahi lukeen adierazle sistema da jarraian aurkezten dena. Adierazle sistema honen eraikuntza Olatukoop[10] sarean biltzen diren kooperatiba ezberdinetako kideekin modu parte hartzailean jorratu da, horiek baitira beraien praktiken gainean gorpuztu eta gizarteratu dutenak Euskal Herrian ESEren proposamena. 6 urte bete berri dituen sare hau, lau printzipio irekieren

[10] Olatukoop zer den aurkezten duen bideoa: https://olatukoop.eus/aurkezpena/

gainean oinarritzen da[11], eta sare honetan biltzen diren erakundeek beren burua ekonomia sozialean kokatzeaz harago, horien izaera eraldatzailean jarri nahi dute indargunea. Halako moduz ze gizarte eraldaketa bati begira lanean diharduten enpresa komunitario gisa definitzen baitute beren burua. Olatukoop-en lan lerro nagusietako bat ekintzailetza kooperatiboen sustapenean oinarritzen da, eta Koopfabrikan gorpuzten da nagusiki lan lerro hau.

Koopfabrika[12] Gipuzkoako lurraldean ekonomia sozial berria eta ekintzailetza soziala sustatzeko eskaintzen den programa bat da, Mondragon Unibertsitateko Lanki ikerketa Institutua[13], Olatukoop sarea eta UPV/EHUko Gezki ikerketa institutuaren[14] artean antolatua, Beterri-Buruntzako Garapen Agentziarekin lankidetzan eta Gipuzkoako Foru Aldundiaren laguntzarekin. Erakunde publiko, unibertsitario eta kooperatiboen arteko lankidetza egitasmo honen bidez ekintzailetza kooperatiboak modu kolektibo eta lurralderatuan eraikitzea da egitasmoaren xede nagusia.

Koopfabrikaren programaren baitan ekintzaile zein bidelagunentzako prestakuntza teoriko zein praktikoa eskaintzen da, ekintzailetza egitasmoen akonpainamendu indibidualizatua eskaintzen da bidelagun sare baten bitartez, eta esperientzia berri horiek lurraldean txertatu eta horien artean saretzen laguntzeko dinamikak ere bultzatzen dira.

Programa osatuz, sorturiko esperientzia eta tresnen hobekuntzarako sistematizazio eta ikerketa dinamikak bideratzen dira, adierazle sistema tresna honen proposamena izanik lan lerro horretako emaitzetako bat.

Adierazle sistemaren eraikuntza prozesua Koopfabrikan diharduten unibertsitateko ikertzaileen eta Olatukoopeko kooperatibisten artean garatu da modu kolektiboan, KoopFabrika programaren ekosistemaren baitan unibertsitatetik planteaturiko ikerketa egitasmo gidatu batetik abiatuz, eta Olatukoopeko kideen balioztatze dinamika eta horien itzultze dokumentu ezberdinen lanketa bidez.

Egitasmoak ikerketa kualitatiboko teknika ezberdinak baliatuz, ezagutzaren sorkuntza partekatu eta kolektiboa ahalbidetzea izan du xede, unibertsitateko ikerketa ezagutzak kooperatibisten ezagutza praktikoekin uztartuz.

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[11] Komunitatea osatzen duten kideek, autoeraketa posible egiten duten erakundearen jabetza eta erabakitzeko ahalmen osoa dute, demokrazia ekonomikoaren eta pertsona bat bozka bat irizpideei jarraituz. Komunitatea osatzen duten kideek, autokudeaketarako beharrezko informaziora, ezagutzara, kudeaketa datuetara, baliabideetara eta horien erabilerara atzipen osoa eta zuzena izango dute, gardentasun irizpideekin bat eginez. Komunitateak, beharrezko baliabide guztiekin, elkartasun pertsonala zein komunitarioa sustatuko ditu, aberastasun banaketa orekatua eta autonomia irizpideei jarraikiz. Komunitateak, ondare komuna eta iraunkortasuna sustatzeko konpromisoa hartuko du, bere komunitatearentzat, inguruko sarearentzat eta bere ekimenak gauzatzen dituen jendartearentzat ongizatea bilatzeko ardura ere. (https://olatukoop.eus/oinarri-irekiak/)

[12] KoopFabrika: www.koopfabrika.eus

[13] Lanki Ikertegia: https://mukom.mondragon.edu/lanki/

[14] Gezki Institutua: https://www.gezki.eus/

### 3.2. Metodologia eta adierazle sistemaren eraikitze prozesua

Adierazle sistemaren eraikitze prozesuari dagokionez, jarraitu den prozesu metodologikoak helburu honekin eginiko beste ikerketek duten logika bera jarraitu du (Yakovleva eta Flinn, 2004; Fritz eta Matopoulus, 2008; Matopoulus eta Bourlakis, 2010; Defourny eta Nyssens, 2013; Lammerts van Bueren eta Blom, 1997). Prozesu horien egokitzapena burutu da, beti ere ESE ikuspegia eta helburuak izanik jomugan. Beraz, mailaz maila helburuak, irizpideak eta adierazleak sortzen joan dira. Nahiz eta kontzeptu horien (helburuak-irizpideak-adierazleak) definizio anitz topatu ahal dira, ikerketari egokituz horrela erabiliko dira:

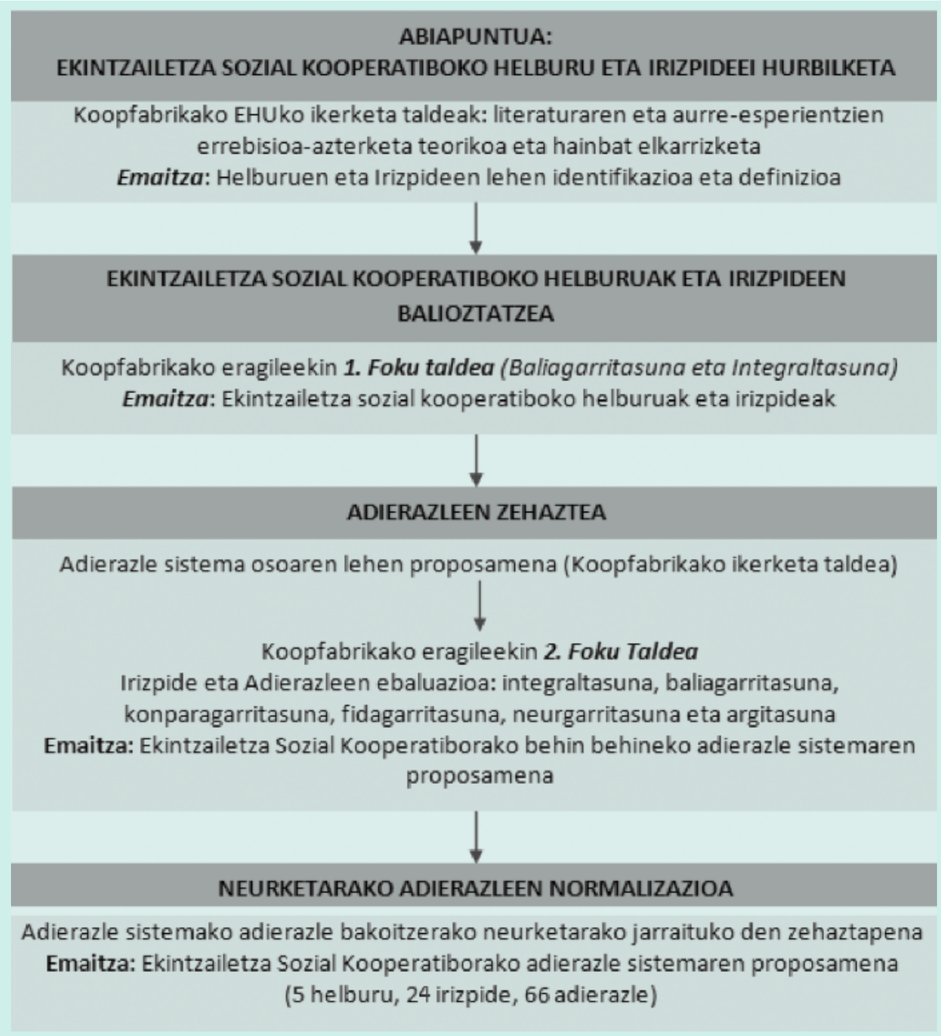
- Helburua: lehenengo maila da eta ekimen sozial kooperatibo batek zein helburu dituen jasotzen ditu, ESE ikuspegitik. Horrela, helburua oinarrizko araua litzateke ESE printzipioen aldeko azterketa eta ekintza bideratzeko.
- Irizpidea: helburu horiek lortzeko zer landu/garatu behar den jasotzen du, hau da, helburuak betetzen direnean ekintzailetza sozial kooperatiboko proiektu batek sortzen dituen emaitzak dira. Horrela, irizpideek oinarrizko helburuak eramaten dituzte proiektu bakanetara; beraz, helburuak baino zehatzagoak dira, eta, ondorioz, adierazleekin lotzeko errazagoak.
- Adierazlea: irizpidearen betetze maila neurtzeko eta ebaluatzeko izaera anitzeko aldagaiak dira. Aukeratutako ekintzailetza sozial kooperatiboko proiektu batek ESE printzipioak azaltzen duten adierazle-multzo esanguratsuak izan behar dute.

Abiapuntutik oso presente izan da, ezarritako helburu, irizpide eta adierazle multzoak zenbait irizpide metodologiko asebete behar lituzketela, besteak beste: integraltasuna, baliagarritasuna, konparagarritasuna, neurgarritasuna, argitasuna eta fidagarritasuna (Bell eta Morse, 2008; Singh *et al.*, 2012; Begiristain, 2016).

Adierazle sistema honen eraikuntza prozesua bost urrats nagusitan garatu da. Une bakoitzean erabilitako metodologia fase bakoitzaren helburu eta beharrei egokitu da. Honela, zenbait unetan teknika nagusiak literaturaren berrikusketan eta ikertzaileen aurre-ezagutzan oinarritu badira ere, behaketa parte hartzailearen bitartez jasotakoekin ere (Flick, 2004), beste zenbait fasetan *sakoneko elkarrizketa* eta *focus group* tekniken bitartez bilatu izan da eragileen (*practitioners*) aldetik jaso beharreko balioztatze bidez. Aukeraketa metodologikoa egiteko literaturaren gomendioak jarraitu dira (Flick, 2004; Marshall eta Rossman, 2011). Guztiarekin, barne tekniken erabilpenarekin, triangulazio metodologikoa bermatu da (Denzin eta Linconl, 2012) –literaturaren berrikusketa eta behaketa partehartzailea, sakoneko elkarrizketak eta focus groupak–.

Jarraitutako prozesu metodologikoa jasotzen da ondorengo irudian.

*2. Irudia.* **ADIERAZLE-SISTEMA PROPOSAMENAREN ERAIKUNTZAN JARRAITUTAKO PROZESU METODOLOGIKOA**




*Iturria:* Egileek egina.

### 3.3. Ekintzailetza sozial kooperatiborako adierazle sistema: Emaitzen interpretazioa

ESEren paradigmatik eta KoopFabrikako ekintzailetza sozial kooperatiboa ulertzeko modutik abiatuta eta azaldutako prozesu metodologikoari jarraituz Ekintzailetza sozial kooperatiborako adierazle sistemaren behin betiko lehen proposamena jasotzen da 1. Taulan. Horretarako, adierazle sistemako helburu bakoitza definitua izan da, honi loturiko irizpideekin batera. Horrela osatzen dira landutako bost helburuak: 1) Lanaren Burujabetza; 2) Ekimen kolektiboa; 3) Lurraldea eta eraldaketa soziala; 4) Bizitza Iraunkorra (Oreka Ekologikoa eta Bizitza Erdigunean); eta 5) Iraunkortasun Ekonomikoa.

*1. Taula.* **EKINTZAILETZA SOZIAL KOOPERATIBORAKO ADIERAZLE SISTEMA**

| Helburua | Irizpidea | Adierazlea |
|---|---|---|
| LANAREN BURUJABETZA | Lan kontzeptua | Lanaren zentzua<br>Lan anitzen aitortza<br>Lan kolektiboa |
| | Lan autoeratua | Atxikipen librea<br>Bazkide kopurua<br>Diru laguntza publikoak<br>Kide langileen ekarpenak |
| | Parte hartze integrala, demokratikoa eta inklusiboa | Erabakitzea kudeaketan<br>Egitura demokratiko eta inklusiboak<br>Boluntariotza eta kidetza komunitarioa |
| EKIMEN KOLEKTIBOA | Gardentasuna | Informazio gune horizontalak eta irekiak<br>Informazioa helarazteko prozedurak |
| | Banaketa justua | Emaitza ekonomikoen banaketa kideen artean<br>Ekitatea soldatan |
| | Berdintasuna | Emakume eta gizonezkoen soldaten aldaera<br>Gaitasunen garapenerako formakuntza eta akonpainamendua<br>Emakumeen edo menderatze arriskuan dauden pertsonen garatzeko eta integratzeko aukera |
| LURRALDEA ETA ERALDAKETA SOZIALA | Izaera politikoa | Lurraldeko gobernantza maila desberdinetan hobekuntza prozesuak sustatuko dituzten ekintzak<br>Intzidentzia politikoaren hedapena gizarte sareetan eta hedabideetan |
| | Interkooperazioa eta izaera banatua | Erosketak «merkatu sozialean»/ ESE mugimenduan edo tokiko hornitzaileei<br>Salmentak merkatu sozialean / ESE mugimenduan<br>ESEko eragileekin lankidetza eta heste-soziala<br>Interkooperazioaren dimentsio politikoa |
| | Sozializazioa eta herrikortasuna | ESEarekin sentsibilizazioa eta formazioa<br>Ondare komunari ekarpena |
| | Tokiko kultura | Tokiko jakintza berreskuratzea eta sustatzea helburua duten ekimenak<br>Euskaraz bizitzea |
| | Gizarte beharrak eta ekintzailetza | Ekintzailetza proiektuen dinamizazioa<br>Gizarte bazterketan diren pertsonen laneratzea |

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| | | | |
|---|---|---|---|
| BIZITZA IRAUNKORTASUNA | OREKA EKOLOGIKOA | Balio katean karbono aztarna | Hondakinen gutxitzea eta birziklatzea<br>Energia berriztagarrien erabilpena (propioak edo kanpokoak)<br>Alperrik galtzeko ondasunen gutxitzea edo berbalorizazioa<br>Merkaturatze bide laburren erabilpena<br>Merkaturatze bide laburren garrantzia<br>Karbono isurketen murrizketa duen logistika edo banaketa sistema |
| | | Jarrera ekologikoa | Biodibertsitatea eta baliabide naturalen mantentzea eta zaintzea ikuspegia duten praktiken erabilpena<br>Ekologia gaietan barne eta kanpo ekintza eta sentsibilizazioaren sustapena |
| | BIZITZA ERDIGUNEAN | Parekidetasuna lanean eta erabakietan | Emakume kopurua<br>Emakumeak botere postuetan<br>Emakumeak lan ez ordainduetan |
| | | Rol eta lan banaketa | Emakumeen parte-hartzea bileretan<br>Rol eta lan banaketen berrikusketa<br>Emakumeen parte-hartzea bozeramailetzan |
| | | Denboraren kudeaketa | Ordutegien zaintza eta malgutasuna<br>Lan produktibo eta erreproduktiboaren banaketa |
| | | Emozioen eta gatazken kudeaketa | Emozioen eta gatazken lanketa<br>Langileen bizitzaren eremu ezberdinen arteko lotura |
| | | Jarrera feminista, dekoloniala eta ez arrazista | Hizkuntza inklusiboa<br>Zapalkuntza anitzen kontzientzia eta lanketa konprometitua |
| | | Bizigarritasuna | Behar materialen asetzea: dirutan<br>Behar materialen asetzea: ez dirutan<br>Behar ez materialen asetzea |
| | IRAUNKORTASUN EKONOMIKOA | Egonkortasun ekonomikoa | Proiektuaren biziraupena<br>Aldagai ekonomikoen jarraipena<br>Kostuak estaltzen dituen prezioa<br>Plangintza operatiboa<br>Plangintza estrategikoa |
| | | Erresilentzia eta dibertsifikazioa | Produktu eta zerbitzuen dibertsifikazioa<br>Proiektuaren erresilientzia<br>Sarreren jatorri dibertsifikatua<br>Interkooperazioaren ekarpen ekonomikoa |
| | | Finantza kudeaketa etikoa | Mailegu eta zerbitzu etikoen datuen oreka<br>Gordailu etikoen datuen oreka |
| | | Barne berrikuntza | Barne berrikuntzaren lanketa eta emaitzak |
| | | Harreman ez merkantilizatuak | Ekonomia ez merkantilizatuaren sustapena<br>Interes talde guztiekin bidezko harremana |

*Iturria:* Egileek egina.

Horrela, Ekintzailetza sozial kooperatiboko adierazle sistemaren proposamen honen osotasunaren lehen argazkia emate aldera, lehenik nabarmendu nahi genuke helburu gehienek enpresen barne antolakuntzako dimentsioei erreparatzen dietela nagusiki, nahiz eta hirugarren helburuak (Lurraldea eta eraldaketa soziala) esplizitatzen duen erakunde horiek *ad extra* lurraldeko eraldaketa sozialeko prozesuetan izan beharreko jarrera. Lurraldearekiko konpromiso hori ESEko egitasmoei aitortzen zaien izaera politikotik eratortzen da, eta lurralde garapeneko esparru ezberdinetan eragitea du xede: dela hizkuntza praktiketan, dela tokiko kulturan, dela gizarte beharrizanetan, edo dela ESEko bestelako erakundeekin indartu beharreko saretze eta interkooperazio dinamiketan.

Barne dimentsioen ezaugarritzea, berriz, helburu nagusi hauen gainean eraiki da: enpresa hauen jabego egiturak (eta beraz erabaki hartze prozesuak) lanaren burujabetzan oinarritzen diren egitura kolektiboen bitartez gauzatzen dira, eta horien iraunkortasun ekonomikoa ziurtatzeaz bat, esfortzu berezia egin nahi da bizitzaren iraunkortasunean positiboki eragiten duten praktiketan sakontzeko, alegia, erakunde horien oreka ekologikoa hobetuz eta bizitza erdigunera ekartzeko politiketan sakonduz.

Esan bezala, ESEko esperientziek zein KoopFabrikaren baitan sustatzen diren ekimenek lanaren burujabetza dute oinarri, hau da, enpresan lan egiten duten pertsonak dira baliabide produktiboen jabe eta erabaki hartzaile nagusiak. Helburu hau gorpuzten duten irizpide nagusiak autoeraketa maila eta pertsona guztien parte hartze integral mailan gorpuzten dira, eta era berean, lanaren kontzeptua bera ere birformulatzeko bide eman nahi da: lana bizitza proiektu gisa ulertzeaz batera, lan mota ezberdinei (produktibo zein erreproduktiboei) aitortza egin nahi baitzaie. Oina-rrian, lanaren burujabetzaren kontzepzio Arizmendiarrietarra dago, Joxe Azurmendik teorizatua, halere, pertsona burujabeak proiektu kolektiboetan eta antolaketa demokratikoz erabakimendduna sustatzeaz gain lanaren zentzu berri bat emateko saiakera dago.

Lanaren kontzepzio burujabeari estuki lotzen zaio bigarren helburua ere (Ekimen Kolektiboa): izaera kolektiboa landu eta indartzearena, hain zuzen ere. Honela, ESE paradigmaren baitan diharduen jarduera ekonomiko bat «norbere kontura diharduen» negozio batetik bereizten duena horixe bera litzateke: talde izaera. Talde izaera hori lantzeko hiru irizpide nagusi ezarri dira: informazio gardentasuna, errenta eta emaitzen banaketa justua eta berdintasun praktikak bideratzea zapalkuntza ardatz ezberdinetan.

Lurraldeko eraldaketa prozesuetan txertaturiko enpresa kolektibo eta burujabe horiek, azkenik, bi dimentsio ekonomiko maila berean jarri eta aldi berean bete edo uztartzea dute xede: iraunkortasun ekonomikoa eta bizitzaren iraunkortasuna, hain zuzen ere.

Iraunkortasun ekonomikoak ohiko parametro estandarizatuei erantzuteaz ba-tera (kostuen kontrola, plangintza estrategiko eta operatiboen lanketa, produktu eta zerbitzuen dibertsifikazioa, etab.). ESEri loturiko bestelako praktika ekonomiko ba-tzuk ere barneratzen ditu, hala nola: finantza etikoen erabilera, harreman ez merkantilizatuen sustapena, edo interkooperazio praktiken ondorio ekonomikoak neurtzea.

Enpresa munduan erabiliagoak diren parametro ekonomiko horiei bigarren adierazle multzo handi bat erantsi nahi zaie: bizitzaren iraunkortasunean laguntzen duten parametro ekonomikoena, hain zuzen ere. Bizitzaren iraunkortasuna bere adiera bikoitzetik jorratzen da: oreka ekologikoaren ikuspegitik eta zaintzen ekonomiaren ikuspegitik. Lehen honen neurketa enpresak bere balio katean uzten duen karbono aztarnaren analisian oinarritzen da, eta energia eta materialen erabilpen eta trataera (berrerabilpena, hondakinen kudeaketa, etab.) aztertzeaz gain, merkaturatze bide laburren aldagaia kontrolatzea du xede.

Zaintzaren ekonomiaren ikuspegitik aldiz, erakundearen egunerokoan agertzen diren praktika patriarkalen ardatzak aztertu eta alderantzikatu nahi dira, ikuspegi integral batetik: erabakiguneen parekidetasun maila, rol eta lanen banaketa, denboraren kudeaketa, emozio eta gatazken kudeaketa, jarrera feminista eta bizigarritasunari loturiko adierazleak landuz.

Esan bezala, helburu horiek lortzeko zein aspektu landu edo garatu daitezkeen kontsideratuz proposatzen da oraintxe xehatu den irizpide zerrenda hori, eta irizpide hauei lotzen zaizkie, horiek neurgarri egiteko helburuz, adierazle konkretuak. Adierazleak finkatzerako orduan, bi ariketa burutu dira: alde batetik adierazle bakoitzaren neurgarritasuna eta argitasuna fintzeko, adierazle bakoitza zein galderaren bitartez neur litekeen zehaztu da. Azkenik, galdera horri erantzuteko neurgailua edo neurketa unitatea ere proposatu da adierazle bakoitzarentzat.

Komeni da azken ohartarazpen batzuk egitea adierazleen neurgarritasunaren inguruan. Izan ere, adierazleei loturiko galdera batzuk modu kuantitatiboan erantzun litezke, bestetzuk ordea modu kualitatiboan, adierazle sistemaren izaera sistemiko eta anitzaren ondorioz. Beraz, adierazleak ez dira unitate berdinetan ez neurtu ez adierazten. Hau, neurgaitzgarritasunaren kontzeptuarekin lotu daiteke (Munda, 2005), bai teknikoa bai soziala. Nolanahi ere, datuak aztertzeko eta konparatzeko moduan jartzeko helburuz, adierazleen balioak erantzun ordinal baten eskalara bihurtzea aurreikusten da bere fase praktikorako (Singh *et al.*, 2012; Yakovleva, 2007), Likert eskalak baliatuz 0-5 tarteko balioak honako hau adierazten dutelarik: adierazlearen inguruko daturik edo informaziorik ez dugu (0), ekarpen oso baxua (1), baxua (2), ertaina (3), altua (4) edo oso altua-bikaina (5) egiten dela. Beraz, azterketan adierazle bakoitzean balio bakoitzerako beharrezkoa da ebaluazioaren esanahia adierazten da. Horrela, eskala horretan eta adierazle bakoitzerako ekintzailetza kooperatiboko esperientzia bakoitzaren emaitzak grafiko erradialetan jasoko lirateke bere erabilpen praktikorako, nahiz eta azterketa honetan erabilpen praktiko hau ez den gauzatu.

## 4. EZTABAIDA ETA ONDORIOAK

Eztabaida ezberdinak antolatu eta ordenatzeko asmoz, adierazle sistema honen inplikazio teoriko eta praktikoetan jarriko da arreta, bereziki erreparatu nahi zaio tresna honek ekonomia sozial eraldatzailearen paradigmari egindako ekarpenari.

Adierazle sistema hau, arestian jorraturiko hurbilketa teorikoan agertu diren zenbait hutsune eta erronkari heltzeko bokaziotik sortu da. Gizarte ekintzailetzen teorietan Young-ek irekitako «jokabideen teorian» beste aletxo bat ezartzen du, jadanik eginiko aurkikuntza batzuk berrestera mugatuz: ekintzailetzen izaera kolektiboa azpimarratuz, horietan kausi daitezkeen logika pluralak (merkatuzkoak eta ez merkatuzkoak) barnebilduz, eta saretze eta interkooperazio mekanismoen garrantzia berretsiz, besteak beste.

Gizarte ekintzailetzen inguruko korpus teorikoaz gain, proposatzen den tresnak ekonomia sozialaren inguruko eztabaida teorikoan eragin nahi luke. Ekonomia sozialeko erakundeen elementu bereizgarria horien konpromiso sozialaren derrigorrezkotasunean oinarritzen denez, erronka garrantzitsua sortzen da helburu sozial horien zehaztapen, definizio eta operatibizazioari dagokionean. Arestian ikusi denez, ekonomia solidarioak proposatzen duen berrikuspenetik bi dira ekonomia sozialari egozten zaizkion herrenak: erakundeon praktika errealak bere erretorikarekin lerrokatzeko estrategia eta tresna konkretuen gabezia, batetik; eta horien engaiamendu politikoaren ahultzea, bai barne dimentsioari dagokionean (demokrazia erreal falta) bai eta gizarteari eginiko ekarpenean ere (gizarte eraldaketarako eredu argi baten falta).

Proposatzen den adierazle sistemak, aurreko atalean garatu den edukietan oinarri hartuz, bi eztabaida teoriko horietan egin nahi luke bere ekarpena.

Alde batetik, helburu sozialak hobeto zehaztu, eta horiei loturiko neurgailuen bidez, helburu horien lorpen mailan hobekuntzak egiteko bide eman nahi du. Prozesu eraldatzaileak sustatzen lagundu nahi luke, emaitzak bilatu asmo diren helburuetara gerturatzen joan daitezen.

Beste aldetik, ekonomia sozialaren dimentsio politikoa indartzeko ere baliagarri izan nahi luke, honen funtzio eraldatzaileari arlo, eduki eta zeregin konkretuagoak ezartzen baitizkio, halako moduz ze, ekonomia sozialeko erakundeetatik bultzatu nahi den gizarte eraldaketa eredua itxuratzen lagundu baitezake. Horretantxe suma liteke ekonomia sozial eraldatzailearen indargunea bera: ekonomia sozialak eragile berezitu gisa proposatzen duen gizarte eraldaketa ereduaren konkrezio handiagoan, hain zuzen ere. Lanaren burujabetza, bizitzaren iraunkortasuna, izaera kolektiboa eta lurralderatua… ezaugarri horiek guztiak, egungo bestelako zenbait korronte kritikorekin sintonian egoteaz bat, baliagarriak suerta litezke jendarte guztiarentzat bilatu asmo den gizarte eraldaketaren egitasmoa ezaugarritzeko, edukiz osatzeko, azaltzeko eta mamitzeko.

Bistakoa da proposamen hau ez dela hutsaren gainean sortua izan. Esperientzia ezberdinen arteko osagarritasuna dago guzti honen azpian. Alde batetik, Arrasateko Kooperatiba Esperientziaren ibilbide kooperatiboaren oinarriak eta argi ilunak, bestetik, Olatukoop Sarearen sei urteko ibilbidea, eta azkenik KoopFabrikako hiru edizioetako gorpuzkera praktiko-teorikoa.

Adierazle sistemako ezaugarri eta elementu askok lotura zuzena dute esperientzia kooperatiboa elikatu izan duten printzipioekin, lanaren burujabetza, antolaketa demokratikoa izaera kolektiboa edo gizarte eraldaketa, nagusienak aipatzearren; bestetzuk, ordea, asko zor diote berriagoak diren ekonomia solidariotik zein ekonomia feministatik eginiko hainbat saiori, enpresen kudeaketa mailan kezka ekologiko zein feministak txertatzeko egindako ahaleginari, edo finantza etikoen erabilerari, zenbait aipatzearren.

Adierazle sistema honen bokazioa izan da KoopFabrikaren praktikan egiten dena jasotzea, ordenatzea eta elementu neurgailuetan zedarritzea. Bokazio horretan, tradizio kooperatibo luzeagoko elementu eraldatzaileak berreskuratzeko inpultsua dago, gaurkotasuna dutelako eta sakonean pertsona eta komunitatea daudelako. Dena den, eta horiek ekonomia solidarioaren proposamen ekonomiko alternatiboekin eta ingurumenaren zaintza zein ekonomia feministak proposatzen dituen elementu berri eta gaurkotuekin uztartzeko edo osagarritzeko ahalegina egiten da.

Gogoetan beste koska bat igoz, adierazle sistema honek mahai gainean jartzen ditu ezagutza zientifikoaren sorkuntzari loturiko beste zenbait eztabaida epistemologiko ere. Nagusiki ekonomia sozial eraldatzailearen ekarpen teorikoa, praktika errealetatik eraikitzen doanaren konstatazioa jartzen du agerian. Nekez uler litezke adierazle sistemako elementu ezberdinak Koopfabrikako programaren baitan bizitako prozesu eta eztabaidetatik aparte. Ekonomia sozial eraldatzailearen paradigma bera, etengabeko eraikuntzan den proposamena da, praktika sozialetik eraikia, eta adierazle sistema hau bezalako ekarpen metodologikoen bitartez indartua eta sostengatua.

Lan honen inplikazio praktikoei dagokienean berriz, eta horiek azken gogoeta honekin kateatuz, adierazle sistemak bi zentzutako inplikazioak dituela esango genuke: teoria eraikitzen lagun dezakeen moduan lagundu nahi baitu gizarte eraldaketarako paradigma bat erakunde mailan gorpuzten, kudeaketa mailara jaisten, operatibizatzen. Horixe da eragin nahi lukeen inplikazio praktiko behinena. Erabilgarri izatea, kudeaketa mailan. Bigarrenik, ekintzailetza kooperatiboko erakunde zein proiektu kolektiboek barrura begirako elementuetan hobekuntzak egiteko eta sortze bidean diren ekimen ekonomikoetan adierazle sorta osoa presente izanik erabakiak eta nora-bide bat hartzen laguntzea; barne zein dimentsio sozial eraldatzaileagori dagokionean.

Erabilgarritasun praktiko horiek luzera, seguruenez, elementuak edo arloak gehitzea ekarri beharko luke. Esperientzia ezberdinen metaketatik adierazle sistema bera ere moldatu beharko da, funtzionalitate berriak bilatuz eta bertsio praktikoak sortuz. Marko moduan ulertuta, arlo batean zein bestean, sakontzeko argia emateko ere baliagarri izan daiteke zenbait kasutan. Zentzu horretan, gorago aipatutako memoria kooperatibo alternatiboaren errelatoaren ebidentzia jasotzeko eta errealitatea eraikitzeko bitarteko baliagarria izan daiteke, beste ekonomia baten –sistema kapitalista gainditu eta ordezkatuko dituen helburuak dituena– eraikuntzan integraltasuna, sendotasuna eta zehaztasuna eta bideragarritasuna emango duten proposamenak behar direlako. Beraz, orainaldiko bitartekoa eta etengabeko eraikuntzan jarraitu dezakeen tresna praktiko zein teorikoa da.

Dena den, aurkezten den adierazle sistema honek ere baditu, bere mugak. Lehen proposamen bat baino ez dela, honen balioztatze praktikoa gauzatzeke dago. Adierazle sistema hau ekintzaile kooperatiboko esperientzietan  edo erakundez erakunde aplikatu beharko litzateke eta balioztatze horrek berebiziko garrantzia dauka proposaturiko adierazle zerrendaren behin betiko bertsioa finkatzeko. Balioztatze horretan zorroztuta geratuko litzateke adierazleen neurgarritasun, fidagarritasun, argitasun edo konparagarritasuna. Zentzu horretan, maila teorikoan landutako fase honetako bigarren foku taldean identifikatuak geratu dira zein adierazlek sor zitzaketen arazo gehien. Behar beharrezkoa da hortaz, azken balioztatze hori burutzeko adierazle bakoitzari dagokion fitxa espezifikoa burutzea, non jasoko baitira, behin betiko, besteak beste: adierazlearen definizio zehatza, dagokion irizpidea, ebaluazio modua eta emaitzen interpretaziorako neurketa unitatea[15].

Horrez gain, eta lehen proposamen honekin eginiko bideari esker, foku taldeetan nabarmendu zen proposaturiko adierazle sistema orokorretik bestelako bertsio sinplifikatu edo laburragoak egiteko aukera ere baliagarria litzatekela, tresna honi eman dakioken funtzionalitate ezberdinetara egokituz.

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[15] Ikus, zentzu honetan Begiristainek (2018) eginiko ariketa elikagai ekologikoen banaketa politikarako eginiko adierazle sistema agroekologikoaren proposamenean.

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**MERINO FERNÁNDEZ, Julia.** Ingeniera Industrial (2010), Máster en Ingeniería Eléctrica (2012) y Doctora en Ingeniería Eléctrica con Mención de Doctor Internacional (2015) por la Universidad Politécnica de Madrid. Desde 2010 a 2014 fue miembro del grupo de Generación Eléctrica con Energía Eólica (GELEO) de la Universidad Politécnica de Madrid. Desde 2014 trabajó en el grupo de Redes Inteligentes y Almacenamiento Energético de TECNALIA, donde participó en varios proyectos de los programas europeos H2020 y financiación privada. Sus líneas de investigación principales estuvieron enfocadas a la integración en red de energías renovables, las microrredes/redes inteligentes y la generación distribuida. Fue Visiting Scholar en la Universidad de Wisconsin-Madison en 2011 y en Michigan State University en 2014. En 2016 recibió el Premio Extraordinario de Doctorado de la Universidad Politécnica de Madrid (curso 2014-2015). Fue también profesora asociada del Departamento de Ingeniería Eléctrica de la Universidad del País Vasco (UPV/EHU). Julia falleció durante la elaboración del actual monográfico.

**MOLINETE CUEZVA, Begoña.** BSC in Telecom Engineering by the University of the Basque Country (Bilbao Engineering School). 15-year period as a researcher, project manager and head of Intelligent Transport Systems in the ICT Division in Tecnalia; research activity focused on smart mobility data analytics and wireless communication (V2X) systems and services for conventional and electric vehicles. Project Manager at the Basque Energy Cluster since 2015, coordinating cluster activities, collaborative projects, working groups and internationalization support actions in the fields of Smart Grids, Solar Energy and Energy & Mobility Services. Wide experience in R&D programmes at European (H2020 and SCC) and Regional level.

**MORANDEIRA ARCA, Jon.** Garapenari buruzko Ikasketetan doktorea eta Ekonomia eta Enpresa Fakultateko Gipuzkoako Ataleko irakaslea, Finantza Ekonomia II (Enpresa Ekonomia eta Merkaturatzea) sailean. GEZKI, Gizarte Ekonomia eta Zuzenbide Kooperatiboaren Institutuko (EHU/UPV) eta 2019-2021 Euskal unibertsitate-sistemako «Gizarte Ekonomia eta bere Zuzenbidea», IT1327-19, ikerketa taldeko kidea. Azken urteetan, Gizarte Ekonomiako Euskal Behatokia, gizarte ekonomiaren sustapenerako politika publikoetan eta gizarte ekintzailetzaren inguruko ikerketa egitasmoetan parte hartu duena.

**SANTOS DÍAZ, María** Nélida. Qualified as Industrial Engineer from the UPV-Bilbao 1994. Her academic background includes various recognitions: Master in Marketing UPV-1998, Specialist in psychotherapeutic intervention UNED-2008, and Specialist in Treasury and Public Finance UPV-2011 (Expert in prevention of money laundering INBLAC -2013). Her professional activity can be described in terms of responsibilities as: Research (LABEIN 1 year), Consulting (ACCENTURE 2 years), Engineering and Manufacturing (GEISER-GASTECH 2 years), Electricity Sector (IBERDROLA 20 years), Administration (Deputy Minister of the Basque Government 3 years, City of Bilbao Council). She also has experience in general management, planning and regulation, purchasing, HR, finance, business management, coordination of international teams and executive negotiation. Appointment: Councelor of ITELASPI, Councelor of EJIE, Vocal of the Board of Directors of the Basque Academy of Police and Emergencies, Councelor of VVMM, Councelor of the Artxanda Funicular, Councelor of Bilbao Zerbitzuak-Services.

**SHAH, Nilay.** Head of the Department of Chemical Engineering and formerly the Director of the Centre for Process Systems Engineering (CPSE) at the Imperial College London, and a Chemical Engineer by training. He has co-authored over 300 technical papers on process systems modelling and engineering, low carbon energy and industrial systems, design and optimisation of built environment systems, sustainable urban systems, supply chain modelling, process scheduling and optimisation and plant safety and risk assessment.  Nilay Shah has received several awards and is particularly interested in the transfer of technology from academia to industry. He has provided consultancy services on process optimisation, innovation and industrial applications of new technology to a large number of process industry and energy companies.

**SOLER GARCÍA, Aitor.** Ingeniero industrial por la Universidad del País Vasco y MSc in Sustainable Energy Futures por Imperial College London. Desarrolla su carrera en el sector de la energía desde 2014. Ha trabajado en el departamento de estadística de la Agencia Internacional de la Energía en Paris y actualmente trabaja en I-DE, empresa del grupo Iberdrola, en el departamento de procesos y tecnología.

**WANG, Henry K.H.** International executive, author and speaker with extensive high level business experience globally. He is President of Gate International and was a former director of both Shell China and SABIC in Riyadh. He is a Fellow of the Royal Society of Arts FRSA and Fellow of Institute of Chemical Engineering. He is a board member of London University SOAS Advisory Board and University College London China Advisory Board plus China Carbon Forum Advisory Board. He has been invited to join the G20/B20 Global Leaders Taskforce. He has published over 100 papers and speeches plus 5 books globally. His negotiation paper was selected as one of Top Five UK Management Papers of the Year. He has been invited to speak at international conferences, leading universities and business schools globally. He is also undertaking charity work on leadership and sustainability globally.

**WILSON, James.** Director de investigación de Orkestra-Instituto Vasco de Competitividad y profesor de la Deusto Business School. Su principal área de investigación es el análisis de la competitividad regional, de procesos de desarrollo socioeconómico, y de las políticas públicas. En ese aspecto, el trabajo de James se centra especialmente en asuntos relacionados con la elaboración de estrategias territoriales, gobernanza, política de clústeres, evaluación de políticas, y el rol que juegan las universidades en la sociedad. Ha publicado más de 60 trabajos relacionados con estos temas tanto en revistas y libros académicos, y ha participado en varios proyectos europeos, sobre todo en los campos de clústeres y estrategias de especialización inteligente. James ha sido invitado como asesor/experto por la Comisión Europea, Banco Interamericano de Desarrollo y por varios gobiernos y universidades, y actualmente es miembro del consejo y secretario de TCI Network.

**ZABALA BERRIOZABAL, Kristina.** She holds a BA in Economic and Business Science from the University of Deusto and a PhD in Economics and Business Management: Sub-programme in Financial Management and Accounting, also from the University of Deusto. She is currently lecturer with PhD at the University of Deusto, where she teaches at the Donostia-San Sebastián campus. She works at the Department of Strategy and Information Systems, teaching different subjects in the area of knowledge of Strategic Management on both BA (hons.) and BA courses. She has been lecturer on the PhD course in Business Competitiveness and Economic Development, on which she has taught a subject within the Innovation Systems module. She forms part of the Innovation and management of organizations in the knowledge society research team, recognised by the Basque Government. Her research interests include servitization, innovation systems, knowledge transfer and business strategy.

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