BASQUE HYDROGEN STRATEGY

H2

ENERGIAREN
EUSKAL ERAKUNDEA
ENTE VASCO
DE LA ENERGÍA

EUSKO JAURLARITZA
GOBIERNO VASCO

EKONOMIAREN GARAPEN,
JASANGARRITASUN
ETA INGURUMEN SAILA

DEPARTAMENTO DE DESARROLLO
ECONÓMICO, SOSTENIBILIDAD
Y MEDIO AMBIENTE

Index


Hydrogen H_2
zero emission

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Executive Summary

Hydrogen has been identified by European and international bodies as an essential element for the energy transition to a greenhouse-gas neutral economy. On the one hand, it can be stored for long periods and in large quantities, which facilitates mass integration of renewable energies into the energy system by enabling sector coupling of generation and consumption. On the other, it enables energy to be transported without using the electricity grid.

Furthermore, hydrogen use has no associated greenhouse gas emissions. Thus, if it is produced from renewable energy sources, it offers a magnificent opportunity to decarbonise sectors where carbon abatement is more difficult, such as the chemical and petrochemical industry, heavy road transport, maritime and air transport, heat supply in existing buildings and a variety of high-temperature industrial heat applications. In addition, hydrogen consumption in fuel cells does not emit local pollutants, another important advantage for the urban environment.

There is currently no global market for hydrogen comparable, for example, to the market that exists for liquefied natural gas. Hydrogen is traded in bilateral transactions between producers/suppliers and consumers, and production is generally located in the vicinity of the consumer's facilities. Most hydrogen is produced by hydrocarbon reforming and only a token amount is produced by electrolysis.

It is anticipated that both a European and global hydrogen market will develop, associated with its function as a facilitator for integration of renewable electric technologies in the energy system

In the European context, the production cost from natural gas reforming is around €1.50 per kg of hydrogen, two to four times cheaper than renewable-sourced hydrogen. The two prices are expected to draw level from 2030.

Ninety percent of the world's production is used as feedstock in the refining industry, to produce ammonia and methanol. Although relatively insignificant in overall terms, there are numerous experiences in the use of hydrogen as an energy carrier, mainly in the field of transport.

From this perspective, it is anticipated that both a European and global hydrogen market will develop, associated with its function as a facilitator for integration of renewable electric technologies in the energy system, its role as a system stabilizer, and its capacity to be used as a decarbonization agent in certain industrial applications, in transport and in the buildings sector.

This development will bring opportunities throughout the hydrogen value chain, both in production and integration with renewable generation plants, storage, transportation, distribution and consumption. It is therefore necessary to adopt a strategic positioning that places the Autonomous Community of the Basque Country and its industrial fabric in the best position to take advantage of opportunities in the field of energy, the environment and industrial and technological development.

The purpose of this *Basque Hydrogen Strategy* is to lay down guidelines for promoting the creation of a hydrogen ecosystem based on renewable hydrogen production and storage, transport and distribution infrastructures that will support the local market and serve as a basis for establishing a logistics centre playing a significant role on the international export market. This will represent an opportunity for decarbonisation in Basque industry and for other sectors where abatement is more difficult and, at the same time, for industrial development in order to position such businesses as technology exporters.

The strategy includes an action plan with 58 lines of action aimed at achieving these objectives. These lines of action are in turn structured into six axes:

AXIS 1: PRODUCTION

AXIS 2: STORAGE, TRANSPORT AND DISTRIBUTION

AXIS 3: END USES

AXIS 4: INDUSTRIAL AND TECHNOLOGICAL DEVELOPMENT

AXIS 5: MARKET

AXIS 6: REGULATORY FRAMEWORK AND CROSS-CUTTING ASPECTS

THE STRATEGY ESTABLISHES A SERIES OF TARGETS FOR 2030 TO MONITOR THE DEVELOPMENT OF THE LOCAL HYDROGEN MARKET:

2030 TARGETS	
PRODUCTION	Installed electrolysis capacity of 300 MW.
	100% of all hydrogen produced to be of renewable or low-carbon origin.
	Annual production of 2,000 t/year of synfuels.
END USES Industry	90% of hydrogen consumed in industry as feedstock to be of renewable or low-carbon origin.
	Hydrogen accounting for 5% of total energy consumption in the industrial sector.
END USES Buildings	10 pilot projects for hydrogen use in buildings.
END USES Transport and Mobility	Fleet of 20 hydrogen buses in the Basque Country.
	Fleet of 450 goods transport vehicles of varying sizes.
	Network of 10 public access hydrogen filling stations, covering all three provinces.

Despite a range of uncertain variables, it is estimated that investment of between 910 million and 1.51 billion euros will be required to meet these targets. If achieved, around 100,000 tons of renewable or low-carbon hydrogen could be produced in the target year. Depending on the weight of each sector and the technological distribution of consumption, this would mean a saving of between 210,000 toe and 290,000 toe of non-renewable primary energy, and a reduction in greenhouse gas emissions of between 590,000 and 790,000 tonnes of carbon dioxide equivalent.

A governance structure will be created consisting of a Follow-Up Committee, a monitoring team and any working groups considered necessary to address the different challenges

Finally, in order to ensure proper roll-out, monitoring and evaluation of the Strategy, a governance structure will be created consisting of a Follow-Up Committee, a monitoring team and any working groups considered necessary to address the different challenges that may arise in developing the lines of action.

1

Introduction: Why Hydrogen?

Hydrogen is an energy carrier which can be stored long-term and in large quantities, facilitating mass introduction of renewable energies into the energy system by sector-coupling generation and consumption, and allowing energy to be transported from producer to consumer regions.

Hydrogen emits no greenhouse gases. Thus, if it is produced from renewable energy sources, it presents a magnificent opportunity to decarbonise sectors where abatement is more difficult, such as the chemical and petrochemical industry, heavy road transport, maritime and air transport, heat supply in existing buildings and a variety of high-temperature industrial heat applications.

In short, hydrogen has been identified in Europe and elsewhere as an essential part of the energy transition towards a GHG neutral economy. A strategic positioning needs to be adopted that will place the Autonomous Community of the Basque Country and its industrial fabric in the best position to take advantage of the opportunities presented in the fields of energy, the environment and industrial and technological development.

2

The Hydrogen Market

World hydrogen production currently stands at around 110 Mt per year[1]. Production is non-centralised and usually takes place close to the centres of consumption, such as refineries and chemical plants. Ninety-five percent of all hydrogen produced comes from fossil energy sources, mainly through natural gas reforming and coal gasification. The remaining 5% is a by-product of chlorine production and is produced by electrolysis. The share of hydrogen produced from renewable electricity is negligible.

By 2030 renewable hydrogen is expected to be able to compete in cost terms with fossil fuel-based hydrogen

The cost of producing hydrogen from fossil fuels in the European Union is estimated at €1.5 /kg, while with carbon dioxide capture and storage it is estimated at €2/kg, still lower than the €2.5-5.5/kg estimated for renewably-sourced hydrogen. However, by 2030 renewable hydrogen is expected to be able to compete in cost terms with fossil fuel-based hydrogen, mainly due to cost reductions in renewable energies and cheaper electrolysers[2].

Hydrogen is mostly used as feedstock in the refining, ammonia and methanol industries. In comparison, its use as an energy carrier is insignificant in quantitative terms, although there are increasing numbers of experiences in transport, industry and buildings.

In terms of commercial demand, there is currently no global hydrogen market comparable, for example, to that of liquefied natural gas. The product is traded in bilateral transactions between producer-suppliers and consumers, generally located close to one another.

In the Basque Country, the situation is largely the same as that described above. Annual production stands at around 50,000 tonnes, mainly from the petrochemical industry, which employs on-site production using natural gas reforming. In addition, there is a small output from the electrochemical industry, which is marketed through industrial gas companies.

In the typical model, the highest level of consumption is in the petrochemical industry, followed at a long distance by the steel, glass and food industries, inter alia. At present, all hydrogen consumed in the Basque Country is used as feedstock in industry.

1 IEA, 2019.
2 A hydrogen strategy for a climate-neutral Europe, COM(2020) 301 final, P.4.

3

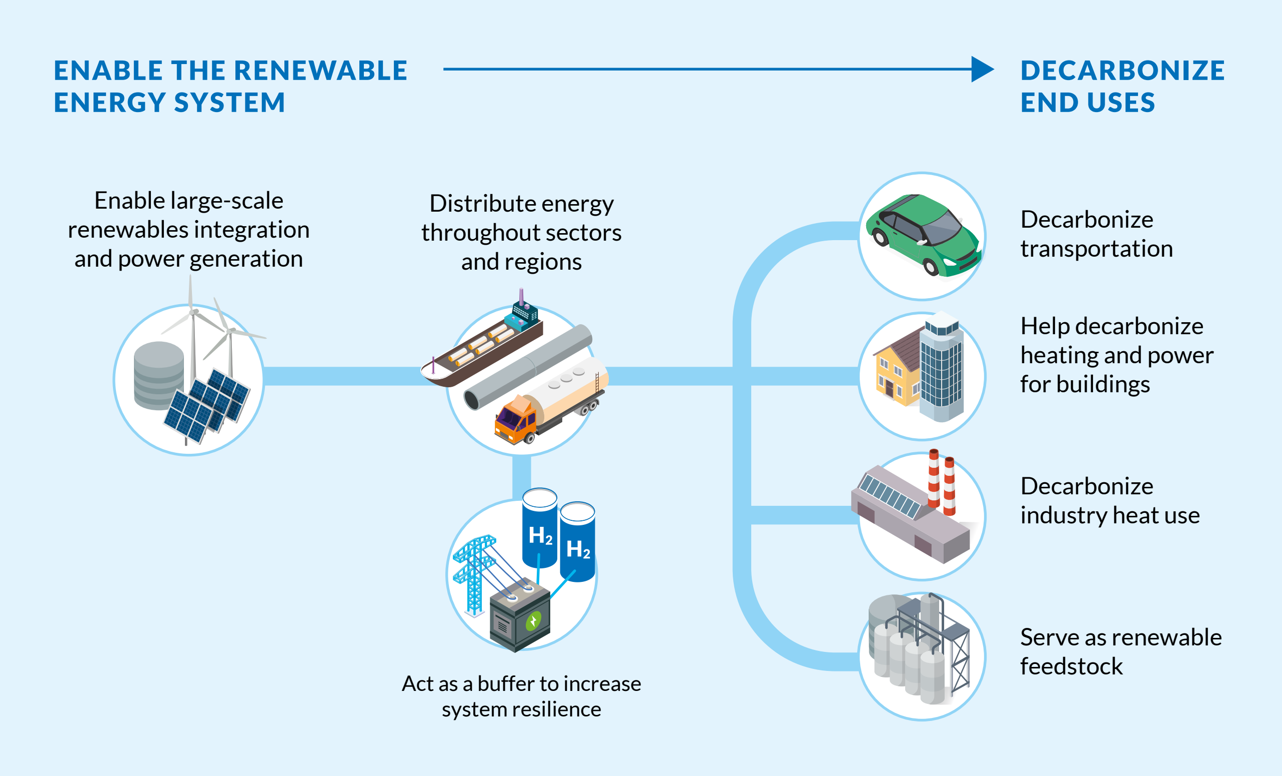
Hydrogen as a Tool for Decarbonisation

In 2018, the German electricity system was forced to reduce renewable generation by a total of 5,436 GWh[3], due to imbalances caused by decoupling from power-consuming sectors. Had it been converted to hydrogen, this energy would have been sufficient to power around 600,000 cars, with no associated greenhouse gas emissions. Moreover, since hydrogen can be stored for short, medium and long periods, the energy could have been consumed when best suited the energy system. Because hydrogen is transportable, it could have been consumed anywhere, not only in the same region in which it was produced.

The situation described above is not dissimilar to that of several European regions, and the prospect is that excess renewable energy generation will become increasingly common, as the price of these energies continues to fall, and they are ever more widely implemented.

The example graphically illustrates how hydrogen can enable mass integration of renewable electricity generation without putting pressure on the capacity of electricity grids, acting as a buffer or shock absorber and providing stability to the whole energy system, and facilitating coupling between renewable generation and consumer sectors. As the graph below shows, these three functions together, focusing on hydrogen production, distribution and storage, have the potential to facilitate the transition to a renewable energy system.

3 Federal Network Agency, quarterly report on network and system security measures for the full year and fourth quarter of 2018.



Source: FCH 2 JU (2019).

On the consumption side, hydrogen is an alternative means of decarbonization in sectors and subsectors where electrification is expensive or technically unfeasible.

In industry, hydrogen can be used as a substitute for other fuels in high temperature applications, or as feedstock in different industrial processes. At a global scale, most output is used in the ammonia industry for fertilizer production, in petroleum refining and in methanol production. To a lesser extent, though to some degree in the Basque Country, it is used in the metallurgical, cement, glass, food and cosmetics industries. In this type of industrial process, use of renewable hydrogen is the only way to decarbonize.

Hydrogen can enable mass integration of renewable electricity generation without putting pressure on the capacity of electricity grids

In the transport sector, the use of hydrogen in fuel cells constitutes a decarbonization alternative for segments where electrification using batteries is not technically feasible; these include certain road transport applications, especially heavy vehicles and buses, non-electrified railways, maritime transport and air transport. Additionally, this type of use does not emit local pollutants such as nitrogen oxides or particulates, offering a significant advantage over conventional fuels, particularly in urban environments.

In addition to the use of fuel cells for electric-drive vehicles, in the future there will also be a significant application of synthetic fuels (synfuels) produced from hydrogen and carbon dioxide captured from industrial processes — or, in the longer term, from the air.

Finally, in the buildings sector, hydrogen will be used in CHP (cogeneration) applications with fuel cells and as a heating fuel for consumption in boilers, in existing buildings where the use of heat pumps is not feasible. This could be achieved through blending with natural gas or by using dedicated infrastructure with consumption in devices specially designed to run on pure hydrogen.

4

Strategic Positioning

4.1. INTERNATIONAL, EUROPEAN AND SPANISH CONTEXT

In line with the targets set in the *Paris Agreement*[4], the *European Green Deal*[5] is the European Union's response to global climate and environmental challenges. The strategy is intended to transform the Union into an equitable and prosperous society with a modern, resource-efficient and competitive economy, no net emissions of greenhouse gases by 2050 and economic growth decoupled from resource use.

Among other factors required to achieve climate neutrality in the economy, the Green Pact mentions the need to develop an electricity sector based on renewable energy and to provide support to the development of decarbonised gases. Among the latter, hydrogen will play a significant role in the integration of renewable energy, energy storage and the reduction of emissions in sectors such as the steel and chemical industries, overland transport and inland waterway transport.

In July 2020, the European Commission published its *European Hydrogen Strategy*[6], which establishes short-, medium- and-long term strategic targets to create the conditions for hydrogen technologies to reach maturity, be deployed in all sectors and to create an open and competitive European market, supported by adequate infrastructures.

The strategy envisages uneven development of the hydrogen ecosystem over time, with different rates of roll-out and differences between regions. The document is structured in three phases, with targets for 2024 and 2030 and an overview of the anticipated situation to 2050.

The first phase of the European strategy runs from 2020 to 2024, with the strategic target of installing 6 GW of electrolysers and annual production of up to 1 million tonnes of renewable hydrogen. The unit capacity of electrolysers is expected to increase to 100 MW[7]. Production facilities will be located close to consumption

4 **Paris Agreement**.
5 **The European Green Pact**, COM(2019) 640 final.
6 **A hydrogen strategy for a climate-neutral Europe**, COM(2020) 301 final.
7 At the time of writing the highest powered electrolysers operating in Europe do not exceed 10 MW (Hydrogen Europe, 2020).

centres, and adaptations will be made to existing natural gas-reforming production plants with carbon capture and storage technologies.

During this phase, the regulatory bases will be established to achieve a mature and cost-effective hydrogen market, and supply and demand in the main markets will be promoted through appropriate funding mechanisms.

In the second phase, from 2025 to 2030, hydrogen should be integrated into the European energy system and, by the end of the period, the electrolysis capacity should be 40 GW, producing 10 million tonnes of hydrogen per year. The target is for renewable hydrogen to be economically competitive by the end of this period. At the same time, it will begin to play a significant role in stabilization of the electricity grid and in seasonal energy storage.

Production facilities will be located close to consumption centres, and adaptations will be made to existing natural gas-reforming production plants with carbon capture and storage technologies

In this phase, hydrogen hubs, clusters or ecosystems will be developed in isolated areas or in regional eco-systems based on local production and consumption, with short-distance transport and distribution. The first logistics infrastructures will also emerge at European level, advancing towards the transport of hydrogen from production to consumption areas.

In the third phase, between 2030 and 2050, renewable hydrogen technologies should have reached maturity and large-scale deployment in hard-to-decarbonise sectors. Under the strategy, around a quarter of the renewable energy generated in Europe will be used to produce hydrogen. Alternative fuels will play an important role and even biogas will be used for hydrogen production with carbon dioxide capture and storage, in a negative carbon cycle.

In Spain, the *Plan Nacional Integrado de Energía y Clima 2021-2030 [Integrated National Energy and Climate Plan 2021-2030] (PNIEC)*[8] sets the targets for emission reductions, penetration of renewable energy and energy efficiency; and establishes lines of action aimed at maximizing the opportunities and benefits for the economy, employment, health and the environment.

The text sent to the European Commission in March 2020 includes hydrogen and its associated technologies as relevant tools for demand management, storage and energy system flexibility (Measure 1.2); in the promotion of renewable gases (Measure 8.1), because of its versatility for use in power generation, to cover energy demand in industrial processes and transport or for production of synthetic fuels; in the promotion of electric vehicles (Measure 2.4); and in the integration of the gas market (Measure 4.7).

8 **Borrador actualizado del Plan Nacional Integrado de Energía y Clima 2021-2030**. At the time of publication of this strategy, the document is still subject to change.

More specifically, in October 2020 the Spanish Government approved *Hoja de Ruta del Hidrógeno: una apuesta por el hidrógeno renovable [Hydrogen Roadmap: a commitment to renewable hydrogen]*[9] by the Ministry for Ecological Transition and the Demographic Challenge, which establishes guidelines for promoting the development of renewable hydrogen in Spain within the framework of the energy transition towards decarbonization of the economy by 2050. The document provides for 60 measures covering the entire value chain, and sets the following specific targets to 2030:

HYDROGEN PRODUCTION

- Installed electrolysis capacity of 4 GW, ideally located close to consumption centres.

INDUSTRY

- Twenty-five percent of the hydrogen consumed in industry, either as feedstock or for energy applications, will be of renewable origin.

TRANSPORT

- Directive (EU) 2018/2001 (RED II) sets a target of renewables accounting for 14% of final consumption in the transport sector, while the PNIEC sets a target of 28%. To meet this target, the plan establishes the following 2030 targets for hydrogen use:
  - 150-200 fuel cell buses, especially in cities with more than 100,000 inhabitants.
  - 5,000-7,500 fuel cell vehicles for freight transport.
  - 100-150 public-access hydrogen filling stations, with a maximum distance between stations of 250 km.
  - Two commercial fuel-cell rail lines on currently non-electrified tracks.
  - Handling equipment and supply points at the five largest ports and airports.

At the same time, countries such as Germany[10], France[11], the Netherlands[12], Norway[13] and Portugal[14] are beginning to take the first steps towards approval and implementation of ambitious development strategies for the hydrogen industry, involving large-scale investment in production and transportation infrastructures, growth in household demand, gradual integration of hydrogen networks in natural gas networks (Germany) and positioning, either as an industrial power in the sector (Germany, France), or as relevant hydrogen hubs in Europe (Portugal, the Netherlands). Other countries, such as the UK and Italy, are also working on developing strategies for development of the hydrogen sector.

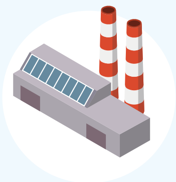
Finally, different European regions have developed plans and strategies around the development of the hydrogen economy. Examples include the Dutch region of Noord Nederland[15] and the Autonomous Community of Aragon in Spain, whose third Hydrogen Master Plan is currently in force (2016-2020)[16], and which is currently preparing its fourth, to cover the period up to 2025.

9 **Hoja de Ruta del Hidrógeno: una apuesta por el hidrógeno renovable** (2020).
10 **The National Hydrogen Strategy** (2020).
11 **Plan de déploiement de l'hydrogène pour la transition énergétique** (2018).
12 **Government Strategy on Hydrogen** (2020).
13 **The Norwegian Government's hydrogen strategy** (2020).
14 **EN-H2 Estratégia Nacional Para o Hidrogénio (versão draft)** (2020).
15 **The Green Hydrogen Economy in the Northern Netherlands** (2016).
16 **Plan Director del Hidrógeno en Aragón 2016-2020** (2016).

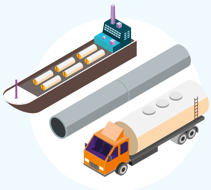
4.2 STRATEGIC POSITIONING OF THE BASQUE COUNTRY

In light of international trends, this *Basque Hydrogen Strategy* has been drawn up to promote the creation of a **hydrogen production, distribution and consumption ecosystem in the Basque Country** based on the country's industrial, logistical and technological capabilities, in accordance with the following guidelines:

To create a **robust and sustainable local market**, boosting renewable and low-carbon hydrogen production and stimulating domestic demand.



To make hydrogen into a **viable decarbonization tool for Basque industry** and other hard-to-decarbonise energy consumption sectors, such as transport.



To deploy a **storage, transportation and distribution infrastructure** to support the development of the local market, and to provide the basis for the establishment of a future logistics centre for international hydrogen trade.

To stimulate **training, R&D and industrial development in order to position the country as a technology exporter** in a market that is expected to grow at a constant rate.

The effective time range of this Strategy covers the decade to 2030, for which it sets specific targets. It also outlines the vision to 2050 and the main guidelines that will guide the development of the hydrogen market in the long term.

THE FOLLOWING TABLE OFFERS A BRIEF DESCRIPTION OF ANTICIPATED DEVELOPMENTS OVER THE TWO PERIODS.

Phase 1

2021-2030

START-UP AND ACCELERATION

- First renewable or low-carbon hydrogen production projects.
- Maturing of these projects and sustained growth of production.
- Relevant experiences in the production of synfuels.
- First pipeline transport and distribution infrastructures.
- First industrial and transport consumers, including installations in buildings in the second part of the decade.
- Construction of the first hydrogen filling stations and transport and distribution infrastructures in all three constituent provinces.
- Alignment of the Basque industrial and scientific/technological fabric with the needs of the international market.
- Establishment of the foundations on which to base sustained growth and the creation of a hydrogen ecosystem.

Phase 2

2030-2050

MATURATION AND DEPLOYMENT

- Mass roll-out of green hydrogen and large-scale spread in production.
- Total replacement of production of conventional fuels by synfuels.
- Existence of a significant hydrogen transport and distribution network to serve industrial consumers and buildings.
- General roll-out of hydrogen consumption in industry and first uses in residential and tertiary buildings.
- General roll-out of hydrogen consumption in transport. Extensive network of hydrogen filling stations in the Basque Country. Easy public access.
- Use of hydrogen as a means of seasonal storage for surplus renewable energy.
- Hydrogen bunkering facilities in the Port of Bilbao.

5

Action Plan

THE ACTION PLAN CONTAINING THE MEASURES OF THIS STRATEGY IS STRUCTURED INTO THE FOLLOWING SIX AXES:

- **AXIS 1: PRODUCTION**
- **AXIS 2: STORAGE, TRANSPORT AND DISTRIBUTION**
- **AXIS 3: END USES**
- **AXIS 4: INDUSTRIAL AND TECHNOLOGICAL DEVELOPMENT**
- **AXIS 5: MARKET**
- **AXIS 6: REGULATORY FRAMEWORK AND CROSS-CUTTING ASPECTS**

5.1. AXIS 1

PRODUCTION

CURRENT SITUATION

In the Basque Country, around 50,000 tons of hydrogen are produced annually. About two-thirds comes from reforming natural gas, and therefore has a certain carbon footprint, although some of the carbon dioxide is captured and put to other industrial uses. Of the remainder, most is obtained as a by-product in the petrochemical industry.

In addition, there is a small degree of production from the electrochemical industry, part of which is marketed by an industrial gas company.

Globally, about 95%[17] of production is from natural gas, oil and coal. The rest is obtained as a by-product of the electrochemical and steel industries. Renewable hydrogen production is limited to demonstration projects.

PHASE 1: 2021-2030

The first experiences in renewable hydrogen production should be seen in the early years of the decade, with the beginning of production of synthetic fuels using hydrogen and captured carbon dioxide as feedstock.

At the same time, the necessary modifications will have to be made to capture the carbon dioxide produced from natural gas reforming, increasing the production of blue or low-carbon hydrogen.

The first experiments in hydrogen production from thermochemical processing of different types of waste, as well as other production technologies with a high innovation component, should also be promoted.

The second half of the decade should see consolidation of the first renewable hydrogen production experiences. As part of a general decentralisation policy, production plants should be operating in all three Basque provinces. Hydrogen production from natural gas reforming without carbon capture should be abandoned, and 100% of production by 2030 should be renewable or low-carbon (excluding the hydrogen obtained as a by-product of other processes).

The strategic objective for 2030 is for installation of 300 MW of electrolysis capacity in the Basque Country. This will in turn require significant investment in renewable electricity generation plants.

By the end of the period, a quantity of more than 2,000 tonnes of synthetic fuels will be produced annually for consumption in transport.

17 IRENA (2018).

THE FOLLOWING LINES OF ACTION HAVE BEEN ESTABLISHED:

1.1 Promotion of installation of **electrolysis plants** to produce hydrogen using renewable energy.

1.2 Promotion of installation of **plants to produce hydrogen from waste, biogas,** or other low-carbon innovative technologies.

1.3 Encouragement of the **adaptation of existing hydrogen production plants** from fossil energy sources to install technology for **carbon capture, storage and use.**

1.4 Promotion of installation of **decentralized hydrogen production plants,** associated with a single consumer to minimise logistics costs.

1.5 Leadership and support for regulatory, financial, technological and industrial initiatives aimed at creating the conditions for a **reduction in green hydrogen production costs.**

1.6 Promotion of the **production of synthetic fuels and biofuels** from renewable or low-carbon hydrogen, with high added value due to their simple logistics and usability.

PHASE 2: 2031-2050

By 2050, 100% of hydrogen production in the Basque Country should be certifiably renewable. At the same time, the production of conventional fuels should have been replaced by a powerful industry for producing synfuels for use in all sectors, including maritime and air transport. In addition, hydrogen production will play a relevant role in valorisation of different types of waste.

5.2. AXIS 2

STORAGE, TRANSPORT AND DISTRIBUTION

CURRENT SITUATION

At present, there are no significant logistics infrastructures in the Basque Country aside from the minimum structure required for the distribution of hydrogen as an industrial gas, since the only large consumer produces it on-site.

At a European level, important pilot experiences in transport infrastructures are underway, including the hydrogen pipelines operating in Germany's Ruhr basin and in the Netherlands.

In addition to the infrastructures for transporting pure hydrogen, the possibility of transporting it in a blend with natural gas using existing pipelines is being investigated. There are many uncertainties, related mainly to leakage, weakening of metal structures and the capacity of boilers, engines and other end-use equipment.

In the longer term, it is planned to transform the natural gas infrastructure to transport pure hydrogen, as set out in the *European Hydrogen Backbone*[18] report, drawn up by eleven of the main European gas infrastructure operators.

In order to enable this gas to be used as an instrument for long-term and large-scale energy storage, the technical and economic feasibility of different alternatives is being studied. These include the use of geological features such as salt caverns and other solutions involving the use of carriers, such as ammonia or liquid organic hydrogen carriers (LOHCs).

PHASE 1: 2021-2030

The first dedicated transport infrastructures associated with the main distribution centres should have been completed by the beginning of this period. At the same time, construction of a network that supports the development of a local hydrogen production, commercialization and consumption ecosystem should be planned.

Following an appropriate review of the applicable legislation and regulations, the first experiments related to injection and transport of hydrogen through the natural gas network should also be carried out.

By the end of the decade, the Basque Country will have a strategic pure hydrogen transport and distribution infrastructure based on the location of the centres of production and the main industrial consumers, following assessment of the alternative of converting existing natural gas transport and distribution infrastructure for use with pure hydrogen or in combination with renewable methane.

In turn, it will be necessary to study the feasibility and need for large-scale storage infrastructures.

18 **European Hydrogen Backbone** (2020)

THE FOLLOWING LINES OF ACTION HAVE BEEN ESTABLISHED:

2.1 Planning and promotion of **strategic logistical infrastructures** to enable a robust and sustainable **local hydrogen ecosystem to be developed,** which will form the basis for a future international trade logistics centre, relying on resources such as the Basque seaports.

2.2 Construction of new **infrastructures for transport and distribution of pure hydrogen** to facilitate access to the product for potential consumers.

2.3 Study of **adaptation and use of natural gas infrastructures** for hydrogen injection, transport and distribution, promoting pilot or demonstration projects to contribute to the establishment of technical standards and requirements.

2.4 Feasibility analysis of producing **hydrogen carriers** as an alternative means of storage and transport.

2.5 Analysis of the need for and feasibility of implementing **large-scale storage infrastructures**, including underground storage alternatives such as salt caverns and other geological features.

PHASE 2: 2031-2050

In 2050, it will be possible to receive a supply of green hydrogen at a reasonable price, for any type of use and anywhere in the Basque Country, as the natural gas network will have been transformed and will only transport renewable gases. The seaport of Bilbao will be active in exporting hydrogen produced locally and within the port's area of influence.

5.3. AXIS 3

END USES

CURRENT SITUATION

In the Basque Country, apart from agents that produce their own hydrogen, a few hundred tonnes a year are consumed in the glass, iron and steel, food and chemical industries, all for non-energy uses.

Worldwide, 110 Mt are consumed annually, practically all as feedstock, mainly in the refining industry, in the ammonia production industry and in the methanol industry, with these processes accounting for approximately 90% of total global consumption of pure hydrogen.

As for its use as an energy carrier, currently non-existent in the Basque Country, there are around 400 supply stations in the world serving just over 10,000 vehicles. There are also increasing numbers of experiments with fuel-cell-driven urban buses, also in Europe. Outside the area of mobility, there are over 200,000 fuel cell installations in the residential sector in Japan.

PHASE 1: 2021-2030

In the first few years, the first experiments in the transport sector should be promoted, and around 2024 the first electric vehicles with fuel cells, mainly buses, should be on the road in the Basque Country. By that time, the first public-access filling station supplying hydrogen for transport will have been opened and, by the end of the decade, at least 10 stations will be operating in all three provinces. These will serve a fleet of around 20 buses or coaches and 450 goods vehicles of different sizes.

In the industrial sector, some consumers using hydrogen as feedstock will start using renewable or low-carbon hydrogen. Later on, there will be numerous experiences of use in energy applications, as a substitute for fossil fuels.

Over the course of the decade, the first application projects in the building sector should be promoted, especially in the vicinity of production sites.

During this period, the first hydrogen bunkering operations will be carried out at Basque ports.

THE FOLLOWING LINES OF ACTION HAVE BEEN ESTABLISHED:

INDUSTRY

3.1 **Analysis of the potential for reducing emissions from Basque industry** through the use of hydrogen as feedstock or for energy applications, developing long-term sectoral decarbonization strategies.

3.2 Associated with the previous measure, it will be useful to have a **map of potential hydrogen consumers** in the Basque Country, in industry and other sectors.

3.3 Promotion of **replacement of grey hydrogen by renewable** or low carbon hydrogen as **feedstock for industrial consumers**, as a way of reducing the carbon footprint of their products.

3.4 Promotion of a **fuel switch to hydrogen** or blends containing it **in industry** as a means of reducing carbon footprint. This measure could be employed in the chemical, petrochemical, steel and logistics industries and, in general, in any sector that is an intensive user of natural gas and other fossil fuels.

3.5 Feasibility analysis of **reducing emissions associated with CHP facilities that consume natural gas** by substituting all or part of it with hydrogen or its by-products.

3.6 Feasibility analysis of introducing **percentages of hydrogen or derived products in electricity generation plants,** such as natural gas combined cycles.

BUILDINGS

3.7 Use in **cogeneration (CHP) with fuel cells in buildings**. Promotion of pilot projects for technological validation and development of incentive programmes for installation.

3.8 Promotion of **demonstration projects for the use of boilers** and other gas equipment to run on **hydrogen or blends** containing it.

3.9 Promotion of the **adaptation of equipment for the consumption of hydrogen** or hydrogen-containing blends in buildings.

TRANSPORT AND MOBILITY

3.10 Promotion of the **replacement of fossil fuels in transport with hydrogen** or hydrogen-containing blends. This measure is mainly aimed at bus fleets and heavy goods transport, but may extend to other users, including maritime transport. Although consumption will generally be in fuel cell vehicles, for certain applications the feasibility of using hydrogen blends with fossil fuels such as natural gas could be analysed.

3.11 Promotion of the **implementation of hydrogen filling stations in the Basque Countr**y, from the perspective of the potential needs of the fleet owners, through aid programmes or other financing instruments.

3.12 Feasibility analysis of creating a logistics company **for supplying hydrogen in mobility with public participation**, to promote the introduction of the first electric vehicles powered by fuel cells in the Basque Country, with particular attention on bus fleets and other heavy vehicle operators.

3.13 Leadership and support for initiatives aimed at **simplifying the legal process for the construction of hydrogen filling stations**, eliminating unnecessary administrative obstacles.

3.14 Implementation of **incentive programs for acquisition of fuel-cell electric vehicles**, especially aimed at heavy vehicles.

3.15 Pilot projects **for the use of synthetic fuels** or other products derived from hydrogen, mainly oriented towards **heavy road transport** and **maritime transport**.

3.16 Use of hydrogen as a fuel in environments such as **seaports**, airports and other public and private logistics infrastructures.

3.17 Feasibility analysis of introducing **bunkering resources for hydrogen** or derived products in Basque ports.

3.18 Study of implementation of **river-borne transport propelled by hydrogen** or its by-products to replace fossil fuels.

CROSS-CUTTING MEASURES

3.19 **Exemplary role of the administration**, promoting the use of hydrogen in its premises.

PHASE 2: 2031-2050

By 2050, hydrogen vehicles will be a familiar sight and will no longer be seen as a novelty. Industrial and residential and service consumers will account for a significant level of demand for energy uses. A high percentage of homes where electrification of thermal needs by heat pump is not feasible will consume hydrogen, either in cogeneration systems with fuel cells, or in boilers, pure or blended with other renewable gases.

A high percentage of homes where electrification of thermal needs by heat pump is not feasible will consume hydrogen

INDUSTRIAL AND TECHNOLOGICAL DEVELOPMENT

CURRENT SITUATION

At international level, there are several guidelines on industrial and technological development, with which the Basque Hydrogen Strategy is aligned.

On the one hand, the European Hydrogen Strategy, mentioned in chapter 4.1, sets out different areas that will require important technological developments over the next decade:

- On the production side, the size of electrolysers will need to be increased, first to 100 MW, and then to 1 GW. Important developments are also expected in production from algae, direct solar production and pyrolysis processes with natural gas.
- With regard to infrastructures, it will be necessary to develop logistics for large volumes and distances, and to study the readaptation of the natural gas network.
- Finally, large end-use projects will be needed to test the technologies, mainly in industry and transport.

More specifically, European industry and the scientific-technological community, through the *Hydrogen Europe* and *Hydrogen Europe Research* associations, have published their *Strategic Research and Innovation Agenda*[19]. This report proposes a research agenda for the coming years, and contains detailed roadmaps for the development of seven specific targets divided into three pillars:

PRODUCTION

1. Low-cost production of clean hydrogen.
2. Enable greater integration of renewable energies into the energy system.

DISTRIBUTION

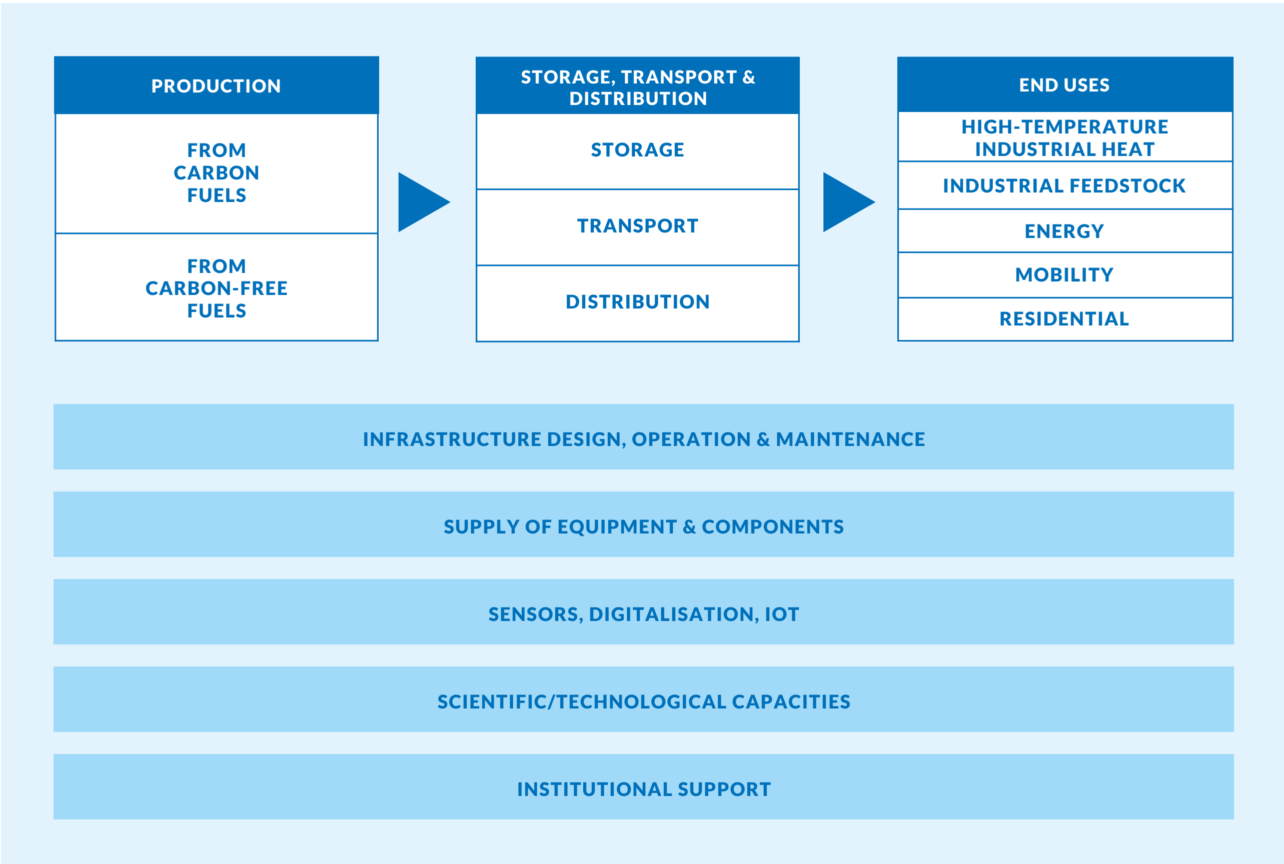
3. Low-cost supply of clean hydrogen.
4. Develop a clean hydrogen refuelling infrastructure.

END USES

5. Ensure competitiveness of clean hydrogen for mobility applications.
6. Meet heat and power demands with clean hydrogen.
7. Decarbonisation of industry with clean hydrogen.

There are currently more than 70 companies in the Basque Country operating in different fields related to hydrogen technologies, covering all links in the value chain.

19 **Strategic Research and Innovation Agenda**.



In addition, seven agents of the Basque Science, Technology and Innovation Network currently have scientific-technological capabilities in hydrogen.

The areas of knowledge and experience identified include hydrogen production from different electric and thermochemical technologies, systems integrating renewable plants and electrolysers, technologies related to transport, storage and separation of hydrogen from blends with other gases, different types of hydrogen solutions in road, rail and maritime transport, and diverse equipment and components.

PHASE 1: 2021-2030

The Basque industrial fabric and the Basque Science, Technology and Innovation Network will have to find potential opportunities in the hydrogen value chain and explore previously identified lines of business and research further.

With reference to the three axes of this strategy set out above, the following areas of industrial and technological development have been identified:

Establishment of an industrial and technological roadmap to take advantage of business opportunities for Basque companies in the hydrogen value chain

Axis 1 **PRODUCTION**	— Solid oxide electrolyser cells. — Components, systems and integration with renewable generation. — Thermochemical production, from solar energy and biological processes. — Production of synthetic fuels.
Axis 2 **STORAGE, TRANSPORT AND DISTRIBUTION**	— Increased durability and reliability of components and systems in operation. — Hydrogen separation from blends. — Hydrogenation and dehydrogenation reactors. — Development of carriers and new liquefaction systems.
Axis 3 **END USES**	— Optimisation, reliability, lightening of components for hydrogen filling stations: compressors, tanks, pipes, etc. — Integration of on-board systems. — Safety systems: monitoring and sensors. — Integration of the drive system in buses and coaches. — Traction with synthetic fuels and on-board hydrogen production on trains and ships. — Aerial urban mobility. — Hydrogen combustion. Systems and components. — Cogeneration for industry and buildings. — Use as feedstock in industry.

THE FOLLOWING LINES OF ACTION HAVE BEEN ESTABLISHED:

4.1

Establishment of an industrial and technological roadmap to take advantage of **business opportunities** for Basque companies in the hydrogen value chain, including production, transport, storage and consumption, to position themselves as technology exporters.

4.2

Reinforcement, widening and deepening of **existing hydrogen-related lines of research in the centres in the Basque Science, Technology and Innovation Network**, in order to position them as suppliers to local and international industry.

4.3

Study of the possibility of including hydrogen technologies as one of the **lines of specialization in one of the research infrastructures** of the Autonomous Community.

4.4

Promotion of Basque participation in **R&D projects to reduce costs** throughout the value chain.

4.5

Promotion of the development of **technology related to fuel cell engines** for vehicles, as part of the process of adapting the Basque automotive components industry to the new engines.

4.6

Development of **technology related to the manufacture of electrolysers with capacity of around 100 MW**, in line with the targets set out in the European strategy.

4.7

Development of **innovative** electrical and thermochemical **technologies for hydrogen production**, from solar energy, biological processes, etc.

4.8

Facilitation of **controlled environments for demonstrating and validating innovative applications** such as the use of gas networks with different hydrogen contents or the implementation of energy solutions for buildings.

4.9

Favour the positioning of Basque companies to take advantage of business opportunities in the **manufacture of buses and other heavy road vehicles, aeronautics, rail and shipping**, and associated equipment.

4.10

Promotion of **participation by Basque companies and technology centres in local and international projects and consortia**, aimed at developing products and technology related to the value chain.

5.5. AXIS 5

MARKET

CURRENT SITUATION

There is currently no wholesale hydrogen market *per se* operating anywhere in the world. Hydrogen is traded on a market comprised of producer-suppliers and consumers, based on medium and long-term supply contracts. These agreements may be framed within centralized production models, with supply of hydrogen to the customer in gas or liquid form via trucks, or in decentralised models, where the supplier builds and operates the production and storage infrastructures on the customer's behalf. These infrastructures are located at the point of consumption.

Hydrogen is traded on a market comprised of producer-suppliers and consumers, based on medium and long-term supply contracts

PHASE 1: 2021-2030

The production, distribution and consumption projects that are beginning to be developed in the Basque Country form the basis for incipient growth of the market. By the end of this period, it is hoped that there will be several green hydrogen producers in the Basque Country, thus creating the conditions for establishing a competition-based market. The bases are established for the constitution of a Basque hydrogen ecosystem, with all agents of a mature market in place.

THE FOLLOWING LINES OF ACTION HAVE BEEN ESTABLISHED:

5.1

Relying on production and consumption capacities, and on transport and storage infrastructures, promotion of the **creation of a local market**, with the presence of all agents: producers, transporters, distributors, marketers and consumers. Growth of this market is essential for the **establishment of a hydrogen ecosystem**, which in turn will serve as a basis for gaining a position for a future international market for the product and its derivatives.

5.2

Establishment of a **hydrogen production and consumption database**, to promote market transparency and facilitate monitoring.

5.3

Use of synergies with seaports to grow towards an **international hydrogen trading centre**.

PHASE 2: 2031-2050

During this period, a solid and transparent mature hydrogen market must be developed, with a large number of players performing production, transport, distribution, marketing and consumption functions.

At the same time, it will be necessary to take advantage of the transport flows from producing to consuming regions, foreseeably on south-north axes, in order to position the Basque port infrastructures as hydrogen import and export logistics centres.

5.6. AXIS 6

REGULATORY FRAMEWORK AND CROSS-CUTTING ASPECTS

CURRENT SITUATION

The current regulatory framework is not well suited to developing the use of hydrogen as an energy carrier due to the fact that, traditionally, it has only been used as feedstock in the industrial sector. Shortcomings have been identified in relation, *inter alia*, to the regulations governing the construction of hydrogen filling stations, training and qualification of professionals, classification of all types of hydrogen production as an industrial activity, the great complexity of the administrative processing required for installations and the lack of regulation on usage in buildings.

This affects the entire value chain, and hinders the development of new uses for hydrogen, for example, in transport or for generating electricity using fuel cells.

It is particularly necessary to establish harmonised European standards on safety and a methodology for certifying origin.

At the same time, it is essential to establish regulations related to criteria for classing hydrogen production as 'green'. These include the distance and connection between the production plant and the renewable generation plant, or how the balance of electric energy consumed in the electrolyser and produced in the renewable installation is quantified.

In addition, it would be helpful for the structure of access fees to the electricity grid to take into consideration the special situation of renewable generation plants legally associated (in whatever form) with the production of green hydrogen, thus facilitating the viability of integrated projects.

PHASE 1: 2021-2030

In the short and medium term, any update to the regulatory framework should focus on measures to address the most immediate needs, with a view to encouraging the development of the first projects and experiences.

During this period, a shared system of guarantees of origin for the whole of Europe will have to be implemented

Firstly, it will be necessary to adopt measures that facilitate the production of green hydrogen from renewable electric energy, eliminating regulatory obstacles and promoting it through tax incentives or other types of economic incentive.

At the same time, it will be necessary to adapt regulations to facilitate the development of hydrogen transport, distribution and storage networks, with a view to facilitating its use in different sectors.

Likewise, regulation should be modified to facilitate the deployment of new facilities, the use and adaptation of natural gas infrastructures, and other types of infrastructures, such as seaports, which could be fundamental in the development of a hydrogen economy.

During this period, a shared system of guarantees of origin for the whole of Europe will have to be implemented, an indispensable tool for adding value to the production and use of renewable gases.

Outside the regulatory sphere, at the academic level, the necessary curricula will have to be designed for training qualified personnel at all levels.

Finally, it will be necessary to implement information campaigns to raise public awareness of hydrogen technologies. Given the gaseous nature of the product, the general public are likely to view it as being dangerous (as has been the case in the past with natural gas and butane). Here it will be essential to apply the lessons learned from previous experiences with other gases.

THE FOLLOWING LINES OF ACTION HAVE BEEN ESTABLISHED:

REGULATORY MEASURES

6.1 Advocate for the establishment of **harmonised sustainability standards**, with clear definitions of hydrogen types according to their impact on the environment, that enable international trade to develop.

6.2 Support for the establishment of a scheme of **guarantees of renewable origin** of hydrogen and other gases, in order to boost the growth of the renewable energy market.

6.3 Proposals to **remove unnecessary regulatory barriers** hindering the development of different elements in the value chain, together with **simplification of administrative procedures**.

6.4 Promotion of the **introduction of new regulations** to boost the development of the hydrogen market.

6.5 Promotion of the introduction of **specific regulations for the construction of hydrogen filling stations** for hydrogen supply in transport.

6.6 Proposals for **changes to the current classification of hydrogen production as an industrial activity** in certain cases, in order to simplify the implementation of small clean production facilities and facilitate decentralization.

6.7 Establishment of a **simplified administrative procedure for small hydrogen production facilities.**

6.8 Promotion of the establishment of a **specific regulation** for the production, storage and use of **hydrogen in buildings**.

6.9 Facilitation of RDI activities and the development of hydrogen demonstration projects by means of **regulatory sandboxes**.

OTHER CROSS-CUTTING MEASURES

6.10	Establishment of **specialized professional qualifications** in the handling of hydrogen and its associated technologies.
6.11	Adaptation of the training offered in **vocational education** and the **university system**.
6.12	Support for Basque participation in a possible **IPCEI project** related to the hydrogen value chain.
6.13	Promotion of participation by the different Basque agents (public and private) in **international networks**, forums, associations, consortiums, etc., related to the promotion of hydrogen and its technologies.
6.14	Study on including hydrogen-related equipment in the **Basque List of Clean Technologies**.
6.15	Introduction of **public information campaigns**, with the aim of providing the population with access to simple, accurate information on the role hydrogen can play in the energy transition and the decarbonization of the economy, as well as safety aspects, which will, in all likelihood, be a topic of some debate.

PHASE 2: 2031-2050

In the medium and long term, the goal must be to develop a specific and comprehensive regulatory framework for hydrogen.

Over the coming decades, the market will have to opt for partial integration of hydrogen into the natural gas system or, more radically, for a complete transformation of the gas system into a pure hydrogen system. This will condition the necessary regulatory developments.

In any case, the introduction of hydrogen within existing professional skills profiles (fitters, fire-fighters, workshop technicians, inspectors, etc.) should be considered, as well as the accreditation of companies specialising in hydrogen installations and centres for verification of hydrogen purity, and the inclusion of training related to the hydrogen sector in the education offered at vocational and university level.


HYDROGEN
ENERGY STORAGE

6

Targets and Impact

6.1. TARGETS

In coherence with the strategic positioning described in this document, the targets to 2030 are set out below. The degree to which these targets are met will give a measure of the prospects for developing a local ecosystem of hydrogen production, distribution and consumption.

2030 TARGETS	
PRODUCTION	Installed electrolysis capacity of 300 MW.
	100% of all hydrogen produced to be of renewable or low-carbon origin.
	Annual production of 2,000 t/year of synfuels.
END USES Industry	90% of hydrogen consumed in industry as feedstock to be of renewable or low-carbon origin.
	Hydrogen accounting for 5% of total energy consumption in the industrial sector.
END USES Buildings	10 pilot projects for hydrogen use in buildings.
END USES Transport and Mobility	Fleet of 20 hydrogen buses in the Basque Country.
	Fleet of 450 goods transport vehicles of varying sizes.
	Network of 10 public access hydrogen filling stations, covering all three provinces.

6.2. ECONOMIC IMPACT

Achieving the above targets will require a major investment agenda that will have to be led by private agents, but with strong backing from all levels of government.

In the area of industrial and technological development, between 130 and 260 million euros will be required

In the area of production, investments of between 350 and 630 million euros will be required over the next decade to introduce the necessary electrolysers and hydrogen production plants using thermochemical technologies, in order to adapt existing production and provide it with carbon dioxide capture capacity or to install plants for producing synfuels.

At the same time, between 250 and 350 million euros will be needed to complete the storage, transport and distribution infrastructures that will enable the growth of a robust local market.

In the field of final consumption and applications, investment of between 170 and 250 million euros will be required. This will be used in installation of hydrogen filling stations, introduction of fuel cell vehicles, adaptation of industry for hydrogen consumption and the first experiences in the buildings sector.

In the area of industrial and technological development, between 130 and 260 million euros will be required to promote actions aimed at placing the Basque business fabric in the best conditions *vis-à-vis* development of the hydrogen market in Europe and globally.

Finally, smaller amounts (around 10–20 million euros), will be required for cross-cutting aspects such as the creation of a market platform, regulatory changes and areas related to education and awareness-raising.

AXES	ESTIMATED INVESTMENT (€m)
AXIS 1: PRODUCTION	€350-630m
AXIS 2: STORAGE, TRANSPORT AND DISTRIBUTION	€250-350m
AXIS 3: END USES	€170-250m
AXIS 4: INDUSTRIAL AND TECHNOLOGICAL DEVELOPMENT	€130-260m
AXIS 5: MARKET	€10-20m
AXIS 6: REGULATORY FRAMEWORK AND CROSS-CUTTING ASPECTS	
TOTAL	**€910-1,510m**

In addition to these investments, it is estimated that between 600 and 900 million euros will have to be mobilised to install the renewable electricity generation capacity needed to feed the electrolysers targeted in this strategy.

6.3. ENERGY AND ENVIRONMENTAL IMPACT

Hydrogen will generally be used as a replacement for a conventional fuel or technology and will lead to a reduction in greenhouse gas emissions. Moreover, when hydrogen is produced from renewable sources, it will also lead to savings in primary energy. The magnitude of the impact on the energy system and environmental aspects will depend on the end uses, which, as explained throughout this document, are very diverse in nature. The following paragraphs review some (though not all) of the main applications and their implications on the replacement of other types of fuels or energy carriers.

In the transport sector, for example, hydrogen can be used in fuel-cell vehicles, which would replace vehicles powered by traditional fuels such as diesel, marine diesel or kerosene. It is expected that most hydrogen consumption in transport in 2030 will be in road transport, mainly in heavy vehicles.

Another applicable technological pathway, also closely linked to transport, is the production of synfuels from hydrogen and captured carbon dioxide. This process can be used to produce fuels with characteristics similar to those of petrol, diesel and kerosene, for example. In this case, the fuels produced would directly replace the corresponding fossil fuels, the advantage being that they could make use of the existing logistical and dispensing infrastructures. This type of arrangement is expected to be especially significant in the market, especially in air transport, from the middle of the next decade.

In the industrial field, there will be two types of usage. In process applications, as a feedstock, the replacement of grey hydrogen by renewable hydrogen will directly reduce the consumption of natural gas used for reforming, thus cutting greenhouse gas emissions. Likewise, when it is used for energy purposes, generally in boilers for high temperature heat generation, it will replace a fossil fuel — which in many cases will again be natural gas.

In buildings, hydrogen can be used for heating and producing hot water in boilers and even to generate electricity and heat through fuel-cell-based CHP systems, substituting electricity and fossil fuel consumption.

Finally, part of the hydrogen produced can be stored, to be used for buffering and balancing the energy system. It can subsequently be used to generate electricity via fuel cells or through the technological pathways described in the paragraphs above or others.

Once the fundamental areas of use have been identified —and accepting that there is great uncertainty as regards distribution among the different sectors and uses— it is estimated, based on the 2030 targets in this document, that around 100,000 tonnes of hydrogen of renewable or low-carbon origin could be produced by that year. This would enable savings of between 210,000 and 290,000 toe of non-renewable primary energy, through a reduction in the consumption of natural gas, electricity, transport fuels, etc.

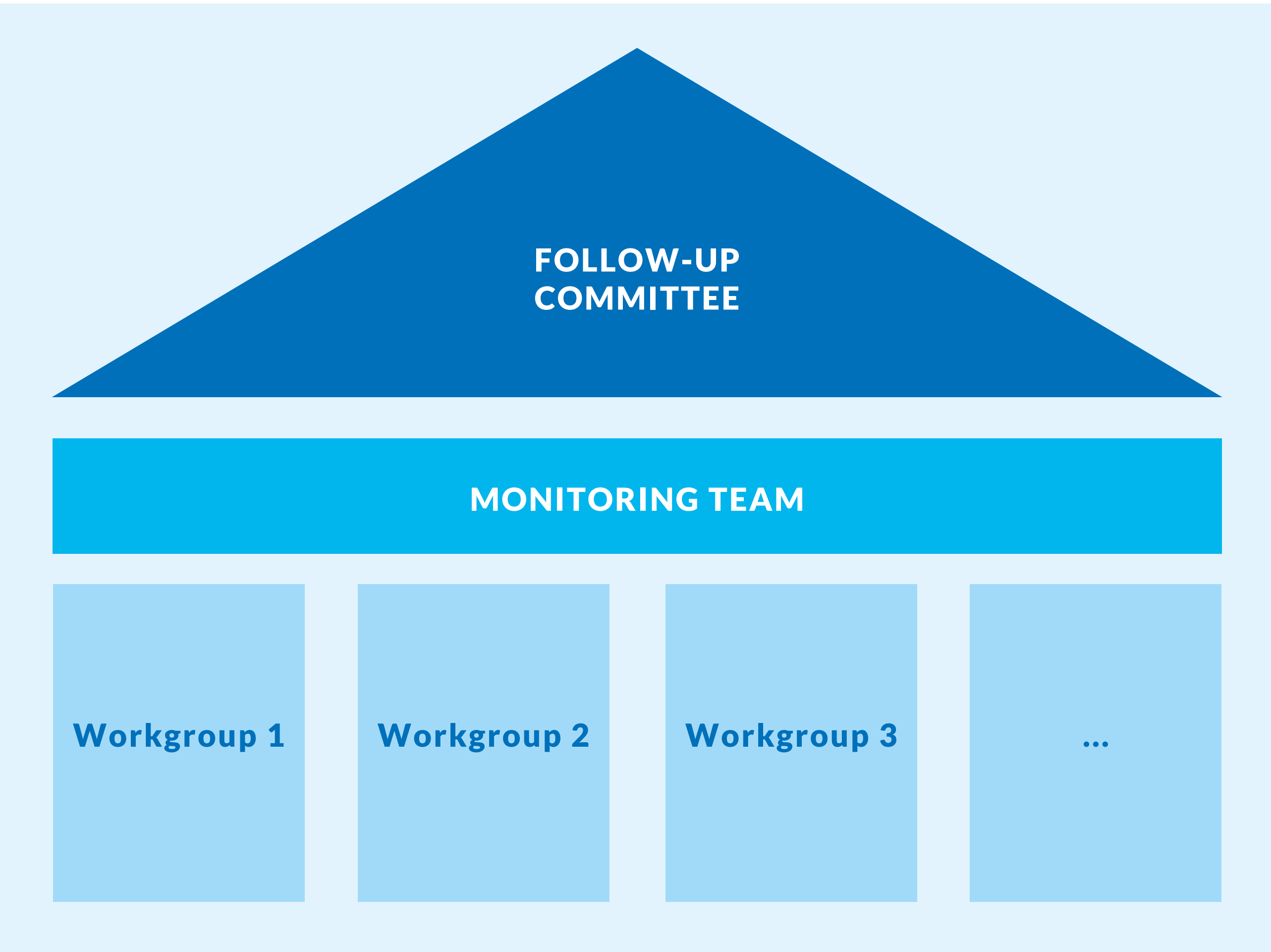
In turn, this reduction in fuel consumption would lead to a reduction in greenhouse gas emissions of between 590,000 and 790,000 tonnes of carbon dioxide equivalent.

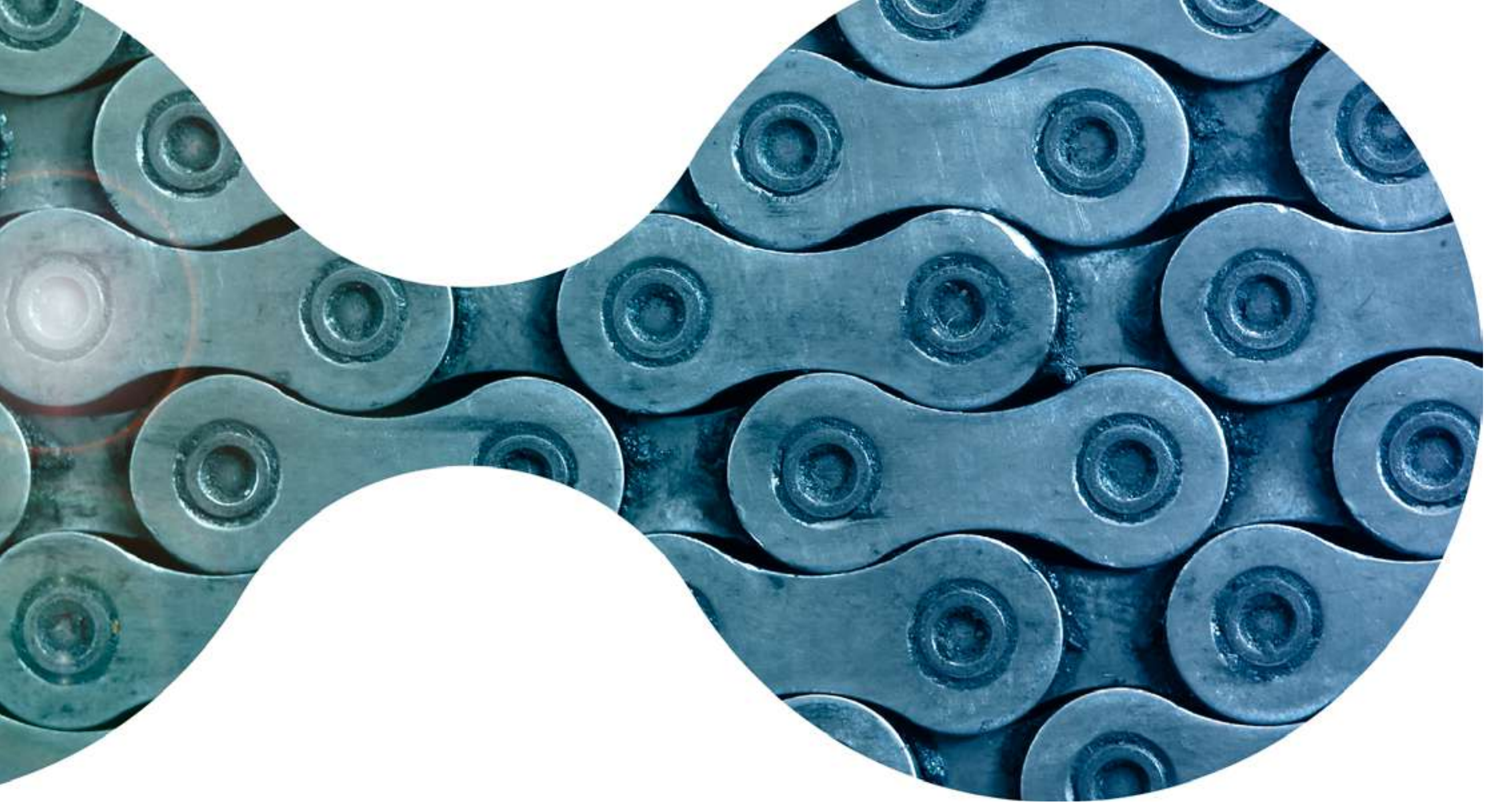
In process applications, as a feedstock, the replacement of grey hydrogen by renewable hydrogen will directly reduce the consumption of natural gas used for reforming, thus cutting greenhouse gas emissions

7

Governance

In order to ensure the deployment, monitoring and evaluation of this Strategy, it is considered necessary to set up the following governance bodies:





7.1. FOLLOW-UP COMMITTEE

The Follow-Up Committee will be responsible for guiding implementation of the strategy and for analysing monitoring and evaluation of its progress and results. It is intended to be a collaborative public-private body consisting of representatives of the following bodies:

- Basque Government's Department of Economic Development, Environment and Sustainability (chair).
- Ente Vasco de la Energía (EVE) (Basque Energy Agency).
- Business Development Agency of the Basque Country (SPRI).
- Energy Cluster Association.
- Basque Science, Technology and Innovation Network (to be chosen at the proposal of the chair).
- 'Driver' companies (to be chosen at the proposal of the chair).

In order to carry out its functions, as described below, the Follow-Up Committee will meet quarterly, although additional specific meetings may be convened when deemed fit. In addition, the members of the Committee may request the participation of additional experts to discuss or reflect on a specific topic when necessary.

The functions to be carried out by this body are as follows:

- To provide a global vision of the Basque Hydrogen Strategy, in terms of implementation, monitoring and evaluation.
- To conduct strategic analyses and submit general recommendations.
- To identify new strategic areas and initiatives to be promoted and become involved in developing them.

7.2. MONITORING TEAM

The Monitoring Team, comprising EVE and SPRI, will be in charge of managing and preparing the meetings of the Follow-Up Committee, and setting up and coordinating the working groups deployed, and also for promoting actions intended to disseminate the activities and results of the Strategy.

In addition, it will be responsible for collecting the data for the table of indicators defined in the Strategy, which it will submit to the Follow-Up Committee in an annual evolution report analysing the most relevant events or deviations during the period.

The Monitoring Team will be in charge of managing and preparing the meetings of the Follow-Up Committee, and setting up and coordinating the working groups deployed, and also for promoting actions intended to disseminate the activities and results of the Strategy

In addition, on a three-yearly basis, the Monitoring Team will submit an overall evaluation report of the Strategy to the Follow-Up Committee; this report may include amendments to the Strategy and its targets, etc. These reports will be submitted in 2024, 2027 and 2030.

In a complementary manner, it will report periodically to the Energibasque Steering Group on the progress and results of the Strategy.

Before 2030, the Monitoring Team will set out a process for developing a new strategy with targets for 2040 and a vision for 2050.

7.3. WORKING GROUPS

Deployment of the Strategy is structured through the creation of specific working groups to address in detail the different challenges identified within the framework of the Strategy.

Each working group will be made up of at least one person representing a public body, one person representing the Basque Science, Technology and Innovation Network and one person representing the private business network.

Specific working groups to address in detail the different challenges identified within the framework of the Strategy

The groups must commit to dedicating the time and, where appropriate, the resources necessary to achieve the targets defined and to preparing deliverables to report to the Monitoring Team and the Follow-up Committee on the progress of the work.


H_2
Hydrogen
Hydrogen H_2
zero emission H_2

8

Interaction with Other Strategies

8.1. BASQUE ENERGY STRATEGY 2030

In the eight axes around which it its initiatives are structured, the *Basque Energy Strategy 2030*[20] addresses the development of hydrogen technologies marginally, mainly in association with the field of transport and mobility. However, deployment of the measures covered in this document is indisputably in line with the general energy objectives established, both at sectoral level and those related to the promotion of renewable electricity production and orientation of technological development.

LINE L1	Improving competitiveness and energy sustainability in Basque industry.
LINE L2	Reducing dependency on oil in the transport sector.
LINE L3	Reducing energy consumption and increasing the use of renewables in buildings and the home.
LINE L4	Promoting a more energy-efficient Basque public administration.
LINE L5	Encouraging efficiency and harnessing existing resources in the primary sector.
LINE L6	Promoting renewable energy production.
LINE L7	Supervising energy supply infrastructures and markets.
LINE L8	Orienting technological energy development.

As explained throughout this document, the deployment of technologies associated with hydrogen has the potential capacity to contribute significantly to primary energy savings; to a reduction in the Basque energy system's dependence on oil; to the introduction and use of renewable energies; and to the decarbonization of certain areas of the different sectors, all of which are specific and quantified targets of the Basque Energy Strategy.

20 **Estrategia Energética de Euskadi 2030**.

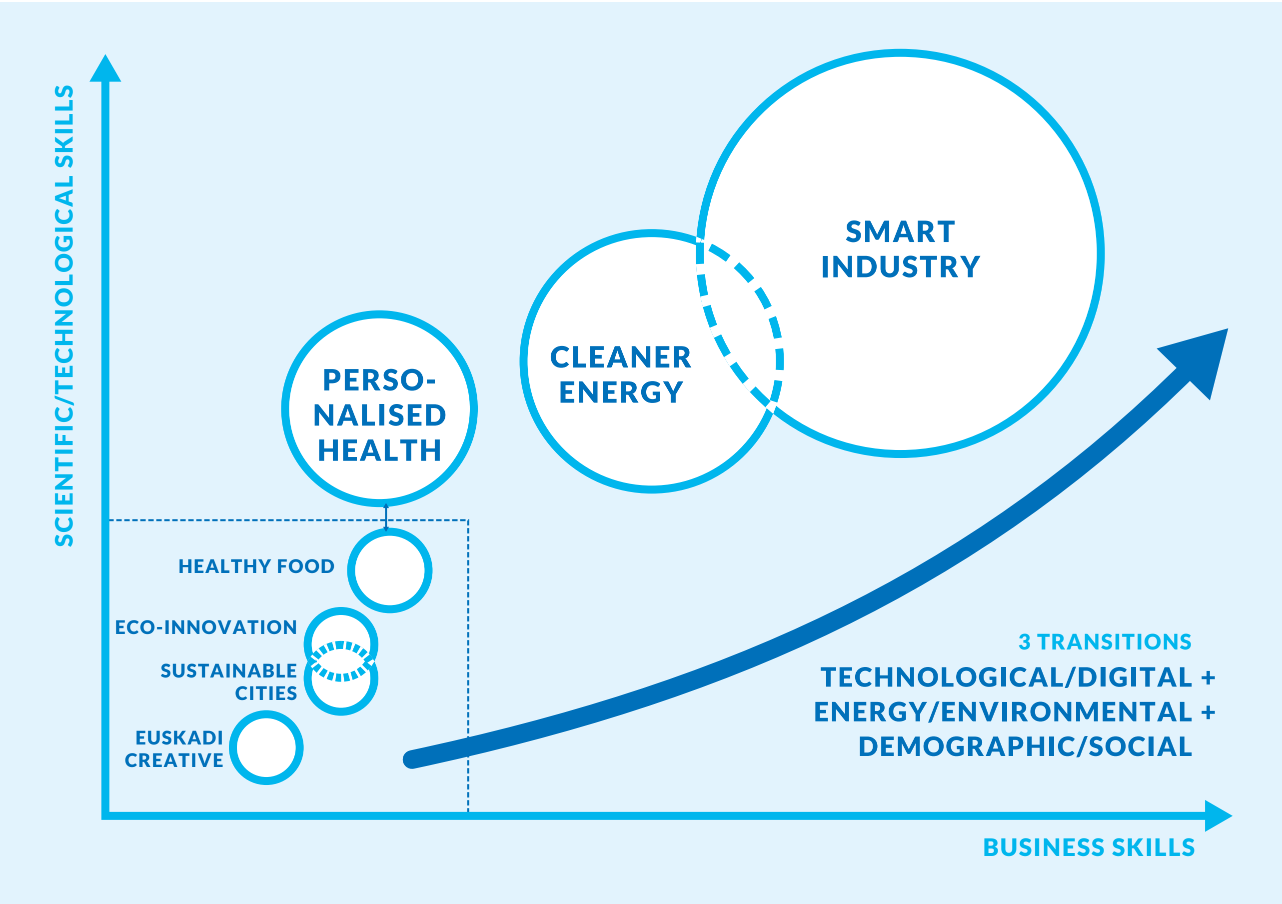
8.2. RIS3 SMART SPECIALISATION STRATEGY

The RIS3 Strategy[21] (*Research and Innovation Strategy for Smart Specialization*) is the strategy for territorial economic transformation that concentrates available resources on a limited set of R&D and innovation priorities.

This concept first arose at the European level when it was realised that many regional governments traditionally targeted their investment at certain areas of science, technology and innovation without considering the plurality and diversity of their contexts or establishing priorities. The strategy defends the need to identify specialised regional strategies that focus their resources and investments on areas with clear synergies with the region's existing and potential productive capacities.

Specifically, *cleaner energies*, *smart industry* and *personalised health* are the three strategic areas identified by the Basque RIS3 to 2030. In addition, the strategy identifies four areas of opportunity: healthy food, eco-innovation, sustainable cities and creative industries.

The details of the Basque Country's vision in the field of energy are set out in the Energibasque Strategy, summarised below.



Source: RIS3 3020, Lehendakaritza, Gobierno Vasco

21 **Estrategia vasca RIS3**.

8.3. BASQUE SCIENCE, TECHNOLOGY AND INNOVATION PLAN 2030

The Basque Science, Technology and Innovation Plan 2030 (PCTI) addresses all the efforts and stakeholders working on the Basque smart specialisation strategy (RIS3).

With the aim of *positioning the Basque Country among the most advanced European regions in the area of innovation, with a high standard of living and quality of employment*, the PCTI 2030 defines three strategic pillars to address a core element (talent) and four operational objectives to advance in the development of the strategic areas and territories of opportunities defined in the RIS3 Strategy.

OPERATING OBJECTIVES	PILLAR 1 SCIENTIFIC EXCELLENCE	PILLAR 2 LEADERSHIP IN INDUSTRIAL TECHNOLOGY	PILLAR 3 OPEN INNOVATION	TALENT
OPERATING OBJECTIVE 1 Results-oriented approach	●	●	●	▬
OPERATING OBJECTIVE 2 Business RDi	▬	●	●	▬
OPERATING OBJECTIVE 3 Internationalization of R&D	●	●	▬	▬
OPERATING OBJECTIVE 4 Talent	▬	▬	▬	●

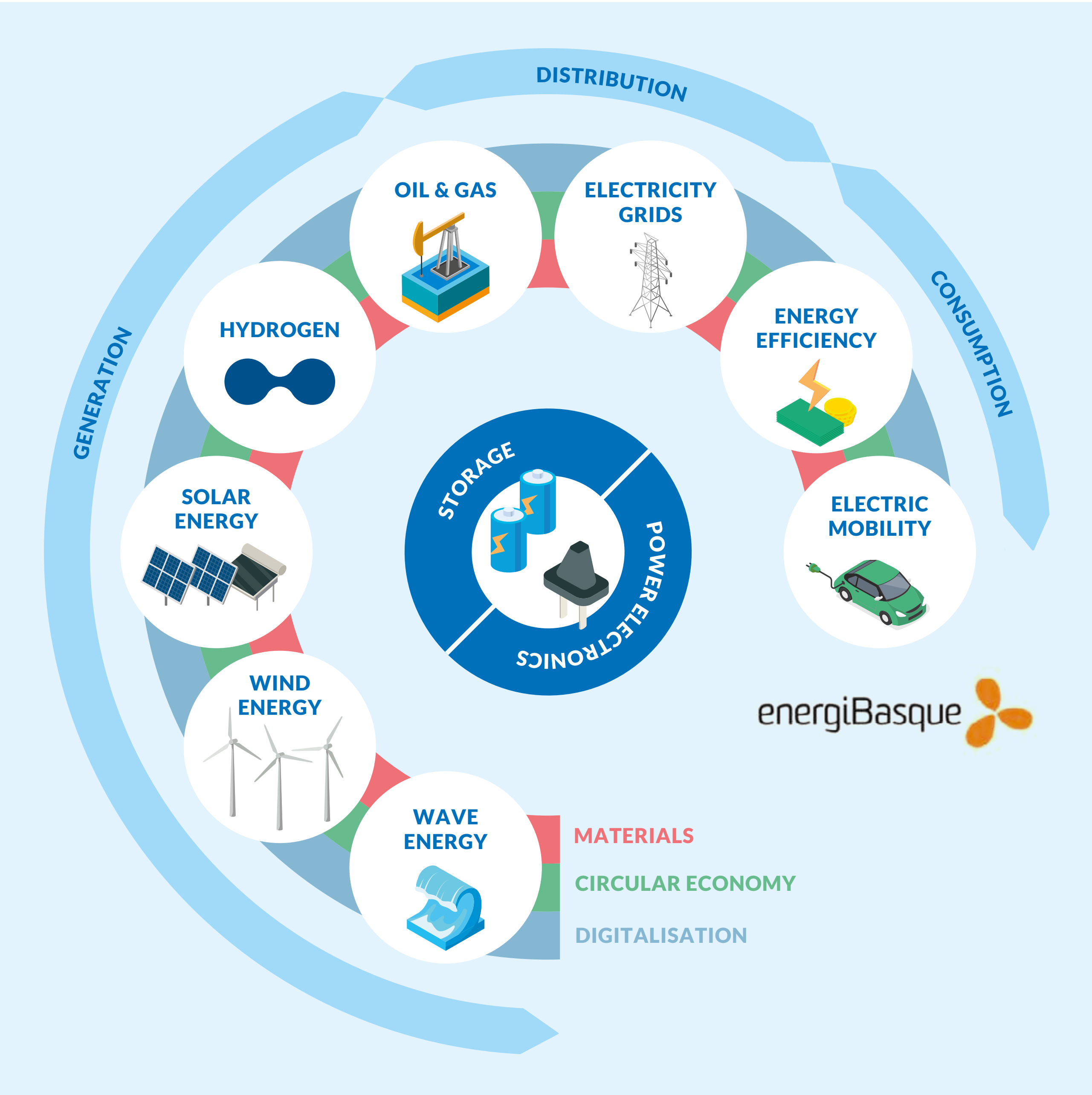
● Direct Contribution ▬ Indirect Contribution

Source: PCTI 2030, Lehendakaritza, Gobierno Vasco

8.4. ENERGIBASQUE STRATEGY

The mission of the Energibasque Strategy is to boost the competitiveness of companies in the energy sector in global markets through technological innovation, based on the smart specialisation policies for the Basque Country (RIS3), with the support of agents in the Basque Science, Technology and Innovation Network.

The latest update of the Energibasque Strategy, drawn up between 2019 and 2020, identifies eight strategic areas (based on traditional or emerging value chains in the sector) and five relevant enabling technologies, viewed as cross-cutting areas of knowledge that contribute value and development to energy areas, as well as related sectors.



Source: EnergiBasque Strategy

In the latest update, hydrogen has been added as a new strategic area of the Energibasque Strategy, in line with the interest and capabilities existing in the Basque ecosystem, as evidenced by an analysis of the value chain and scientific-technological capabilities summarized in Chapter 5.4.

The Energibasque Strategy establishes three general objectives, aimed at converting the region into a European benchmark for the development of industrial and technological initiatives in prioritised energy fields, thus contributing to the generation of wealth, employment and quality of life. These objectives are:

- To attract and engage leading companies on global markets to exert a driving influence throughout the value chains, by means of technological challenges and strategic initiatives to improve the competitive positioning of suppliers.
- To support business and technological activities with the aim of taking advantage of new business opportunities in the energy markets, based on the competitive advantages of the industrial fabric and the areas of specialisation of the scientific-technological agents.
- To promote the application and integration of key cross-cutting technologies for the development of value-added solutions in the prioritised energy areas and challenges.

The latest update of the Energibasque Strategy identifies eight strategic areas and five relevant enabling technologies, viewed as cross-cutting areas of knowledge that contribute value and development to energy areas, as well as related sectors

9

Conclusions

The growth of a hydrogen market at European level, associated with its use as a decarbonization mechanism in the most hard-to-decarbonise sectors and with mass integration of renewable energies, will create business opportunities and industrial and technological development opportunities for Basque companies.

Likewise, the establishment of a local ecosystem for the production, distribution and consumption of green or low-carbon hydrogen and its by-products will enable new decarbonization channels and thus place Basque consumer sectors in a position of greater competitiveness.

This Strategy proposes a number of different lines of action aimed at coordinating political action and business initiatives. Its aim is to place the Basque Country in the best position to respond to the challenges involved in developing a hydrogen economy.

APPENDIX 1
DEFINITIONS

The following terminology has been used in this document:

- **Renewable hydrogen** or **green hydrogen** is hydrogen produced from renewable sources, with associated greenhouse gas emissions that are either null or below the established threshold.
- **Non-renewable hydrogen** or **grey hydrogen** is hydrogen produced from non-renewable sources.
- **Low carbon hydrogen** or **blue hydrogen** is hydrogen produced from sources that are non-renewable but have associated greenhouse gas emissions below the established threshold.

The thresholds used to define renewable and low-carbon hydrogen will be as established in any guarantee-of-origin scheme, such as, for example, the one currently being tested within the framework of the CertifHy project[22].

22 **CertifHy** project.

APPENDIX 2
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DEPARTAMENTO DE DESARROLLO ECONÓMICO, SOSTENIBILIDAD Y MEDIO AMBIENTE