Why does Europe need green molecules?

Accelerating the decarbonisation of industry and heavy transport is key to Europe's energy independence and industrial competitiveness

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Welcome letter

The energy transition is one of the most important transformations of our time. In 2025, global energy consumption grew by 3%, driven by rising demand from electric vehicles and data centers. That same year, solar energy became, for the first time in history, the main driver of growth in global energy supply, accounting for more than a quarter of the increase in global energy demand, according to the International Energy Agency (IEA). The energy transition offers an opportunity to activate three key levers for Europe's future: decarbonizing the economy, gaining energy independence, and boosting industrial competitiveness; in fact, thanks to renewables, the EU saves €30 billion annually in energy costs. To activate these three levers, not only are electron-based renewable energies (solar and wind) necessary, but, as we will see in this report, they also depend largely on the rapid production and adoption of new energies based on green molecules, such as green hydrogen and its derivatives, 2G biofuels, biomethane, and other sustainable chemicals. At Moeve, we foresee these energies representing between 25% and 33% of the European energy mix by 2050. To achieve these goals, the energy transition requires unprecedented collaboration between the private sector, public institutions, and civil society. The era of setting targets is over; now the era of taking action begins.

Currently, the greatest global challenge lies in the risks posed by growing geopolitical conflicts and disruptions to energy supply chains, as seen in the cases of Ukraine and Iran. In this context, security of supply and energy independence come to the forefront as strategic necessities to reduce external vulnerability and ensure a reliable, competitive energy supply.

At Moeve, we forecast that by 2040, green molecules could replace approximately 20% to 40% of current fossil fuel demand in Europe. The deployment of green molecules would reduce the European Union's external energy dependence by 50%, bringing it down to 28%. Reducing this dependence could not only strengthen the continent's energy stability but also help develop a new industry that, according to ManpowerGroup, will generate 1.7 million new jobs and a €145 billion increase in European GDP.

Additionally, the World Economic Forum's 2026 Global Risk Report noted that, over a ten-year horizon, 5 of the top 10 global risks are related to climate change and the environment. In this regard, without the integration of green molecules into the energy mix, it will be impossible to meet the goals of the Paris Agreement and achieve carbon neutrality by 2050. Green molecules are crucial for hard-to-abate sectors (such as energy-intensive industries, aviation, maritime transport, and long-haul trucking), where electrification alone is not viable.

In this report, we present a compilation of the latest reports from consulting firms and international organisations on the development of green molecules and the range of available solutions, highlighting their fundamental role and the European Union's strategic position to lead these technologies and thereby achieve a cost-effective and secure energy transition.

This decade, we are laying the necessary foundations to build a solid platform that will enable the accelerated deployment of hydrogen in the next. Acting now is key to developing the infrastructure needed to achieve the scale that will be required in the future. In this regard, at Moeve, we are developing what will be the largest green hydrogen project in Europe, and 2G biofuels complex in southern Europe, acting as true "market makers" capable of staying ahead of the market and paving the way for other players to join.

Our commitment is clear: to rely on facts, build alliances, and develop projects that have a positive impact on people and the planet through the development of value chains for the creation of a new industry that not only enables emissions reductions but also lays the groundwork for Europe's energy independence and competitiveness.

Maarten Wetselaar, CEO of Moeve

Executive summary

The world is at a pivotal moment in the global energy landscape, marked by geopolitical conflicts and disruptions to energy supply chains that have exposed the vulnerability of many countries stemming from their external dependence. In this context, the energy transition no longer responds solely to the need to advance the fight against climate change, but also to a strategic imperative: strengthening security of supply, reducing exposure to fossil fuel price volatility, and consolidating a competitive and resilient domestic industry.

The European Union is leading this global energy transition strategy as an opportunity to also gain independence and boost the competitiveness of its industry. This is because, in this constantly changing environment of geopolitical tensions, Europe will not be able to grow or compete globally without an industry that can develop using energy produced locally. Green molecules would make it possible to meet the emerging needs for energy sovereignty and transform decarbonisation into an engine of industrial growth, enabling Europe to gain a competitive advantage.

There is a growing consensus: Europe's competitiveness will not be able to take off as long as it maintains external dependencies that third parties can use as instruments of political or strategic pressure, as has been made evident in the most recent conflicts. As Enrico Letta has stated, "there is no Europe without industry, there is no security without financial resilience, and there is no security without energy independence."

This vision takes shape in a context of accelerating

international commitments to the energy transition, including the gradual phase-out of fossil fuels, a fourfold increase in the use of sustainable fuels by 2035, a tripling of global renewable energy capacity by 2030, and efforts to limit global warming to 1.5°C, reinforcing the need to move toward a safer, more competitive, and more sustainable energy model.

Aligned with these global goals, the European strategy can be seen in initiatives such as the "Green Deal," the "Clean Industrial Deal," and more recently the "Industrial Accelerator Act," which promote not only the production but also the demand for low-carbon products and technologies, based on three fundamental principles: Energy Affordability, Security of Supply, and Environmental Sustainability. This transformative process largely depends on the growing contribution of green molecules, particularly in hard-to-abate sectors, where direct electrification may not be a viable solution or, even when it is, it may not be the most advantageous option for the consumer. In this regard, renewable energies and green molecules play a crucial role in decarbonisation and are essential to achieving net-zero emissions targets.

To achieve this reduction in energy dependence and cut fossil fuel imports, the European Union aims to increase the share of renewable energy in the mix from 25.4% in 2024 to 42.5% (with an additional 2.5%) by 2030, according to the latest Renewable Energy Directive (RED III). This approach ensures more stable and competitive prices compared to resources affected by fossil fuel volatility in the global market, while contributing to environmental sustainability. However, this will not be enough; the European Union (EU) will not be able to meet the decarbonisation goals of the Paris Agreement without also promoting the rapid deployment of green molecule-based energies capable of decarbonizing sectors that may be difficult to electrify. Geopolitical conflicts, such as those involving Ukraine, Israel, and Iran, are accelerating the reform of the European Union's energy system, with green molecules playing an increasingly important role in this evolving energy transition landscape. In recent years, the EU has enacted several policies, such as the "Green Deal," REPowerEU, the Fit for 55 Package, the Clean Industrial Deal, the Renewable Energy Directive (RED III), the EU Competitiveness Compass, and

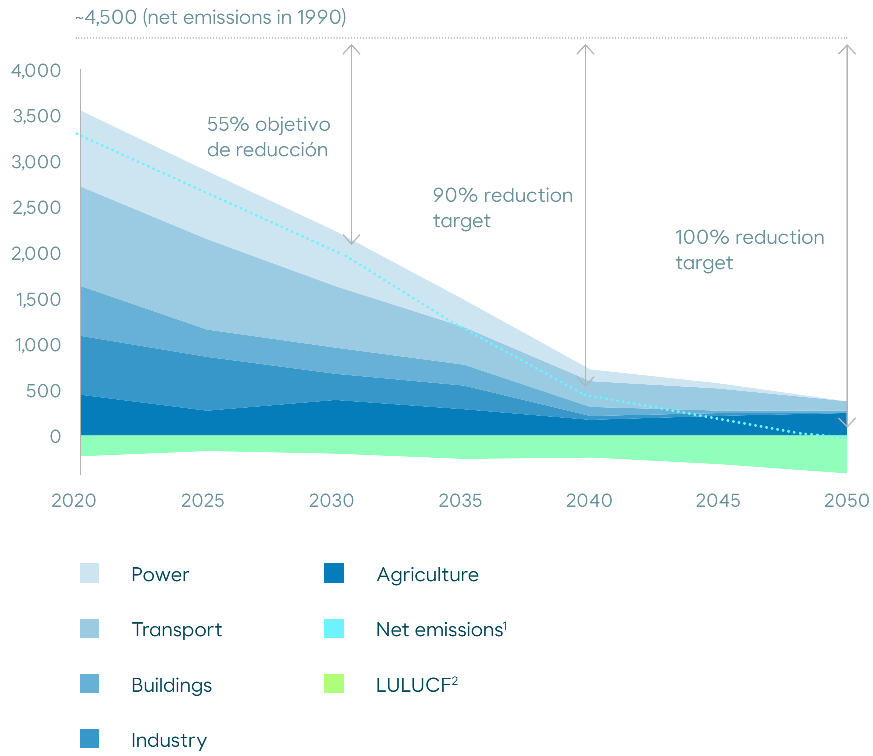
the Affordable Energy Action Plan, among others, to provide the necessary guidelines to advance decarbonisation and achieve the emissions reduction target of 55% by 2030 and 90% by 2040 compared to 1990 levels, as well as climate neutrality by 2050. Now, the urgency is focused on translating these policies into action to accelerate the transition toward a sustainable energy future.

The 2040 climate target, approved in early 2026, highlights the need for the energy transition to advance at an increasingly rapid pace. In this context, green molecules help accelerate the transformation by leveraging part of the existing energy infrastructure and, in doing so, reducing a significant portion of the investments that would be necessary in a scenario based exclusively on electrification[1]. This not only facilitates a faster and more efficient transition but also helps mitigate its economic impact on consumers.

2G biofuels represent an immediate and practical solution for decarbonizing the European Union, serving as a bridge in the transition toward synthetic fuels until they are mature enough for implementation in the medium and long term.

[1] "Market Activation Strategy", (2025), Global Hydrogen Mobility Alliance

Chart 1 Projected CO_2 emissions in the European Union by sector (Mt)

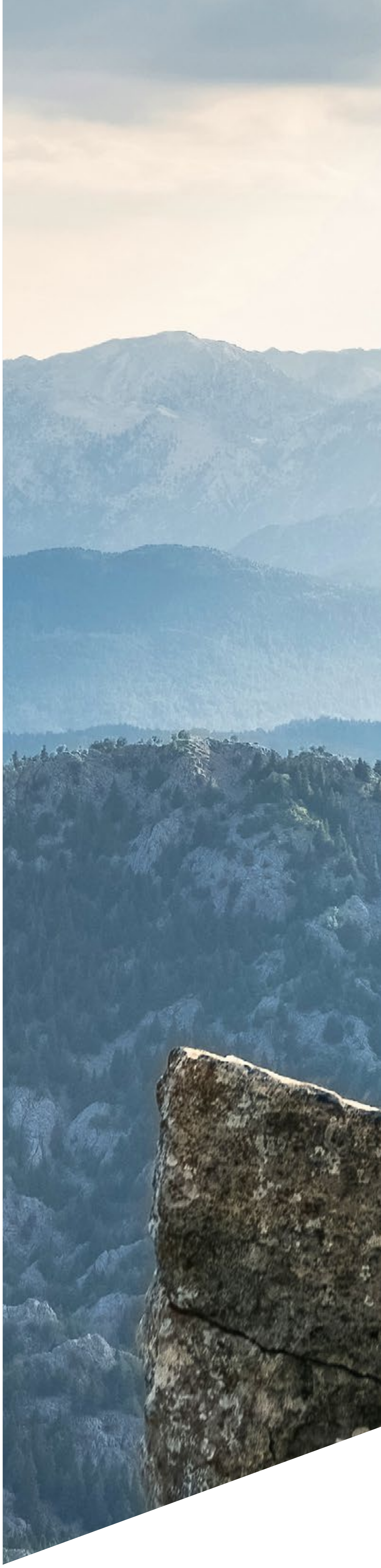


Main decarbonisation drivers

- Demand-side measures and circularity
- Biomass as fuel or feedstock
- Energy efficiency
- Carbon capture and storage or use
- Electrification and carbon-neutral power
- Land use or agricultural practice changes
- Carbon-neutral H2 as fuel or feedstock
- Other innovations

Notes: 1) Includes absorption technologies; 2) Refers to land use, land-use change, and forestry, which encompasses all the ways in which atmospheric CO_2 can be captured or released as carbon in vegetation and soils of terrestrial ecosystems.

Source: Moeve análisis based on McKinsey



The green molecule revolution

In 2024, fossil fuels accounted for approximately 68%[2] of the energy mix, and fossil raw materials for more than 90% of chemical supplies. Green molecules will be essential not only to replace them, but also to reduce the European Union's energy dependence, which in 2024 reached 57% of total demand.

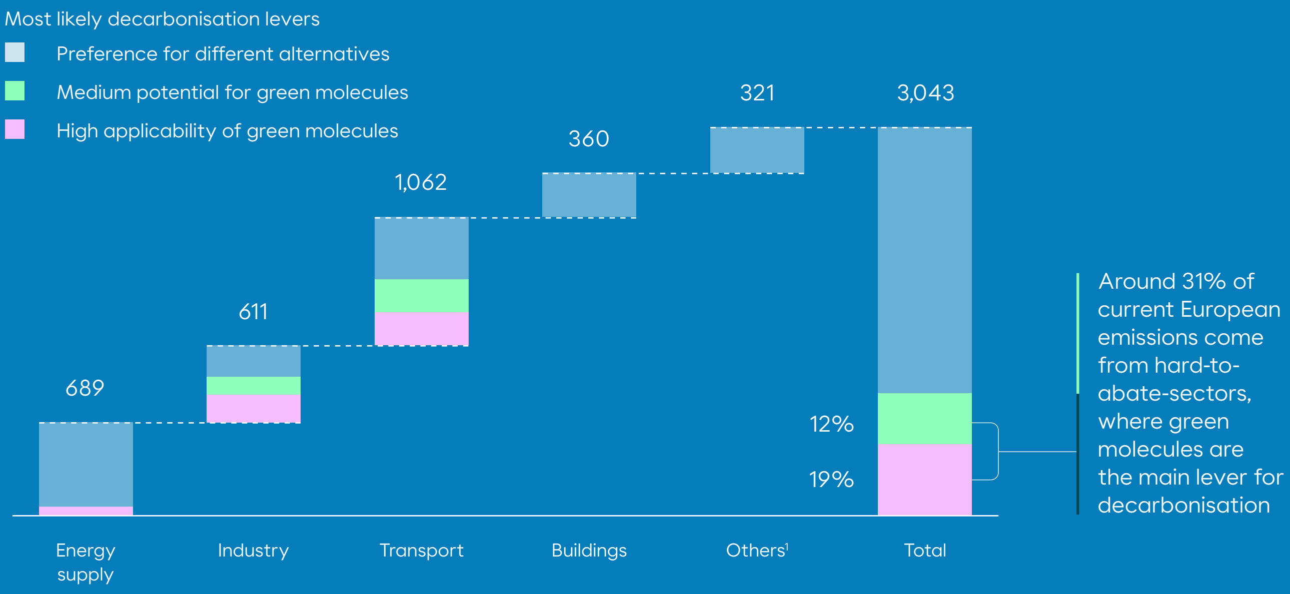
Direct electrification, which encompasses solutions such as solar photovoltaic energy, heat pumps, electric boilers, heaters, and electric vehicles, among others, is distinguished by its high energy efficiency and advanced degree of technological maturity. On the other hand, green molecules, used both in 2G biofuels and in synthetic fuels through indirect electrification (green hydrogen and its derivatives), possess specific characteristics that make them particularly suitable for decarbonizing sectors where direct electrification is not a viable option. These hard-to-abate sectors include, for example, certain industries such as chemicals, non-metallic minerals, steel, and refining, as well as long-distance transport—primarily aviation, maritime transport, and heavy-duty road freight—which account for approximately one in three (31%) of the European Union's total emissions and 20–25% of European primary energy demand, according to data from Eurostat and the European Environment Agency.

Greenhouse gas (GHG) emissions from hard-to-abate sectors have a proportionally greater impact in the European Union than at the global level, underscoring the urgency of accelerating the energy transition in the European context.

[2] "Energy Balance", (2024), Eurostat

While the European Union is making significant progress in the development of solar and wind energy, thereby reducing greenhouse gas emissions from electricity and heat generation by 48% in 2023 compared to 1990, the rest of the world still largely depends on coal, oil, and natural gas for electricity and heat generation, with a 97% increase in emissions over the same period, according to Our World in Data[3]. Given this context, accelerating the development of green molecules is key for the European Union to achieve its established decarbonisation targets and facilitate the transition toward a carbon-neutral economy.

Chart 2 **European Union emissions by sector ($MtCO_2eq$, 2024)**



Sectors with high-medium applicability of green molecules for their decarbonisation

- Oil refining
- Chemicals
- Iron and steel
- Non-metallic minerals
- Maritime shipping
- Aviation
- Heavy-duty trucks

Notes: (1) Agriculture and other minor sectors

Sources: European Environment Agency

Green molecules offer a transformative pathway to decarbonise hard-to-abate sectors, which currently account for approximately 31% of the European Union's total emissions.

[3] "Breakdown of carbon dioxide, methane, and nitrous oxide emissions by sector", Our World in Data

Green molecules can be sorted into two main categories: biomass-based and hydrogen-based (also known as synthetic fuels), depending on the compounds needed for synthesis. Second-generation biomass-based green molecules, which are already in use, give rise to more sustainable fuels or chemical raw materials such as biomethane, biomethanol and renewable diesel, and are obtained from raw materials such as organic waste, biomass or agricultural and livestock farming waste.

Green molecules based on hydrogen or synthetic fuels are compounds of non-biological origin produced using green hydrogen from renewable energy[4], together with CO_2 or N_2. Although still in the early stages of development compared to biofuels, rapid advances are expected to position hydrogen-based compounds as a relevant alternative for medium-to-long-term decarbonisation. They are often referred to as "power to X", as they are carriers of both energy (for fuels) and chemical raw materials.

Green molecules are the main lever for decarbonisation in hard-to-abate sectors and have the potential to cut Europe's emissions by up to 22% by 2050.

Uses of green molecules in hard-to-abate industries can be grouped into two. The first use relates to green molecules as a raw material, harnessing the chemical properties of green hydrogen to facilitate the production of compounds such as e-ammonia, fertilisers and green methanol (both biomethanol and e-methanol), as well as in refining processes and as a reducing agent in steel manufacturing. Secondly, green molecules are used as fuels, encompassing both hydrogen and its derivatives and biofuels, particularly in sectors where electrification is not technically or economically viable. These new-generation fuels made from green molecules offer high energy density and greater power capacity, making them suitable for heavy-duty transport and intensive thermal industries, such as the production of non-metallic minerals (cement, glass, ceramics) and chemical products, among others.

Despite the recent reductions, the European Union still has to make further efforts to achieve its target of cutting emissions by 55% below 1990 levels, which is necessary to meet the 2030 targets. To achieve these ambitious goals, significant transformations will be required across all industries by triggering five main levers: (i) reducing demand, (ii) enhancing energy efficiency, (iii) switching to low-carbon fuels and raw materials, (iv) capturing, utilising and storing carbon (CCUS), and (v) other measures, such as sustainable land use and farming practices.

While electrification is the main pathway to decarbonisation, green molecules are emerging as the second most significant lever, with the potential to mitigate approximately 22%[5] of emissions in Europe by 2050.

[4] Green hydrogen can be generated by means of electrolysis using renewable electricity such as solar photovoltaic or wind power, as well as by using biomethane and the steam methane reforming (SMR) process. This report will focus specifically on the electrolytic hydrogen route.

[5] Moeve analysis based on McKinsey "Net-Zero Europe"

Chart 3 Potential of emissions reduction mechanisms and share by 2050

Decarbonisation lever	Share of reduction by 2050	Description
Demand reduction and circular economy measures	7%	Seeks to **reduce** overall energy and resource consumption by **promoting circularity through recycling and product reuse.**
Technological efficiency	11%	Energy efficiency enhancement through **technological advances**, such as in power generation, or **through infrastructure improvements**, such as heat recovery for industrial uses.
Fuel change – Electrification	44%	Transitioning from fossil fuels to renewable power sources (such as **solar PV, onshore and offshore wind, etc.**) for various applications, such as **electricity generation and electric vehicles.**
Fuel change – Green molecules	22%	Switching from traditional fossil-based feedstock to **low-carbon alternatives, referred to as green molecules** (such as **ammonia, methanol, biogas,** etc.).
Carbon capture, usage and storage	6%	**Capturing CO_2 emissions and storing them underground or using them to make synthetic fuels,** particularly in industries where fuel switching is challenging.
Others	10%	**Sustainable land use practices,** including reforestation and the adoption of sustainable farming practices, can also help to trim emissions and preserve biodiversity.

Sources: Moeve analysis based on McKinsey

In the European Union, the maritime shipping, aviation, heavy-duty road transport and industrial sectors play a pivotal role in economic growth, global trade and international exchange. But, as mentioned above, these industries are also major contributors to the European Union's emissions. In this context, innovative solutions are emerging, spurred by regulatory initiatives such as the FuelEU Maritime and ReFuelEU Aviation policies, among others. This comprehensive strategy entails embracing biofuels, green hydrogen and synthetic fuels, all aimed at reshaping transport and industrial practices while meeting the stringent emissions reduction targets set by European Union regulations.

Gradual adoption of green molecules

The adoption of green molecules will be influenced by factors such as the type of molecule, the intended end-use sector, resource availability, funding availability, market acceptance, the cost and intensity of decarbonisation, and competition from other decarbonisation alternatives. However, the European Union is well equipped to accelerate adoption across the region.

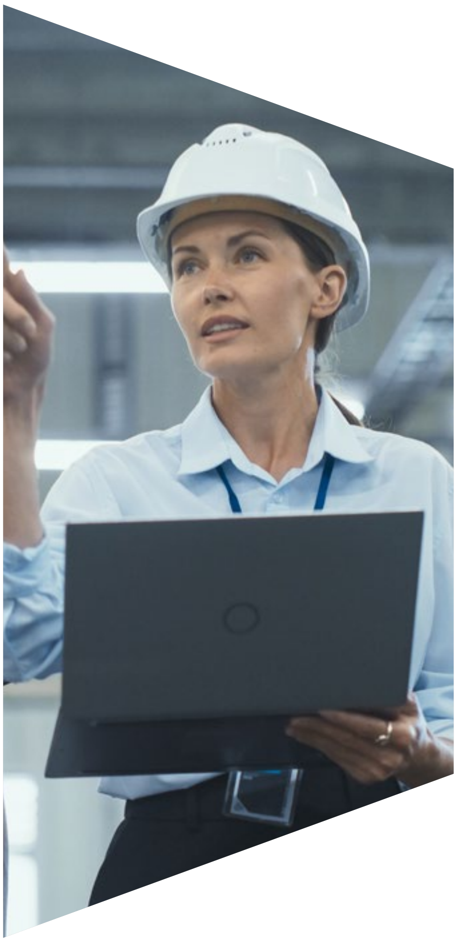
Nowadays, biofuels are at the head of the pack in the energy transition drive and are expected to remain there in the short-to-medium term. An example of this is Moeve's 2G biofuels development project in Huelva, which is expected to begin operations in early 2027. The plant will have a flexible production capacity of 500,000 tonnes of SAF and renewable diesel, making it the largest 2G biofuels industrial complex in southern Europe. Projects like this not only reinforce the role of biofuels today but also help pave the way for the transition towards other renewable alternatives in the future.

As technology advances and infrastructure consolidates, hydrogen-based synthetic fuels, sustainable feedstock and pure hydrogen are expected to play a more prominent role in the medium-to-long term. These renewable alternatives could replace up to half of the demand for fossil fuels, accounting for between 25% and 33% of the European Union's final energy demand in 2050.

According to the Hydrogen Council, half of global hydrogen demand by 2030 could come from Europe, reaching 5 Mtpa, driven by regulatory requirements such as RED III[6]. In this context, the forecasts from the "Clean Hydrogen Monitor 2025" indicate that Europe would reach 2.3 Mtpa of this demand by 2030 through local renewable hydrogen production, which would cover approximately 60% of its estimated regulatory demand. While these estimates fall short of the REPowerEU target of achieving an internal production capacity of 10 Mtpa by 2030, they reflect real and essential progress in developing the infrastructure needed to accelerate hydrogen production in the years ahead.

Furthermore, the current international landscape is led by China, which is at the forefront of electrolyser deployment for renewable hydrogen generation and accounts for more than half of the global committed capacity[7], with the aim of reducing its dependence on fossil fuels. Europe, for its part, holds second place in committed renewable hydrogen capacity, with around 20% of the global total. This push by China highlights an increasingly clear reality: strengthening energy security and industrial competitiveness through the energy transition is no longer just an option, but a strategic priority for Europe. Sustaining and accelerating this progress will be key not only to covering domestic demand with local production, but also to laying the foundations of a market that will define the next decade.

Green molecules could replace up to 50% of fossil fuel demand by 2050 and form approximately one-third of the European Union's energy mix, a crucial step towards climate neutrality.



[6] "Global Hydrogen Compass 2025", McKinsey

[7] Projects that have either reached a final investment decision, are under construction, or have commenced operations.

Within Europe, Spain is recognised as a leader in the Power-to-Hydrogen (PtH) project pipeline and has the most ambitious electrolysis target in the European Union for 2030. According to Hydrogen Europe, this leadership is attributed to Spain's favourable conditions related to energy resources and ambitious government initiatives[8]. In Iberia (Spain and Portugal), renewable hydrogen production of 0.39 Mtpa is forecast for 2030, associated with a generation capacity of 3 GW in Spain and 0.9 GW in Portugal. Although this figure falls below the 12 GW initially envisaged in Spain, the long-term vision remains intact and continues to underscore the country's commitment to this technology. The gradual ramp-up in the commissioning of projects in newly emerging sectors is commonplace and is expected to accelerate as the regulatory framework is consolidated, with the transposition of RED III or the binding adoption of the emissions reduction targets approved by the IMO in the maritime transport sector. Furthermore, progress in grid access and connection procedures, as well as the materialisation of public funding that facilitates final investment decisions, will drive the execution of a greater number of projects. In this context, Spain holds a leading position in Europe, ahead of other benchmark markets such as Germany, where a deployment of 2.2 GW[9] is expected.

This Spanish leadership is due, in part, to the deployment that has already begun to materialise, with multiple players having reached a final investment decision on their hydrogen projects. This is the case of Moeve, which has approved the first phase of the Andalusian Green Hydrogen Valley, Onuba, with 300 MW, is the largest green hydrogen project in the EU dedicated to the energy industry. Repsol, for its part, recently installed its second 100 MW electrolyser at Petronor, aimed at strengthening industrial decarbonisation. Initiatives in the final construction phase are also noteworthy, such as the BP and Iberdrola project in Castellón, with 25 MW.

At the European level, other cases where this trend is also gaining momentum are worth highlighting, such as the Stegra project in Sweden, the largest FID project in Europe, which completed the installation of 740 MW of electrolysers in April 2026, to be used for the manufacturing process of green steel.

In terms of recent developments, many biofuel projects are focusing on Sustainable Aviation Fuels (SAFs). The European Union anticipates approximately 53 production plants by the end of the decade. This represents around 43% of global projects currently under way (~125) with a capacity of 3.5 million tonnes, accounting for approximately 15% of the total projected capacity, estimated at around 23 million tonnes[10].

EU regulations incentivising green molecules need to focus on actions with high emissions reduction potential, prioritising biomass-based fuels for immediate decarbonisation, supplemented by hydrogen solutions in the medium-to-long term.

[8] "Clean Hydrogen Monitor 2023", Hydrogen Europe

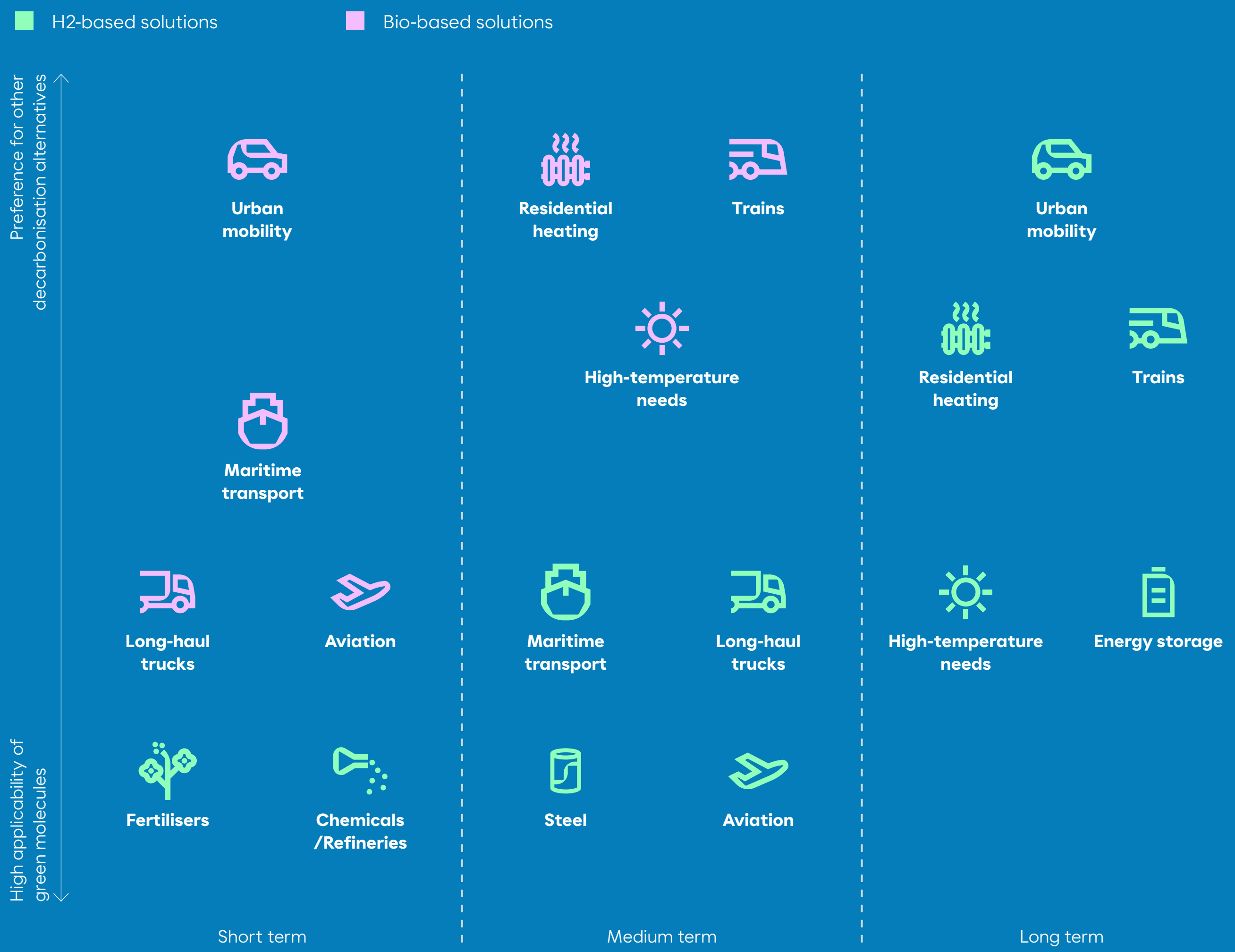
[9] "Clean Hydrogen Monitor 2025", Hydrogen Europe

[10] Moeve analysis

A prioritised adoption hierarchy for green molecules should focus on the most efficient reduction cases, considering factors such as decarbonisation intensity, resource efficiency and economic feasibility. The European Union benefits from robust infrastructure and widespread availability of resources, giving it a competitive edge over other regions in the transition to green molecules.

Biomass-based fuels are expected to drive decarbonisation efforts, while hydrogen-derived alternatives will gain prominence in the medium and long term as their competitiveness improves. Adoption across sectors will depend on factors such as public subsidies, adaptation costs, fuel cost competitiveness, resource availability, the required level of decarbonisation, and the implementation of regulations that set clear decarbonisation targets. Ultimately, these elements will shape the transition toward a greener economy in the European Union.

Chart 4 Hierarchy of green molecule solutions



Sources: Moeve analysis based on Ramboll Group

Second-generation biofuels could reach cost parity with fossil fuels in the 2030s, while green hydrogen could achieve parity in the 2040s, according to different scenarios based on public sources.

The cost gap between conventional fossil fuels and green molecules is expected to narrow as the cost of CO_2 emissions increases, biomass- and hydrogen-based fuel production becomes more efficient, and renewable energy prices, which account for 70-80% of the price of hydrogen, fall. According to various price scenarios prepared by the IEA (International Energy Agency), the WEF (World Economic Forum), the Mærsk Mc-Kinney Møller Center and IRENA (International Renewable Energy Agency), among others, biofuels are the first solution projected to achieve cost parity with conventional fuels, potentially by the 2030s. In contrast, hydrogen-based fuels are expected to reach cost parity during the 2040s.

Besides efforts to ensure cost competitiveness, offtakers are being forced to explore ways to decarbonise their production processes and Scope 3 emissions by means of mandatory regulatory measures and voluntary decarbonisation pledges. The main players in this field include car manufacturers and food and beverage companies, which are working with various industries to decarbonise products and processes.

Exploring the impact of the green premium

An assessment of the impact of the green premium on different products from 2030 onwards shows that the premium tends to dissipate along the product's entire value chain[11]. For example, the impact on the price of a car of using green steel instead of conventional steel is less than 2%. Similarly, the price increase associated with the use of green ammonia for green fertilisers could result in a 1% and 5% rise in wheat production costs. Also, when considering the additional cost of using vessels powered by green fuels to carry products, it is estimated that the impact on the price of each item varies between 1% and 4%. This is because freight costs represent only a small portion of the final price charged to consumers. The adoption of SAFs reflected in the regulatory targets is expected to trigger a limited increase in passenger ticket prices, ranging from €1 to €40, depending on the type of flight.

The green premium impact declines along the product value chain, reducing its effect on end-user prices to moderate increases of 1–5% from the 2030s onwards.

[11] Price analysis based on current price estimates and forecasts. The effect of the green premium on these products will be felt the most in the short term, as technological advances continue to bring down the cost of green molecules in the medium-to-long term, while CO_2 costs push up fossil fuel prices.

Chart 5 Assessment of the green premium for key hard-to-abate industries in 2030

Hard-to-abate industries	Steelmakers	Fertilisers	Maritime transport	Aviation
	Metallurgical coal	**Grey H2**	**Marine fuel**	**Kerosene**
Decarb. alternative	Green H2 for DRI-EAF route	Green H2 / Ammonia in urea plant	Biofuels (methanol, LNG or diesel) with e-methanol and ammonia vessels	Bio-based such as HEFA, FT, AtJ and green hydrogen-based such as PtL
Green premium impact	**1-2%** Passenger car	**1-5%** Wheat and maize	**1-4%** Retail price increase	**1-5%** Ticket price increase

Sources: Moeve analysis based on Hydrogen Europe, IEA, Mærsk Mc-Kinney Møller and WEF

Ensuring the adoption of green molecules

Europe is ready to drive global decarbonisation and promote a broader use of green molecules. The region has several levers supporting a green transition, including the ability to produce hydrogen-based fuels at a competitive cost thanks to abundant renewable power generation. European backing for the reuse of waste to produce biofuels, coupled with the availability of biomass and forestry waste, provides the necessary raw materials. Europe also benefits from state-of-the-art infrastructure, diverse consumption patterns and a robust industry, making it a global leader in industrial, logistics and aviation hubs.

Although these efforts are commendable, concerns have been voiced by European institutions and associations about a possible "raw material supply crisis" based on current trends, as evidenced by the sharp growth in imports of used cooking oil into the EU from non-EU countries since 2015. This highlights the importance of diversifying the biofuel feedstock envelope through innovation, reducing reliance on imported waste oils, and strengthening Europe's domestic supply chains. Despite these challenges, continued promotion of and regulatory support for sustainable practices in Europe remain strong, driven by the region's need for energy security and independence, combined with the limitations of the electricity grid.

The role of green molecules is becoming key to securing future energy supplies and facilitating an efficient electricity system, particularly amid concerns regarding potential bottlenecks and grid saturation. Once the necessary green hydrogen infrastructure is in place, green hydrogen can contribute to managing the intermittency of an electricity system based on renewables, by turning green electricity into green hydrogen when there is a surplus of renewable generation, and converting it back into electricity when there is a deficit. Green molecules can therefore help against grid saturation, highlighting the importance of identifying the combination of solutions with the greatest potential.

Europe is at the global forefront in the adoption of green molecules, boosting its energy security and autonomy while facilitating a resilient, sustainable transition to a low-carbon economy.

Hydrogen is one of these solutions, and Southern Europe, particularly the Iberian Peninsula, is emerging as a region with considerable potential for achieving a highly competitive Levelised Cost of Hydrogen (LCOH). This potential is driven by a competitive Levelised Cost of Electricity (LCOE) thanks to abundant solar photovoltaic and onshore wind resources. According to the Goldman Sachs analysis entitled "Carbonomics: The Clean Hydrogen Revolution", projections suggest that, by 2030, Spain and Portugal could produce green hydrogen at approximately half the cost compared to Central Europe and the Nordic countries, becoming a potential large-scale supplier of green molecules in the region. The synergy between the abundant wind resources in northern Europe and the solar radiation in southern Europe reflects optimal conditions for the development of efficient wind farms and solar facilities. These renewable sources play a pivotal role in ensuring the lowest LCOE and facilitating the roll-out and scaling of hydrogen-based green molecules across the region.

Southern Europe, particularly the Iberian Peninsula, has exceptional potential for producing green hydrogen at highly competitive costs, achieving prices almost half those of Central and Northern Europe.

According to the “Clean Hydrogen Monitor 2025” report by Hydrogen Europe[12], and in line with studies by the Hydrogen Council and the European Hydrogen Backbone, announced projects in the European Union total 12.7 Mtpa of green hydrogen production by 2030, although currently only 5% of these projects are in the development phase. The study identifies southern Europe, highlighting regions such as Iberia, as well as northern Europe, including the Nordic countries and the United Kingdom, as the main future producers. These regions are anticipated to contribute more than 70% of hydrogen supply by 2040, leveraging their abundant natural resources. To maintain a competitive edge in synthetic fuels, southern Europe must focus on harnessing the cost advantages of raw materials. While subsidies and incentives can provide support, regions with access to low-cost hydrogen and CO_2 sources will lead in synthetic fuel production, with the cost of renewable electricity being the primary factor influencing green hydrogen production costs. Proof of this is that, in the European Hydrogen Bank auction, promoters submitted surprisingly low premium bids. The aid needed to cover the difference between the cost of producing hydrogen and the price that offtakers are willing to pay was set at a maximum of €4.5/kg, while all winning bids ranged between €0.37/kg and €0.48/kg. This highlights the importance of cost-effective renewable electricity to remain competitive in the synthetic fuels market.

Also, Europe’s commitment to a circular economy and the reuse of waste is key to ensuring a sustainable supply of biomass, which is crucial for the development of biofuels and the transition to clean energy. The continent’s diverse climates and ecosystems offer a rich variety of biomass resources for bioenergy (for biofuels such as SAFs or biomethane). Through innovative practices such as the reuse and recycling of organic waste from agriculture, livestock farming or municipal sources, together with sustainable forestry methods, Europe is harnessing these resources to drive its renewable energy agenda. According to several publicly available studies, such as those conducted by Concawe and Imperial College London[13], together with scenarios prepared by the European Commission[14], the availability of second-generation biofuels could exceed 2,000 TWh (terawatt-hours) by 2050. This projection implies a tenfold increase in demand for biofuels compared to current levels, according to the latest Eurostat data.

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[12] “Clean Hydrogen Monitor 2025”, Hydrogen Europe

[13] “Sustainable biomass availability in the EU, to 2050”, Concawe

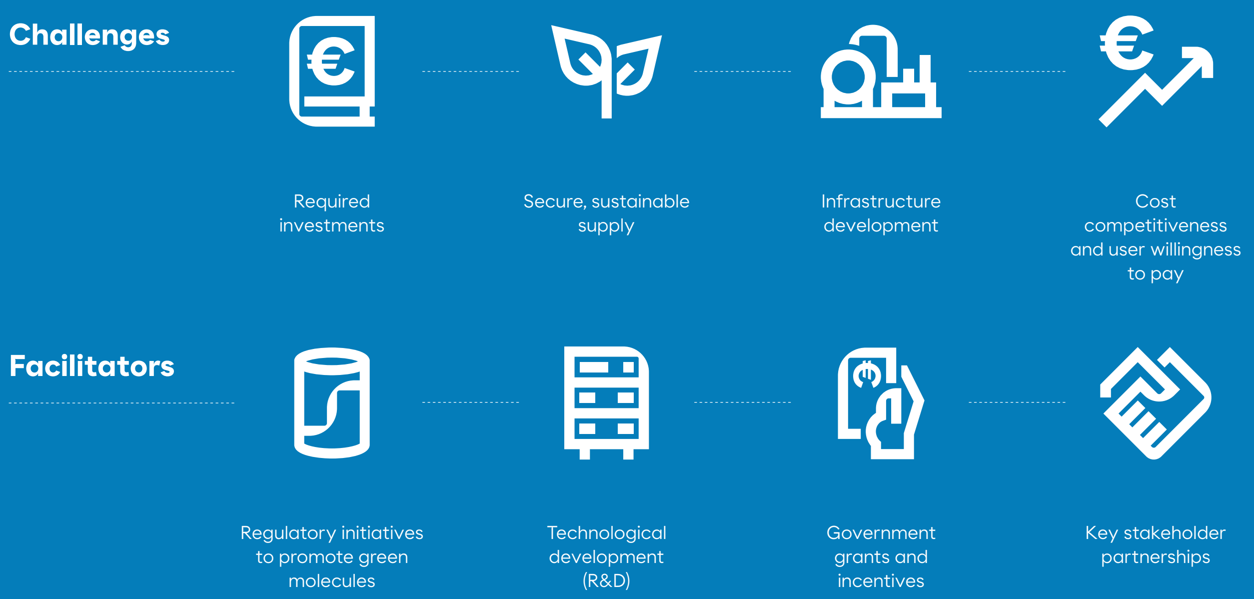
[14] “Development of outlook for the necessary means to build industrial capacity for drop-in advanced biofuels”, European Comission

Consumption patterns across Europe will also play a decisive role in shaping the adoption of green molecules. Regions such as Spain, among others, with high demand in the maritime shipping and aviation industries, have the potential to become strategic hubs for the sustainable production and supply of SAFs and green molecules.

Despite this promising outlook, there are a number of barriers and challenges to the adoption of green molecules. Critical factors such as investment needs, resource availability and the willingness to pay for decarbonisation-related cost increases are significant obstacles to the integration of green molecules into the European energy landscape. However, a number of support measures and enablers are being actively developed to prevent these challenges from becoming hindrances, such as ambitious regulatory targets and technology R&D alongside government subsidies and incentives, among others. Key stakeholder partnerships are helping in a joint effort to overcome obstacles and promote the adoption of green molecules across the board.

Comprehensive measures are being developed, including ambitious regulatory targets, advanced R&D, government subsidies and strategic incentives, to overcome barriers to the widespread adoption of green molecules.

Chart 6 Key challenges and enablers for accelerating the adoption of green molecules



Sources: Moeve analysis

The challenges associated with implementing these technologies underscore the importance of combining strategic investment and collaborative efforts with regulatory frameworks that not only stimulate production but also drive demand. Alongside regulatory support and financial incentives, partnerships between public and private stakeholders are essential for scaling up production, aligning it with to market demand, and reducing the risks taken by early investors. In this context, the transition will be accelerated through European policies that support, in a coordinated manner, the development of supply, the creation of demand, and the deployment of infrastructure, ensuring balanced progress among the different market actors.

The adoption of green molecules throughout the European Union is set to drive considerable economic growth and job creation by 2040. According to projections by Moeve and ManpowerGroup[15], the development of green molecules could generate up to 1.7 million new jobs in the EU and the United Kingdom, averaging around one hundred thousand (100,000) jobs per year. Spain is projected to lead the other EU countries in job creation, creating 181,000 new posts by 2040, closely followed by the United Kingdom and Germany. This growth in employment will also bring substantial economic benefits by increasing GDP in the area (European Union and the United Kingdom) by up to €145 billion by 2040, of which €15.6 billion will come from Spain.

Major investments will also be needed within the European Union to achieve carbon neutrality and decarbonise the economy. As underlined in the reports "New Energy Outlook: Europe" by BloombergNEF[16], "Net-Zero Europe: Decarbonization pathways and socioeconomic implications" by McKinsey[17] and "Road to Net Zero" by the Rosseau Institute[18], Europe's transition to a net-zero economy by 2050 will require more than €29 trillion[19] in cumulative investment, of which approximately 20%, or around €5 trillion, will be incremental investment compared to a scenario devoid of climate action, as the remaining €23 trillion will come from redirecting investments that would traditionally have funded fossil fuel technologies. BloombergNEF also estimates that the required hydrogen supply side investments will increase steadily over the years, expecting around €300-400 billion in the period 2022-2050.

To drive green industrialisation in Europe, it is essential that policies promote not only supply but also demand in a coordinated manner, to ensure synchronized progress among the different market players.

The need to decarbonise our economy so as to curb the rise in greenhouse gas emissions and limit global warming must not be postponed. Ignoring this challenge would have serious, irreversible consequences for the planet, such as rising temperatures and sea levels, melting polar ice caps, more frequent heat waves, floods and other extreme events.

A European Commission study[20] reveals the economic implications of climate change. Higher temperatures trigger a further decline in well-being, affect economic output and impact household well-being. In a 3 °C-warming scenario, the annual loss of well-being in the European Union could reach at least €54 billion. In contrast, limiting warming to 1.5 °C will reduce the additional well-being loss by 89% down to €6 billion per year. The implications of not decarbonising will be economically significant, including much greater well-being losses in southern regions compared to northern areas.

15 "Green Molecules: The Imminent Labor Market Revolution in Europe". The impact was assessed using the EHB's green hydrogen projections. These projections anticipate approximate output ranging between 1,200 TWh and 1,400 TWh of green hydrogen by 2040, spanning the European Union and the United Kingdom.

16 "Energy sector investment requirements in Europe under BNEF Net Zero Scenario", BloombergNEF

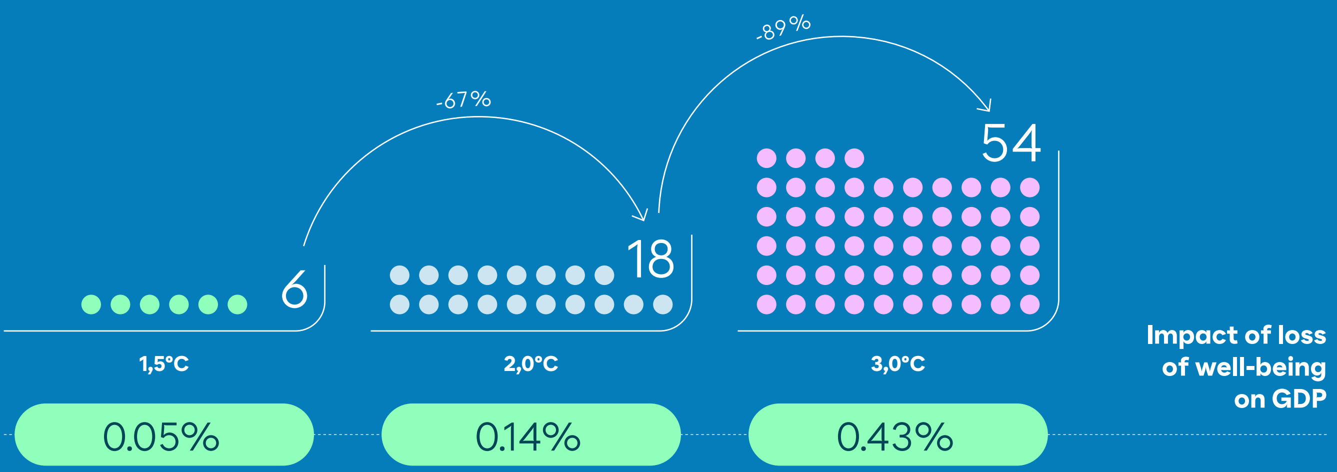
17 "Net-Zero Europe, Decarbonization pathways and socioeconomic implications", McKinsey

18 "Road to Net-Zero, Bridging the Green Investment Gap", Institut Rousseau

19 "De-risking the energy transition in Europe", PwC

20 "Welfare loss from climate change impacts", European Commission

Chart 7 Annual loss of well-being due to the impacts of climate change (€bn)



Fuentes: Comisión Europea y PESETA IV.

Failing to act on climate change could also lead to a substantial decline in GDP. In Europe alone, the cumulative economic effects are estimated to exceed €6 trillion over the next 50 years. In contrast, achieving global climate targets could bring considerable economic benefits, with an estimated potential of up to €730 billion in Europe. Acting now is not only crucial for our health and the environment, but also to drive new opportunities for economic growth.

So, climate inaction would have adverse consequences not only for the environment and public health, but also from an economic viewpoint. Compared to the estimated additional investment of €5 trillion[21] needed to achieve climate neutrality by 2050[22], the economic impact of failing to decarbonise would exceed the required investment by 10–20%, amounting to over €6 trillion in the next 50 years.

Without climate action, the European Union faces potential losses of €6 trillion, a cost that well exceeds the €5 trillion needed to achieve a carbon-neutral economy by 2050.

[21] The additional investment needed to achieve Net Zero refers to the incremental investment required compared to a climate inaction scenario

[22] "New Energy Outlook: Europe" de BloombergNEF

Green molecules driving European strategy

The adoption of green molecules is key to Europe meeting its energy transition, supply security, energy sovereignty, reindustrialisation and industrial competitiveness goals. Replacing up to 40% of fossil fuel demand with locally produced green molecules will reduce the European Union's energy dependence by 50%, from the current 57% to 28% by 2040, bolstering the continent's energy stability.

For this to be possible, Europe must harness its potential and commit to innovation and the local manufacturing of the technology needed to meet energy needs autonomously, competitively, and sustainably. In this context, green hydrogen will play a key role, as it will enable greater penetration of renewables into the electricity system, while providing demand and flexibility to the system. Thus, becoming a key opportunity for reindustrialisation, competitiveness, and job creation.

This will be a catalyst for more competitive reindustrialisation in Europe, attracting industries such as chemicals and steel, which are capable of embracing hydrogen and biofuels as clean energy sources. So decarbonisation must become a driver of growth in European industries and position our continent as a leader in the green economy of the future.

The first step along this path is to develop the necessary infrastructure, such as H2Med or the Hydrogen Valleys, which will lay the groundwork for the first projects and facilitate subsequent scaling-up until a single, integrated market can be established at the European level. Regulation is key at this point in time and must provide a clear, stable framework that facilitates investment and ensures a fair, efficient transition.

The groundwork must be laid during this decade for a solid platform that will enable the accelerated deployment of hydrogen in the following decade. Acting now is essential to develop the infrastructure needed to achieve the scale that will be necessary going forward.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