Unlocking European Energy Security

with clean, affordable and domestically produced renewable energy and green hydrogen

SIEMENS Gamesa
RENEWABLE ENERGY

Foreword

The ongoing humanitarian crisis caused by Russia's invasion of Ukraine is the most immediate and visible result of the war. We are shocked and appalled at the tragedy unfolding and continue to do everything we can to support our colleagues and collaboration partners who are affected by this war.

Additionally, there are wider implications that need to be considered and addressed as part of the global response to the aggression. Energy security is among the most significant.

Since the invasion began at the end of February, energy security has been in the limelight as never before. Europe relies on massive volumes of imported fossil fuels from Russia, and that dependence exposes Europe's governments, businesses and communities to volatilities in supply and pricing and, ultimately, to the geopolitical tension that we are currently suffering.

Importing gas, oil and coal from Russia has impacts beyond energy security. Addressing the climate emergency, meeting net zero targets and realizing the socio-economic benefits of the EU Green Deal are all compromised.

The European Union's response outlined in the REPowerEU[1] initiative includes a plan "to make Europe independent from Russian fossil fuels well before 2030, starting with gas."

Commission President Ursula von der Leyen said in the initiative presentation that "accelerating the clean energy transition" is fundamental to reaching the new targets outlined in REPowerEU. However, the need to speed up the roll-out of renewable energy was evident before the invasion.

Siemens Gamesa was a co-signatory to a letter sent by WindEurope to the President of the European Commission[2], two days before the first incursions took place. The letter laid bare how Europe's roll-out of new wind capacity falls short of the targets that were in place before the REPowerEU updates: in 2021 only 11GW of new wind farms were built in the EU, while to reach the 2030 targets, Europe needs 32GW a year, every year. With the new REPowerEU target of 530GW[3] of wind installations by 2030, Europe will now need 40GW a year, every year.

Wind energy is needed to decarbonize and secure Europe's electricity supply, but is also required to power the production of green hydrogen, a clean fuel for hard-to-electrify industries. Green hydrogen – produced using electrolyzers powered by renewable energy – is essential to meet the Green Deal targets and to secure important and strategic European industries such as chemicals, cement, fertilizers, iron, steel and more.

These energy-intensive industries are big consumers of imported fossil fuels, and green hydrogen is the only viable alternative to slash their greenhouse gas emissions. But for green hydrogen to reach scale and, thus, competitiveness, it too needs a seismic shift in the scale and speed of renewables roll-out.

The current crisis should not be allowed to push the climate emergency down the agenda. It is imperative that the entire renewable energy ecosystem is aligned on the need to reduce the demand for fossil fuels in general. Generating significant volumes of renewable energy was on the agenda before the invasion began; the current situation dictates that now it must drive the agenda.

Dr. Jochen Eickholt
CEO, Siemens Gamesa Renewable Energy

Executive Summary

Russia's invasion of Ukraine has reinforced an inescapable truth: all nations need to prioritize energy security. Geopolitical uncertainty and volatility are nothing new. However, the increasing dependence across Europe on imported fossil fuels, reaching the highest level in over 30 years in 2019 means that economies and societies are increasingly susceptible to political uncertainty.

As the current situation shows, speeding up and scaling up the production of renewable energy in Europe, for European use, needs to start happening now.

Energy security is vital for economies and communities to thrive. Europe's businesses and consumers saw energy costs rise over the past two years as a result of changes to the global supply and demand patterns because fossil fuels still dominate how energy is priced.

At the same time, Europe needs to produce significantly more renewable energy in order to meet the net zero targets outlined in the Glasgow Climate Pact, which is key to tackling the climate emergency.

Europe clearly requires an urgent and earnest reduction in its reliance on fossil fuel imports. The direct benefits from this shift include:

- Greater energy security
- Stabilization of energy prices
- An accelerated pathway for low-carbon energy transformation
- Green economy-driven growth such as technology, investment, employment, infrastructure
- A long-term healthy and sustainable energy market.

With more renewable energy in the system, Europe can start to not only decarbonize direct power markets but also secure the supply of zero-carbon fuel for heavy industry, mobility and agriculture. Specifically, green hydrogen, which is produced using electrolyzers powered by renewable sources, must replace the imported fossil fuels which currently power Europe's fertilizer, chemicals, urban mobility, shipping, aviation, cement and steel sectors.

The success of advancing power-to-x opportunities relies on the underlying systems and infrastructure that can support the change. Increased production of energy also needs to be aligned with increased storage capacity across Europe to manage and ensure supply, and to ensure grids can be stabilized.

Achieving energy security requires buy-in from and collaboration between governments, industry and investors, as well as support and commitment of civil society.

This paper outlines how an expanded renewable energy sector within Europe is fundamental for energy security, and the need to speed up and scale up onshore and offshore wind production across Europe. It reaffirms Siemens Gamesa's commitment to renewable energy and green hydrogen as the backbone for a decarbonized and more secure European energy supply.

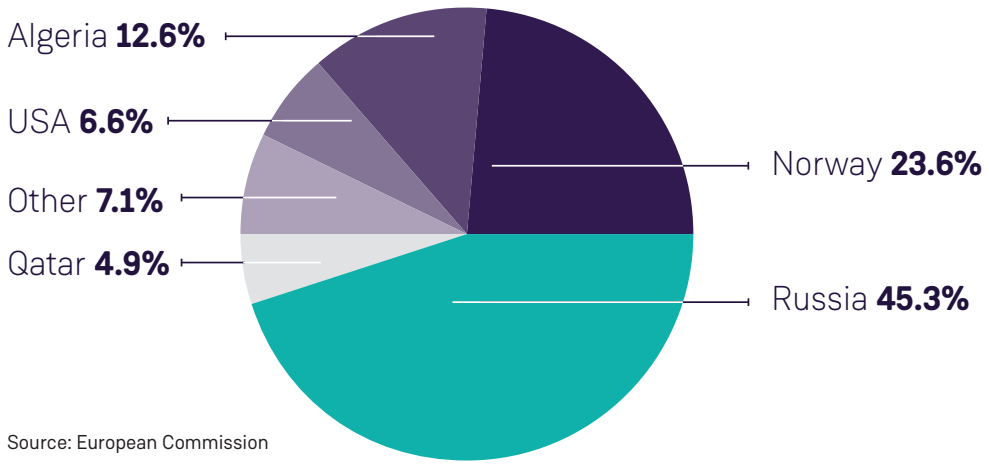
Introduction

Europe's energy supply relies on imports of fossil fuels from outside the bloc to meet demand, supplementing the regional access to own coal, oil and gas reserves. The continent has thus long been exposed to the volatility in energy pricing and availability which comes from a reliance on imported fossil fuel, and this situation persists despite the climate emergency and the growth in renewable energy produced.

The REPowerEU communication[4] outlined in the clearest terms how reliant Europe is on natural gas imports from Russia, releasing top-line figures for 2021.

"The EU imports 90% of its gas consumption, with Russia providing more than 40% of it. Russia also accounts for 27% of oil imports and 46% of coal imports," it stated.

Share in EU natural gas imports, 2021



Source: European Commission

The EC's State of the Energy Union report[5] has detailed figures for 2020. It reveals that over the past few years, the volume of energy imports has increased to the highest levels in three decades. In 2020, the EU imported 57.5% of the total energy it consumed.

The most important fuel sources in the EU energy mix in 2020 were dominated by imports. Oil and petroleum products accounted for 34.5% of total fuel, with the level of crude oil import dependency reaching 96.2% in 2020.

Meanwhile, natural gas clocked up 23.7% of the EU energy mix, of which 83.6% was imported.

Coal's importance in the mix has been declining and in 2020 accounted for around 10% of the energy mix, of which over a third (35.8%) was imported.

Fossil fuels are used in many sectors, and many of the key use cases will, in time, be met by green hydrogen. The versatility and functionality of green hydrogen and its low-carbon byproducts reinforces its pivotal role in helping to address the climate emergency while securing the energy supply for hard-to-electrify heavy industries and heavy transport.

Any delay in starting work on the green hydrogen ecosystem reinforces the reliance on imports and continues to expose the European Union and its Member States to the volatility of energy pricing, supply disruption and geopolitical insecurity.

Energy security is vital to economic and social stability

The oil crises of the 1970s serve as a stark reminder of how impactful volatility in energy supply and pricing can be on the world's financial and geopolitical landscape. The crises led to far-reaching socio-economic changes which hit individuals as well as corporations and investors. But hardship can inspire innovation; the realization of the dependency on fossil fuel imports accelerated the drive within Europe to find alternative, locally available and renewable sources of power.

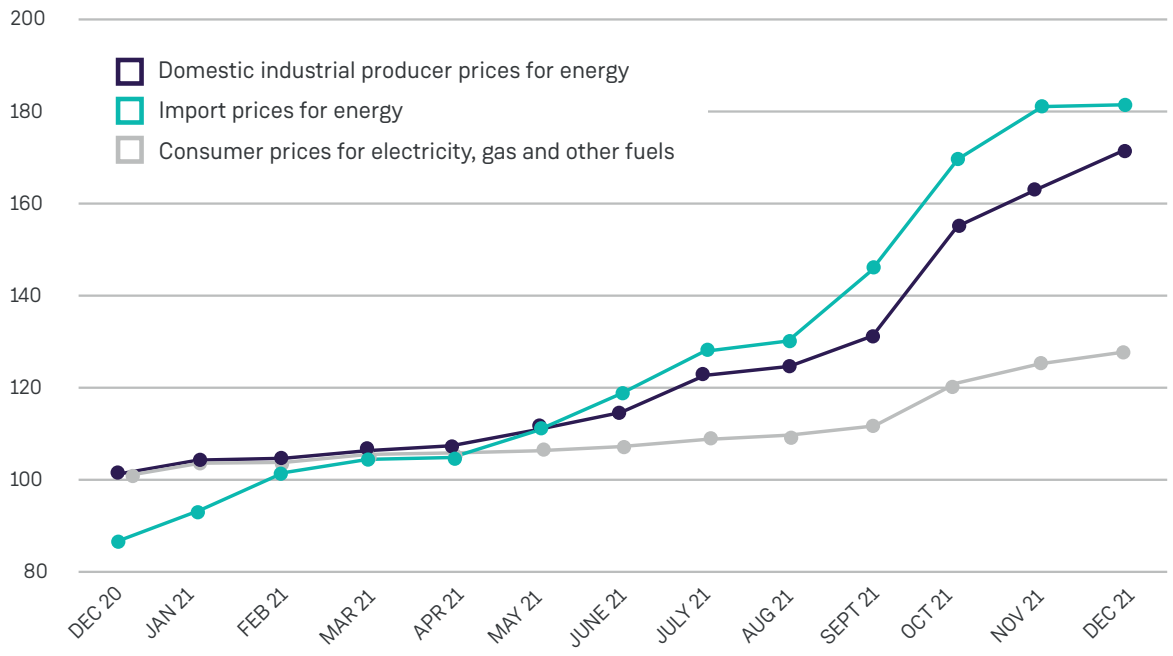
The world has moved on since the 1970s but the underlying paradigm remains – societies need secure sources of energy in order to function on a day-to-day and long-term basis.

Therefore, the current situation reinforces the need for the pace of innovation to increase across the entire energy ecosystem in order to accelerate the shift away from imported fossil fuels. Finding alternative source markets for imported fossil fuels will diversify supply options away from the big exporting nations during the transition.

At the same time, the connection between energy security and Europe's need to ramp up renewables is increasingly evident. Even before the tragic events in Ukraine, Europe experienced big increases in the cost of imported gas, partly driven by the resurgent post-COVID demand.

The widely-reported, triple-digit percentage increases in the cost of gas imports during 2021 led to rising electricity prices across Europe, ramping up the cost for consumers and businesses alike. Many firms in energy-intensive or natural-gas-dependent industries such as fertilizer and steel manufacturing were forced to pass on these increased costs or, in some cases, even halt production. This in turn has led to logistical pressure on supply chains and inflationary pressures on economies.

Energy prices in the euro area, 2011[6] (2015=100, unadjusted)



Source: eurostat

In response, some European countries reactivated coal-fired power stations to reduce the demand for expensive imported gas to power the grid. Replacing imported fossil fuels with domestic or regionally sourced fossil fuels is out of sync with long-term net zero targets. This situation reinforces the need to ramp up the amount of renewable energy generated within Europe.

Many other areas of economic activity require security of supply and price. Food, for example, is an often-overlooked part of the climate emergency, even though the warming climate and changes to weather patterns are already impacting farming and agriculture.

Food production – from subsistence farmers to industrial-scale multinationals - need fertilizers to optimize output, and ammonia is the most important fertilizer for crops and for grazing. Today, almost all ammonia production uses natural gas as the feedstock, so an increase in the price of natural gas, or a change to supply patterns, as is happening as a result of Russia's invasion of Ukraine, increases the cost of production for food.

According to the United Nations[7], world food prices shot up by 28% in 2021 with the organization warning that the trend of increasing prices will continue into 2022. The current situation has the potential to further exacerbate food price inflation.

The input costs of fertilizer and fuel, as well as the emissions generated from current production techniques, need to be addressed immediately. Access to affordable food resources produced in a low-carbon way, is part of our climate future. Renewable hydrogen is the only viable option on the market to reduce emissions in the long-term, replacing the current dependence on natural gas to produce fertilizers.

The need is urgent. UK thinktank Chatham House[8] said that "to meet global demand, agriculture will need to produce almost 50% more food by 2050."

Fertilizer production must transition to domestically produced green hydrogen in order to meet net zero targets and to help secure food supplies.

Energy security allows societies to function effectively and to ensure citizens and businesses have reliable access to food and fuel. The current situation reinforces the connection between energy security and Europe's need to scale up homegrown renewable energy production.

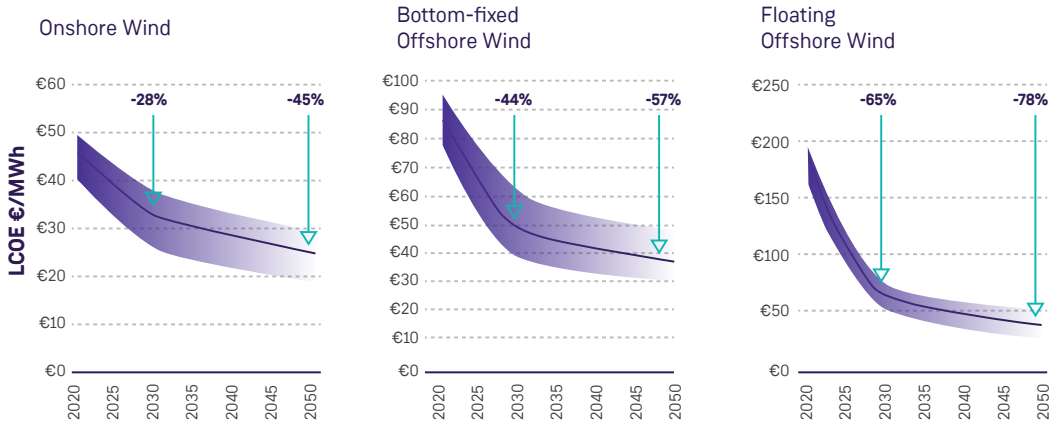
Only by accelerating investment in renewable energy can Europe deliver greater energy security

Johannes Juul, one of the wind industry's pioneers, realized the importance of wind in 1962, recognizing that wind was the only significant domestic source of power for his homeland, Denmark. Some sixty years later, Denmark, according to the IEA[9], "has the highest share of wind in both total primary energy consumption and electricity of any IEA member country."

His premise still holds for most countries in Europe, if not the world: renewables, by definition, are an unlimited, naturally occurring, locally available resource upon which a sustainable, and in time more secure, energy sector can be based.

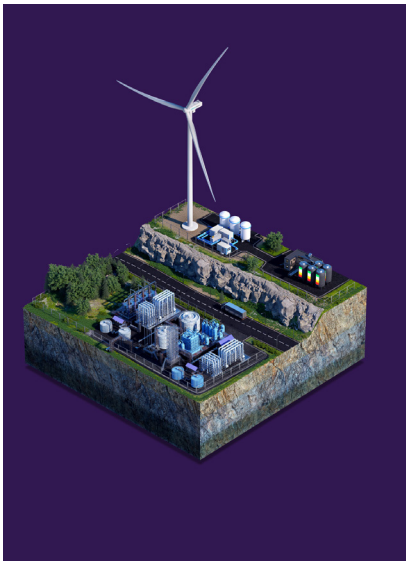
Renewable energy is also becoming cheaper to produce. The economics of wind energy mean that cost is no longer a barrier to adoption, making the arguments for widespread adoption at scale economically viable as well as fundamental for both energy security and fighting the climate emergency..."

Wind energy costs will keep falling over the next 30 years[10]



Source: ETIPWind, WindEurope

Moving Europe's energy supply away from fossil fuels towards renewables will help energy security by reducing the bloc's reliance on fossil fuel exporting nations. However, during the transition towards net zero, Europe will still need to import energy to meet demand, and regulators need to ensure that where possible these imports are based on renewables. Potentially, there will be a larger supply pool for renewable imports than there is for fossil fuels because wind and solar are present everywhere, unlike fossil fuels which are present at scale in only a few parts of the world.



Investing in stable renewable energy frameworks creates jobs and supports local and regional economies. Social commitment to the move to net zero is essential to its success and establishing long-term employment prospects in renewables can help win over people and societies.

The 27 EU Member States have access to wind, as well as solar and hydro, to power and eventually decarbonize electricity, either domestically or thanks to interconnections between the Member States. Wind turbines and solar panels are already feeding into grids, providing the carbon-free electricity to power homes and businesses. In time, residential heat pumps and electric vehicles will also be powered by renewable energy, not imported fossil fuels.

Five benefits of a secure regional energy supply based on renewables

1. Europe will be less vulnerable to the supply and pricing fluctuations which are today a significant risk when so much of Europe's energy is imported.
2. The full potential of a green socio-economic shift will be met as renewable production scales up, including the 160,000 new green jobs in the EU construction industry alone by 2030[11].
3. Europe's industrial ambitions can be achieved in a net-zero compatible way with more access to renewable energy at scale for production of green hydrogen to power hard-to-electrify sectors. A competitive domestic renewable energy sector will foster innovation and encourage investment.
4. The EU can realign its international energy partnerships by sharing its expertise with nations building up their own renewable sector, offering them a market for export.
5. At the same time, this will create new market forces to encourage economies based on producing and exporting fossil fuels to speed up their own transition to net zero through adoption of renewable energy.

The missing element: energy security and storage

Storing energy – albeit natural gas - is part of REPowerEU. Legislation is being considered to ensure that all of Europe's underground gas storage facilities are 90% full at the start of every winter. This, in theory, will keep supply in synch with demand during the peak season. In the short-term, the gas can be sourced from markets outside the bloc other than Russia.

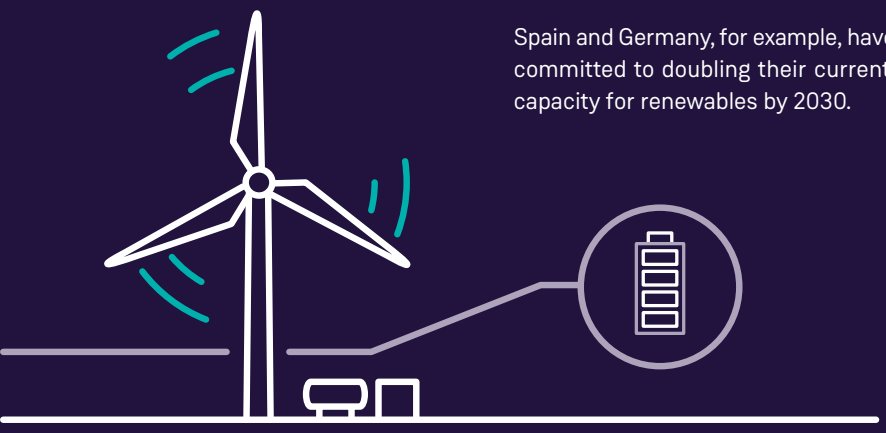
IRENA's World Energy Transitions Outlook: 1.5°C Pathway[12] identified storage as an area ripe for innovation and investment. Emerging storage technologies such as iron flow and vanadium redox batteries which work at scale, will play a key role balancing the electricity grids of the future which will be driven by variable renewable energy power plants. Upgrades to existing pumped storage hydropower systems are also solutions for storage.

Spain and Germany, for example, have already committed to doubling their current storage capacity for renewables by 2030.

There is a role for green hydrogen in energy storage as well. Today, stored natural gas is used to balance grids powered by renewables. In the medium term, natural gas can be substituted with green hydrogen, serving the same purpose but in a cleaner and more competitive pace.

IRENA agrees. It says "the production of a very large volume of hydrogen from renewable power, in combination with hydrogen storage, can help provide long-term seasonal flexibility starting from 2030 onwards and would provide an estimated storage capacity [globally] of 2,000 TWh by 2050."

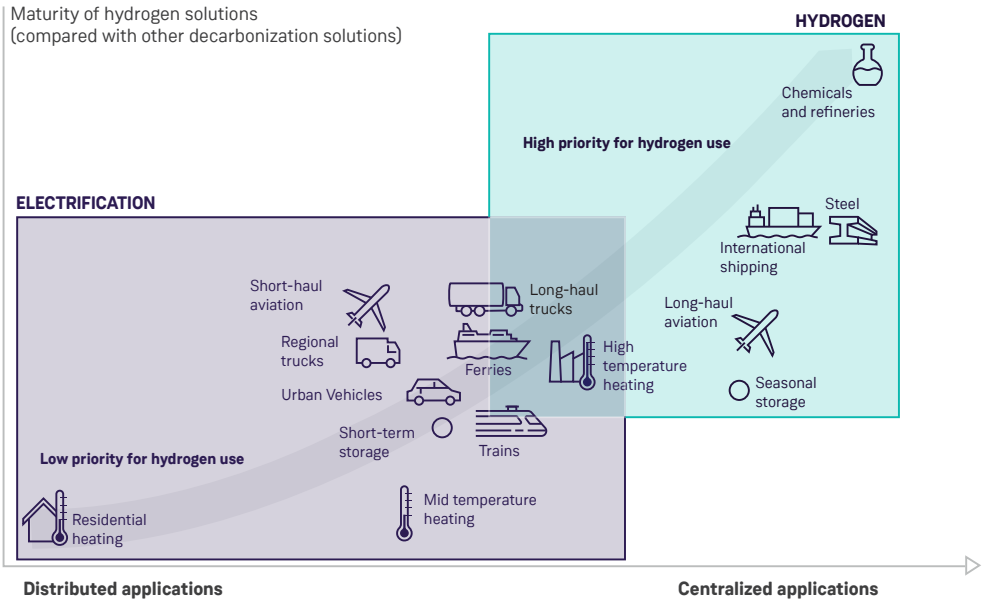
Storing regionally produced renewable energy is essential for Europe to meet its plans for net zero, but without storage facilities and easy access to energy, Europe's energy security will remain fragile.



The perfect equation: Energy security, renewable energy and green hydrogen

Green hydrogen - produced using electrolyzers powered by renewable energy - is the only viable option to reduce the greenhouse gas emissions from hard-to-electrify industries such as fertilizers, cement, iron and steel. Green hydrogen and low-carbon byproducts are also being developed as a fuel for aviation, trucking and ships.

Green hydrogen use cases[13]



Source: IRENA

Securing a climate-friendly power source for industries which cannot be electrified is essential for Europe to have a competitive heavy industry sector of its own, which can compete on the global market. Powering heavy industry through regionally produced green hydrogen will slash the reliance of the bloc on imported fossil fuels, while also significantly reducing the emissions from these sectors.

Progress is under way. Technology for green hydrogen production is available, with many successful trials completed, taking place or planned around the globe, albeit at relatively modest volumes. Siemens Gamesa's pioneering Brande Hydrogen demonstration project in Denmark, for example, is producing green hydrogen which is fueling some of Copenhagen's taxi fleet[14].

Looking ahead, the focus for green hydrogen is now on scaling up what works while continuing to develop and innovate. The AquaVentus[15] initiative, promoting renewable hydrogen production off the coast of Germany, is one of the most ambitious, with more than 80 companies, research institutes and organizations supporting the project.

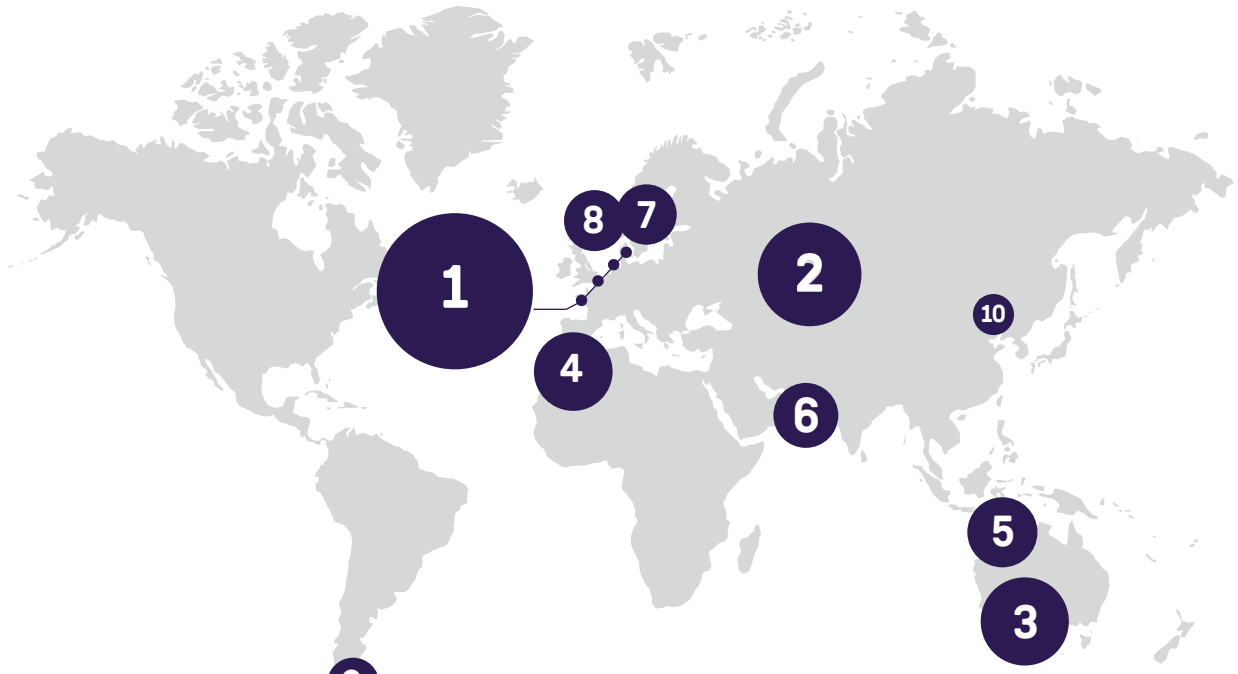
By 2035, the AquaVentus initiative aims to generate green hydrogen from offshore wind energy from 10GW of electrolyzer capacity, capable of producing 1 million metric tons of green hydrogen per year. This initiative alone would secure enough energy to decarbonize half of Germany's current steel production.

Siemens Gamesa, Siemens Energy and RWE, among others, are working together on the AquaPrimus2 part of the project – a decentralized offshore hydrogen power plant, next to the island of Heligoland. Siemens Energy is developing an electrolyzer, which would be the first of its kind, specifically to produce green hydrogen at sea powered by offshore wind. Siemens Gamesa meanwhile is adapting its existing 14-MW offshore turbine to accommodate the breakthrough direct production of offshore hydrogen and to optimize the output from and performance of the co-located electrolyzer.

Elsewhere, Siemens Energy, Porsche and others are involved in a 2.5GW project in Chile which is the first integrated, commercial, industrial-scale plant for making synthetic climate-neutral fuels[16]. Carmaker Porsche is a major investor and will be using the e-fuels in its own engines. Siemens Gamesa is providing the wind turbine to power the electrolyzer for the pilot installation.

Both these projects reinforce the need for collaboration and innovation at scale. In order to meet net zero targets, projects need to be more ambitious and become capable of generating gigawatts, and in time terawatts, of energy.

Largest green hydrogen projects, 2021[17]



Source: IRENA

Note: Size refers to electrolyzer capacity. Information based on announced plans.
a. Estimated electrolyzer capaciy based on a comparison with similar-sized schemes.

1	**HyDeal Ambition (67GW)**	Western Europe
2	**Unnamed (30GW)**	Kazakstan
3	**Western Green Energy Hub (28GW)***	Australia
4	**AMAN (16GW)**	Mauritania
5	**Asian Renewable Energy Hub (14GW)**	Australia
6	**Oman Green Energy Hub (14GW)[a]**	Oman
7	**AquaVentus (10GW)**	Germany
8	**NorthH2 (10GW)**	Netherlands
9	**H2 Magallanes (8GW)**	Chile
10	**Beiging Jingneng (5GW)**	China

*Seven Hydrogen Hubs announced in Australia, totaling 58.6GW

REPowerEU[18] identifies green hydrogen as one of the levers that can be pulled to help the continent to reduce its dependence on Russian gas. It proposes "a hydrogen accelerator to develop infrastructure, storage facilities and ports, and replace demand for Russian gas with additional 10 mt of imported renewable hydrogen from diverse sources and additional 10 mt of domestic renewable hydrogen."

Looking ahead to when scale is reached, the end users for the green hydrogen will be the same heavy industries which are responsible for large volumes of today's emissions. However, there are potential new markets for green hydrogen-based fuels in heavy transportation, shipping and aviation.

Ammonia, for example, is primarily used today as a fertilizer but has potential as a fuel for heavy transportation in the future, giving it a vital role in food production and logistics. The IEA[19] said that ammonia "is nearly twice as emissions intensive as crude steel production and four times that of cement, on a direct CO_2 emissions basis."

The steel industry accounts for around 8% of total emissions[20]. Demand for steel is unlikely to drop – it is needed for wind turbine towers, nacelles and other components as well as for cars, large appliances, buildings and more. Replacing fossil fuels with green hydrogen as the energy source for steel production in Europe will secure supply, helping to avoid disruptions to the wider supply chain.

Meanwhile, the demand from the construction industry for concrete is also likely to increase. The chemical process used to produce concrete will always release carbon dioxide, but green hydrogen can be used to power the processes, reducing the overall impact. Estimates vary, but the World Economic Forum[21] says that concrete production is responsible for 7% of the world's emissions.

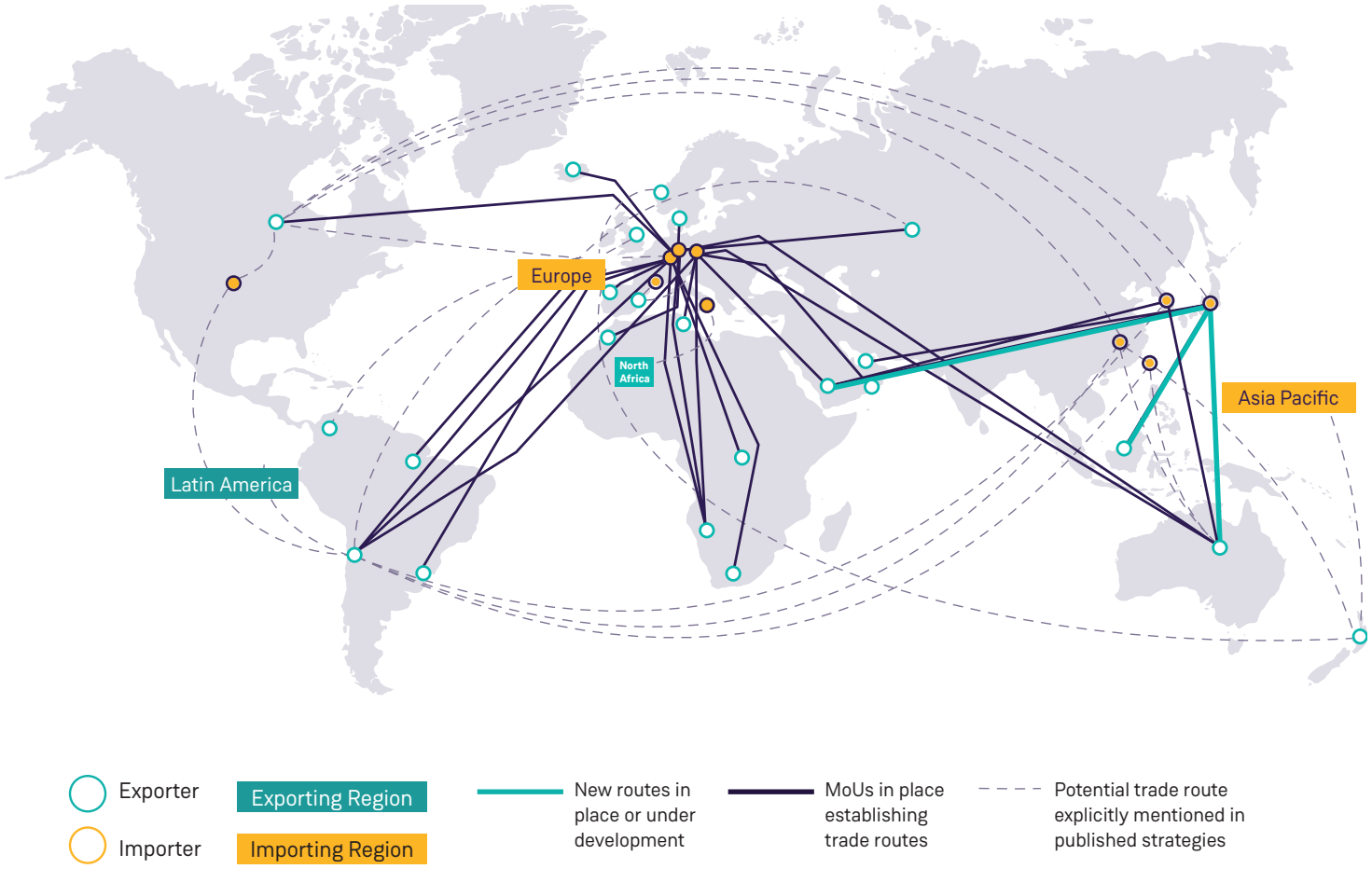
The world that will emerge from the renewable energy transition will be very different from the one which has been built on a foundation of fossil fuels. Bilateral deals related to green hydrogen were being agreed even before the REPowerEU created the demand for an additional 10 mt of imports. This incentivizes emerging nations to develop their green hydrogen capabilities, in turn creating a more inclusive global energy market.

Another way green hydrogen can help provide energy security is as a feedstock for gas turbines. Some peaker plants are already using turbines which have been converted to burn high concentrations of green hydrogen, reducing the reliance on imported fossil fuels when demand is at its highest and providing a business case for this technology to be developed further.

Europe and the entire world will need substantial amounts of green hydrogen in the coming decades in order to meet the net zero targets because green hydrogen is the only viable way to address the hard-to-electrify sectors. The volume of energy needed reinforces the call for European regulators to facilitate more effectively gigawatt-scale wind power plants.

As is the case with renewables and wind in particular, the EU is capable of leading the green hydrogen revolution on a global scale by sharing the experience, knowledge, best practice and proof points in partnership with other regions.

An expanding network of hydrogen trade routes, plans and agreements[22]



Source: IRENA, report published in January 2022. Additional MoUs have been announced since then.

The pathway to a secure energy supply requires action on multiple fronts

The demand for renewable energy and green hydrogen is set to increase, which will encourage and support the investment needed to fund the expansion of renewable energy production, scale up electrolyzer production and, in time, establish a distribution chain to transport green hydrogen from producers to end-user.

Increased energy security for Europe will be a direct consequence as the dependence on imported fossil fuels recedes over time. There will be many socio-economic benefits, with new jobs created, benefiting local economies.

Five ways to realize the benefits of a secure energy supply based on renewables and green hydrogen:

1. Increase the volume of renewable energy produced within Europe by speeding up the permitting process, particularly for gigawatt-scale wind power plants, generating enough energy to decarbonize electricity in the short term and to decarbonize hard-to-electrify industries in the long term.
2. Improve the existing hydrogen infrastructure – pipelines, transportation, port facilities - making it compatible with not only regionally produced green hydrogen but also imported green hydrogen to support demand.
3. Innovate storage solutions and technologies to optimize how renewable energy is stored in order to guarantee continuity of supply.
4. Introduce legislative and regulatory tools to create a market in which EU-generated green hydrogen and its byproducts are guaranteed to be cost-comparable with fossil-fuel-based imports, while fostering the open and fair trade of global renewable energy supply chains.
5. Collaborate across industries in order to scale up the production of electrolyzers, backed by investment in research and development to improve the reliability, output and distribution.

Conclusion

Even before Russia's invasion of Ukraine, there was an urgent need for policies and investments to support renewables and green hydrogen. The current situation presented European leaders with a choice: continue to be exposed to the volatility and uncertainty embedded into the dependence on imported fossil fuels, specifically from Russia, or to state an unequivocal commitment to accelerating the transition to an energy system based on regionally produced clean energy sources.

Decision over the choice has already been made. "We must become independent from Russian oil, coal and gas," said Commission President Ursula von der Leyen. "We need to act now to mitigate the impact of rising energy prices, diversify our gas supply for next winter and accelerate the clean energy transition."

Acting now will lead to immediate changes, such as the recently announced United States and EC "task force" focusing on how the U.S. can help Europe reduce its reliance on Russian fossil fuels[23]. But there also needs to be action now when it comes to getting Europe's wind sector back on track.

Electricity from regionally generated renewable sources will, in time, replace a lot of the European energy needs currently met by imported fossil fuels. The growth in electric vehicle ownership and phasing out of the internal combustion engine, plus the emergence of low-carbon e-fuels, will lead to a drop in demand for imported petrol and diesel. On the other hand, in the case of hard-to-electrify industries such as steel, fertilizers and concrete, the demand is set to increase.

To meet this demand, the European wind energy supply chain needs more support from the European Member States and local authorities in order to generate the volumes required. The WindEurope letter to the Commission in the days before the invasion highlighted the existing shortfall and is worth repeating again: in 2021, only 11GW of new wind farms were built in Europe – for the target at the time to be met that number should have been 32GW. This deficit needed urgent action, even before the targets were lifted in response to Russia's invasion of Ukraine.

The recommendations in the letter still stand. If anything, implementing them is even more important in light of current events:

- Simplify the permitting process for wind power plants and make it easier for grids to be upgraded. Rapidly deployable stable volumes and associated grid connections are crucial.
- Strengthen the position and financial sustainability of the European wind industry in the auction design by introducing factors other than pure cost, which is inevitably ruining the resiliency of the industry and undermines Green Deal and carbon neutrality targets.
- Support innovation - data and digitization, predictive analytics, repowering existing farms, storage, distribution, floating offshore wind power plants.
- Avoid negative bidding, where developers pay the government for the right to operate a wind farm, putting additional pressure on the supply chain.

Green hydrogen's role in energy security relies on increased renewable volumes. This will require the steps above to be applicable at scale, relevant for projects measured in gigawatts.

Europe is in a strong position to draw on its experience, innovation and investment in renewable energy. There is enough on- and offshore wind available to decarbonize electricity production and ramp up the deployment of green hydrogen if we can build enough wind power plants. Yet, unless the challenges are dealt with, effectively and immediately, the bloc could lose its early adopter advantages.

The year 2022 could be a tipping point – the year in which Europe became aware that the delay and disconnections in energy policy threaten energy security as well as the climate. Work must begin immediately on removing every obstacle blocking the path to net zero and on speeding up and scaling up the volumes of renewable energy and green hydrogen produced in Europe.

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