Lux Research

E-BOOK

# A Reality Check on the Energy Transition

# A NOTE ABOUT THIS E-BOOK


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This e-book is an abridged version of our popular webinar “A Reality Check on the Energy Transition.”

For the full webinar, which provides more research and context, please visit our website here.

# Executive summary

The EU stands at a pivotal moment in its pursuit of climate leadership. With ambitious targets to achieve net-zero emissions by 2050, the EU has introduced a comprehensive framework of policies, from the Green Deal and EU Hydrogen Strategy to REPowerEU and ReFuelEU Aviation. These initiatives aim to drive decarbonization across key industries, but their implementation reveals significant hurdles that threaten the bloc's competitive edge on the global stage.

As the EU grapples with rising costs, resource dependencies, and complex regulatory frameworks, it faces a critical question: How can it remain competitive with global leaders like the U.S. and China while accelerating its transition to a sustainable future? From sustainable aviation fuel and energy storage to green hydrogen, the technologies needed for this transformation are advancing, yet each presents unique challenges in scaling and adoption.

This e-book explores the EU's clean tech journey, examining the progress made, the barriers encountered, and the strategic opportunities that lie ahead. By highlighting critical technologies and actionable solutions, it provides a roadmap for navigating the EU's most pressing decarbonization challenges.



Image source: Canva

# Obstacles to progress, according to Draghi

Before examining the EU as a whole, it's worth focusing on one individual: Mario Draghi. Draghi is not only the former prime minister of Italy but also the ex-president of the European Central Bank.

Why bring him up? Recently, Draghi published a report addressing the future of European competitiveness. In his analysis, Draghi presents Europe with a stark choice: exit, paralysis, or integration. This framework challenges the EU to decide whether it will retreat from the global stage, remain stagnant, or embrace deeper integration into global affairs.

A central theme of Draghi's argument is the issue of regulation. He asserts that overregulation has been a key obstacle to progress within the EU. To illustrate this, Draghi highlighted Europe's position in critical digital technologies compared with global leaders like the U.S. and China. In areas like the Internet of Things and cybersecurity, the EU lags significantly. Draghi attributes this gap largely to regulatory barriers that stifle innovation and hinder the EU's digital transformation efforts.

This point has drawn both support and criticism. While many acknowledge the challenges of overregulation, others question Draghi's push for deregulation and its potential risks. Yet one thing seems broadly agreed upon: The EU has a strong tendency to overregulate. This regulatory mindset extends beyond digital technology to areas like energy, further shaping the EU's competitive landscape.

**"Europe faces a choice between exit, paralysis, or integration."**

Mario Draghi
September 2024



Quote source: European Parliament; image source: Microsoft Creative Commons

# A brief history of the EU's energy sector regulations

In December 2019, the EU introduced the Green Deal, establishing a comprehensive framework to achieve net-zero emissions by 2050. Over the following years, the EU rolled out additional policies to support this vision, ranging from the EU Hydrogen Strategy to ReFuelEU Aviation. Each initiative aims to set benchmarks and strategies tailored to achieving net-zero across various industries.

A brief timeline of key policies:

- **December 2019:** EU Green Deal
- **July 2020:** EU Hydrogen Strategy
- **July 2021:** Fit for 55
- **May 2022:** REPowerEU
- **April 2023:** Net-Zero Industry Act
- **July 2023:** ReFuelEU Aviation

Politicians have lauded these efforts. European Commission President Ursula von der Leyen, for example, has expressed confidence, suggesting the EU might even exceed its 55% emissions-reduction target by 2030. But while political optimism is abundant, the data present a more nuanced picture.

**"The European Green Deal is delivering the change we need to reduce $CO_2$ emissions. The legislation to reduce our greenhouse gas emissions by at least 55% [from 1990] by 2030 is now in place, and I am very happy that we are even on track to overshoot this ambition."**

Ursula von der Leyen
October 2023



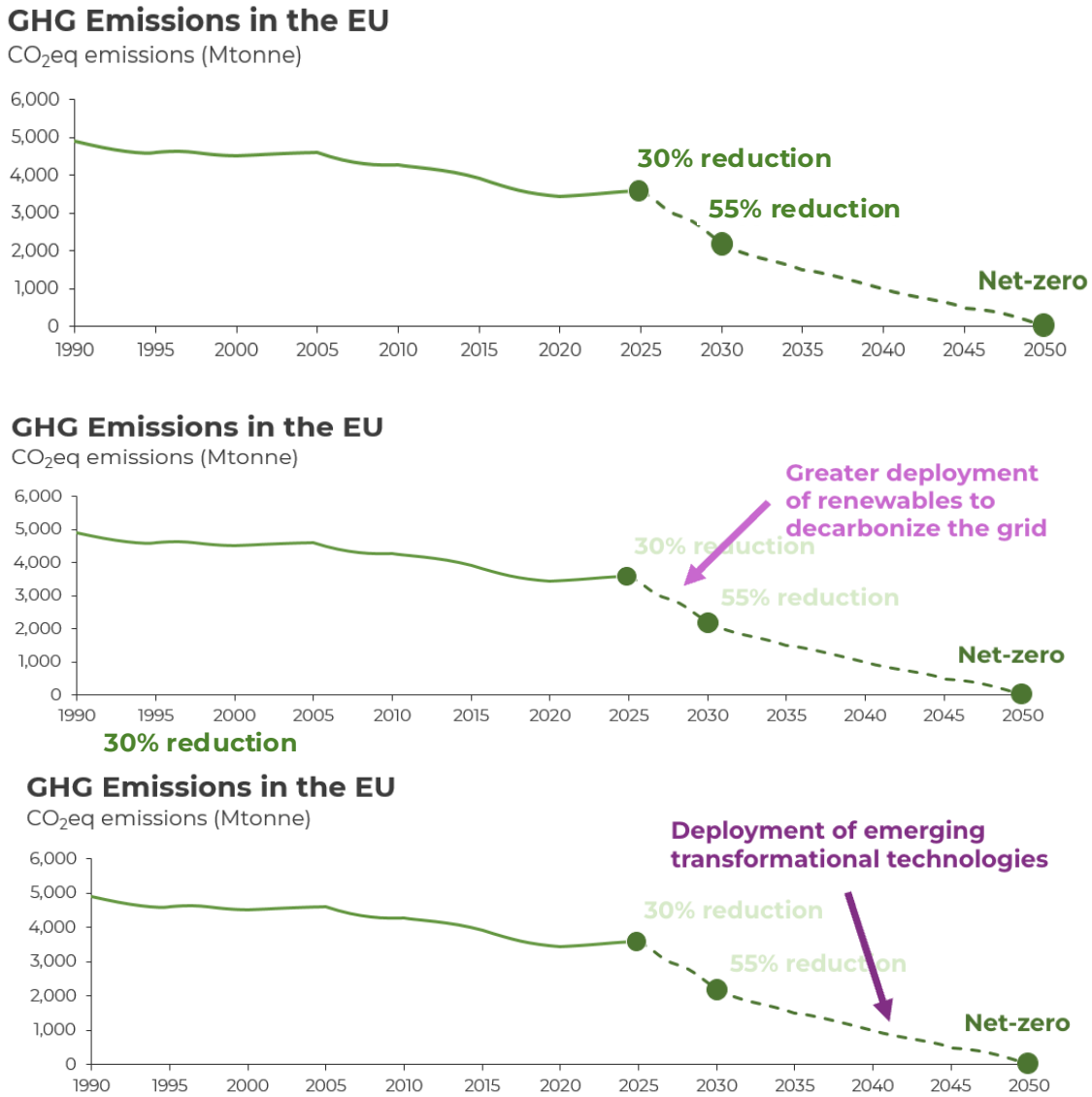
Quote source: European Commission; image source: Microsoft Creative Commons

# GHG emissions from the EU

Since 1990, the EU has achieved a 30% reduction in greenhouse gas (GHG) emissions. While this progress is commendable, the trajectory to a 55% reduction by 2030 demands a significantly steeper decline. Achieving this interim target will largely depend on accelerating the deployment of renewable energy sources, particularly solar and wind, to decarbonize power generation.

The real challenge lies beyond 2030. Reaching net-zero will require transformational changes, including the adoption of breakthrough technologies for hard-to-decarbonize sectors like heavy industry and aviation. These areas demand innovation at a scale that exceeds current capabilities and investments.

Based on current trends, the data suggest that while the EU is making strides, it remains unclear whether the bloc is truly on track to meet its ambitious net-zero goal. Achieving this vision will require not just policy frameworks but also tangible, accelerated progress in technology deployment and sectoral transformation.




The EU has reduced its GHG emissions by 30% from 1990 levels, but it will have to accelerate efforts to hit 55% reduction by 2030 — while hitting the 2050 net-zero target remains extremely challenging.



$CO_2$eq: $CO_2$ equivalent

# Key technologies driving the EU's net-zero transition

However, not all is lost in the EU's journey toward net-zero. Over the past few years, the EU has introduced a series of legislative acts with specific targets for technologies deemed critical to achieving its climate ambitions.

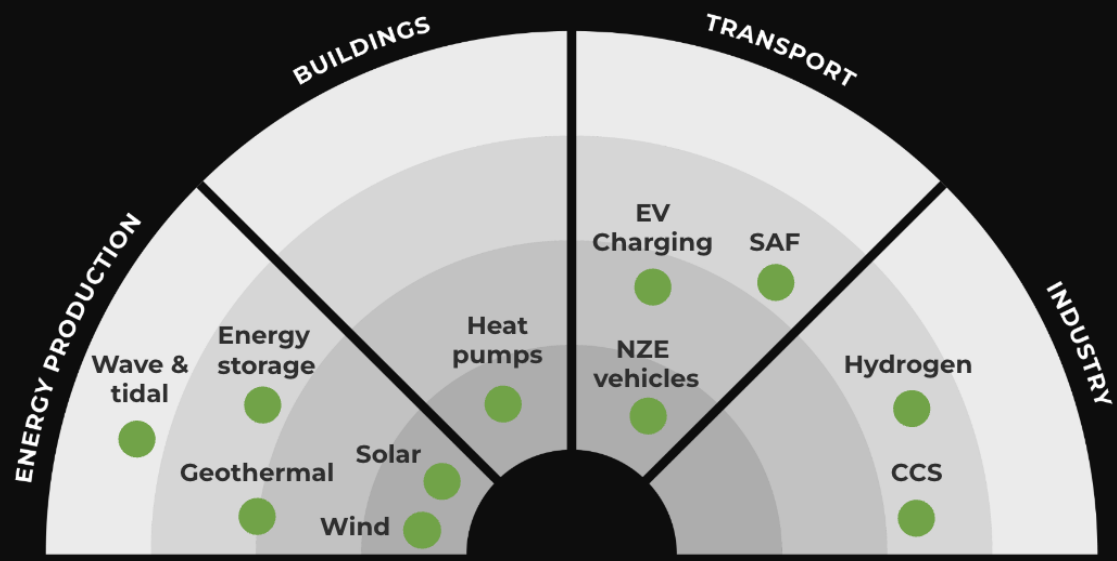
These technologies span the entire energy value chain, from the production of low-carbon energy to its application across sectors like buildings, transportation, and industry. Each has clearly defined deployment targets for both 2030 and 2050, reflecting the EU's strategic approach to incremental progress.

While it isn't feasible to cover every technology here, three stand out as pivotal for meeting the EU's climate goals:

1. Sustainable aviation fuel (SAF)
2. Energy storage
3. Low-carbon hydrogen

These technologies represent core pillars of the EU's strategy, offering pathways to address some of the most challenging aspects of the net-zero transition.

The EU has identified key technologies for net-zero by 2050.






In the radar graph above, ring colors represent developmental stage, ranging from scale (darkest color) to lab (lightest color). EV: electric vehicle; NZE: net-zero emissions; CCS: carbon capture and storage.

# SAF

The first key technology is SAF, a critical component of the EU's strategy to decarbonize aviation. According to the ReFuelEU Aviation Act, the EU aims to blend approximately 3.3 billion L of SAF by 2030.

However, current production capacity falls far short of this target. As of 2024, the EU's maximum production capacity for SAF is only around 300 million L — and actual production is significantly lower. This figure represents the upper limit of what could be achieved if every biorefinery in the EU were fully dedicated to SAF production, a scenario that is far from reality.

The gap between the current state and the 2030 target is stark. Meeting this ambitious goal would require substantial investment — amounting to billions of euros — and the construction of new biorefineries and production facilities, which are both time and resource intensive. Given these challenges, it appears increasingly unlikely that the EU will reach its SAF target within the next six years.

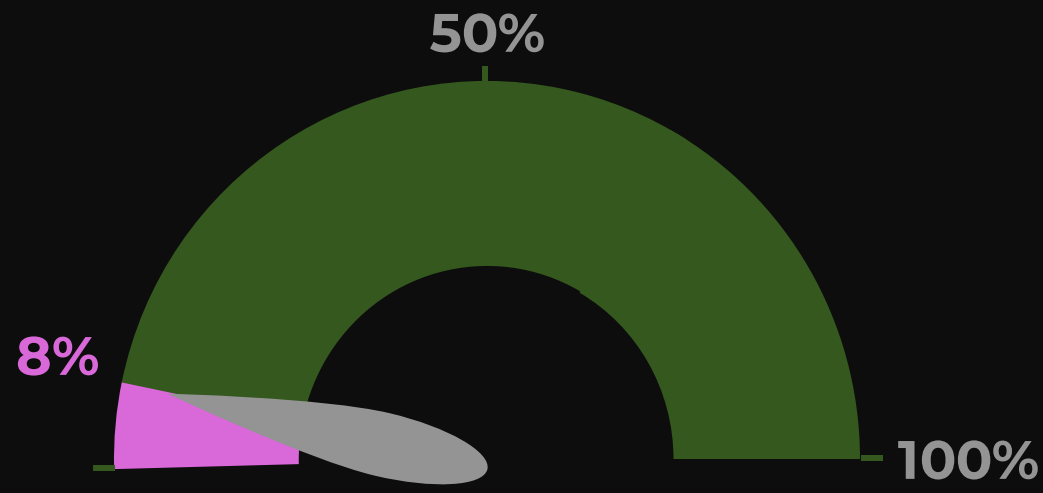
**GOAL**

~3.3 billion L of SAF blended into fossil jet fuel by 2030

**PROGRESS**

The EU's maximum production capacity for SAF is 288 million L in 2024

Progress toward 2030 target



# Barriers and solutions for SAFs

The EU faces significant challenges in meeting its ambitious SAF targets:

- **Policy limitations:** The ReFuelEU Aviation Act mandates SAF blending but doesn't address its high costs. SAF is significantly more expensive than fossil jet fuel, making airlines hesitant to adopt it due to fears of losing global competitiveness. Incentives like the U.S. Inflation Reduction Act's tax credit of up to USD 1.75/gallon could make SAF more viable in the EU.
- **Technological constraints:** While SAF is commercially producible, the dominant production method — hydroprocessed esters and fatty acids — relies on limited feedstocks like vegetable oil and waste oil. This constraint creates a scalability bottleneck for SAF production.

Addressing these challenges to scale SAF production requires two things:

- **Policy innovation:** Introducing tax incentives like those in the U.S. could bridge the price gap between SAF and fossil fuels, encouraging broader adoption.
- **Feedstock expansion:** The EU has significant untapped biomass resources. Advanced technologies, such as gasification, Fischer-Tropsch synthesis, and alcohol-to-jet processes, could convert biomass into SAF, reducing reliance on scarce feedstocks like waste oil.

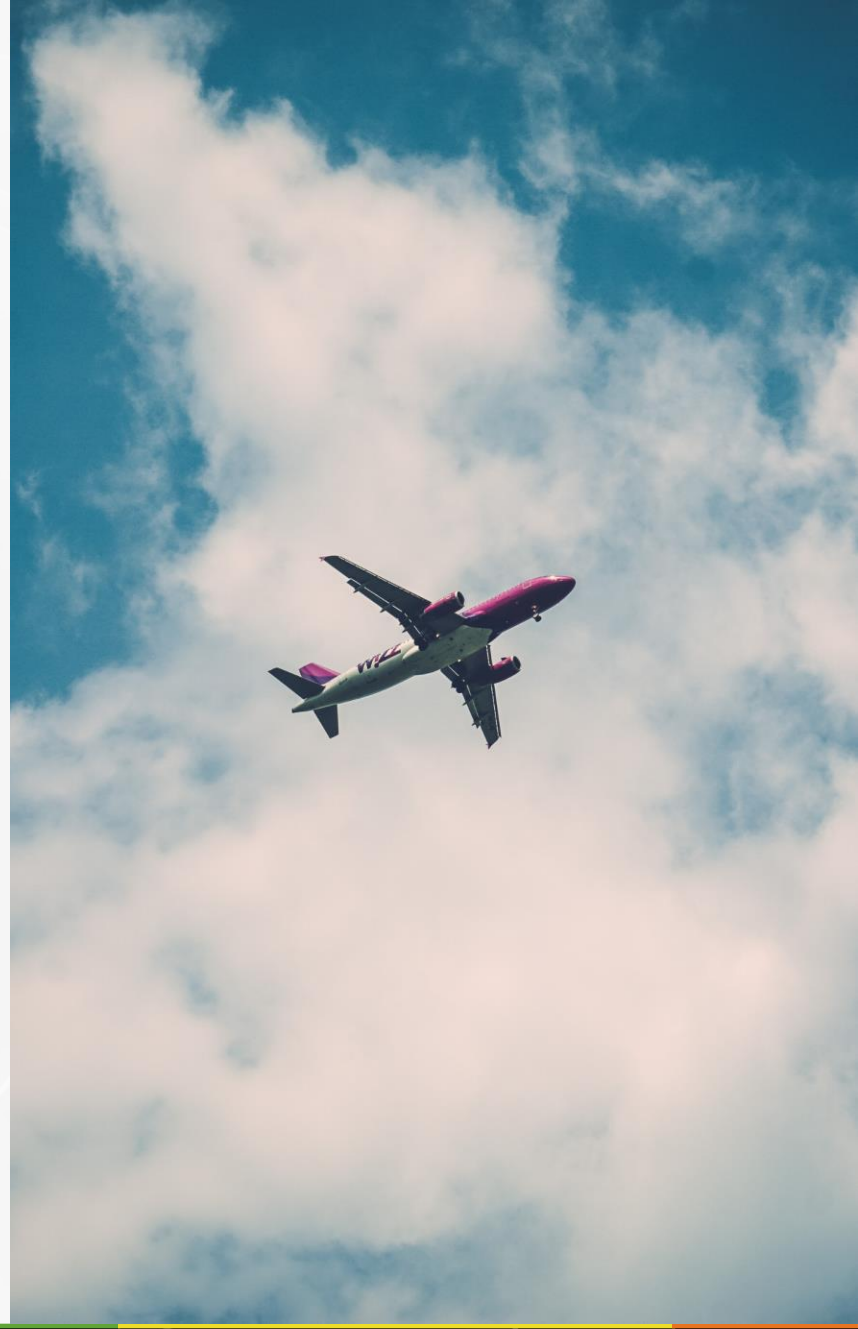




Image source: Canva

# Energy storage

Energy storage is essential for the EU to achieve its 55% emissions reduction by 2030. The EU aims to deploy 200 GW of storage by 2030 and 600 GW by 2050.

Currently, only 20 GW of storage has been deployed, including pumped-storage hydroelectricity, which is effective but limited by geographical constraints. To close the gap, Europe must turn to other technologies like electrochemical, mechanical, and thermal energy storage.

**GOAL**

200 GW of storage by 2030 and 600 GW by 2050

**PROGRESS**

The EU's maximum production capacity for SAF is 288 million L in 2024

Progress toward 2030 target

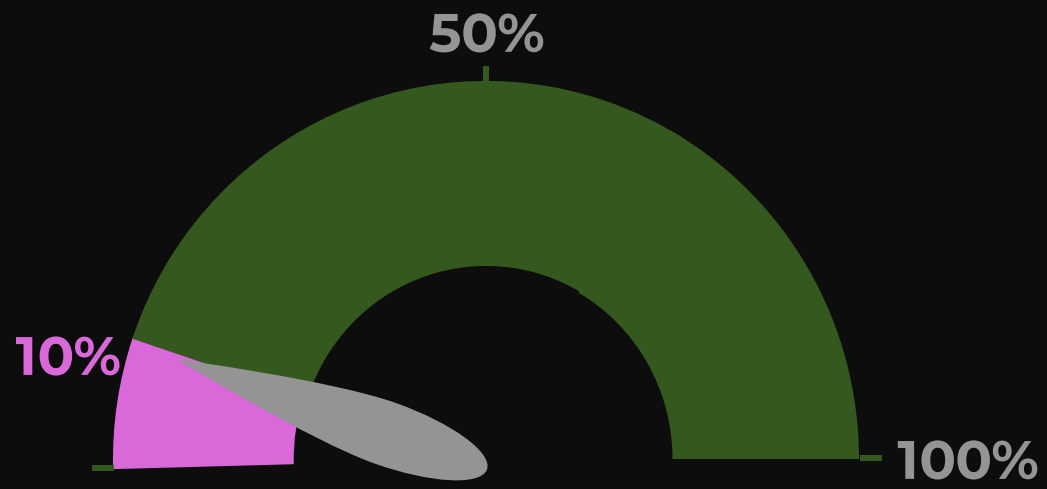





Image source: ChatGPT

# Barriers and solutions for energy storage

Energy storage is critical for meeting the EU's climate goals, but significant barriers must be addressed:

- **Policy gaps:** The EU's energy storage targets lack clear regulations for implementation, leaving developers uncertain about revenue streams and market integration. Regulatory improvements have been proposed, but progress varies across Member States due to differing grid systems.
- **Lack of incentives:** Energy storage receives less financial support than renewables like wind and solar, creating a competitive disadvantage and slowing its deployment.
- **High costs:** Li-ion batteries remain expensive, limiting scalability. Competing technologies face difficulties matching Li-ion's cost-effectiveness for most applications.

However, there are steps to accelerate energy storage adoption:

- **Policy improvements:** Expanding the applications of energy storage — such as longer-duration storage, microgrids for resilience, and backup systems for industrial users — will help unlock its potential. Clear regulations and market certainty will encourage operators to invest with confidence.
- **Cost reductions:** Investments in emerging storage technologies and scaling production can reduce costs, making these solutions more accessible in Europe.



Image source: Canva

# Low-carbon hydrogen

Finally, let's examine the third technology: low-carbon or "green" hydrogen.

The EU has two key targets for green hydrogen by 2030:

- Produce 10 million tonne domestically
- Import an additional 10 million tonne

Today, however, the EU's production capacity is only 37,000 tonne, and no hydrogen is being imported. With just six years left to 2030, it's clear the EU is very far behind.

**GOAL**

10 Mtonne of hydrogen production + 10 Mtonne of hydrogen imports by 2030

**PROGRESS**

The EU has capacity to produce 37,000 tonne of green hydrogen in 2024

Progress toward 2030 target

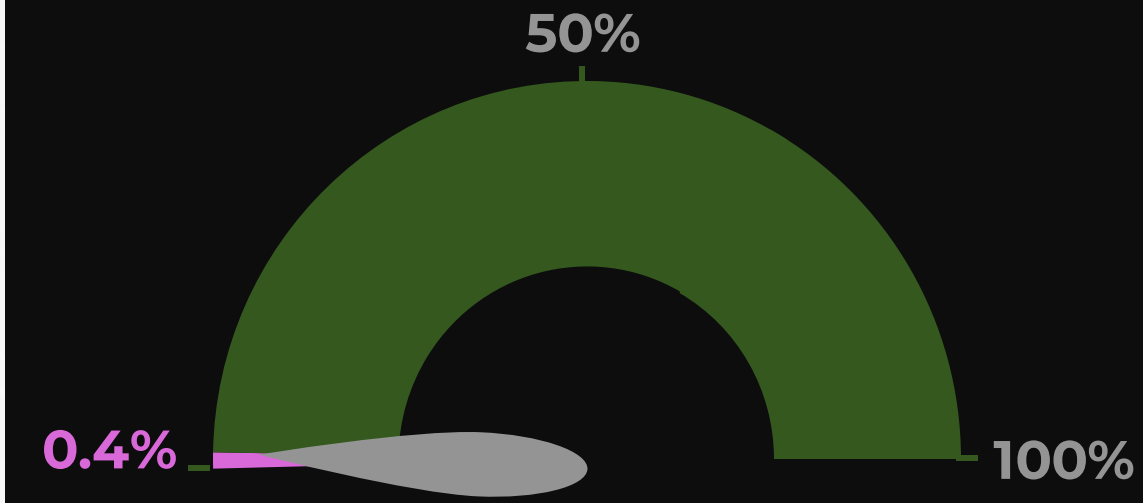





Image source: ChatGPT

# Barriers and solutions for low-carbon hydrogen

Green hydrogen is critical to decarbonizing industries and achieving the EU's net-zero goals, but significant barriers prevent its widespread adoption:

- **Market acceptance:** Despite existing policies and technologies, adoption of green hydrogen remains limited. Its high cost makes industries like steel, chemicals, and aviation reluctant to transition, as they are unwilling to pay a premium.
- **High production costs:** Green hydrogen production costs in most EU countries average EUR 8/kg, far exceeding what industries are prepared to pay. Spain is an exception, with relatively lower costs, but the gap remains significant.

Addressing these challenges will require targeted strategies to drive adoption:

- **Focus on industrial sectors:** Targeting industries already reliant on hydrogen, such as ammonia production and steel refining, can drive initial adoption where the transition is most feasible.
- **Encourage imports:** Regions like the Middle East and South America can produce green hydrogen at lower costs. Supporting imports from these areas could help the EU bridge its supply gap and alleviate domestic cost pressures.



Image source: Canva

# The EU’s unique challenge

As a global player, the EU faces the central question of how to balance ambitious net-zero targets without losing its competitive edge to the U.S. and China.

This issue was a key focus of Draghi’s report, which highlighted several factors contributing to the EU’s competitive gap in clean tech:

- **Higher costs:** Building and operating in the EU is significantly more expensive than in the U.S. or China.
- **Resource dependence:** The EU relies heavily on critical minerals it does not produce domestically.
- **Complex permitting:** Lengthy and cumbersome permitting processes delay projects and increase costs.

A critical conclusion of Draghi’s analysis is the disconnect between innovation and commercialization. While the EU excels in innovation, it struggles to scale emerging technologies and bring them to market effectively.

Although the EU leads in energy technologies like wind and geothermal, its position is under threat. China, for instance, is advancing rapidly in batteries and hydrogen and could soon surpass the EU. To secure its leadership in clean tech, the EU must not only innovate but also ensure effective deployment at scale, turning policies into actionable results.



Image source: Canva

# Key Takeaways

1

**The EU is on track to miss all its net-zero technology targets for 2030, possibly for 2050.**

A combination of weak policy support, lack of technology readiness, and low market adoption holds back net-zero technology in the EU.

2

**Cleantech will be key for the EU to retain global leadership.**

By focusing on what needs to be done in the innovation space, companies can further enable the adoption of these technologies and help achieve net-zero goals.

3

**Scale, don't just innovate.**

Companies must focus on scaling cleantech from lab and pilot stages to full commercial deployment.

# ABOUT LUX

Our mission is to advise leaders about commercially viable science and technology to enable sustainable innovation. We deliver research and advisory services to inspire, illuminate, and ignite innovative thinking that reshapes and grows businesses. Using quality data derived from primary research, fact-based analysis, and opinions that challenge traditional thinking, our experts focus on finding truly disruptive innovations that are also realistic and make good business sense.

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