



CLEANTECH REALITY CHECK

Renewable hydrogen



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SCALING RENEWABLE HYDROGEN AND ITS DERIVATIVES IN EUROPE

EUROPE'S SCALE OR FAIL MOMENT

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- **When it comes to cleantech, European policymaking needs to shift gears. In a world of increasing global competition and geopolitical challenges, in which industrial policy is making a ferocious comeback, targets – even the most ambitious – are nothing to celebrate until they are achieved.** In Europe, too often strategies don't result in progress and laudable goals aren't reached. Nowhere is this more apparent than in Europe's goal to reach net zero, which while admirably ambitious is on the whole far from being achievable at the current rate of progress. Consider: by 2030, meeting Europe's climate targets will require 500–900 gigawatts of extra solar and wind capacity, 11–20 million tonnes of renewable hydrogen use, and 0.6 million tonnes of Sustainable Aviation Fuels, among other clean technologies. It's a tall order.
- **With the European Commission slated to come out with a Clean Industrial Deal in the first 100 days of its new mandate, it is more urgent than ever that policymakers strive harder to use real-time metrics that shed light on actual performance – and not bask in the warm glow of far-off targets.** That's why at the start of a new political cycle in the European Union, when Europe is facing a 'scale or fail moment', we're kicking off this *Cleantech Reality Check* series.
- **We purposefully kick off the series on renewable hydrogen**, an emerging clean technology that dominated EU political discourse and attention for several years, and where European ambition is epitomised by some of the world's boldest targets. In an effort to not only offer the latest critical data points pertaining to Europe's overall performance on hydrogen but also shed light on its end use in key markets, we include deep dives on shipping, aviation and refineries.
- **Since it was launched, Breakthrough Energy Europe has set out to share what we know about clean tech innovation: from discovery and development all the way to deployment.** Success and impact will always be predicated on the actual use of clean technologies and it's here where Europe too often falls short, both in manufacturing and deployment. This is why it is imperative to have a 'reality check' from time to time. Despite the ambition of the 2020 Green Deal, today's realities point to serious challenges: whether in electric vehicles or batteries, renewable hydrogen or electrolysers, wind and solar, heat pumps, sustainable fuels, there is not a single unequivocal success story.
- **Over the coming months we will provide a snapshot of the enablers, barriers, and action agenda for select technologies and sectors that are of strategic importance to Europe's industrial future.** What will this entail? For a start, looking at whether final investment decisions are reached on clean energy projects – not just at announcements made. It is also necessary to measure not only supply but actual demand: is anyone buying the clean technologies we are trying to nurture? Is investment flowing into the technologies and industries we've prioritised, and what share is coming from the private sector? These metrics provide valuable insight into the state of the clean energy transition in Europe and important cues as to where private investors see opportunity and future markets. **But only if we make the effort to look.**
- It is our hope that such a timely reality check can help policymakers, industry leaders, startups and investors to assess the progress made to date, and if necessary, rejig strategies or pivot to entirely new approaches. After all, innovation rarely presents itself as a linear pathway and is more akin to a multidimensional game of chess. And if we want to win this game, it is time to sharpen up, speed up and scale up.

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- > The European Union has one of the most ambitious green hydrogen targets globally. Under the REPowerEU plan, the EU aims to produce 10 million tons (Mt) of renewable hydrogen domestically. This Cleantech Reality Check assesses the renewable hydrogen project pipeline, final investment decisions (FIDs), cost-competitiveness, demand generation and market dynamics focusing on transportation use.
- > The future of sustainable transportation hinges on the successful adoption of renewable fuels. Renewable hydrogen, e-SAF, e-ammonia, and e-methanol are vying for a place in the energy mix, each offering distinct pathways to decarbonisation in sectors of strategic importance to Europe. This reality check delves into the comparative progress and challenges in three key sectors.

OFF-TRACK



ON-TRACK

E-FUELS FOR SHIPPING

e-fuels in shipping are well off-track for mid-term scaling with current policy flexibility promoting non-breakthrough technologies such as LNG, limited public funding for OPEX over CAPEX, and uncertainty in the accounting of emissions reductions for the voluntary market all stifling demand signals, leaving vessel owners/operators unable to make the business case for long-term offtake.

~2x – 4x

~€750 (price)
~€1600-2700 (costs)

Green premium gap

Grey price (€/t)
Approx. range of e-fuel costs

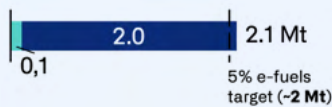
Projects having reached FID

4 PROJECTS REACHED FID
2 for Methanol | 2 for Ammonia

Project pipeline

- Announced
- Operational
- Reached FID / Construction

e-Methanol



e-Ammonia



- EU industrial leadership
- Maturing technology and market mechanisms
- Ambitious project development

- Near term LNG fuel uptake permitted
- Insufficient offtake incentives
- Unclear pooling additionality guidance under Fuel EU maritime

😊 What is working well

😞 What is not working well

E-SAF FOR AVIATION

e-SAF projects are not getting to FIDs due to a lack of adequate public support for the first wave of e-SAF projects, a lack of bankable offtake agreements and adequate mitigation mechanisms for first-of-a-kind project risk, and perceived regulatory uncertainty (despite the legally binding nature of ReFuelEU Aviation)

~5x – 8x

~€950 (price)
~€5000-8000 (costs)

0 PROJECTS REACHED FID

e-SAF



- Long-term demand signal
- EU industrial leadership
- High long-term interest from banks and equity

- Regulatory uncertainty
- Lack of bankable offtake contracts (10+ year)
- Inadequate public funding

HYDROGEN FOR REFINERIES

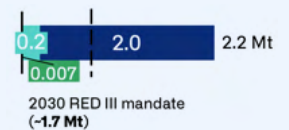
The use case for renewable hydrogen in refineries is clear, but stronger and clearer policy targets are required for business certainty, more accessible and higher project funding support to bridge cost premiums is needed to overcome economic failures and coordinated infrastructure support to leverage EU's cheapest hydrogen production.

~1.5x – 3x

~€3400 (price)
~€4500-9000 (costs)

23 PROJECTS REACHED FID

Renewable H2



- First mover offtaker enabling early scaling
- Comprehensive policy framework established
- Incumbents absorbing project risk

- Targets failing to mobilise required demand
- Complex and misdirected funding
- Lack of infrastructure investment and pan-EU coordination










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- The transition to a sustainable and clean mobility future in Europe and investments into renewable hydrogen based production factories demands more than just technological innovation. Successful scaling of clean technologies hinges on a delicate interplay of factors. Let's explore the critical elements that will pave the way for the widespread adoption of renewable fuels.










ARE THE ENABLING CONDITIONS FOR RAPID SCALE UP IN PLACE?

DEMAND ENVIRONMENT ENCOURAGES EARLY OFFTAKE










-    Legislated GHG reduction targets set an ambitious horizon
-    Sector is included in the EU Emissions Trading System (EU ETS) with appropriate exceptions for financial signal
-    Subsidies and incentives effectively reduce green premium

-  In place and sufficient
-  In place and insufficient
-  Missing

SUPPLY ENVIRONMENT ENABLES ECONOMIES OF SCALE

-    Technology specific mandates ensure timely volumes for targets
-    Infrastructure funding is targeted and deployed
-    Technology and enabling infrastructure are mature

MARKET IS FACILITATED AND COORDINATED

-    Product Standards & Certification Schemes include green product
-    Accounting & Reporting Frameworks on national and value chain level
-    Voluntary market mechanisms are in place

ACTION AGENDA

Key actions and intervention areas to develop the EU project pipeline

1

MARITIME

- Create markets by providing short-term demand certainty

2

- Enable the downstream business case through OPEX orientated support

3

- Support supply chain demand signals with regulatory clarity for insets (within value chain emissions reductions)

AVIATION

- Build a business case for e-SAF by establishing an adequate mix of incentives and penalties while ensuring that European first-movers remain competitive
- Increase targeted public funding in the short-term and long-term to support the first wave of projects
- Stimulate accessible and affordable loans

REFINERIES

- Establish long-term regulatory certainty around set-out policy targets
- Strengthen public funding to support longer term scale-up and enable more private sector investments
- Guide pan-EU coordination to streamline ongoing H2 infrastructure development