A photograph of two men in dark suits sitting on a concrete bench outdoors. They are facing each other and appear to be in conversation. The background features a concrete wall and a metal fence with greenery behind it. The ground is covered in dry grass and small plants.

Supersizing renewable hydrogen

Inside the plan to make large-scale
renewable hydrogen production real

Key industry experts Dominique Rouge and Stefano Innocenzi talk large-scale renewable hydrogen projects, mass electrolyzer production and how partnerships across sectors will lead to a sustainable world.

By Bill Hinchberger

The European Union's ambitious targets for carbon dioxide (CO₂) and greenhouse gas reduction will require a massive scaling- and speeding-up of renewable hydrogen production and imports – already 20 million tons will be needed by 2030 as part of the REPowerEU plan to fast-forward the green transition. So just how will the renewable hydrogen market be accelerated? The answer, say Dominique Rouge and Stefano Innocenzi, two leaders from different branches, is establishing new partnerships.



the first priority will be electrification, but electrification can't cover all industry sectors. That's the reason why renewable hydrogen and derivatives of renewable hydrogen are so important: Because they'll decarbonize sectors that are hard to decarbonize, as well as bring clean energy from areas where there are more renewables to regions like Europe, where there is a huge demand but the amount of renewables is limited.

Europe driving the new energy landscape

Out of the 20 million tons of renewable hydrogen that the European Union wants to have by 2030, 10 million tons per annum will have to

“Obviously, the first priority will be electrification, but electrification can't cover all industry sectors.”

Stefano Innocenzi

Rouge is Vice President of Sales & Technology, Engineering & Construction at Air Liquide, a world leader in gases, technologies and services for industry and health; Innocenzi is Senior Vice President for New Energy Business at Siemens Energy – together they have decades of experience with hydrogen. They invited me to listen in as they sat down at Air Liquide's offices in Frankfurt, Germany, to address the role of collaboration and the new projects the two companies are undertaking together to lay the groundwork for Europe's renewable hydrogen economy.

Is it a model for the rest of the world? What follows is an edited version of that conversation.

Stefano Innocenzi: Dominique, I think if you look at the needs of decarbonization, obviously,

come from imports, which will actually drive development. The imports we see coming from traditional energy exporters like the Middle East and Australia, but also from countries which are new to the energy landscape like, for example, Chile, Namibia or Morocco, which are coming up strong.

Dominique Rouge: Europe is at the forefront, but things are evolving very quickly in the USA as well. Two or three years ago, we weren't even discussing the topic; it was all about the US Gulf Coast, for example, the shale gas boom or the oil and gas industry. Now, we see a real change in the USA. So, that's coming in all areas, and I think our partnership should have this global view and global objective. Of course, the basis and foundation are today here in Europe, but the ambition is global. ▶

“First, we need large projects and the mass manufacturing and the large-volume manufacturing.”

Dominique Rouge



The development of renewable hydrogen

Stefano Innocenzi: Absolutely, if you look at the development of renewable hydrogen, we have a little bit the issue that every new industry has, which is the chicken and egg question. So, a lot of companies need clear subsidies, quotas and clear frameworks – as well as a clear competitive cost for renewable power and electrolyzers in order to make the investment, but if you don’t start you’ll never get to an economy of scale.

Dominique Rouge: First, we need large projects and the mass manufacturing and the large-volume manufacturing, and that’s the challenge we’re addressing with our partnership where we’re joining the best of two worlds. Siemens Energy has strength in manufacturing, industrial capabilities and technology. And Air Liquide has strong experience in electrolyzer operations.

We operate more than 30 electrolyzers worldwide, not all giga-scale electrolyzers, but quite a lot of them. We already operate the largest PEM (Proton Exchange Membrane) electrolyzer in the world, we’re installing and constructing 30 megawatts in Oberhausen, Germany (not so far from here), with Siemens Energy technology. So, we can feed our operations experience back into the development of projects. And we’re engaged in very large projects.

We want to bring up our electrolysis capacity to 3 gigawatt before 2030, and we’re totally committed to that. The 200-megawatt project in Normandy, France, [one of the largest

electrolyzer projects in the world] is one example, which has strong support from the French state and was the opening for our partnership.

So, I think we’re all set, the best of two worlds making it happen to resolve this chicken and egg situation.

Driving sustainability through partnerships

Stefano Innocenzi: And our partnership will help because we’ll get the production volumes for our customers and the knowledge of companies that have rarely been in such a venture before, right? So, that’s the beauty of it. Normally, you rarely find those capabilities all combined in one offering – and that, I think, is very exciting. We can support Air Liquide customers and then also significantly improve what we as Siemens Energy can offer to other customers in all industries.

Siemens Energy has been working on developing PEM electrolyzers since 1995. Having Air Liquide be part of this development in the area of the balance of the stack and the operational aspect, is a big plus: bringing in the operating experience of many, many years of managing plants and doing maintenance – in my experience, an industrial gas company like Air Liquide can only help us be more competitive!

And we’ll need more partnerships like this because we have these cross-sector interactions. I think the two companies have been smart in that sense, really taking the opportunity to look at the win-win.





How to get renewable hydrogen to an economy of scale? Dominique Rouge and Stefano Innocenzi discuss the steps needed in Europe and beyond.

Air Liquide and Siemens Energy partnership

Dominique Rouge: The partnership is really articulated around two strong pillars: the development of a new generation of electrolyzers – so, R&D or development work together, fed by our experience of operations, fed by customer expectations, fed by all the technological background of Siemens Energy. I would say that’s probably the anchor of of the partnership.

The second pillar, of course, is the manufacturing part. We intend to do this very large mass manufacturing of stacks from the first factory in Berlin. There could be others in the future, but let’s start with the one in Berlin –

quickly ramping up to 3 gigawatts per year as per 2025.

Those two pillars will allow us at Air Liquide to come to the market with Power-to-X [gas or liquids produced with the help of sustainable power] solutions for our customers. And Siemens Energy will also be able to develop a very extensive offer of renewable hydrogen supply for their customers. I would say, that’s the beauty of this overall partnership.

Stefano Innocenzi: If we’re smart, we’ll find many more areas in which we can create value with these two companies, but I fully agree. These are the two pillars: Make the existing product better, develop new and innovative products and then ramp up the manufacturing and increase the volumes and capabilities of both companies. ▶

“Our partnership will help because we’ll get the volumes and the knowledge of companies that have rarely been in such a venture before.”

Stefano Innocenzi





“We have one of the strongest CO₂ legislations in Europe, which is a key element.”

Dominique Rouge

Decarbonizing industry and mobility

Dominique Rouge: One of the first key areas will be the industrial basins where Air Liquide is already operating – Normandy to supply hydrogen for refining chemicals, but also basins for the steel industry where we can create large electrolyzer projects.

Hydrogen is really a key element in decarbonizing feedstock for the chemical and refining industry. There are already new decarbonization applications which will be based on hydrogen. In the steel industry, the switch from blast furnace to DRI (direct-reduced iron) has to be supplied with low-carbon hydrogen. And we shouldn't forget mobility. We speak a lot about industry, but mobility is also driving the need for renewable hydrogen.

Stefano Innocenzi: And industry and mobility are the two areas identified by the European Union. If you look at Fit for 55 (the EU's plan

to reduce greenhouse emissions by at least 55 percent), these are exactly the two areas being targeted: not only heavy-duty mobility, but aviation and shipping also require new, cleaner fuels with e-Fuels that can be produced from renewable hydrogen.

You know, I think Europe is the place where the majority of the activity is happening at the moment because of the strong government support and the willingness of companies and society to do this change. And now with the Ukrainian crisis, I think there's even more political need for energy independency and obviously, renewable hydrogen and renewables can support this energy.

Dominique Rouge: Well, we need real industrial solutions, not only dreamers, I'd say – real industrial solutions to make it happen with a long-term plan because we also have the responsibility to bring costs down. >

<p>6 MW PLANT</p>  <p>Using green hydrogen to manufacture low-carbon steel in Linz, Austria</p>	<p>8.5 MW PLANT</p>  <p>Green hydrogen for the grid creates a model city for the future in Wunsiedel, Germany</p>	<p>20 MW PLANT</p>  <p>Local pipeline delivers green hydrogen to industry and mobility in Germany</p>	<p>50 MW PLANT</p>  <p>E-Methanol for CO₂ neutral shipping at large scale in Kasso, Denmark</p>
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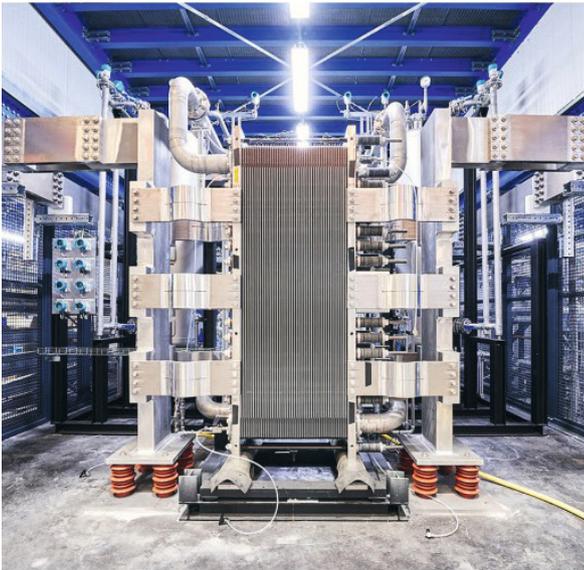
Renewable hydrogen scale-up projects in implementation based on a Silyzer 300 platform.

Renewable hydrogen policies

Stefano Innocenzi: That's why it's quite critical at the beginning for governments to support [renewable hydrogen solutions] with both subsidies and quotas. And later on, there will obviously be the need to scale, and with this scaling we expect the cost to go down so that it'll sustain itself without subsidies and most probably only with CO₂ taxation. At that time, the European ETS (Emissions Trading System) scheme should be sufficient to make companies invest in renewable hydrogen.

Dominique Rouge: Right, we have one of the strongest CO₂ legislations in Europe, which is a key element. So, Europe is set to start having an ecosystem emerge and be a key player. With the Inflation Reduction Act in the US, we're also going to see a real change. There are a lot of milestones [coming up] in the next few months which are critical to make these first projects happen, but the framework is there. We just have to make it happen now.

Bill Hinchberger is an independent journalist based in Paris, France.



Electrolyzers like the one seen here (top left) are the centerpieces to hydrogen technology. In 2023, as part of the partnership between Siemens Energy and Air Liquide, large-scale manufacturing of gigawatt electrolyzers will begin at the multigigawatt factory in Berlin.