

Hydrogen report



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Energy Minister Eamon Ryan TD: ‘Vital that Ireland realises the full potential of green hydrogen’

Ahead of the imminent publication of the hydrogen strategy for Ireland, Energy Minister Eamon Ryan TD comments on its significance and balancing stakeholder confidence with a coherent policy position.

“It is vital that Ireland realises the full potential of green hydrogen in decarbonising our economy and energy systems.”

Minister for the Environment, Climate, Communications and Transport, Eamon Ryan TD

The imminent hydrogen strategy for Ireland represents a key part of the country's efforts to reduce greenhouse gas emissions and achieve its climate targets. The Department of the Environment, Climate and Communications has stated in the National Energy Security Framework, published on 13 April 2022, that the development of an integrated hydrogen strategy for Ireland is to be prioritised, in line with the Climate Action Plan.

A key aspect of the Programme for Government is a commitment to reduce overall greenhouse gas emissions, committing to an average reduction of 7 per cent per year from 2021 to 2030, a 51 per cent reduction over the decade, and to achieving net zero emissions by 2050. The Programme for Government recognises the importance of researching and developing green hydrogen for use as a zero-emission energy source in difficult-to-decarbonise sectors such as transport and industry.

Green hydrogen has been identified in the Climate Action Plan as having the potential to support decarbonisation across several sectors including heavy goods transport, high temperature heat for industry and electricity generation. The plan envisages that green hydrogen could play a significant role in sector coupling (the increased integration of energy supply and end-use sectors), and in minimising the overall cost of decarbonisation across all sectors.

Specific actions relating to hydrogen set out in the Annex of Actions include testing the technical feasibility of safely injecting green hydrogen blends in the gas grid, assessing the potential for system integration between the electricity and gas networks, which will include the production, storage, and use of green hydrogen, and progressing research and pilot studies

regarding the use of hydrogen in the transport sector.

There are a number of other actions, such as those concerning renewable energy in the heat sector, where hydrogen is a relevant factor. Further measures set out in the plan include incentivising electrolyser production, developing storage capacity for long duration and seasonal storage of renewable energy, and colocation of electrolysers with renewable energy production infrastructure.

‘Incredible opportunity’

Hydrogen provides us with an incredible opportunity in Ireland. It provides the potential for long-duration energy storage, dispatchable renewable electricity, the decarbonisation of some parts of high-temperature processing; as well as a potential export market opportunity, given Ireland's offshore renewable potential.

It is vital that Ireland realises the full potential of green hydrogen in decarbonising our economy and energy systems, and we are taking important steps to achieve this. The imminent hydrogen strategy for Ireland represents a key part of the country's efforts to reduce greenhouse gas emissions and achieve its climate targets.

The strategy will provide certainty to industry on the role and priority end uses that hydrogen is envisioned to play in decarbonising our economy, delivering an important first step in the establishment of a significant hydrogen industry in Ireland. But this is just the start. If Ireland can harness the opportunities offered by hydrogen, we can achieve our goals of a secure, integrated, zero-carbon energy system and possibly even become a net exporter of clean renewable energy.

Accelerating the hydrogen economy through digital technology



Transitioning to clean hydrogen can be accelerated with the help of leading-edge technologies. Accenture's Catherine O'Brien, hydrogen fellow at the World Economic Forum, and Aoife Ahern, Accenture's utilities lead for UK and Ireland, share real-world examples.

Clean hydrogen has captured global attention in the race to net zero. Alongside its potential to decarbonise hard-to-abate industry and heavy-duty transport applications, hydrogen can play a key role at the nexus of electricity and gas systems through large-scale storage and balancing capabilities. Hydrogen can thus complement intermittent renewables such as wind and solar energy.

However, there are challenges that need to be addressed, and rapidly, if clean hydrogen is going to play a significant role in a net zero future. Despite a healthy pipeline of global projects, only 4 per cent have reached a final investment decision with cost, standards, and certifications, infrastructure, and supply-demand dynamics amongst the key barriers¹.

The good news is that the European Commission has shown clear support for scaling green gases and the hydrogen economy through policy frameworks including Fit for 55, *REPowerEU*, and the Green Deal Industrial Plan. Closer to home, Ireland's Climate Action Plan targets 2GW of offshore wind for dedicated hydrogen production by 2030². Ireland has a real opportunity to create a scalable hydrogen economy to support domestic decarbonisation targets, energy security and resilience. Furthermore, there is potential for Ireland to create an export market which could attract significant green investment and green jobs. The forthcoming national hydrogen strategy is a critical catalyst to kick start the industry in Ireland.

While hydrogen can unleash many system value benefits, it also increases complexity in terms of project planning, development, operations and trading. From Accenture's work with a range of digital technologies, it is clear that this complexity is surmountable in ways that were unimaginable just a few years ago.

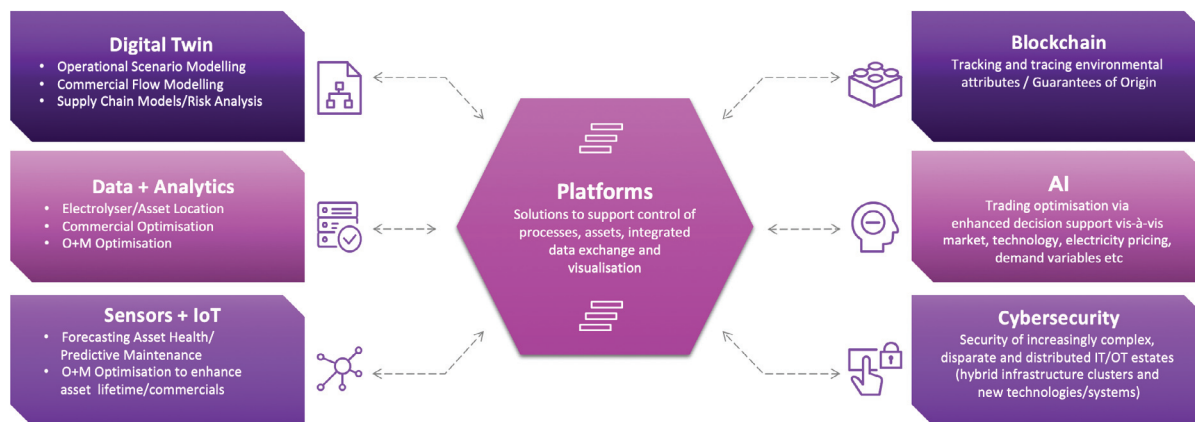
Harnessing digital technologies to accelerate progress

Unlike the early stages of the wind industry, hydrogen can benefit from the intervening decades of technological innovation to drive greater speed and efficiency. Harnessing the power of data, AI and other technologies can unlock barriers to accelerating and scaling the hydrogen economy; ultimately

1. <https://iea.blob.core.windows.net/assets/c5bc75b1-9e4d-460d-9056-6e8e626a11c4/GlobalHydrogenReview2022.pdf>
 2. <https://www.gov.ie/pdf/?file=https://assets.gov.ie/249626/1c20a481-bb51-42d6-9bb9-08b9f728e4b5.pdf#page=null>

Digital and Technology Applications in the Hydrogen Economy

*Not Exhaustive



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contributing to the delivery of national, European and global climate targets, as well as the creation of new value along the way.

Accenture is supporting a variety of industry initiatives aimed at accelerating the hydrogen economy through the deployment of innovative technology solutions (see example graphic ‘Digital and technology applications in the hydrogen economy’).

Digital twin industrial cluster modelling

Through the *Transitioning Industrial Clusters* initiative, the World Economic Forum – in collaboration with Accenture and EPRI – is supporting global industrial clusters to establish and accelerate the path to net zero³. Many of these clusters are enabling the hydrogen economy through aggregation of hydrogen demand to create economies of scale via shared infrastructure, reducing cost and risk for all players in the cluster.

There is an opportunity to make industrial clusters epicentres for hydrogen activity, but success will depend on significant infrastructure investment and orchestrating complex operating models involving multiple players, technologies and commercial flows in the right way. Digital twins can be used to create a digital representation of the cluster, whereby

stakeholders can experiment with multiple scenarios.

Options and trade-offs can be explored with minimal upfront investment and risk; physical infrastructure and commercial flows can be modelled to maximise returns on investment. During operation, IoT devices can feed in data via the cloud to enhance a digital twin’s real-time operational model and enable AI-powered process analytics that help cut carbon, reduce asset down-time, maximise asset lifetime, and enhance commercial outcomes.

Microsoft, Accenture, and the University of Sheffield Advanced Manufacturing Research Centre are developing the foundation of a digital testbed for the Zero Carbon Humber (ZCH) partnership in the north-east of England, which aims to build the world’s first net zero industrial region. The development of this testbed has begun with the creation of a digital twin to better understand the hydrogen infrastructure and local market. It will enable the modelling of decarbonisation pathways and scenarios to assess risk, carbon abatement potential, hydrogen market evolution and the development of the UK’s hydrogen supply chain.

Built in the cloud, the digital twin will apply open data principles to predict hydrogen supply and demand based on current and forecasted consumption as well as production costs, end-user pricing and economic value creation. It

will also be used to inform hydrogen infrastructure location decisions by ingesting large data sets and modelling interacting variables, such as renewable resources, demand, grid connection and land availability.

Blockchain-powered marketplace

One of the key concerns for buyers of green hydrogen is traceability to guarantee origin. With our partners at Shell and American Express Global Business Travel, Accenture launched Avelia, one of the world’s first blockchain-powered digital sustainable aviation fuel (SAF) book-and-claim solutions for business travel. The platform brings together airlines, corporates, cargo players and SAF suppliers within a trusted ecosystem that no individual company could build or access on its own.

It is the largest SAF book-and-claim project at launch, offering around one million gallons of fuel, enough to power almost 15,000 individual business traveller flights from London to New York. The pilot phase of the programme aims to demonstrate the credibility of the model, using blockchain technology to ensure secured allocation of SAF to companies and airlines after it has been delivered into the fuel network.

With Avelia, airlines and business customers could simultaneously reduce

3. <https://initiatives.weforum.org/transitioning-industrial-clusters/home>

The System Value Framework developed by the World Economic Forum supported by Accenture



hydrogen report

Advertorial

emissions in their respective scopes, while ensuring transparency and accountability by avoiding issues such as double counting. It offers the potential to create a positive fly-wheel effect, whereby initial demand creation spurs momentum, powered by verifiable tracing technology, which in turn provides investor confidence to develop supply. The knock-on effect will accelerate industry scale-up and reduce prices over time.

System value for an inclusive transition

Delivering a resilient energy transition depends on delivering a just and inclusive transition. That is to say, resilience and inclusion are inextricably linked. Why does that matter? Because it means that decisions about energy systems must be holistic, and incorporate factors such as jobs, health, air quality, energy affordability, and fairness of access. Ultimately, it is about a broader definition of value as codified by the System Value Framework developed by the World Economic Forum supported by Accenture⁴. The framework aims to shift political and commercial focus beyond cost to

include value (see example graphic above 'The System Value Framework').

While data, digital twin and other technologies can support hydrogen location, sizing and operational scenarios, end consumer and local community engagement is critical to understand sentiment towards adoption and infrastructure deployment. In California, Accenture performed a Social Listening study to understand market sentiment towards the energy transition and emerging clean energy technologies such as hydrogen. The study outcomes informed the engagement strategy to address consumer concerns and engage communities in defining the joint vision and system value outcomes for the regional hydrogen cluster.

Delivering on the promise of a hydrogen economy will require the right mix of technology and human ingenuity. Developing the workforce capacity and new skills to serve the hydrogen economy will require planning and investment. Through the Coal to Renewables Toolkit, developed by the World Economic Forum supported by Accenture, we see examples of policy and planning best practices to approach

4. <https://www.weforum.org/projects/system-value>

coal repurposing in a way which considers the social implications of the transition⁵. In Portugal, a utilities company is repurposing what was the country's largest coal plant into a green hydrogen hub. As part of the transition programme, the utility designed an innovative just transition programme with plans for reskilling and upskilling of workers.

Technology can also play a key role together with understanding of the hydrogen value chain and engagement with the local community. The Greater Houston Partnership, The Center for Houston's Future, and Accenture have teamed up to establish a Hydrogen Workforce Development programme aimed at improving the accessibility of training and job opportunities in the hydrogen economy for those from disadvantaged communities. Accenture are leveraging AI technology to support profiling the requisite skills and proficiency levels and matching these with transferable skills within the local community. The data has also enabled the development of an educational roadmap outlining the pathways for individuals in the community.

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How Ireland can prepare

Through the Accelerating Clean Hydrogen initiative, the World Economic Forum supported by Accenture, developed the Hydrogen Enabling Measures Roadmap for Europe which identified key barriers which must be overcome in order to scale the hydrogen economy⁶. Innovation and ecosystem-wide collaboration will be required to unlock these barriers, and stakeholders in Ireland will need to work together to assess how to:

1. **Prepare for standards and certification:** To unlock financial investment, projects in Ireland will need to meet rigorous sustainability criteria as outlined in the EU Renewable Energy Directive. Collaboration between public and private sectors and other stakeholders will be required to ensure a practical ecosystem that guarantees the origin and sustainability of hydrogen produced.
2. **Unlock demand:** The potential to create anchor demand for hydrogen through aggregation around clusters, for instance around industrial and energy generation zones linked to ports, should be examined in order to support economies of scale, shared infrastructure, financing, risk and operating models between players in a cluster.
3. **Scale-up supply:** Significant acceleration and reform of Ireland's permitting, consents and planning regime will be needed to bring the targeted volumes of renewables on stream in time to deliver on both electrification and green hydrogen ambitions. Furthermore, Ireland must also consider how to secure its renewable technology supply chain in a disrupted market where competition for scarce materials and resources is strong.
4. **Deploy and phase infrastructure investment:** Developing a hydrogen economy in Ireland will require investment in electricity, gas, storage, ports, logistics and associated infrastructure. Stakeholders across the ecosystem must work together to assess how to plan and phase the investment against supply and demand scenarios (local and export), and other societal, environmental, market and technical variables, while ensuring the evolution and deployment of grid infrastructure keeps pace.
5. **Engage consumers and communities:** In order to support the scale up of hydrogen supply and demand, early engagement of Ireland's energy citizens and communities will be critical to ensuring a just and inclusive transition which unlocks system value for all stakeholders. In parallel, early planning for hydrogen workforce new skilling and re-skilling will be fundamental to ensuring Ireland has the workforce skills and capacity to support the hydrogen economy.

5. <https://initiatives.weforum.org/micee/ctr-toolkit>
6. <https://initiatives.weforum.org/accelerating-clean-hydrogen-initiative/home>



Rory Monaghan, Lecturer of Mechanical Engineering, University of Galway.

Towards a national hydrogen strategy

In anticipation of the Government’s forthcoming unveiling of Ireland’s national hydrogen strategy, Odrán Waldron speaks with hydrogen experts Rory Monaghan and James Carton to ascertain what the experts expect.

What do you expect to see from the upcoming national hydrogen strategy?

Rory Monaghan

What I expect to see is an aspirational statement of the potential for hydrogen in Ireland, especially the potential to produce hydrogen. It will talk about how hydrogen can be used as an additional route to market for offshore wind, so I think there will be a lot of statements about the positives that hydrogen can deliver. There will also be a lot of recognition of the direction of travel in Europe with respect to hydrogen, so they will talk about the European Hydrogen Strategy and some of the progress being made in countries like Germany and the Netherlands that are looking to become hydrogen importers. They will probably also point to the progress in Portugal and Spain, who are looking to become big producers.

It will mostly be laying out the vision for what hydrogen could be; I would worry that we will not see a huge amount of concrete support or policies.

James Carton

I expect it to be a nicely written document, with lots of objectives to engage with the hydrogen economy to help with the deployment of renewable energy. That will be all noted and explained well, and it will touch on the areas the Government see hydrogen being used, such as backup power. Other than that, I think the document will not have much else. It might mention the 2GW target for hydrogen production from offshore wind; it might give some clarity on that and how it can be achieved. Unfortunately, I am not sure if the strategy will have enough detailed targets for what needs to be achieved to reach the bigger targets that have been mentioned.



James Carton, Assistant Professor in Sustainable Energy, Dublin City University.

What would you hope to see from the strategy?

Rory Monaghan

What I would hope to see would be something that would resemble in structure the German hydrogen strategy. What they have got are specific targets, dates, and actions. Some of the specific approaches that I would like to see would be mandates for hydrogen production; we have got this target for 2GW of offshore wind being dedicated to hydrogen production for 2030. How is that going to be delivered and enforced? That is just production, and we have a real focus on the potential production of hydrogen in Ireland.

The other side is the market and the demand for hydrogen. What are we going to do to stimulate demand for hydrogen in Ireland? If we export it all, we are missing value. I would like to see statements around implementing the alternative fuels infrastructure requirement, which would set specific targets for where and how many hydrogen filling stations there should be. There has been talk in the Department of Transport around east coast and west coast hydrogen corridors, so I would like to see some mention of them in there as a way to stimulate demand. What is going to be said around the burning of hydrogen in gas stations? I would like it if there was some sort of incentive or requirement for gas power plant operators to burn hydrogen.

There is a support scheme in the Climate Action Plan for zero emissions vehicles, but it is not particularly big, and so having that expanded massively for heavy duty vehicles would be very important. It would be good to see how government plans to help set a price for hydrogen. The American Inflation Reduction Act has come out with a tax credit worth \$3/kg, which is very generous, and the British Renewable Transport Fuel Obligation has a subsidy of £7/kg, so is Ireland looking at a similar level of support?

The final thing is planning; how do we speed up planning and permitting? If it is a block of renewables, then there

is going to be no electricity source for hydrogen production, so if hydrogen producers are going through that block and then an additional block on hydrogen-specific infrastructure, that could damage a lot of projects, so I would like to see something in there on planning and permitting.

James Carton

I would like to see acknowledgement that Ireland is on par with Europe. The EU has its own objectives and Ireland recognises that it is behind, but it wants to contribute to the European targets; I think that statement would be important to align us with Europe and *REPowerEU*.

Aligning ourselves at that level would also mean that I would like to see more ambition. The Government has mentioned the 2GW target a number of times but has not locked it self into what that means. I would like to see that put into the strategy with some realistic figures around it, such as a certain date and how it proposes to support the development. For example, offshore wind development needs grid connection by 2030, but if you are producing hydrogen offshore, you may not need grid connection. We need clarity on that and how it might enable both electricity and other applications other than electricity.

I would also like to see recognition for how hydrogen can be used in various industries in Ireland, not just the basic language that says hydrogen can back up renewables. There are lots of options for hydrogen, and I would like to see specific sectors mentioned. One could be transport, and the Government could detail how it sees it working there and aligning with what is happening in Europe and the UK.

Finally, I would like to see a budget to get hydrogen going. It could be part of the Covid recovery funds, the funds for getting off Russian gas, European funds, a carbon tax, or a windfall tax. There should be a budget to kick-off the hydrogen economy, put into certain projects and clusters. I would like to see some commitment funding for some of these initial lighthouse projects.



The road forward for hydrogen in Ireland



SSE Renewables is leading the delivery of Galway Hydrogen Hub (GH₂), Ireland's first Hydrogen Valley, with consortium partners including NUI Galway, the Port of Galway, CIÉ Group and Bus Éireann, Aran Islands Ferries, Lasta Mara Teo, Aer Arann Islands, and SSE Renewables. Pictured at the launch are (from left) Rory Monaghan, University of Galway, John O'Sullivan, SSE Renewables, and Caoimhe Donnelly, CIÉ Group.

Ireland is on the path to net zero. The Climate Action and Low Carbon Development Act of 2021 sets out that the country must reach net zero emissions no later than 2050, with a 51 per cent reduction in emissions by 2030. To reach this target, it is clear that the electricity sector is going to have to do the heavy lifting, with Ireland's wind power potential an area of strength.

When it comes to developing this renewables-led future, SSE Renewables, Ireland's largest operator of wind power, continues to lead the way. The company has an ambitious Irish offshore pipeline of up to 4GW, which includes the country's most advanced offshore project Arklow Bank Wind Park Two off the coast of Wicklow,

and the Celtic Sea Array and Setanta Wind Park projects which are located off Ireland's south and north-east coasts respectively. In the last few weeks, SSE Renewables also announced it is seeking an investigative foreshore licence to facilitate survey work for a possible new offshore wind farm in the Atlantic Ocean off the coast of Tarbert,



An employee at SSE's Keadby site where there are plans to build the world's first 100 per cent hydrogen-fuelled power station.

“Hydrogen could be utilised in power stations, heavy goods vehicles, and, in the longer term, aviation and shipping. This will deliver greater flexibility to a future energy system that has an even greater penetration of renewable generation.”

Oonagh O’Grady, SSE Renewables’ Director of Power to X



Credit: Beatrice Offshore Wind Farm/SSE Renewables.

SSE Renewables is leading the exploration of how surplus wind production from onshore and offshore energy can be used as a feedstock to create green hydrogen to replace fossil fuels like diesel and natural gas.

County Kerry. The wind farm could generate up to 1GW of clean, renewable energy and marks SSE's first licence application for an offshore wind project off the west coast of Ireland.

Looking beyond wind power, it is clear that other clean solutions are going to be required, not only for the generation of electricity but for other hard to decarbonise parts of the economy. For Oonagh O'Grady, SSE Renewables' Director of Power to X, this underlines the need for us to investigate how we can use our expansive renewable energy in other ways. This includes the potential for Power to X – using electricity to create other forms of energy such as hydrogen gas or its derivate fuels and e-heat solutions. This type of technology has the potential to complement the electrification-led decarbonisation of Ireland while maximising the use of our greatest natural occurring resource, renewable energy.

As O'Grady outlines: "We now need to investigate how hydrogen and other Power to X solutions can play a part, and what is needed to deliver these technologies both from a technical, business model and market design perspective".

The potential for hydrogen in Ireland is an area of increased interest across the industry. As O'Grady explains: "The focus for offshore wind is, correctly, how it can deliver Ireland's energy security and independence. Beyond that, Ireland's significant and plentiful homegrown renewable energy potential could be used in other ways. We can use surplus wind production as a feedstock to create green hydrogen through the process of electrolysis. This could be used as a low carbon replacement for fossil fuels like diesel and natural gas. This hydrogen could be utilised in power stations, heavy goods vehicles, and, in the longer term, aviation and shipping. This will deliver greater flexibility to a future energy system that has an even greater penetration of renewable generation."

To support this goal, SSE Renewables is developing the Galway Hydrogen Hub (GH2) project, as part of a seven member consortium. GH2 will position Galway as the home of Ireland's first hydrogen valley, providing green hydrogen for use in transport, industry, and within local communities in the greater Galway region. The GH2

consortium's intention is to develop a flagship pathfinder project at The Port of Galway, for the indigenous production and local supply of clean green hydrogen fuel for public and private vehicles.

O'Grady adds: "The opportunity could go beyond just domestic. Ireland has one of Europe's best offshore wind resources which could potentially be used to provide Europe with energy – whether that be in the form of electricity or as green hydrogen. For green hydrogen exports, business models, full value chain economics, and transmission solutions will determine the scale of this opportunity."

Decarbonising flexible generation

When the wind does not blow and the sun does not shine, Ireland will need a low-carbon flexible back-up. Future power stations have the potential to be powered by green hydrogen. For its part, SSE is taking the bull by the horns and placing low-carbon projects at the top of its strategic agenda.

As Peter Cunningham, SSE Thermal's Head of New Ventures, outlines: "Our vision is ambitious but simple: To be the leading provider of low-carbon flexible energy in a net zero world. That means managing our business to help keep the lights on today while transforming our business to provide that same flexibility without emitting carbon in the future."

SSE owns and operates four thermal power stations in Ireland, including sites at Tarbert on the Shannon Estuary in County Kerry, Rhode in County Offaly and Tawnaghmore, south of Killala in County Mayo. Rounding out the quartet is Great Island, the newest CCGT in Ireland and one of the most-efficient power stations on the island, generating enough electricity to power half-a-million Irish homes.

Just as Great Island represented a step change from the previous generation of power stations when it opened seven years ago, so too will the next generation of thermal plants. The sector has already seen a major shift in how these stations operate. Where once they ran almost constantly, now they are more flexible in nature, responding to variations in demand and intermittent renewables supply whilst providing additional system stability services.

SSE Thermal is already bringing forward the next generation of lower-carbon power stations, with two plants in

"Not only does hydrogen present an opportunity to utilise our offshore wind potential, it also provides a pathway to reduce Ireland's reliance on imported fossil fuels thereby enhancing security of supply. It is a low-carbon solution, tailor-made for flexible generation."

**Peter Cunningham, SSE Thermal's
Head of New Ventures**

development at Tarbert and Platin which would initially run on biofuels with the potential to convert to hydrogen in the future. In April, SSE won 10-year capacity agreements at each site, highlighting the role it can play in Ireland's future energy system.

As Cunningham outlines: "Not only does hydrogen present an opportunity to utilise our offshore wind potential, it also provides a pathway to reduce Ireland's reliance on imported fossil fuels thereby enhancing security of supply. It is a low-carbon solution tailor-made for flexible generation. It can replace fossil fuels in thermal generation, with 100 per cent hydrogen-fuelled plants producing zero carbon emissions at the point of combustion."

SSE Thermal is embarking on several low-carbon flexible projects in the UK including in the north-east of England where they are developing plans for one of the world's first major 100 per cent-hydrogen-fuelled power stations, with a peak demand of 1,800MW of hydrogen.

SSE Thermal is also developing what could be one of the world's largest hydrogen storage facilities, with an initial expected capacity of 320GWh – enough to power 860 hydrogen buses for one year. They also have plans to decarbonise a gas-powered unit by blending hydrogen.

As Cunningham says: "The experience we are gaining through these diverse projects will undoubtedly stand us in good stead when it comes to delivering the right low-carbon solutions for Ireland, and there is no reason why Ireland cannot be a leader in hydrogen."

Ireland's hydrogen strategy

With the Government due to publish Ireland's first hydrogen strategy later in the year, Oonagh O'Grady believes this will be a critical first step in establishing the role hydrogen will play in Ireland's energy system and Ireland's role in the wider hydrogen market.

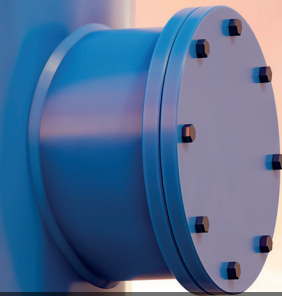
"Hydrogen undoubtedly has as a potential role in our energy system, but we now require the Government to define what its ambitions are and where it would like to see hydrogen being used."

She adds: "Fundamental to the success of hydrogen in Ireland is the need to identify the optimal usages and develop effective incentives for the use of hydrogen, along with the enabling infrastructure required to link production with demand. We need to clearly define the intended uses for hydrogen in Ireland, including our export ambition and how Ireland can be competitive versus other countries."

W: www.sserenewables.com

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Hydrogen and Climate Action Plan 2023

The headline provision for hydrogen contained within Climate Action Plan 2023 is the revision of Ireland's offshore wind targets, with 7GW now to be operational by 2030, including 2GW specially pledged to the production of green hydrogen.

Announced before the official publication of Climate Action Plan 2023, the second of annual updates to the original Climate Action Plan, and the first to be prepared following the Climate Action and Low Carbon Development (Amendment) Act 2021, the increase in the offshore wind targets was made official within the 2023 update as part of a major increase in Ireland's renewable energy ambitions, as the Government aims for a 75 per cent reduction in emissions in the electricity sector by 2030.

Green hydrogen is mentioned within the 2023 Climate Action Plan as a key performance indicator for 2030 with regard to the accelerated generation of renewable energy, with its production from surplus renewable electricity included as one of five key indicators under that theme. The continued production of green hydrogen specifically from the 2GW of offshore wind included in the 7GW target is a

2031-2035 measure along with the design of a roadmap for a net zero power system.

Under the theme of accelerating flexibility in electricity, hydrogen will play a role in the generation of zero emission gas, and will commence by 2030.

Hydrogen is also said to be key to the abatement of industrial emissions within the plan, with policies relating to hydrogen and carbon capture and storage slated for the third carbon budget period (2031-2035), with the plan warning that the Government "will need to start preparing regulatory and policy frameworks for longer-term measures such as hydrogen" within the period of the first two carbon budgets (present-2030). Carbon abatement in industry is said within the plan to require "improvements in energy efficiency... and increased supply and use of biomethane and green hydrogen". Green hydrogen is specifically

mentioned for its potential in generating carbon-neutral heat for industry, but "is expected to have limited impact until after 2030".

The Department of Transport's cross-border work with the Department for the Economy in the North, researching the safety regulation and interoperability of green hydrogen refuelling throughout Ireland under the aegis of the Department of the Taoiseach's Shared Island Fund, is also mentioned within the plan, with the plan outlining that a second phase of the research, concerning the feasibility of said refuelling being organised on a cross-border basis, will progress in 2023.

Concrete targets for hydrogen outside of the 2GW of offshore wind for its production remain scarce, meaning that industry will continue waiting for the publication of the hydrogen strategy for Ireland for further clarity.

Power-to-X: The potential role of Ireland's hydrogen economy



Assistant Professor in Sustainable Energy at Dublin City University, James Carton, speaks to *eolas Magazine* about Power-to-X and the shape that Ireland's potential hydrogen economy could take.

"Power-to-X, X being hydrogen in this case, means you are producing power from excess, curtailed, constrained, or dedicated renewable generation via electrolysis," Carton explains.

"Hydrogen is also a base element for lots of chemicals, which is where X could be converted from power to hydrogen to ammonia, methanol, kerosene, hydrogen peroxide, and another handful of chemicals.

"By 2050, any industry in the country that uses those materials will have to have zero carbon emissions. The idea of hydrogen is in using excess electricity; you do not rob Peter to pay Paul. Industry is very important in this, using electricity but also hydrogen for inputs and some heat and transport uses."

With the Government aiming for a 51 per cent reduction in emissions by 2030 and a net zero atmosphere by 2050, Carton says that hydrogen, most likely green hydrogen, has the potential to be transformative and backs the Climate Action Plan's provision for its use in hard-to-decarbonise sectors and as a backup for renewable energy storage.

While a hydrogen strategy has not yet

been finalised, Carton points out that electrolysis is happening in Ireland: BOC's plant in Dublin; Intel's use of it to produce microchips; Hygen Energy in Ballymena; and other plans are afoot across the country in Galway, Cork, Clare, Belfast, Mayo, and Dublin.

Development of storage will also be crucial, as Carton points out: "There is over 400MW of battery storage installed today; that is interesting for grid balancing but it works on less than half hour storage. Once you go beyond 24 hours of grid management, you need storage in the TW scale. In Ireland, we have potential in the south and the west, but we have massive opportunities in salt caverns in the east and at Larne in the North. These are geological storage capable, two to three kilometres beneath the ground, with all the technology we have developed since the 1970s for methane across the world."

The colour of the hydrogen used will be key to Ireland's environmental targets; with current trajectories meaning that the State will have to pull carbon from the atmosphere to meet those targets, Carton says that Irish hydrogen will

"most likely have the opportunity to go green and nothing else". Costs will also play a key role. "If you want to inject hydrogen into the gas grid, you will probably have to produce hydrogen for less than €2/kg (€0.06/kWh)," Carton says.

"Today, we cannot do that, in 2030 we probably will be aiming for that, by 2040 we will easily produce it for cheaper. The optimal price for hydrogen for the next 10 years is around €5/kg (€0.15/kWh), so if supports come in, they should match that, which does not include the costs of moving hydrogen."

Concluding, Carton says that the most important aspect will be a whole-system approach that does not forewear any options and maintains an eye on 2050: "We are running models with SEAI, and we are even putting nuclear in there because we want to understand how it can engage with our energy system. We are putting everything on the table, let the policymakers take things off the table. We need to plan for 2030 but think for 2050. We do not want to build infrastructure for today that we end up decommissioning in 2035."

The gas network: Ireland's hydrogen-ready infrastructure



In March 2023, Gas Networks Ireland hosted the German-Irish Chamber of Industry and Commerce and a special delegation from the State of Hessen at its Future Lab at the Network Innovation Centre as part of its fact-finding tour on hydrogen. Photograph shows members of the delegation trying to spot the difference between the kettle being boiled on 100 per cent natural gas cooker flames and the kettle on the cooker flames of a blend of 20 per cent hydrogen with 80 per cent natural gas.

In line with the latest Climate Action Plan (CAP), there is a need to decarbonise the national gas network with renewable gases. Gas Networks Ireland is now working on replacing natural gas with renewable gases, such as biomethane and hydrogen, to substantially reduce the country's carbon emissions while complementing intermittent renewable electricity and ensuring a secure energy supply.

Replacing natural gas with renewable gases and using the existing renewables-ready 14,664km national gas network can reduce carbon emissions across a number of key sectors while also enhancing Ireland's energy security and diversity. Ireland's national gas network is a ready-made decarbonisation solution that can be leveraged to accommodate biomethane made from farm and food waste and hydrogen produced from offshore wind.

Biomethane: Renewable gas of the now

Structurally identical to natural gas, biomethane is a carbon neutral renewable gas that can be made from

farm and food waste through a process known as anaerobic digestion. Gas Networks Ireland first introduced domestically produced biomethane onto Ireland's gas network more than two years ago and it is beginning to seamlessly replace natural gas and is fully compatible with existing appliances and technology.

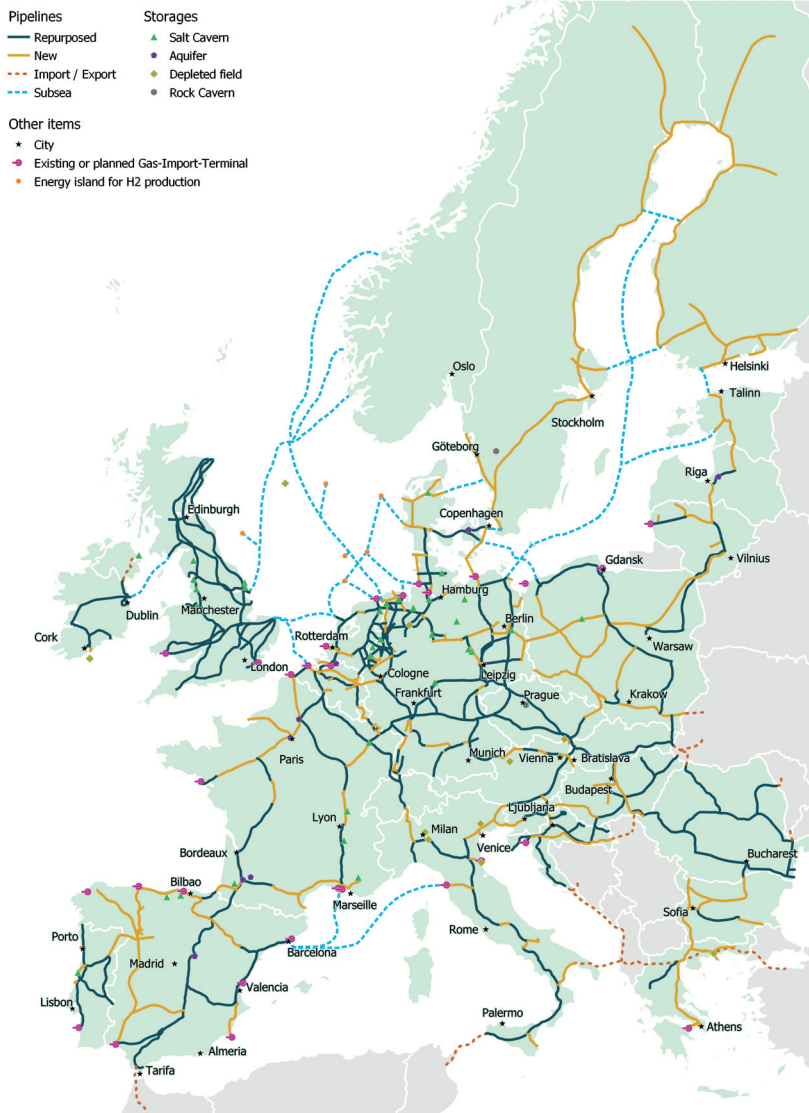
Green hydrogen: Renewable gas of the future

Green hydrogen is a carbon free gas that can be made from renewable electricity through a process known as electrolysis and stored until needed, making it an attractive option to decarbonise the Irish

and EU energy systems and a strong example of how greater integration between Ireland's gas and electricity networks can support a low carbon economy.

Testing blends of hydrogen gas on the network

Gas Networks Ireland has been working with University College Dublin's Energy Institute (UCDEI) on a research project at its network innovation centre to investigate the potential use of hydrogen in Ireland and find out if we can heat homes and cook dinners with this renewable gas. The initial part of the research concluded in late 2022 and



The European Hydrogen Backbone map shows the hydrogen network of 39,700km by 2040 comprising of 70 per cent repurposed gas networks connecting 21 European countries www.ehb.eu

found that householders using natural gas blended with up to 20 per cent of hydrogen will not need to make any change to their existing domestic appliances or notice any difference and even the flame motion and colour is very similar to the flame produced with 100 per cent natural gas.

The research results also outlined that significant reductions in emissions can be achieved by blending hydrogen with natural gas; including the following average reductions for domestic gas boilers operating at maximum load conditions – a 12 per cent reduction in carbon dioxide (CO₂), a 37 per cent reduction in carbon monoxide (CO) and a 40 per cent reduction in nitrogen oxides (NO_x) emissions. The next phase of the research will focus on the operation of the gas distribution network with blends of natural gas and hydrogen.

The report is available at:
www.gasnetworks.ie/hydrogen-blend

European Hydrogen Backbone

With our European neighbours, Gas Networks Ireland is participating in a major project to help the European Union meet its new accelerated goals and radically increase the use of hydrogen by 2030. The European Hydrogen Backbone initiative is focused on planning for the future development of a European hydrogen market through new pan-European hydrogen transport infrastructure. Five large-scale hydrogen pipeline corridors are envisaged.

These new corridors will initially connect domestic local hydrogen supply and demand in Europe, before expanding and connecting European regions amongst each other, and then connecting neighbouring regions with hydrogen export potential. The planned hydrogen backbone network will largely be based on repurposing existing natural gas infrastructure. It is envisaged that by 2040, for example, Ireland could be

connected to the new European hydrogen backbone via a repurposed subsea pipeline to the Moffat interconnector in Scotland.

Academic partnerships

Gas Networks Ireland is one of a number of industry players funding a new €16 million strategic partnership with Irish third level institutions that will examine how to holistically decarbonise the overall Irish energy sector. Led by UCDEI, NexSys (Next Generation Energy System) is also supported by Science Foundation Ireland.

Hydrogen technical and safety feasibility study

The Government's Climate Action Plan (CAP) sets out detailed measures to cut emissions and meet Ireland's targets in each sector. One of the actions is to develop renewable gas in the gas grid. As part of this Gas Networks Ireland produced a technical and safety feasibility study of injecting green hydrogen blends into Ireland's gas network. In line with other UK and European studies, this assessment has concluded that utilising the existing gas network to transport up to a 20 per cent hydrogen blend is safe and feasible.

The report is available at:
www.gasnetworks.ie/hydrogen-study

National hydrogen strategy

As part of the Government's development of a national hydrogen strategy, Gas Networks Ireland made a submission outlining the central role Ireland's gas network plays in Ireland's future clean energy and hydrogen economies and how it is preparing the existing gas network to accept hydrogen/natural gas blends from the UK as well as preparing for the injection of green hydrogen at appropriate locations into the gas network.

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Reaching Ireland's green hydrogen potential



Ross Moore, Partner and Head of Energy,
Infrastructure & Natural Resources, A&L Goodbody

As an island with extensive renewable electricity generation resources, Ireland should be favourably positioned to take advantage of the significant opportunities offered by green hydrogen production, storage, and usage in the decarbonisation of Ireland's energy and transport system.

Many stakeholders comment that strong policy direction coupled with appropriate financial incentives are necessary to provide a springboard to the realisation of Ireland's hydrogen potential.

We have examined the direction of some of the EU and Irish policies.

EU

The EU's Green Deal outlines the EU's objective to be the first climate neutral continent by 2050. As a core part of this objective, the EU Commission's prioritisation of renewable and low-carbon hydrogen development, particularly from wind and solar energy, is evident. A myriad of EU policy and legislative initiatives aim to support this prioritisation.

Promotion of renewable hydrogen

Over the last few years, the EU has adopted progressive policies and strategies to achieve the promotion of renewable hydrogen. As a first building block, the EU Energy System Integration Strategy and the EU Hydrogen Strategy were published in 2020. The EU Commission has stated that it has implemented the full list of the twenty key actions identified in the EU Hydrogen Strategy.

These key actions aim to:

- create a strong investment agenda;
- boost demand in end-use sectors and scale up production to support production and demand;
- design a framework for hydrogen infrastructure and market rules;
- promote research and innovation in hydrogen technologies; and
- create international dimensions to redesign EU energy partnerships with EU neighbours and international partners.

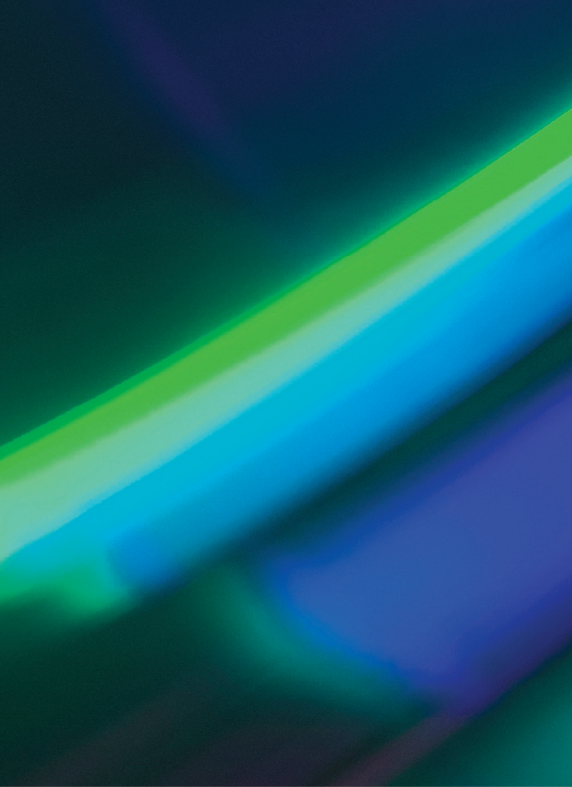
Implementation of EU Hydrogen Strategy

Implementation of the EU Hydrogen Strategy included measures such as:

- development of an investment agenda through the European Clean Hydrogen Alliance which brings together industry, national and local authorities, civil society, and others to achieve an ambitious deployment of hydrogen technologies;
- advancing proposals for a European Hydrogen Bank to unlock the private investment in hydrogen value chains by connecting

renewable energy supply to EU demands;

- legislative proposal for a Net-Zero Industry Act to ratchet up the manufacturing of clean technologies and creation of green jobs in the EU;
- identification of further funding for hydrogen projects in the Clean Hydrogen Partnership and the EU Innovation Fund;
- creation of funding tools such as the hydrogen public funding compass to help finance hydrogen projects. The hydrogen public funding compass provides orientation to members of the European Clean Hydrogen Alliance with respect to funding opportunities for future investment opportunities in projects related to the large-scale deployment of renewable and low carbon hydrogen; and
- proposal (as part of *REPowerEU*) of the "hydrogen accelerator" strategy which seeks to increase the deployment of renewable hydrogen and the uptake of hydrogen in hard-to-decarbonise sectors.



Legislative framework for renewable hydrogen

The *Fit for 55* legislative package includes a number of legislative proposals that aim to translate the European Hydrogen Strategy into a concrete European hydrogen policy and legal framework, including the Hydrogen and Gas Markets Decarbonisation Package. There are proposals for inclusion of mandatory sub-targets for renewable hydrogen in industry and transport in a recast Renewable Electricity Directive.

The proposed Directive on Common Rules for Internal Markets in Renewables Gases and Hydrogen intends to create a common threshold/standard for the promotion of hydrogen production installations as well as certification schemes for renewable and low-carbon hydrogen. It also, along with the proposal for the Regulation on the Internal Markets for Hydrogen, includes proposals covering hydrogen infrastructure, access to hydrogen markets, and renewable gas market integrity.

In February 2023, the EU Commission proposed detailed rules to define what constitutes renewable hydrogen with the adoption of two Delegated Acts under the Renewable Energy Directive. The first defines under what conditions hydrogen and hydrogen-based fuels can be considered as renewable fuels and clarifies the principles for additionality, including production from renewable energy sources. The second delegated act provides a methodology for calculating life-cycle greenhouse gas emissions.

IRELAND

National Energy Security Framework

In April 2022, the Department of the Environment, Climate and Communications (DECC) published the National Energy Security Framework. This framework document provided that the development of an integrated hydrogen strategy for Ireland is to be prioritised in line with the Climate Action Plan and will include the possibility of setting clear national targets for hydrogen.

Climate Action Plan 2023

Published by DECC in December 2022, the Climate Action Plan 2023 outlines several key milestones and actions in the context of renewable hydrogen. These include:

- a target of 2GW of offshore wind for green hydrogen by 2030;
- at least 2.1TWh consumption of zero emission gas by 2030; and
- zero emission gas fired generation from biomethane and hydrogen by 2030.

A supplementary annex of actions published in March 2023 provided specific actions required to implement the targets set out in the Climate Action Plan 2023.

The Climate Action Plan 2023 aims to deliver a National Biomethane Strategy and a policy/regulatory roadmap for green hydrogen use – both to be delivered in 2023. In addition, there is an action to introduce a Renewable Heat Obligation Scheme by 2024 to incentivise suppliers of all fuels in the heat sector to ensure that a certain proportion of the energy supplied is renewable.

Hydrogen strategy consultation

In July 2022, DECC published its *Consultation on Developing a Hydrogen Strategy* to invite discussions on the potential role and opportunities for green hydrogen. Key questions asked of stakeholders in order to develop the hydrogen strategy related to priorities

for hydrogen research, demand and end-uses, supply, transportation and storage, export opportunities, safety, necessary support measures to be taken, and energy security questions. The consultation period has now closed, and the outcome is expected shortly. The hydrogen strategy will outline the pathways towards the production of green hydrogen in Ireland and set out a holistic overview of hydrogen supply and demand, transportation, and its use in Ireland's energy mix in the period to 2030 and beyond.

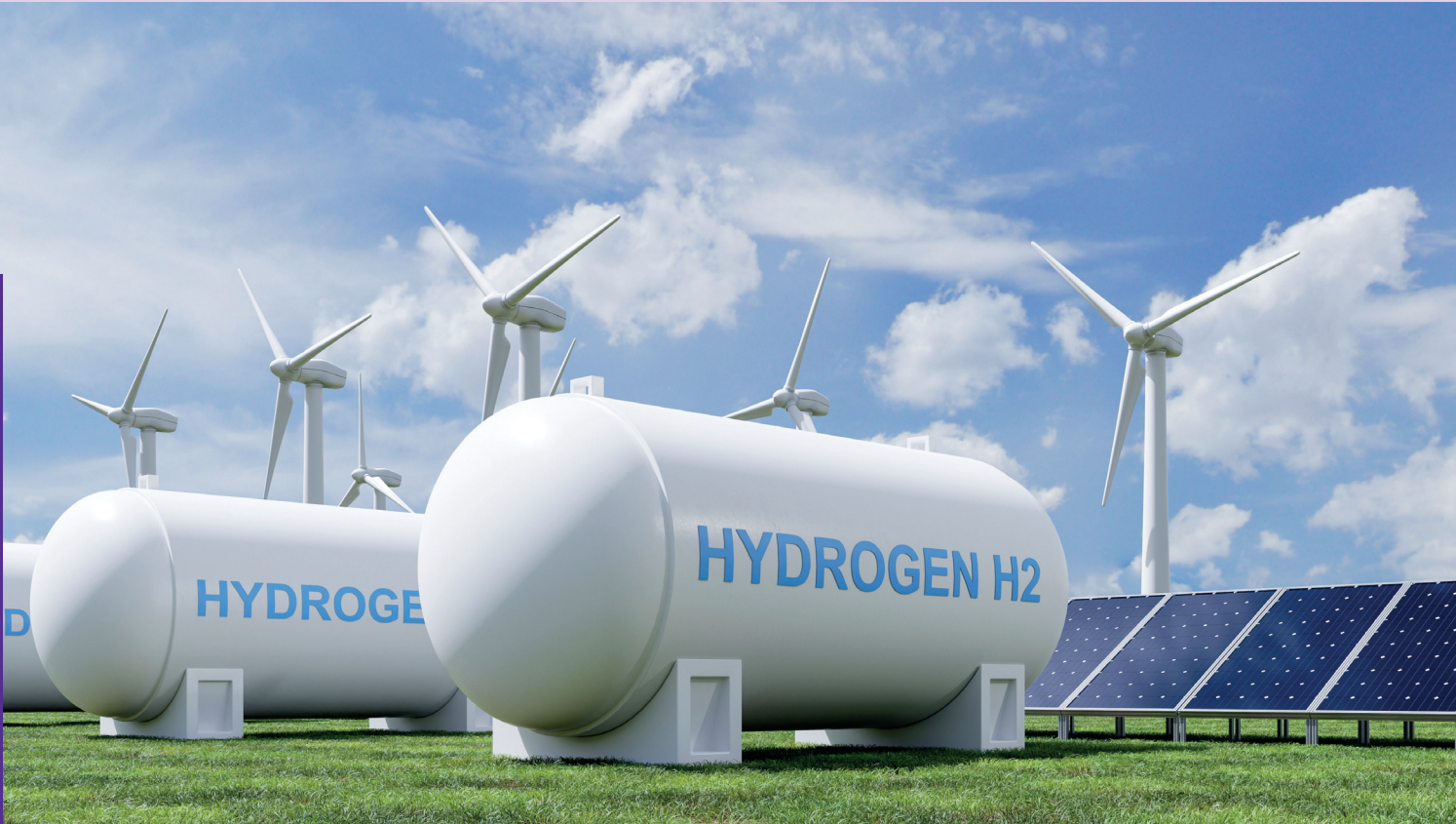
Gas Networks Ireland

Gas Networks Ireland recently completed its Network Innovation Centre where they are developing a detailed hydrogen technical strategy to ensure that the existing gas network is capable of safely transporting and storing both blended and 100 per cent hydrogen into the future. Another important step in hydrogen development over the last year was the appointment (pursuant to Statutory Instrument No. 350 of 2022) of Gas Networks Ireland as the body responsible for issuing guarantees of origin for renewable gases which are to be administered in a yet-to-be-published supervisory framework established by the Commission for the Regulation of Utilities.

A&L Goodbody was pleased to advise Energia on its partnership with Translink to supply hydrogen from one of Energia's windfarms in Northern Ireland, to fuel public buses in Belfast. Let us hope that is one of many hydrogen production and offtake transactions on the island of Ireland in the near future.

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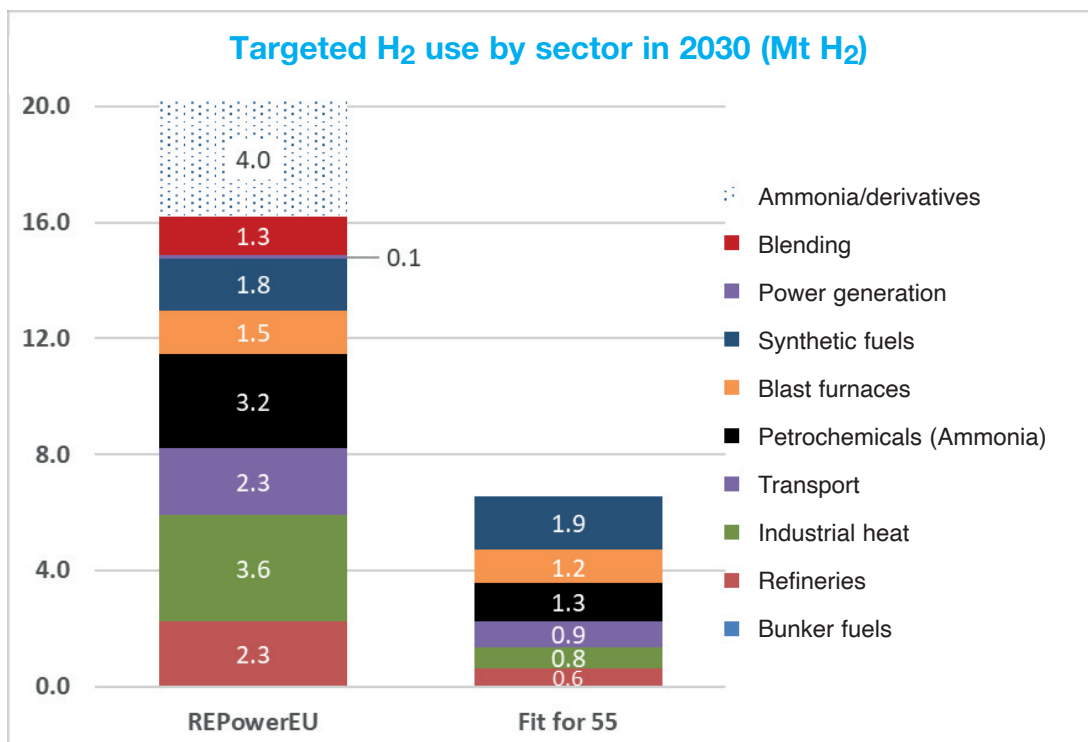
EU pushing hydrogen development

As part of the EU's push to reduce reliance on Russian oil and gas imports, the *REPowerEU* plan has set a European target of 10 million tonnes of domestic renewable hydrogen production by 2030, to be complemented by a further 10 million tonnes of renewable hydrogen imports.

Although an EU-wide target has been set, the responsibility for member states is to set their own hydrogen strategies. Therefore, this target does not delegate a level which must be reached by each respective member state.

In order to achieve the target of domestic renewable hydrogen production foreseen in *REPowerEU*, total investment needs are estimated at between €335 billion and €471 billion, including between €200 billion and €300 billion needed for additional renewable energy production. The vast majority of this will come from private funding, but public funding (through the EU financial instruments and state aid) can play an important role in pump priming so as to increase the ability in leveraging private investment, especially in the initial stages of establishing a European hydrogen market.

With the level of required funding in mind, on 16 March 2023, the European Commission announced plans to establish a European Hydrogen Bank (EHB). The Commission is intending for the EHB to cover and lower the cost gap between renewable hydrogen and fossil fuels for early projects. The Commission hopes to achieve this by the establishment of an auction system for renewable hydrogen production to support producers through a fixed price payment per kilogramme of hydrogen produced for a maximum of 10 years of operation.



The first pilot auctions are currently being designed and they are due to be launched in autumn 2023, backed by €800 million from the Innovation Fund. The bank will create an EU auction platform offering “auctions-as-a-service” for member states, using both Innovation Fund and member state resources to fund renewable hydrogen projects without prejudice to EU state aid rules.

Another central focus of the EU hydrogen strategy is the doubling of the number of hydrogen valleys in the EU by 2025, with Ireland’s first hydrogen valley currently being created off the coast of Galway. At the time of the publication of *REPowerEU*, there were 23 hydrogen valleys in the EU. This number is now 25, with an additional two in the United Kingdom.

Beyond using renewable hydrogen in industry and transport, it is necessary to look at other sectors where hydrogen uptake could be increased without causing harm. The Commission has stated that blending hydrogen into the natural gas grid requires “careful consideration as it diminishes gas quality,” adding that it “can increase overall system costs and the costs of heating for the residential sector, and it is in most applications a less efficient alternative to direct electrification”.

Blending up to around 3 per cent by volume of renewable hydrogen in the gas grid may absorb about 1.3 million tonnes of hydrogen and replace 4.7 bcm natural gas. However, this will require considering all consequences and costs of blending, including overall system costs and adaptation costs for household and industrial end users. For example, the costs for end-users and infrastructure operators to adapt to a 5 per cent blending level (by volume) would amount to around €3.6 billion per year.

Development of a State hydrogen strategy

Currently, Ireland’s hydrogen strategy is being developed, with consultations being reviewed as of April 2023. A hydrogen strategy is a key development goal and is being done under the aegis of Climate Action Plan 2021, which itself is heavily influenced by the European Green Deal.

In Ireland, the development of a hydrogen strategy is one of the key priorities in the plans outlined in the National Energy Security Framework, which aims to ensure the affordability and sustainability of Ireland’s energy supply.

This prospective hydrogen strategy is set in the context of three prongs of EU hydrogen development:

1. From the present to 2024, the EU will support the installation of at least 6GW of renewable hydrogen electrolyzers, and the production of up to 1 million tonnes of renewable hydrogen across member states.
2. From 2025 to 2030, it recognises that hydrogen needs to become an intrinsic part of an integrated energy system, with at least 40GW of renewable hydrogen electrolyzers and the production of up to 10 million tonnes of renewable hydrogen in the EU.
3. From 2030 onwards, it sets out that renewable hydrogen will be deployed at a large scale across all hard-to-decarbonise sectors.

The State hydrogen strategy is due for publication before summer 2023. With Climate Action Plan 2023 already earmarking 2GW of offshore wind development for the development of green hydrogen, it is expected that the sector will see significant expansion, particularly for transitioning Ireland’s car-reliant transport system. Ireland’s location makes it an important asset for the EU and, if successful in its hydrogen endeavours, could make the State among the most influential energy producers in Europe.



Energy for generations

Delivering net zero with hydrogen: The key to an integrated and secure energy system



ESB is investing in Ireland with more than €1 billion spent every year towards our goal of delivering a zero-carbon energy future. Hydrogen will feature prominently in these future investment plans. Aodhán McAleer, Hydrogen Manager at ESB, discusses the rationale behind the role of renewable hydrogen in the transition to net zero.

The role of hydrogen

Over the past couple of years, policy discussions on renewable hydrogen have evolved beyond just its ability to decarbonise the energy system but also to its vital role in security of energy supply. The evolving geopolitical landscape has highlighted the need to focus on energy security, with increased urgency to develop a resilient energy system. EU legislators turned their attention to bolstering Europe's energy resilience, to provide a policy pathway to energy independence through green hydrogen production and sufficient energy storage capacity. Now, more than ever, we must continue our focus on climate action through homegrown clean electricity to improve energy independence and improving long-term

resilience and affordability. An unwavering focus is required to increase Ireland's renewables, drive the production of green hydrogen, and develop storage capacity for the country's hydrogen in order to meet climate and security of supply objectives.

Harnessing Ireland's renewable potential

ESB is playing a key role in the delivery of Ireland's climate objectives across the energy sector and has committed to achieving net zero by 2040. At national level, there is a legally binding target to achieve net zero emissions by 2050, and an interim target to reduce carbon emissions by 51 per cent by 2030 from a 2018 baseline.

The energy from Ireland's abundant onshore and offshore wind resources can be converted into renewable green hydrogen using an established technology, electrolysis, to provide clean, reliable, and storable energy. Over the next decade, developing and scaling our hydrogen economy will require significant levels of investment. The forthcoming national hydrogen strategy will set out the Government's vision for the 2GW of offshore wind earmarked for green hydrogen production. This provides a unique opportunity to decarbonise the energy consumption of large-scale energy users currently using fossil fuels, with the potential to scale and attract new low carbon industries around the coast of Ireland.

The first step in achieving this will be to harness Ireland's renewables. While early green hydrogen projects will use existing onshore renewables, our significant homegrown offshore wind resources will enable Ireland's green hydrogen sector to grow at scale. We have the resources to match our ambition. As noted in the Climate Action Plan, this requires dialling up to 9GW onshore wind, 8GW solar and at least

7GW of offshore wind by 2030 – with 2GW earmarked for green hydrogen production.

Our analysis shows that an integrated net zero energy system will require >30GW of offshore wind, hydrogen production capability >15GW, subsea hydrogen storage of circa 90 days, and backup dispatchable zero-carbon power generation >10GW.

There is broad agreement across industry that project attrition along the development pathway, particularly in relation to planning consents, is inevitable. Plans must provide a sufficient level of contingency to give confidence that the initial 5GW target by 2030 will be achieved from an offshore wind perspective, this means procuring more than 5GW from the first two offshore RESS auctions to allow contingency for delays and project attrition. We should accelerate the development of floating offshore wind (FLOW) to capture the full potential of the Celtic Sea and Atlantic Ocean beyond 2030, regain the competitive ground we have lost to other countries pushing ahead with developing local FLOW supply chains, and demonstrate Ireland’s willingness to play its part in the *REPowerEU* plan. FLOW technology is proven in other jurisdictions. The Scotwind leasing round has shown both the appetite for FLOW, with 17.8GW of FLOW projects awarded leases, and the confidence of the major developers. A strong offshore wind sector at scale is a prerequisite for driving a green hydrogen economy of scale. We believe a green hydrogen economy is essential to deliver Ireland’s net zero future.

In order to enable the timely delivery of projects, we should leverage existing infrastructure where possible to bring this energy ashore. One obvious way to do this is to use hybrid grid connections, which allows new renewable generation to link into existing grid connections. Two or more forms of generation could share a single connection to the grid and because their combined output would not exceed the existing connection capacity at any one time, no capacity upgrades would be required.

Hydrogen economy

The significant step in building the hydrogen economy is to incentivise the production of renewable hydrogen. Hydrogen producers need a line of sight to customers who want to use their product, this can be achieved by signalling much stronger ambition around the decarbonisation of the transport or heavy industry sectors that are not easily

Key enablers to develop Ireland’s green hydrogen sector:

Storage	Cluster development	Replace fossil fuels
Provide lease arrangements for sub-sea hydrogen storage	Prioritise and incentivise investment in hydrogen valleys	Hierarchy of use for renewable hydrogen consistent with EU policy
Set national targets for large-scale storage in line with best practice in other European jurisdictions: 2TWh target for 2030 and >10TWh for 2050	Accelerate the development of offshore wind and hydrogen production through timely consenting processes to meet 2030 targets	Support mechanism for hydrogen production and consumer ‘fuel switching’ support
Develop funding model for large-scale storage similar to other EU member states to regain competitive ground and secure energy independence	Smart innovative use of existing infrastructure and hybrid grid connections	Introduce ambitious hydrogen targets to replace fossil fuels in transport, industry and dispatchable electricity power generation

electrified but could switch to using zero carbon hydrogen and by incentivising zero carbon dispatchable electricity generation where methane gas is replaced with zero carbon hydrogen. Aside from the environmental benefits associated with developing zero carbon dispatchable energy, it will enhance security of supply when meteorological conditions mean wind and solar resources are not enough to meet demand. Financial supports will also be necessary to lure energy users away from lower-cost, readily available fossil fuels.

The final building block for the hydrogen economy relates to large-scale energy storage. Primary energy security is currently provided by storage reserves of oil and coal, and by gas interconnection with Britain. These fossil fuels provide baseload energy and most of the flexibility to balance supply and demand on the system. In a zero-carbon system based on high levels of wind, there will be times of imbalance on the system as both demand and supply fluctuate. Alternatives to fossil fuels are needed that offer cheap, large capacity and long duration storage options, and which provide flexibility and balancing solutions.

Subsea geological storage of green hydrogen can provide this through large-scale seasonal storage of renewable energy. Due to the long lead times involved in developing subsea hydrogen storage, effective market solutions are needed urgently to provide investors with a clear route to market. ESB is currently partnering with dCarbonX/Snam on the development of renewable hydrogen subsurface storage as part of hydrogen valleys and clusters in the east (Dublin), south (Cork) and west (Shannon Estuary).

This concept of hydrogen valleys and clusters, currently being promoted by the EU, where all the elements of renewable hydrogen production, storage, and end-use are in an integrated ecosystem is an efficient cost-effective approach that supports balanced regional economic development and should be incentivised. They are key to kickstarting and rapidly scaling hydrogen supply and demand, especially around industrial clusters where hydrogen infrastructure could be shared amongst multiple users in proximity, including zero carbon dispatchable power generation. By locating these clusters on coastal sites, port infrastructure can be leveraged to enable export of hydrogen and, hence, achieve a scale to lower the cost of green hydrogen.

Net zero energy system

Renewable hydrogen coupled with offshore wind is a compelling proposition to accelerate decarbonisation as part of the larger integrated zero-carbon energy system. As part of our strategic vision, ESB is invested in the delivery of net zero and playing our part in the foundation of the four large infrastructure elements required, namely renewables, hydrogen, storage, and zero-carbon dispatchable power generation, to deliver a secure, resilient, reliable net-zero integrated energy system for generations to come.

W: www.esb.ie/esb-and-renewable-energy



Scotland's hydrogen journey

Katy McNeil, Head of the Scottish Government's Ireland Office, outlines the details of Scotland's growing hydrogen value chain, the scope for collaboration with Ireland, and the lessons learned during Scotland's hydrogen journey.

Contextualising the Scottish decarbonisation journey, McNeil recalls the first decarbonisation strategy under then-First Minister, Jack McConnell, which initially targeted 40 per cent of Scotland's electricity to be powered by renewable energy sources by 2020, a target which she remembers was initially regarded as "too ambitious".

In 2011, a new administration in Scotland increased the renewable electricity target to 100 per cent by 2020. McNeil recounts: "Similarly, at that time, critics suggested that our ambition was 10 years too premature".

Although the Scottish Government did ultimately miss its target, its success in delivering 97 per cent renewable-powered electricity by 2020 was nevertheless widely acclaimed.

Scottish Hydrogen Action Plan

In December 2022, the Scottish Government announced its Hydrogen Action Plan. As the

nation continues to transition its energy model away from oil and gas, McNeil explains that hydrogen production and exportation is "a big opportunity for [Scotland], economically, as well as in terms of clean air and energy independence".

The Hydrogen Action Plan sets an ambition of 5GW of installed hydrogen production by 2030, and 25GW by 2045.

McNeil explains: "This could add in the region of £5 billion plus per year to the Scottish economy. Furthermore, our modelling suggests that we could create anything between 70,000 and 300,000 jobs in the hydrogen sector alone."

Identifying hydrogen as the "gas for the future", McNeil lists off its projected uses including the role it can play in replacing carbon-emitting internal combustion engines.

"We are expecting hydrogen to play a significant role in high-temperature industrial heat, in refining, as chemical feedstock, and in distilleries. We also think that a significant

“People often observe that the gas interconnection is between Ireland and the UK, but to be more specific, it is between Ireland and Scotland.”

proportion of the hydrogen produced in Scotland will be exported via pipeline to the rest of the UK and to Europe. We see the role that hydrogen could be playing in maritime and in the aviation industry, and in heavy goods transport as well.”

As hydrogen is still a new and emerging sector with low levels of private sector confidence, an additional key strand of the Scottish Hydrogen Action Plan is establishing certainty for private investment.

Taking the initial investment steps, McNeil outlines how the Scottish Government is pump-priming investment with a long-term vision for attracting private investment: “There is an emerging energy technologies fund with £180 million of investment available up to the 2025/26 financial year. Of that, a £100 million capital programme is available for hydrogen projects.”

Celtic collaboration

Providing an overview of the ongoing ScotWind developments, McNeil states: “We are already having conversations with [Ireland’s] Department of the Environment, Climate and Communications about how we share the learning about how we went through our offshore leases.

“By recognising the potential Scotland has and how we could use and develop it, we began to think about how we would develop aligning hydrogen policies, assessments, and action plans.”

Although the much anticipated hydrogen strategy will not be published until mid-2023, McNeil expresses optimism for the prospects of hydrogen production in Ireland.

“Scotland and Ireland both have the potential to be major producers and exporters of hydrogen. We in the Scottish Government are here in Ireland to foster and encourage that and to say that we would like to talk to you about how we develop that collaboration, how we can

build those partnerships, and how we can help each other in supporting the development of that network.

“People often observe that the gas interconnection is between Ireland and the UK, but to be more specific, it is between Ireland and Scotland. We are keen to determine how we can connect Ireland’s east coast into Scotland’s hydrogen backbone, and how can we help Ireland create a bridge into the northern European market.”

Lessons learned

Overall, McNeil identifies four broad lessons which emerged during Scotland’s hydrogen journey. They are:

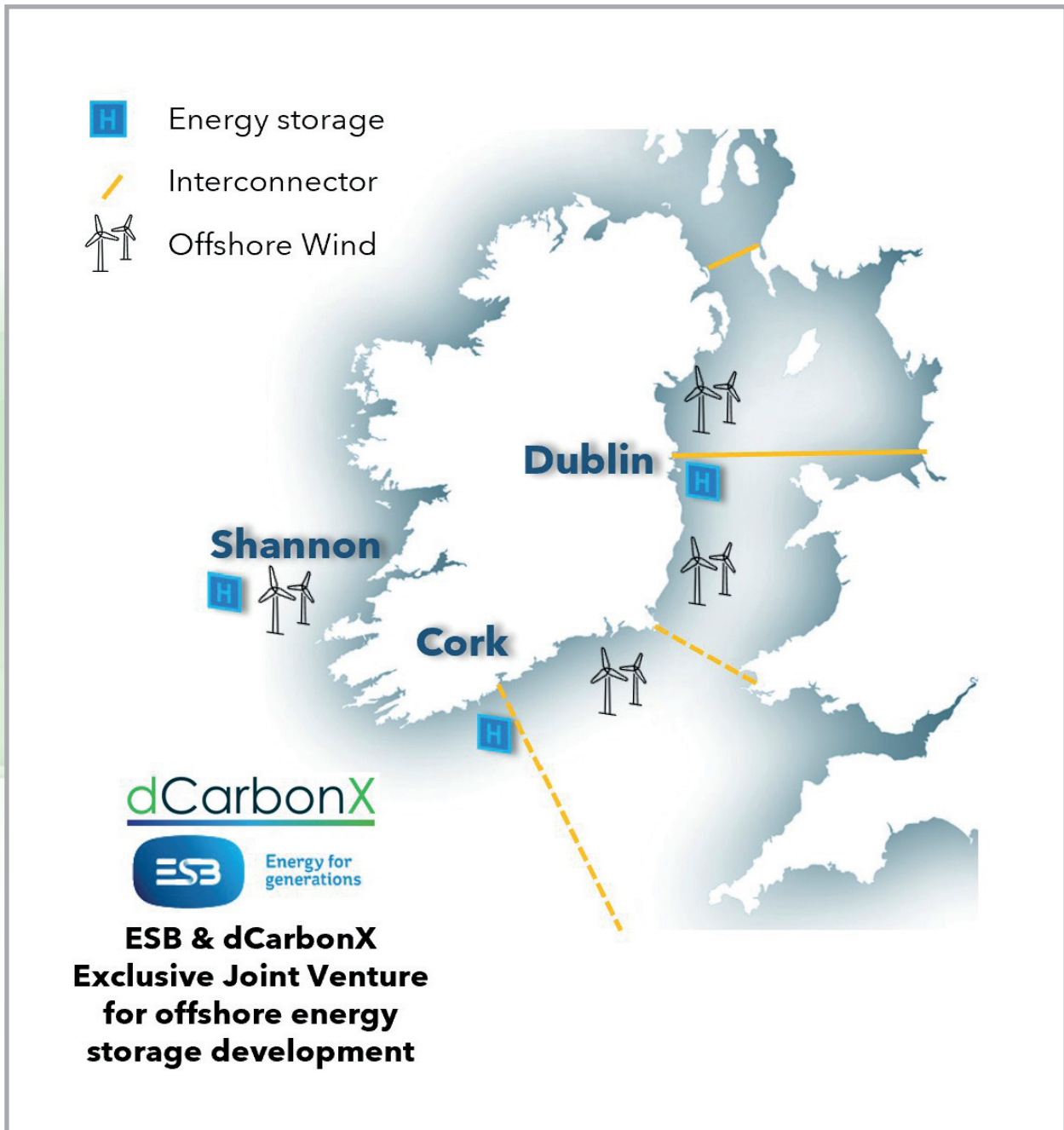
1. the importance of location;
2. the importance of pace;
3. the importance of whole systems thinking; and
4. the importance of studying demonstration projects which can help give us the confidence to develop at scale.

Demonstration projects in Scotland have been particularly prevalent in Aberdeen, which she describes as “the world’s most advanced hydrogen city”.

“There are two publicly available hydrogen refuelling stations in Aberdeen and there are 65 hydrogen vehicles on the streets, including 25 buses. The city is primed for more developments as an energy transition zone, and there are other ambitious projects which are demonstrating offshore hydrogen production.

“Scotland’s decarbonisation must continue to move at an unprecedented pace that spans our whole economy, allied with energy demand reduction. In green hydrogen, we have a huge opportunity; one that we know is shared with Ireland.”

dCarbonX: Developing Ireland's energy storage capability



dCarbonX is an asset focused geo-energy private company established in 2020 to develop underground assets for clean molecular energy storage and the sequestration of CO₂.

Present

Future



Based in London and Dublin, dCarbonX has Snam as its leading corporate shareholder. Snam is Europe's largest natural gas storage and distribution company. Acknowledged as a best-in-class operator in Europe, Snam holds the largest natural gas transportation network (over 41,000km including international assets), has an unmatched gas storage capacity (approximately 20 BCM including international assets) and has major re-gasification operations as Italy's leading LNG operator. Snam is also a leader in hydrogen storage and transportation developments.

The transition from fossil fuels to renewable sources of energy requires new fit for purpose energy infrastructure and the development and adoption of innovative new technology and solutions. To address the natural lack of consistency and resilience in wholly renewable energy systems, molecular energy storage of natural gas today and hydrogen in the future is required to address intermittent renewable power. On stormy days, natural surges of wind power must be curtailed due to lack of grid capacity, whilst on calm days with little to no wind, a heavy dependence is put on back-up fossil fuel power generation.

Fundamentally, intermittent wind destabilises power grids without appropriate energy management. Due to infrastructure limitations around grid flexibility and existing forms of energy storage (such as pumped hydro and/or short-life battery storage), energy systems struggle to balance the grid. Large-scale molecular storage of natural gas

and renewably produced hydrogen provides balancing energy storage capacity to effectively manage and smooth out intermittency.

dCarbonX has two main focus areas:

- **Underground energy storage:** dCarbonX has an exclusive JV partnership with ESB, Ireland's leading integrated utility, to develop three large-scale offshore underground energy storage facilities adjacent to the country's strategic electrical infrastructure hubs at Dublin, Cork, and Shannon. dCarbonX additionally has technological solutions for underground energy storage at the small to medium scale for managing more local needs.
- **Geological sequestration of carbon dioxide:** dCarbonX is working with industrial partners including US multi-national Pentair on carbon capture and sequestration opportunities in Ireland and the UK. Pentair's subsidiary Haffmans B.V., a world leader in biogas upgrading and CO₂ recovery systems, will utilise its carbon capture technology to focus on the extraction, recovery, and purification of CO₂ from Irish and UK assets, while dCarbonX originates and will develop offshore subsurface sequestration sites.

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dCarbonX

Green propulsion: The rail alternative to fight global warming



Credit: AlstomSA/Platinmonteur – François Susset / Coradia iLint™

The situation is clear; the world is experiencing a climate emergency where reducing greenhouse gas emissions is critical to meet the 2015 Paris Agreement targets. The rail industry has a key role to play in this transition. Providing alternative solutions to fossil fuels and further developing the ecological performance of railway systems is a key part of Alstom's mission.

Indeed, the Dublin Metropolitan Area requires the bus and commuter rail fleet to be 100 per cent electric and zero-emission by 2035. Furthermore the transport sector must meet its sectoral emissions ceiling and contribute to the delivery of a 51 per cent cut in economy wide emissions by 2030. We also need to remember that we should first "avoid" spending energy, so energy efficiency will be key. It is not only about decarbonisation, it is also about reducing our energy consumption which is a very scarce resource and thus expensive.

Alstom leadership in the hydrogen train market

The UK and Ireland's leading train manufacturer and maintenance provider,

Alstom has been the first company worldwide in 2016 to introduce a new regional train based on hydrogen fuel cells and batteries. Alstom has the ambitious goal of using this technology to replace a large part of the current market for diesel trains in Europe.

Hydrogen as the energy source of the future

Electrification, hydrogen and battery technologies and solutions will play an important role in our global vision of the future. Alstom's aim is to position these technologies as strategic factors in the energy transition, as we are convinced that they will bring about the change in road and rail transport – towards a clean and ultimately emission-free energy

system. Different non-competing options exist depending on the usage case: full electrification (high capital cost but high efficiency), hydrogen (high autonomy but lower efficiency), batteries (low autonomy but high efficiency) and partial electrification. All these need to be considered in the round. Indeed Irish Rail have already ordered 31 battery trains that can run on non-electrified lines.

Alstom offers multiple solutions of green mobility solutions for non-electrified networks: Bi-mode (diesel and catenary), battery (BEMU – battery electric multiple units) and hydrogen (FCMU – fuel cell multiple units). For example in Ireland Alstom will provide the most sustainable fleet of trains in Irish transport history. The company has signed a ten-year framework agreement with Iarnród Éireann/Irish Rail (IE) for up to 750 new X'trapolis commuter rail cars for Ireland's DART (Dublin Area Rapid Transit) network.

Commenting at the signing ceremony, Alstom Managing Director, UK and Ireland, Nick Crossfield said "Alstom is delighted to have been selected to deliver the new DART+ fleet. Ireland is a very important market to us, and the new electric and battery-electric X'trapolis fleet is a big step for making rail even more sustainable while transforming the passenger experience in the Greater Dublin area and beyond. This order reinforces Alstom's position as the world's leading innovator and supplier of green mobility technologies."

Battery technology is particularly well suited to extend or fill gaps on routes that are electrified with overhead catenary, as is the case with DART+. On longer and less intensely trafficked routes, using hydrogen fuel cells provides a viable, zero emission, and cost-effective alternative to the capital costs of electrification.

It was at InnoTrans 2016 in Berlin that Alstom presented the Coradia iLint™ for the first time. The launch of the CO₂-



Credit: SA 2021 - Tommy Hvitefeldt / Coradia iLint™

“On longer and less intensely trafficked routes, using hydrogen fuel cells provides a viable, zero emission, and cost-effective alternative to the capital costs of electrification.”

emission-free regional train positioned Alstom as the first railway manufacturer in the world to develop a passenger train based on hydrogen technology. Just two years later, in 2018, the iLint™ entered into commercial service in Germany.

The Coradia iLint™ is the world’s first passenger train powered by a hydrogen fuel cell which produces electrical power for traction. It is unique for its combination of different innovative elements: clean energy conversion, flexible energy storage in batteries, and smart management of traction power and available energy.

Specifically designed for non-or partially electrified lines, the Coradia iLint™ enables clean, sustainable train operation while ensuring high levels of performance. It can cover ranges up to 1,000 kilometres, and in September 2022 set a new record of 1,174km. For a range below 100km, battery trains are more appropriate, and Alstom now has both solutions in its portfolio.

How does a fuel cell work?

The hydrogen fuel cell produces electrical power for traction. The fuel cell supplies electrical energy by combining hydrogen, which is stored in tanks on board, and oxygen from the outside air. Hydrogen trains are 100 per cent CO₂ emission-free and the only exhaust is water. The generated heat is used for air conditioning.

H₂ trains are already a commercial reality for Alstom: Alstom has signed four contracts for hydrogen fuel cell powered trains. The first one was for 14 trains in the German region of Lower Saxony in 2017. The second one, also in Germany, for 27 trains to the Frankfurt metropolitan area. In 2020, we sold six trains with an option for eight to FNM in Italy and in 2021, SNCF Voyageurs has placed an order with Alstom for the first 12 dual mode electric-hydrogen trains (plus two optional trainsets) in the Coradia Polyvalent range for Régiolis.

Still, electric trains are not always a fit

since 46 per cent of the network in Europe is not electrified and sometimes overhead line electrification represents a too significant investment for customers, especially for low density lines. Until now, diesel trains were used for those non electrified lines.

Alstom acknowledges its responsibilities to further decarbonise mobility and meet the acceleration of sustainability and green mobility need all over the world. We are the only rail player that today offers the entire scope of green traction solutions, and our regional train powered by hydrogen fuel cells is now in successful passenger operation on a daily basis.

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• mobility by nature •

Plans to double hydrogen valleys by 2030

Ireland's first hydrogen valley will be located off the coast of County Galway.

In March 2023, the European Commission signed a joint declaration with European stakeholders to boost the EU hydrogen economy, aimed at enhancing the use of hydrogen valleys and helping reach hydrogen production targets in *REPowerEU*.

Hydrogen Central defines a hydrogen valley as “a project usually funded by local, national and international funds, that clusters several industrial and research initiatives to carry out pilot projects across the complete hydrogen value chain (production, transport, distribution, and end use with storage sometimes in the mix)”.

Through the signing of this joint declaration, the European Commission, the wider hydrogen industry, scientific community, and other European regions have committed to accelerate joint actions in research, development, demonstration, and deployment of hydrogen valleys, in line with the objectives outlined in the EU Hydrogen Strategy, forming a central role in the *REPowerEU* plan.

Under *REPowerEU*, EU member states are obliged to play their role in ensuring that the number of hydrogen valleys doubles by 2030. Globally, it is estimated that only 15 per cent of hydrogen valleys are finished being constructed, although many of the 85 per cent which are still being built are operational to varying degrees. The Commission has allocated €200 million to accelerate the rollout of hydrogen valleys.

In 2022, it was announced that plans are underway to build Ireland's first hydrogen valley off the coast of Galway, with the project being touted as a demonstrator project ahead of the publication of the Government's hydrogen strategy later in 2023.

There are currently at least 37 hydrogen valleys globally, spread throughout five continents and 19 countries; 25 of them are in Europe, with two situated in Britain. The Benelux Union countries have been particularly strong, facilitating the deployment of four hydrogen valleys, whilst Germany has already built five hydrogen valleys, and the German Government has plans to build more.

It is hoped that the further support for these valleys will connect hydrogen production, transportation, and a range of cutting-edge applications from clean mobility to industrial feedstock, creating fully functional and sustainable clusters of supply and demand, advancing renewable hydrogen deployment, and subsequently driving forward the clean energy transition.


Ireland is already seen as a leader in the production of wind energy, with an ambitious offshore generation potential placing it in a promising position for the expansion in the use of green hydrogen. Hydrogen experts, such as University of Galway professor Rory Monaghan have stated that Ireland “must develop the technology at home” if it is to meet its potential in hydrogen production.

Waste-to-energy continues to play a vital role in energy recovery

DID YOU KNOW?

In 2021, CEWEP Ireland's waste-to-energy facilities produced enough electricity to power the equivalent of

140,000 HOMES



Events of the past year have sharply exposed the precariousness of Ireland's security of energy supply, as oil and natural gas prices have skyrocketed. Simultaneously, the country is continuing to grapple with the challenge of reducing carbon emissions while striving to meet legally binding climate change targets and circular economy ambitions.

Against this backdrop, the waste-to-energy sector is continuing to play a vital role in the recovery of energy and valuable materials that cannot be reused or recycled from residual (black bin) waste.

The treatment of indigenous waste as a resource to generate energy, over 50 per cent of which is renewable, has the added benefit of enabling Ireland to reduce its reliance on imported fossil

fuels, ensuring a more secure and sustainable energy system. Energy is harnessed to reliably and sustainably generate 90MW of electricity that is delivering power to over 140,000 homes and business around the country.

In addition to generating electricity, valuable metals are recovered from the ash generated by the waste-to-energy process, most of which is then reused by the construction industry.

As the representative body for the waste-to-energy sector in Ireland, CEWEP is committed to supporting national policy objectives designed to enhance the State's security of energy supply and the transition to a circular economy.

This involves highlighting how policy can be improved upon in order to create a more sustainable and prosperous future for the country and its citizens. Enhancing policy with respect to levies on waste recovery and disposal, national waste management planning, preventing the curtailment of electricity from the grid, and the position of waste-to-energy within net zero carbon and circular economy strategies will be critical to this.

Currently, there are two waste-to-energy facilities in Ireland, located in Dublin and Meath, that are pursuing ambitious plans to ensure a better tomorrow. In the coming years, Dublin Waste-to-Energy in Poolbeg will act as the heat source for Dublin City Council's planned district heating network, while Indaver's facility in Meath is exploring how it can produce hydrogen from surplus energy it produces when curtailed from the electricity grid.

CEWEP Ireland believes that waste-to-energy offers massive untapped potential that can realise many positive outcomes, that we are committed to working towards with our stakeholders.

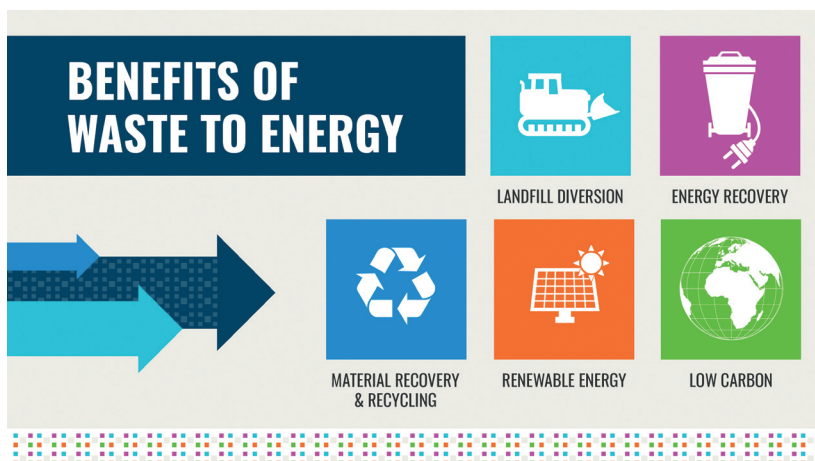
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BENEFITS OF WASTE TO ENERGY



- LANDFILL DIVERSION
- ENERGY RECOVERY
- MATERIAL RECOVERY & RECYCLING
- RENEWABLE ENERGY
- LOW CARBON

**cewep
ireland**

Confederation of European Waste-to-Energy Plants

Bord na Móna

Green hydrogen will play a key role in Ireland's energy transition



As one of Ireland's leading climate solutions companies, Bord na Móna believes that green hydrogen, a zero-carbon gas, will act as a key vector in our national transition to support the full decarbonisation of our energy system, writes Paul Schütze, Senior Project Development Manager at Bord na Móna.



Paul Schütze, Senior Project Development Manager at Bord na Móna.

Ireland's decarbonisation strategy, with its ambitious target of having 80 per cent of electricity coming from renewable energy sources by 2030, relies primarily on electrifying end uses where possible. However, there are certain challenges that come with a high penetration of

renewables on the electricity grid. Green hydrogen can play a key role in combating those challenges.

Dunkelflaute events

In times of low wind speeds and low levels of sunlight, often referred to by the German word "dunkelflaute", Irish demand may exceed renewable electricity supply. Battery system storage solutions can provide short- and medium-term solutions to this and bridge the energy supply gap over short periods of time. For a secure and robust energy system with a high proportion of renewable generation there is a need for energy storage that can span a number of months and support inter-seasonal supply. Fossil fuels such as natural gas and distillate fuel oil are currently used in those type of scenarios. However, large

amounts of greenhouse gases are emitted when electricity is produced using fossil fuels. As a sustainable alternative, green hydrogen, a carbon-free gas produced by splitting water into hydrogen and oxygen using renewable electricity, could be used to great effect during those periods of low renewable energy supply.

Grid stability

The intermittency of renewables presents a challenge to the electricity grid in regard to grid stability. There currently is a requirement to have a number of thermal generation plants on the system to maintain frequency and grid stability. Those thermal plants predominantly run on fossil fuels. Replacing this fossil fuel requirement with green hydrogen, as well as adding synchronous condensers (devices that take a small amount of power from the grid to operate a motor and flywheel which stabilise the grid at times of high renewable generation) would decarbonise this element of the grid.

Abundance of renewable energy potential and levels of curtailment

In its Wind Energy Roadmap, the Sustainable Energy Authority Ireland (SEAI) states that Ireland can achieve a deployment of 30GW of offshore wind generation by 2050. To put this figure into perspective, Ireland's forecasted electricity demand for 2030 is estimated at approximately 7GW. In addition, Ireland has a substantial onshore wind resource, which needs to be further developed, as offshore wind is still in its early stages. Onshore wind will not only bridge the gap before offshore projects are in operation but also help to decentralise the renewable generation across the country. Bord na Móna has a track record of delivering a number of onshore wind projects and has demonstrated that onshore wind can be delivered significantly faster than offshore wind projects. The 2023 Climate Action Plan sets out targets of 9GW of

onshore wind, 8GW of solar and 7GW of offshore (2GW of which is to be dedicated to green hydrogen production). With Ireland's forecasted electricity demand of 7GW in 2030 in mind, and with electricity interconnection to mainland Europe remaining limited the question is how can the country exploit this excess renewable energy resource? In addition, levels of curtailment (times when our renewable electricity supply exceeds demand) will increase as more generators connect to the grid. This excess electricity, that would otherwise be wasted, could be used to produce green hydrogen.

Energy security

Given the geopolitical situation over the course of the last year, the EU's focus has shifted towards energy security. Being dependent on non-EU countries for fossil fuel supply has emerged as a key weakness for Europe and represents a significant challenge for various European industries. The production of green hydrogen as a form of green fuel will enable Europe to be less dependent on external fossil fuel imports and, ultimately, help support price stability for consumers.

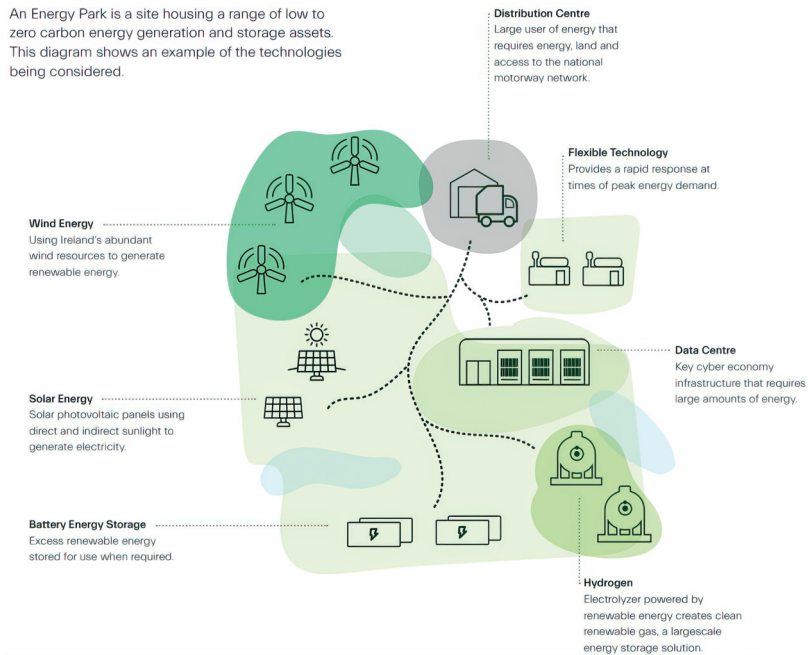
Domestic impact of emerging industry

Green hydrogen production also presents Ireland with an opportunity to become part of the supply chain of this emerging industry. Numerous local jobs will be created and communities will benefit from these developments. An emerging industry also spurs innovation and growth, allowing people to develop new ideas and diversify the local economy.

Bord na Móna's Energy Park Concept

Bord na Móna's landholding of 80,000 hectares allows us to develop a large portfolio of renewable energy projects including onshore and offshore wind, solar, flexible generation, and green hydrogen projects. The Bord na Móna Energy Park concept was developed to harness this strategic advantage, where supply (wind and solar) is co-located with demand. Green hydrogen production also plays a significant role in the energy parks, as the clean renewable gas can be utilised for a variety of applications: to fuel the onsite back-up generation of the customer demand; to decarbonise local cement

An Energy Park is a site housing a range of low to zero carbon energy generation and storage assets. This diagram shows an example of the technologies being considered.



production or other industries; to fuel the mobility sector; or to produce 'hydrogen value-added products'.

The role of hydrogen value-added products

In order to reach net zero by 2050 we will have to replace as much fossil fuel consumption as possible. Green hydrogen, combined with biogenic carbon dioxide, can be used to produce renewable fuels called e-fuels such as green ammonia and fertiliser, e-methanol or sustainable aviation fuels (SAF). Those e-fuels will, ultimately, help to decarbonise parts of the agricultural and mobility sectors that cannot be electrified.

Bord na Móna's green hydrogen strategy

The challenge that this industry is facing currently is the timescale. In order to achieve the targets set by the EU, large-scale hydrogen production is required as quickly as possible. However, Bord na Móna believes that it is crucial to demonstrate progressive development in the sector and as a result we are following a three-stage approach.

In Phase 1, Bord na Móna will develop a 2MW green hydrogen project at our existing Mount Lucas windfarm in County Offaly. Planning consent for this project is expected at the end of Q1 this year. If the project can be delivered in the timelines currently set out, it will be the first green hydrogen production facility in the Republic of Ireland. This

project will enable us to build knowledge and expertise on green hydrogen production and stimulate demand for the renewable gas.

In Phase 2 of our hydrogen strategy, we intend to develop medium-sized green hydrogen projects on our existing landbank. The green gas may be injected into the gas grid to decarbonise thermal generation plants, decarbonise other sectors of industry (such as cement factories local to the hydrogen production), or used for the production of hydrogen value-added products as described above.

Phase 3 of our hydrogen strategy includes large-scale, green hydrogen production both on our existing landbank as well as from offshore wind energy.

Ireland's leading role

We believe Ireland has a major role to play in this emerging industry. Time is of the essence with projects urgently required to stimulate demand allowing project developers like Bord na Móna to upscale their projects even further. With the opportunity to reach energy independence for the country in mind, positive change is on the horizon if we fully embrace renewable energy solutions like green hydrogen as a nation.

For more information visit:
W: www.bordnamona.com

A new approach for green gases

The European Network of Transmission System Operators for Gas (ENTSOG) has proposed a dual gas system modelling approach considering hydrogen and methane networks simultaneously, following contrasted scenarios reflecting the European climate and energy ambitions.

The proposal, entitled the Ten-Year Network Development Plan 2022 (TYNDP), aims to accelerate the rollout of green gases and aid EU member states to reach their net zero obligations. The draft development plan is currently open for consultations from European stakeholders until 19 May 2023.

When the consultations process is complete, ENTSOG aims to utilise the TYNDP to develop a new standard for hydrogen and natural gas by collecting dedicated hydrogen projects submitted to TYNDP and the first projects of common interest (PCI) selection process and by introduction of hydrogen infrastructure levels for the system assessments. The draft TYNDP also includes import and production capacities of renewable and decarbonised gases, including hydrogen, as well as demand for hydrogen.

The TYNDP outlines two prospective hydrogen infrastructure levels to be

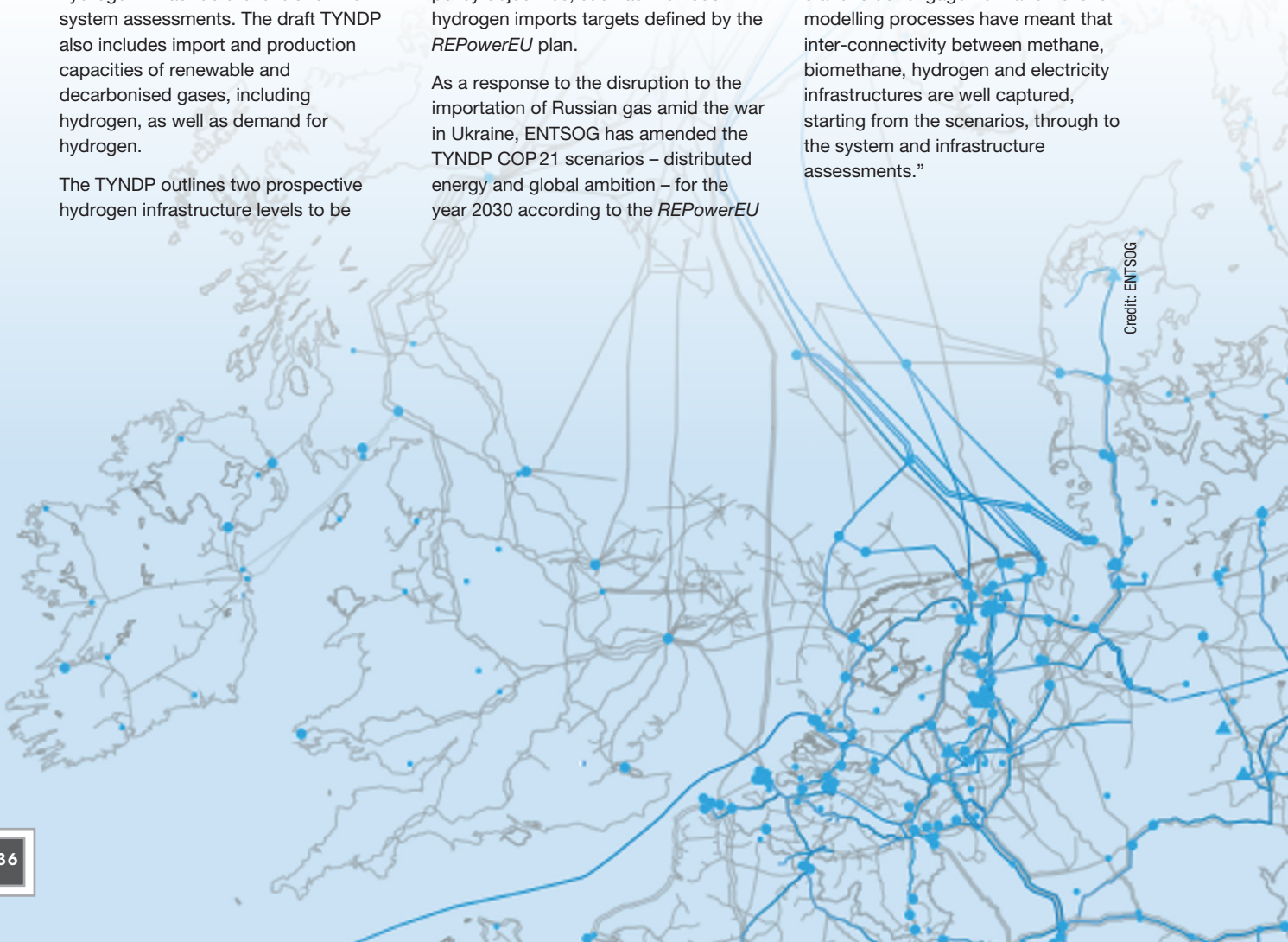
considered. Hydrogen Infrastructure level 1 is a project-based infrastructure level, composed of all hydrogen projects submitted by project promoters to the TYNDP 2022 (including infrastructure that was submitted as hydrogen-ready) as well as hydrogen projects submitted by project promoters to the first PCI selection process under the revised TEN-E Regulation.

Hydrogen infrastructure level 2 is defined as a policy-based infrastructure, composed of hydrogen infrastructure level 1 and additional infrastructure assumptions that were developed by ENTSOG together with the transmission system operators (TSOs) to enable policy objectives, such as the 2030 hydrogen imports targets defined by the *REPowerEU* plan.

As a response to the disruption to the importation of Russian gas amid the war in Ukraine, ENTSOG has amended the TYNDP COP21 scenarios – distributed energy and global ambition – for the year 2030 according to the *REPowerEU*

plan and to address its objectives of 10Mt domestic green hydrogen production and 10Mt hydrogen import. The results of this TYNDP for PCI/PMI candidate projects should be complemented by the latest energy strategies of the member states, for further and complete analyses.

Upon announcement of the proposal, Piotr Kuś, ENTSOG General Director, said: “The hydrogen and natural gas TYNDP 2022, a first of its kind, evaluates the benefit of relevant decarbonised gas projects and shows that the gas system is a resilient, efficient and cost-effective infrastructure. The extensive stakeholder engagement and holistic modelling processes have meant that inter-connectivity between methane, biomethane, hydrogen and electricity infrastructures are well captured, starting from the scenarios, through to the system and infrastructure assessments.”





Green hydrogen: Ireland's new energy carrier

Green hydrogen is a promising energy carrier that has the potential to play a crucial role in achieving net-zero emissions, writes Paul McCormack, Director of Hydrogen Ireland.

Hydrogen can be produced from various sources such as water, natural gas, biomass, or even waste, and when burned or reacted with oxygen, it produces only water and heat, making it a zero-emission fuel. However, green hydrogen produced from renewables is the cleanest form of hydrogen and has zero CO₂ production footprint.

One of the key benefits of green hydrogen is its versatility. Green hydrogen has the potential to be used in a wide range of applications, including transportation, power generation, and industrial processes. For instance, in the transport sector, hydrogen can be used to power fuel cell electric vehicles (FCEVs), while in industry, it can replace fossil fuels in high-temperature processes.

However, globally the production of hydrogen is currently dominated by fossil fuels, which generates emissions, including greenhouse gases. Therefore, it is essential to develop clean hydrogen production technologies such as electrolysis powered by Ireland's abundant renewable energy sources like solar or wind power. This will allow hydrogen to be produced in a way that is environmentally friendly and cost-effective. (A recent report mentioned the

potential for Ireland to be one of the cheapest locations to produce hydrogen in Europe!) It is also important to ensure that the transportation and distribution of hydrogen are done safely and efficiently. This includes developing appropriate infrastructure such as pipelines and storage facilities as well as training for our industry to gain the experience to work with, store, transport, and use hydrogen easily and safely, making it a viable option for areas where renewable energy sources are not readily available.

Green hydrogen is a promising pathway advocated by Hydrogen Ireland with the potential to not only contribute to but accelerate Ireland's journey to net-zero emissions using Ireland's abundant renewable energy sources such as solar or wind power. However, the widespread adoption of green hydrogen faces several challenges, including long lead times for electrolysis units, lack of regulation to integrate with renewables, and is hampered by the slow progress of policy development as well as a limited financial support from government to build infrastructure to support green hydrogen's ability to remove fossil fuels from our energy system.

To overcome these challenges mentioned, green hydrogen requires significant investment in research, development, and deployed infrastructure now, so it can play an effective part to decarbonise hard-to-decarbonise sectors at scale in the near future.

Overall, green hydrogen represents a balanced pathway to achieving net-zero emissions, working in tandem with other energy carriers, providing a clean and sustainable alternative to fossil fuels while supporting the transition to a low-carbon economy.

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Local authority HGV roadmaps among Shared Island projects

A feasibility study for local authorities to develop zero-carbon heavy goods vehicles (HGV) roadmaps on a cross-border basis is among the projects receiving Shared Island funding, with green hydrogen specifically earmarked as an enabler for the energy transition.

In September 2022, 25 cross-border projects were named as having been awarded funding by then-Taoiseach Micheál Martin TD under the Shared Island Local Authority Development Funding Scheme, which is funded by the Department of the Taoiseach's Shared Island Fund with an onus on cross-border co-operation among local authorities. Among these awards was the funding of €150,000 delivered to fund the feasibility study into the future of zero-carbon HGVs.

Led by Monaghan County Council in partnership with Louth County Council; Newry, Mourne and Down District Council; Ards and North Down Borough Council; Armagh, Banbridge and Craigavon Borough Council; and the East Border Region group, the study will query zero-carbon roadmaps for HGVs, seeking to identify opportunities and conditions for clean energy transition. Green hydrogen is specifically mentioned as being to the fore in this transition, being the only fuel source specifically mentioned in the Government's description of the project.

The project will seek to map out three phases for sustainable energy use in the HGV fleets of local authorities: planning, where renewable refuelling routes will be identified; development, where HGVs will be trialled and tested; and development, where the HGV routes developed will be expanded.

Notable in this funding award is the mention of green hydrogen without any mention of electric HGVs, with the two fuel sources thought to be the two most likely to decarbonise HGVs in the future. Such decarbonisation is crucial within all transport, but for HGVs especially due to their weight, typical distance travelled, and reliance on diesel over petrol meaning that the vehicles have higher polluting profiles than the average vehicle.

Given that any electric HGV would require a battery of substantial size that would limit its freight capacity, this is perhaps an indication of future policy in this area. Hydrogen's main advantage over electricity in this regard is its flexibility and compatibility with existing infrastructure. Hydrogen HGVs can refuel as quickly as their diesel equivalents in a manner that is

virtually identical and operate at distances that range from similar to better, although the production of green hydrogen is more energy intensive than electricity.

The project will join a growing cohort of similar projects globally as states attempt to get to grips with the emissions of HGVs, a small proportion of road vehicles that accounts for 26 per cent of global road transport emissions; this stat is even more acute in Ireland, where HGVs account for 4 per cent of road vehicles and 30 per cent of transport emissions. The Scottish hydrogen firm HVS was awarded £30 million in joint UK Government and industry funding as it continues to build a hydrogen fuel cell to be used in HGVs, with a 5.5-tonne demonstrator model for its hydrogen commercial vehicle having been unveiled in November 2022. Such HGVs are projected as having the capability to cover over 500km depending on variables such as road conditions and driving style.



German-Irish cooperation: Hydrogen export potential

An agreement has been reached that could see Ireland emerge as a major exporter of green hydrogen to Germany.

The joint Declaration of Intent on cooperation in research in the context of green hydrogen was signed by Minister for Environment, Climate and Communications and Minister for Transport, Eamon Ryan TD, and Germany's Parliamentary State Secretary to the Federal Minister of Education and Research, Mario Brandenburg.

Generation and utilisation of green hydrogen in Ireland are still in its infancy but Ireland's potential as an exporter of green hydrogen in the future has long been recognised, given its level of wind reserves.

A forthcoming hydrogen strategy for Ireland is expected to recognise a post-2030 role for green hydrogen in decarbonising Ireland's energy system, however, a number of significant green hydrogen projects are already in planning.

In Ireland, green hydrogen will initially be targeted at reducing emissions in hard-to-decarbonise sectors such as heavy transport and industry, however, in the long term, green hydrogen is a viable alternative to replacing natural gas within the gas grid.

Given Ireland's significant levels of wind energy generation, including ambitious offshore targets, it is projected that Ireland will not only reduce its dependence on imported fossil fuels, but export its surplus green energy, including hydrogen.

In contrast to Ireland, where a hydrogen economy will need to be built from the base up, including sourcing off-takers, building supply chains, and developing market mechanisms, Germany has a ready-made hydrogen industry, set for transition. Germany's ambitious National Hydrogen Strategy targets up to 5GW by 2030, only about one-seventh of the projected German hydrogen demand. The projected gap between production and demand underlines Germany's plan to import hydrogen.

The cooperation agreement between Ireland and Germany is set in the context of the EU's hydrogen strategy which aims to scale up the deployment of renewable hydrogen. The ambition is to produce 10 million tonnes and import 10 million tonnes of renewable hydrogen in the EU by 2030.

In 2022, the German-Irish Chamber of Industry and Commerce formed the German-Irish Hydrogen Council, comprising representatives of the new and emerging hydrogen industry in Ireland.

In April 2023, the chamber announced "a pioneering cooperation between Germany and Ireland in the field of green hydrogen", which it says will "pave the way to important new projects on a big scale in the renewable energy sector and beyond for Germany and Ireland".