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H2GO NEWS

December 2022

Saarland State Secretary welcomes GenComm input

For quite some time now, hydrogen has been considered an environmentally friendly and almost "infinitely" available future energy carrier. We, in the Federal State of Saarland are also tackling this issue. Saarland wants to become a hydrogen model region. We are pursuing this progress in all possible directions.

We have already taken the first big step towards building a hydrogen economy in Saarland. In Saarland, we were able to secure five so-called IPCEI projects of the Federal Ministry of Economics and the Federal Ministry of Transport in the field of hydrogen technologies and systems. We, as the Federal State of Saarland, are also financially involved in order to make an important contribution to growth, employment and competitiveness of the European industry and economy by means of state funding.

The pioneering project GenComm is also an important pillar on our way to becoming a hydrogen model region. Since 2017, it has had the goal of advancing hydrogen technology, and that is exactly what it is doing. I am particularly pleased that, with the help of IZES gGmbH, many projects have already been initiated and put into practice. We now have a large portfolio of active projects in Saarland - such as the cross-border project mosaHYc, HydroHub Fenne or the Hyland projects HyExpert “Hydrogen Model Region Saarland” and HyStarter “Municipality Perl”.

By establishing new hydrogen economy infrastructures in the region, we can attract new employers to the region, who will in turn create additional new jobs.

I am convinced that we will succeed in creating a value-added network in the future market of hydrogen, especially through close cross-border cooperation within the three-country border of France, Luxembourg and Germany.

By Elena Yorgova-Ramanauskas
State Secretary for Economic Affairs, Innovation, Digital Affairs and Energy

Elena Yorgova Ramanauskas, Ministry of Economy,Innovation, Digital and Energy, Saarland, Germany

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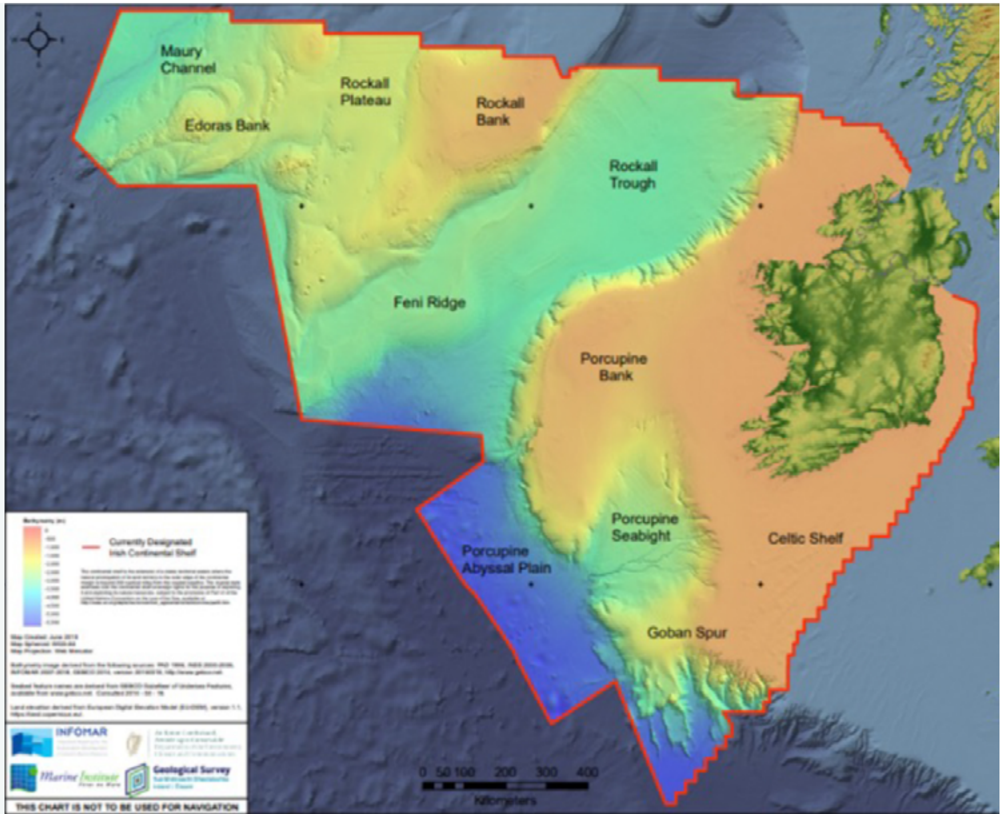
Can Ireland become Europe's Green Energy Dynamo?

As the continent pivots away from reliance of natural gas from Russia and drives ever more demanding climate goals, it is looking globally for partners to meet its energy needs. These partners need to be renewables rich, politically stable and financially credible. Step forward Ireland.

Ireland's offshore wind resources have, until recently, been overlooked in favour of land-based alternatives. However, now Germany, the Netherlands, and UK are knocking on the door of the Irish government. They are all seeking to utilise the best renewable resource in Europe – Ireland's offshore wind – to aid their own decarbonisation.

Ireland's majestic western coast hides a well-kept secret. The country's territorial waters extend far beyond its coast to an area up to 10x the country's land mass. With only a single offshore windfarm operational today the untapped opportunity is estimated to hold a potential of up to 70GW of green energy – just from wind. If tidal arrays could also be incorporated this figure would grow even further.

So, the Irish government is facing a dilemma. To date it has not embraced hydrogen as widely as some of our neighbours. The forthcoming hydrogen strategy should map out its future intent. Without these potential commercial suitors, a small-to-medium-scale (5 to 100MW Hydrogen equivalent) system roll out could have been expected.



The Western coast of Ireland

However, with increased momentum from both the public and private sector, the focus has shifted to the timeline, technology, and mechanisms to be deployed to access and monetise the opportunity. This will likely be dominated by big business due to the scale of deployments necessary, but the entrepreneurs and communities who have been pushing for offshore access and development rights for many years must not be forgotten about if a fair, just, and inclusive transition is to be realised.

Mirroring the development of other countries who are yet to deploy large-scale hydrogen technologies, Ireland needs to undertake a stepwise process to grow domestic knowhow and public confidence in hydrogen technologies. Projects like SH2AMROCK, where a proposed Galway-based hydrogen hub will refuel a number of vehicle fleets, including public buses, will be key. Further examples are springing up all over the island of Ireland. Add to this the need for Ireland to apply the Alternative Fuels Infrastructure Regulation, currently before the EU parliament, and there is a legal necessity to rollout hydrogen transport applications across the country. These will likely be well in advance of and, therefore, seed the way for, large scale hydrogen production for export.

The Irish hydrogen sector needs the government to be inclusive and forward thinking with its hydrogen strategy and public facing deployment support.
As Minister for Environment, Climate, Communications and Transport, Eamon Ryan TD saw when he addressed a full house at the Hydrogen Ireland conference in Dublin in late November, the sector has momentum. It has grown and proliferated extensively in the last 18 months and now needs government to put in place solid policy and support schemes which organisations can rely on to make investment.

Delivering this partnership between government, the renewables sector, and the hydrogen industry can give Ireland a sustainable future, create wealth for its people, and help satisfy Europe with its clean energy needs.

By Ian Williamson,
Hy Energy

Eamon Ryan, ROI Minister for Transport, Climate , Environment and Communications

First ever Hydrogen Ireland Conference a big success

Eamon Ryan, the Irish Government's Environment Minister may have been at COP27 the week previous but on Tuesday November 22, 2022 he made an address at the first ever Hydrogen Ireland Conference, staged this time in Dublin.

The Minister since June 2020 and leader of the Green party since 2011 had come to listen as well as speak at an event aimed at securing Ireland's green energy future. Minister Ryan discussed hydrogen production, hydrogen demand, hydrogen port opportunities in Cork/Shannon/Foynes, the existence of hydrogen hubs and targets for green hydrogen. The Minister alluded that momentum is building behind green hydrogen in Ireland and with the conclusion of the consultation period for the Irish Hydrogen Strategy who would argue with that.

Session One on day one of the 2 day event, 'Europe's Hydrogen Journey (Destination and best route to achieve this) included an address by Mr Jorgo Chatzimarkakis, CEO at Hydrogen Europe. Jorgo said that Ireland could become a giant of hydrogen production based on renewable wind production in Europe. Jorgo told conference of the importance of securing future energy needs. With electricity this is sometimes not possible as there is no grid. Hydrogen comes in as a vector. Hydrogen will become an enabler says Jorgo, not a silver bullet but a change of direction with regard to energy. Jorgo then mentioned he had met Eamon Ryan calling him a 'pragmatic green', who is not just about being fixed on one particular energy.

Bart Biebuyck, Executive Director, Clean Hydrogen Partnership also took part in Session One discussing REPower EU, increased hydrogen targets, the new Hydrogen bank to fund projects, the need for more hydrogen hubs and the need for action from Ireland.

Liam Nolan from Gas Networks Ireland discussed in the Session the development of hydrogen pipe networks across Europe and Ireland to enable decarbonisation.

In Session 2, 'Hydrogen Demand-Power Generation, Industry, Transport and Aviation among the speakers was Mary Considine, the CEO of the Shannon Group. ESB and the Shannon Airport Group have signed a memorandum of understanding to explore the development of a hydrogen project in the vicinity of Ireland's west coast. The project aims to explore the development of a sustainable green hydrogen plant at Shannon to demonstrate the use of hydrogen in aviation, heavy goods transport and Industry.

Important communication was relayed at this initial conference. Jim Dollard, Executive Director Generation and Trading ESB told Session 3 hydrogen storage is a top priority for Ireland.

On day 2 of the event, Wednesday 23 November the opening session, 'The Hydrogen Horizon' saw Sean Kelly MEP suggest an energy policy needs concrete steps to achieve decarbonisation targets and that a national hydrogen strategy is urgently needed to ensure that we can leverage Ireland's competitive advance for hydrogen.

Even outside the conference venue of the Radission Blu Royal Hotel, Stephen Kent, CEO of Bus Eireann was discussing the hydrogen fuel cell bus that was parked there. Buses that were launched in Dublin in July 2021 still making headlines. Still in the news just like hydrogen itself.

By Eugene McCusker
GenComm Communications Officer

Minister for Transport, Climate, Environment and Communications Eamon Ryan with key Irish hydrogen sector figures at the Hydrogen Ireland conference

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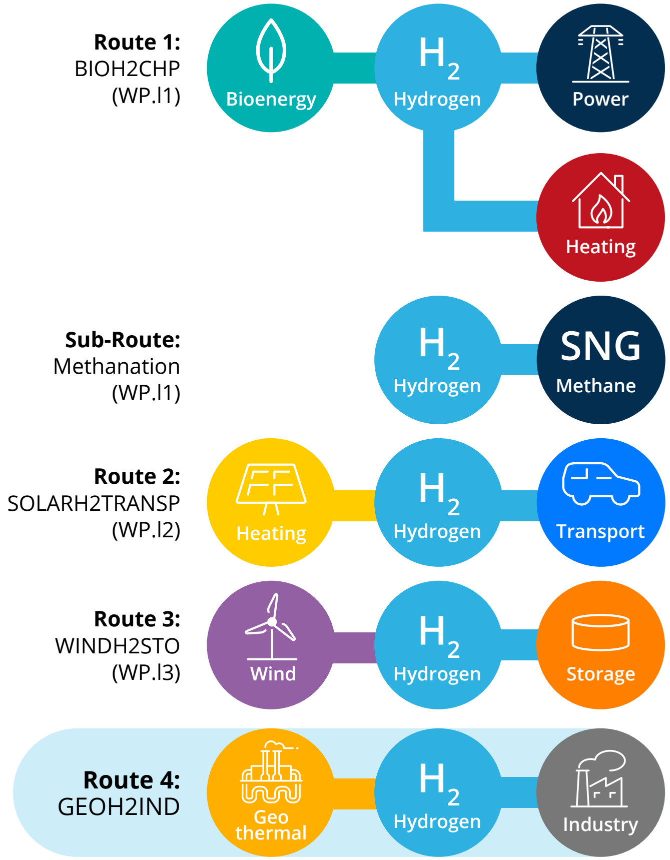
Geothermal Green Hydrogen – a cost competitive climate solution

Hydrogen is the most abundant element on the universe, primarily produced from water, Hydrogen as a clean energy carrier can address issues such as the sustainable and environmental aspects of our energy generation. Hydrogen projects globally have demonstrated the opportunity for molecules to be used as an energy storage medium, for use in hard to decarbonise sectors and also for electricity use.

The GenComm team has been researching the economic, environmental and social competitiveness of green hydrogen production and storage since 2015. This research has examined and developed pilot plants in renewable sources such as wind, bio and solar in producing green hydrogen. Over the last few years we have also carried out early stage investigations into other renewable energy sources including geothermal energy as a clean energy source in the production of hydrogen.



The 3 original GenComm H2 routes – with the integrated new area geothermal 2 H2

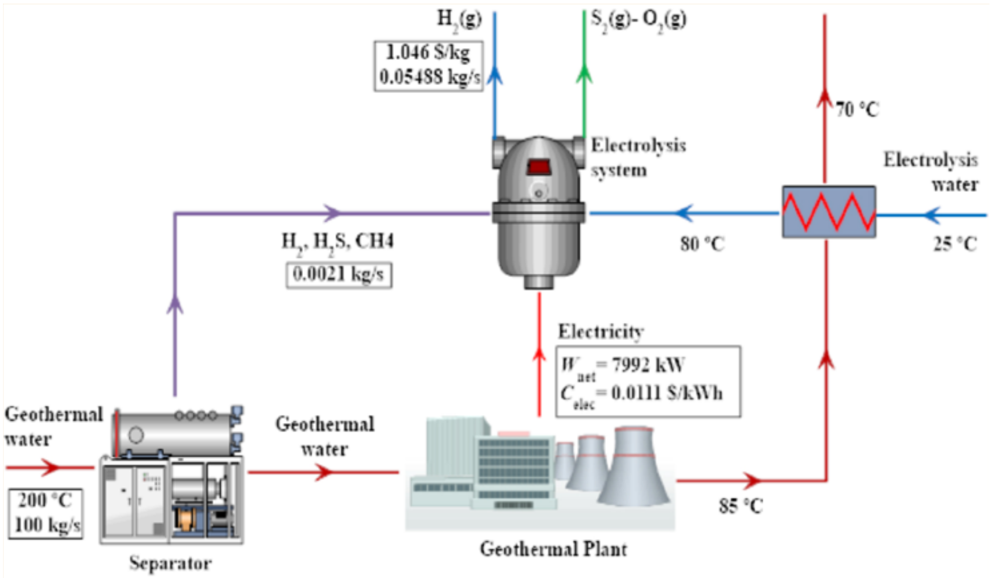
Geothermal energy is within the earth's thermal energy and is transferred to the underground water trapped beneath and within the earth. This energy exists in the form of steam and hot or liquid water and is released naturally or by drilling operations.

As a result of our research, we have identified that geothermal energy can deliver significant competitive economic advantages in green hydrogen production and storage.

The major technical and financial barriers for green hydrogen production from renewable energy include;

1. Overcoming the intermittency of supply from renewables such as wind, bio and solar
2. Securing a competitive cost of electricity supply to ensure the green hydrogen is economically competitive with alternative fuels.

Our research has indicated that geothermal energy is more advantageous than other renewable energy sources in hydrogen production as it provides heat energy to preheat electrolyzed water. Furthermore, H2 and H2S, which are included in the non-condensable gases of the geothermal fluid, would make an important contribution in hydrogen production and thus decreasing the hydrogen production cost.



A Proton Exchange Membrane (PEM) electrolyzer at a hydrogen energy pilot project inside Gasunie's Hystock site in Veendam, the Netherlands.

Our work to date has indicated that a cost competitive price could be achieved with the use of geothermal electricity and geothermal heat in combination and then the cost for hydrogen production cost could become economically advantageous to fossil fuel alternatives. Our research to date has indicated that the unit cost of hydrogen production by geothermal electricity is more competitive than wind and solar energy.

Geothermal based hydrogen production is one of the potential clean energy pathways for a future hydrogen economy. Geothermal energy provides an affordable, clean method of generating electricity and providing thermal energy to produce clean hydrogen technology. In some countries, with abundant amounts of geothermal energy, geothermal hydrogen has potential to become a major energy vector.

Our work to date has identified cost and technology effective alternative ways of hydrogen energy technologies. The next steps in this work is to further examine the possibilities for utilization of geothermal energy to generate hydrogen in parallel with the possibilities to use hydrogen to enhance geothermal power with other renewable competitiveness.

In order to achieve these goals we are currently developing project specifications and parameters to establish a pilot facility as with the previous GenComm wind, bio and solar installations. This work will investigate the operational optimisation of a Geo – to - H2 facility and will build techno-economic modelling for the future.

By Paul McCormack,
GenComm Programme Manager

How to ramp up Hydrogen under the new REPowerEU targets

As we look to build a greener and secure energy for Europe we must ramp up Green Hydrogen use under the new REPowerEU strategy. The earlier 'Fit for 55' target for hydrogen was 5.6Mt, this is now increased to 20Mt under the new strategy.

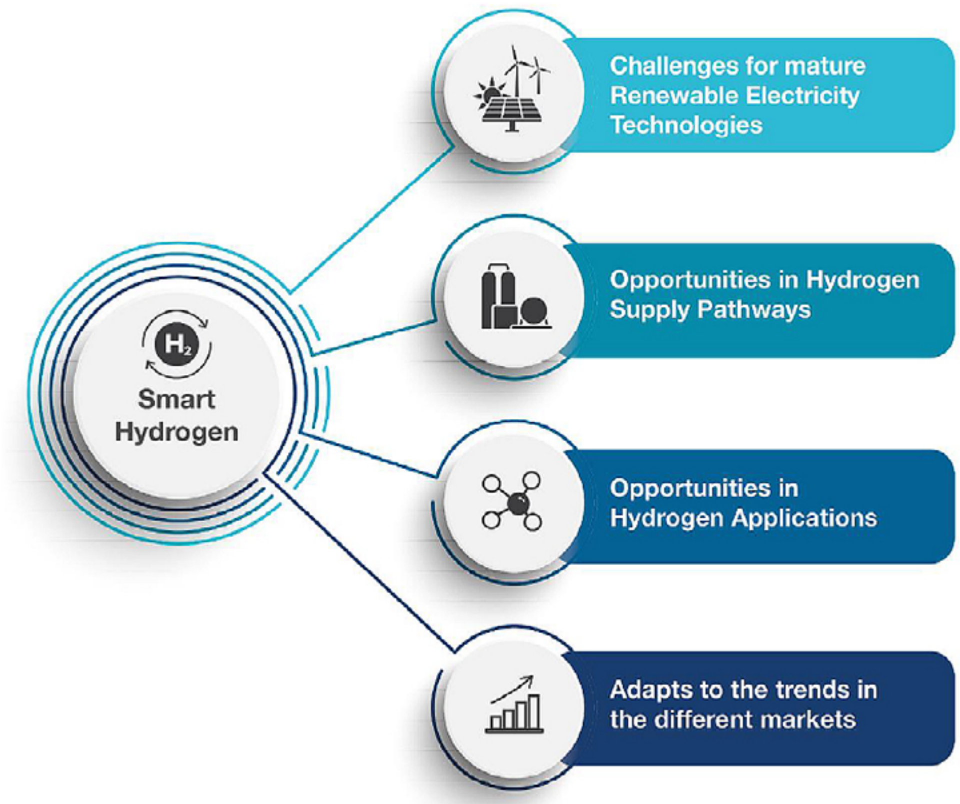
In order to achieve this we must mainstream Green Hydrogen and position it where it is a commodity not an addition or a luxury. When we mainstream hydrogen we can accelerate all steps of the value chain, development, distribution, deployment and use.

The Commodification of Green Hydrogen was a topic presented during EU Energy Week 2022 by Bart Biebuyck Executive Director of the Clean Hydrogen Partners, Paul McCormack Innovation Manager Belfast Met, Diana Raine Worley, Marianna Rossi IZES and Rory Monaghan Galway University. They have taken the presentation and produced a paper on the topic. This is a short summary of the findings – **the full article can be accessed here.**

Hydrogen as an energy commodity

Energy is a commodity and if we are to integrate hydrogen into our energy supplies then we must strive to make hydrogen a commodity to ensure the transition is seamless.

How can we position Hydrogen technically and environmentally to become an energy commodity? Examining and detailing the key steps in the 4-stage Green H2 value chain, production, storage and use to maximise green energy outputs and accelerate the transition to net zero.



The SMART H2 Sector Coupling Opportunity

Clean Hydrogen will play a significant role in increasing domestic energy independence as well as enabling new networks of international collaboration. As Europe switches from fossil fuel dependence to renewables and clean hydrogen it will create diversification and achieve energy security.

4-stage green h2 commodification value chain

As Europe creates a new frontier for clean technologies with clean hydrogen as the transformational key energy vector we need to examine and maximise each of the links in the 4-stage green h2 commodification value chain, optimisation, actualisation, evaluation, and validation.

H2 optimisation

Hydrogen is the catalyst driving Europe's energy transition, enabling us to pioneer new and innovative paths to sustainability. Optimising this journey, enhancing its cost-competitive production, storage, and end-use is critical.

Delivering SMART H2 through valorization of the hydrogen supply chain, production, storage, and use is key to creating a successful, sustainable secure energy future for Europe.

H2 actualisation

The 2020's were heralded as the decade of action in the fight against climate change. Hydrogen is universally recognised as having a significant role to play in the move away from fossil fuels, but we now urgently need a holistic, agile approach to address existing barriers and to drive costs out of the supply chain if this really is to be the decade of action.

H2 evaluation

Hydrogen can be the key to creating a successful, sustainable, and secure energy future for Europe. But it is people who need to open the door. It is crucial to understand and consider people's needs and attitudes around hydrogen to make the transformation process socially valuable and viable. Therefore, to successfully target the commodification of green hydrogen, it is equally relevant to target a consensus

The 4 stage Green H2 Commodification Value Chain on its social value and desirability. To achieve such understanding, people need to develop an overall positive attitude towards hydrogen and the process that comes with incorporating it in the current system.

H2 validation

We need to speak to the End Users, those whose jobs it is to decarbonise and strengthen energy security. We cannot promote “hydrogen for the sake of hydrogen”. We must find the right roles. Industry-Research collaborations are essential for enabling clear-headed, objective decision-making.

Validation of the use of Green H2 and accelerating through the creation of a techno-economic model enabling support tool. Europe finds itself in the middle of a H2 energy revolution and crisis – where all of Europe must be informed, assisted, and enabled to transition from fossil fuels to a net zero C02 destination.

Digitalisation

The Green Economy is predicated on the Green Economy and Digitalisation. We can use digitalisation and digital tools to optimise value at every stage in the Green Hydrogen value chain. Blockchain will be a powerful tool in tracking emissions and green molecules along energy value chains As we prioritize green hydrogen in the energy transition this will drive profound change and deliver new policies, business models, and regulatory models in the rapidly changing energy sector. Blockchain and other digital tools will play a prominent role in supporting these strategies.

Gearing up

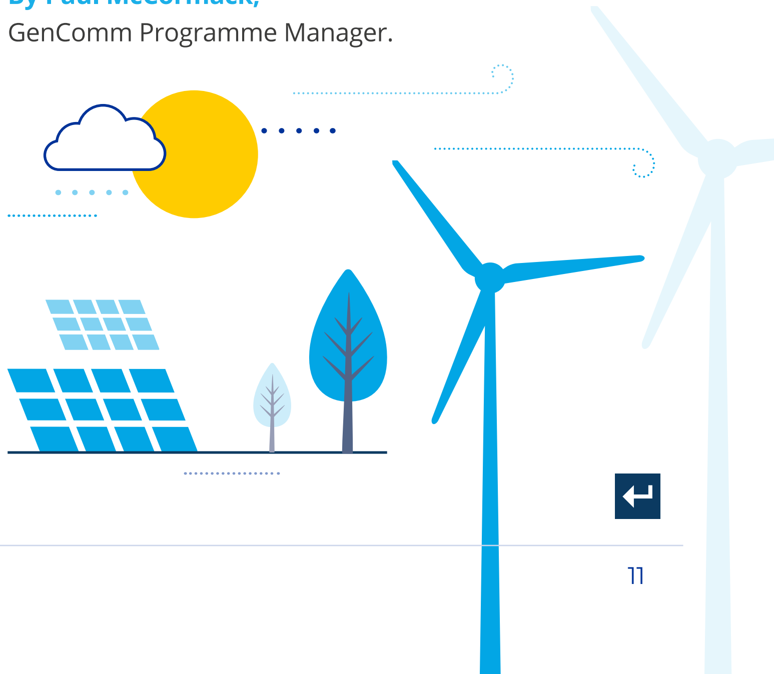
As we build the fundamental basics of the hydrogen value chain and achieve commodification, the challenge then remains how do we scale this to meet national and international needs and accelerate the development, deployment, and use in applications. We need to add in external inputs that will multiply the outputs from the basic hydrogen value chain. Once we have 4 Stages, optimisation, actualisation, evaluation, and validation of the Green H2 Commodification value chain locked together we can then start to ‘move up the gears’ and accelerate the process to meet the energy needs of Europe.

Conclusion

Green H2 plays a twin parallel critical role of delivering the EU’s long-term decarbonisation goals and being the foundation stone of the EU’s energy independence. With Green H2 as the catalyst Europe can develop our renewable energy technologies exponentially, take control of our energy supply chains and become masters of our own energy destiny.

Energy innovation is not linear, it is a conversion and Green H2 innovation can and will convert our energy systems to the green alternatives we need to fully transition to a new zero carbon energy model with Green H2 as a constituent vector we need a different energy market structure. One which will deliver on the renewables opportunity and provide us with renewable capacity and flexibility.

By Paul McCormack,
GenComm Programme Manager.



An INVEST NI look at the NI Energy Scene-Context: Net Zero, Energy Transition, Energy Efficiency

Northern Ireland has a goal for net zero carbon emissions by 2050. Energy generating systems are in the process of transitioning from fossil fuel – based technologies to those in which renewable, carbon - free energy sources will form the core of these systems.

For example, in 2000 most electricity generation was from coal and natural gas. Since 2000, wind – generated electricity has grown substantially from a very low base. For the 12 month period from July 2021 to June 2022, 47.1% of total electricity generation in Northern Ireland was from renewable sources located in Northern Ireland, which represents an increase of 1.7 percentage points on the previous 12 month period (July 2020 to June 2021). Renewable energy generating technologies for net zero include wind, solar, biogas from anaerobic digestion, and geothermal energy. Storage is a key technology for an energy system based on renewables in order to smooth out intermittent generation and provide grid stability. Energy efficiency will play an increasingly important role in helping the economy and society reduce cost and achieve Net Zero, provided suitable policies are in place to incentivise uptake of energy efficient technologies and simple, cost-effective measures, e.g. insulation. For example, from 2005 – 2015, UK overall energy consumption decreased by over 16% as a result of appropriate policies, with petrol consumption decreasing by 13.1%, electricity by 15.2% and natural gas by 33%. This took place in a context of an increase in GDP of 16% in the same period.

Green Hydrogen

Green hydrogen, produced by the electrolysis of water powered by electricity supplied by a renewable source such as wind or solar, has a role to play in enabling Northern Ireland to reach Net Zero and develop new technologies to help foster economic growth. Green hydrogen can potentially provide an emissions' – free energy source for applications in which the power source cannot practically be electrified, for example high temperature processing operations such as steel

Invest NI HQ

and cement manufacture. Synthesis gas, a starting material in the manufacture of fuels for applications such as aerospace and road transport, can be made from a mixture of green hydrogen and carbon monoxide, provided these fuels are cost-effective.

However, while hydrogen has a high energy density by weight, it has a much lower energy density by volume compared with fuels such as methane, diesel, petrol and ethanol. There are fundamental efficiency issues with green hydrogen as an energy carrier. A much greater number of turbines is needed to supply a given amount of energy compared with the turbines required to deliver the same amount of energy via electrification.

These efficiency issues have major cost implications for certain potential applications. If used to power cars, overall conversion efficiency is around 23% from wind turbine to wheel. This means that for every 100kW from a wind turbine, 23kW are delivered to the wheel due to losses from converting electricity to hydrogen via various steps such as electrolysis and compression. In comparison, battery-powered cars are around 90% efficient.

If used in heating, the overall conversion efficiency from a wind turbine to a hydrogen – powered boiler is 46%, i.e. for every 100kW from a wind turbine, 46kW is delivered as heat. In comparison, for an electric space heater, efficiency from the turbine is around 86%. For a heat pump, 100kW wind power will deliver around 270kW heat. As hydrogen has a much lower energy content by volume than natural gas, bigger diameter pipes are needed to transport the same amount of energy, while 3 - 4 times more energy is needed to pump the same amount of energy as for natural gas.

Hydrogen has the potential for storing electricity generated from curtailed (stopped) wind turbines when demand for wind-generated electricity is low/zero. Curtailment can be prevented by allowing the turbines to generate hydrogen for storage after which it could be burned in a gas turbine to generate electricity. However large scale hydrogen storage, e.g. storage in depleted oil/gas fields or salt caverns to smooth out fluctuations in wind power and electricity demand, has yet to be successfully developed in the UK. The round-trip efficiency of storing green hydrogen, then passing through a fuel cell to generate electricity, is low at around 32%. So for every 100kWh of renewable electricity, only 32kWh returns to the electricity grid after the storage process.

Bigger electrolysers will reduce the conversion cost of electricity to hydrogen due to economies of scale. As there are potential markets for green hydrogen in applications that require very high process temperatures and cannot be readily electrified, e.g. steel and cement manufacture, there are opportunities for NI companies to develop green hydrogen technologies to supply these markets, for example composite tank technologies that can store hydrogen at 700 bar pressure. These tanks could store hydrogen generated on the same site as a high temperature manufacturing process thereby minimising efficiency losses in transport and therefore reducing cost.

Academia, industry and Skills Base

Queens University Belfast are considering various applications for hydrogen as a research focus in developing new technologies. Ulster University's Hydrogen Safety and Engineering Research Centre has a focus on safety in the production and use of hydrogen. Ulster University runs a number of post-graduate courses in hydrogen for engineers. Local manufacturing industry will use green hydrogen but only where practicable and at low cost.

NI as an Energy Leader

Utilising its extensive wind resource for generating green hydrogen, Northern Ireland has the potential to be an Energy Leader in the transition from fossil fuels. By minimising efficiency and energy density issues that are fundamental to hydrogen as an energy carrier, and building on an established reputation for manufacturing excellence, Northern Ireland can focus on developing green hydrogen technologies for suitable applications that cannot be electrified.

By Dr Jim Clarke,
Technical Advisor, Energy and Resource Efficiency, Invest NI.

German Cross border hydrogen project mosaHYc can begin prior to the scheduled start

Creos Deutschland Wasserstoff GmbH was granted permission by the Federal Ministry of Economics and Climate Protection (BMWK) to start work "early" on the mosaHYc (Moselle-Saar-Hydrogen-Conversion) pipeline project being part of the IPCEI on Hydrogen ("Important Project of Common European Interest") programme. This enables Creos to start the project now, before the final decision concerning the public funding has been made.

With mosaHYc, the grid operators Creos and GRTgaz want to establish an approximately 100-kilometre-long hydrogen pipeline in the Greater Region in cooperation with the Luxembourg energy group Encevo. For this purpose, about 70 kilometres of existing gas pipelines, some of which are out of service, are to be converted into hydrogen pipelines. The additional construction of about 30 kilometres of hydrogen pipelines will then create a first local and independent hydrogen network, see Figure 1. Thus, mosaHYc enables hydrogen producers and consumers to develop new, climate-neutral business models in industry, the heating market and the transport sector in the "Greater Region" of Saarland, Luxembourg and Moselle.

Now Creos will in particular push ahead with the planning of the construction routing of the new hydrogen pipeline between Dillingen and the village of Ihn, which is located on the German-French border. Creos has set itself the goal of defining the concrete route by the beginning of next year in order to quickly launch the approval process for the construction of the new pipeline in 2023. In 2023, Creos also wants to carry out technical feasibility studies to advance the conversion of existing pipelines between Völklingen-Carling and Perl.

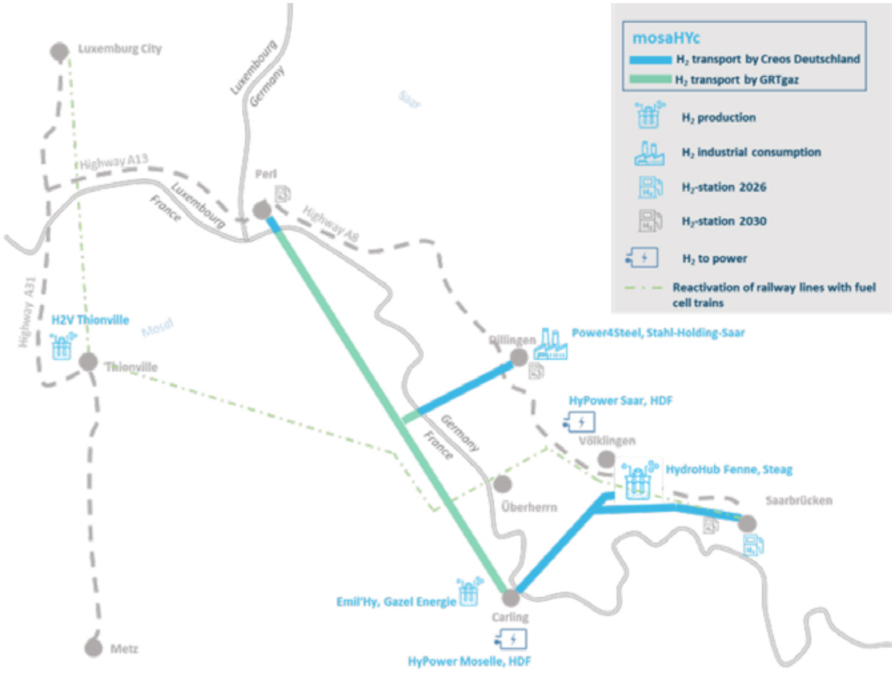


Figure 1: Cross-border hydrogen pipeline between Völklingen, Carling and Perl

➡ mosaHYc has the potential to really advance the energy transformation. Not only for Creos itself, but for Saarland and beyond for the entire "Greater Region".
It is the opportunity to utilize hydrogen in production processes, for climate-neutral green steel in Saarland, for hydrogen producers in the "Greater Region" and for the future connection to the large European hydrogen grid.

Together with the partners of the Grande Region Hydrogen EEIG (GRH), mosaHYc succeeds in bringing a functioning cross-border hydrogen economy to life with various market players participating. GRH has grid operators, hydrogen producers and hydrogen consumers working together at the right time and in the right place.

Representing an association of European economic interests (EWIV - Europäische Wirtschaftliche Interessenvereinigung), the "Grande Region Hydrogen EEIG" (GRH) initiative aims to develop and support a hydrogen economic system in the Greater Region of Saarland (Germany), Moselle (Grand-Est, France) and the Grand Duchy of Luxembourg. There it offers market participants a forum to dovetail hydrogen projects in this region, to communicate with a mutual goal - to jointly leverage synergies.

The EEIG was founded in August 2021. Its members are currently Creos Deutschland GmbH, Encevo S.A., GazelEnergie, GRTgaz, H2V, HDF Energy, SHS - Stahl-Holding-Saar GmbH & Co. KGaA (SHS) and Steag GmbH. It is a non-profit organisation based in Luxembourg. Its managing directors are provided by Creos, GRTgaz and Encevo, see www.grande-region-hydrogen.eu.

By Norman Blaß and Carola Jung, Creos.

KoNSTanZE: German Industrial sector coupling based on hydrogen

The 3.5 million € project KoNSTanZE was started in October 2021 and has a duration of three years. The aim of KoNSTanZE is to evaluate whether and how an industrial production site can be fully decarbonised and what role hydrogen can play in this transition process.

In the first year of the project, the necessary planning with regard to the layout of the overall test field was carried out and the concept for the collection of measured values and data, which is necessary for scientific support, was created. The following Figure 1 shows the schematic diagram of the KoNSTanZE test field at the Bosch plant in Homburg.

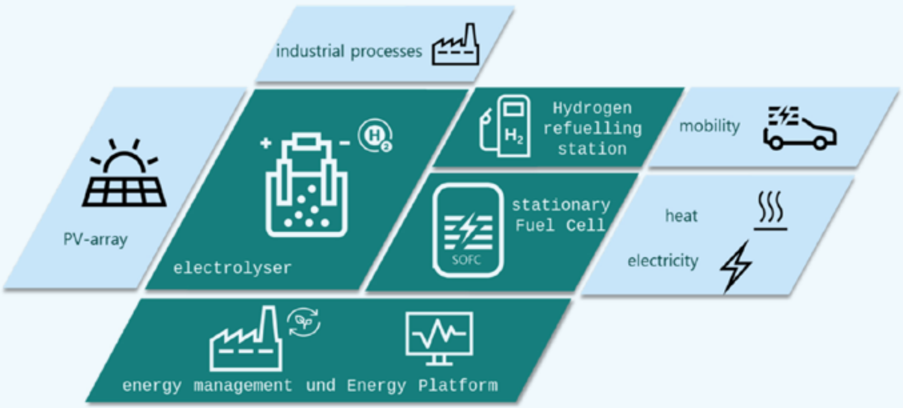


Figure 1: schematic diagram of the KoNSTanZE test field (image source: Bosch)

Figure 2: KoNSTanZE test field or connected eH2-Cycle at the Bosch site in Homburg/Saar (image source: Bosch)

The key components, electrolyser and mobile refuelling station, have already been delivered and put into operation, and the related civil engineering and electrical work has been carried out as far as possible. The planned vehicles, four Toyota Mirai, three forklifts and two haulers, have also been delivered and are ready for use. Our image shows the electrolyser in the background on the left, the mobile refuelling station in the centre, the low-pressure storage tank on the left and the hydrogen vehicles available at the Homburg site in the foreground.

The joint project KoNSTanZE (03EI3043A,B) is funded by the Federal Ministry for Economic Affairs and Climate Protection on the basis of a decision by the German Bundestag.

by Dr Bodo Groß, IZES gGmbH and **Michael Reinstadtler,** Robert Bosch GmbH

The Youngsters Research & Technology Centre in St Ingbert, Germany with ‘Green Steel in the laboratory’ as a prominent topic

The Youngsters´ Research & Technology Centre (SFTZ), located on the site of a former ironworks (“Alte Schmelz”) in the town St. Ingbert, is exclusively devoted to hands-on experimentation of young people. STEM broad-based promotion as well as individual and talent promotion is carried out.

The focus is on STEM Sustainability Education with subjects like Green Chemistry, Ecological Biology, Energy-relevant Electrochemistry including Hydrogen, Mechatronics / Environmental Sensors, and Metallurgy / Green Steel. This is an efficient way of dissemination of STEM knowledge and climate awareness, aiming at transformative sustainability education. “Green Steel from Local Iron Ores” is studied by the school student Helena Patricia Dell as her contribution to the school-student National Science Competition "Jugend forscht" 2023, Figure 1.

250 years ago, in the former ironworks, the iron production was based on Limonite, also called Brown Iron Ore (a mixture of related hydrated iron oxide minerals like Goethite and Lepidocrocite, FeO(OH)·nH2O) which occurs as layers in the local sandstone formation. When digging up the garden in St Ingbert, pieces of such iron ore can be found. Those iron ore pieces are used in the present study. By cerimetry, an iron (chemical symbol: Fe) content of 17 wt.% for a piece of this ore was determined. This low content is the reason why the former ironworks after some time switched to an iron ore deposit near the town of Lebach (distance about 30 km). This is a Siderite (FeCO3) ore deposit. The ore occurs in form of egg-shaped globules which are called “Lebacher Eier” (Lebach eggs). At special places in the local forest known to the residents, “Lebacher Eier” can still today be found. The Fe content according to our measurement is 36 wt.%, corresponding to a FeCO3-content of 75 wt.%. For comparison it was also worked with a high-quality Haematite (Fe2O3) iron ore imported by our industrial partner, the steel factory Dillinger Hüttenwerke AG, from Brazil; its Fe and Fe2O3 content amounts to 65 and 92 wt.%, respectively.

Figure 1: Helena Patricia Dell and Rolf Hempelmann at the direct reduction laboratory set-up in the chemistry lab of the SFTZ (Source: Bodo Groß)

That means about 8 wt.% is waste rock, mainly aluminium silicates. The direct hydrogen reduction of the iron ore is done in a quartz tube flow reactor.

The reaction water is removed from the chemical equilibrium by means of a desiccant (mole sieve). The reduction process was performed alternatively at 500 °C and at 700°C for 10 hours each. For the 500°C sample a pronounced sponge morphology of this Directly Reduced Iron (DRI) can be seen in a stereo microscope. For the 700°C sample, grain growth has occurred already in the glass tube flow reactor, the sponge morphology is less pronounced.

On a future industrial scale, the sponge Fe from a future shaft furnace is briquetted and then melted, together with some carbon, in a future large-scale electric arc furnace using graphite electrodes; this process introduces carbon into the DRI thus transforming carbon-free DRI into Green Steel provided the used hydrogen is green. In the laboratory, the iron ore is briquetted into a small tablet by pressing with a hydraulic press. The tablet is melted into DRI in our laboratory-scale electric arc furnace using a tungsten electrode. The so-called waste rock, i.e., the silicate impurities, are segregated on the surface of the resulting metal button.

The characterisation is done by metallography. No carbon is found in DRI from Hematite, whereas the grain boundaries of DRI from Siderite contain carbon. Thus, a piece of steel was successfully produced from the direct hydrogen reduction of Siderite, which would be called green steel if the hydrogen used in the DRI process came from electrolysis and the electricity to run the electrolyser was green. The SFTZ building, see Figure 2, has a photovoltaic system on its roof and during periods of sunshine the electricity in the SFTZ actually is green, the commissioning of a PEM electrolyser is work in progress now.

Conclusion

The SFTZ enables young people to take a look into the decarbonised future of the region, of the country and beyond, in line with the EU's Green Deal. At the same time, historical work processes are traced - practically hands-on - according to today's STEM knowledge and evaluated with today's possibilities and knowledge. In this way, young people with STEM affinity can draw conclusions about sustainable, resource and climate-friendly behaviour for their own future.

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by Rolf Hempelmann,
MINT Campus, St Ingbert, Germany

Figure 2: SFTZ-building in St. Ingbert’s STEM Campus
(Source: Rolf Hempelmann)

For more information

on the GenComm Project and our work in the green hydrogen arena contact

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