Chambers Ireland Submission to the Department of Environment and Climate Change on the National Hydrogen Strategy

September 2022

Chambers Ireland, the voice of business throughout Ireland, is an all-island organisation with a unique geographical reach. Our 40 members are the Chambers of Commerce in the cities and towns throughout the country – active in every constituency. Each of our member Chambers is central to their local business community and all seek to promote thriving local economies that can support sustainable cities and communities.

In September 2019, our Network pledged to advocate for and support the advancement of the Sustainable Development Goals. In doing so, we use the Goals as a framework to identify policy priorities and communicate our recommendations. We have a particular focus on five of the goals encompassing Decent Work and Economic Growth (SDG 8), Sustainable Cities and Communities

(SDG 11), advancements in Gender Equality (SDG 5), viable Industries, Innovation, and Infrastructure (SDG 9) and progress in Climate Action (SDG 13).[1]

The Department's decision to initiate a National Hydrogen Policy is welcome and timely. Chambers Ireland has been calling for a greater government focus on this area since 2019. We strongly believe that Ireland is in a unique position to benefit from the hydrogen aspect of the Green Transition. Given our extensive Exclusive Economic Area, our sea territory offers us access to enormous volumes of renewable energy. It is however variable with suggests that projects that would link us to the EU grid will be limited in the utility – not least because much of that grid infrastructure will not be needed except for during peak periods. Fixing this energy in chemistry offers us a way to commercialise our energy potential, it also allows us to smooth out our own electricity supply to suit our highly variable daily demand curve. Ireland has an enormous opportunity to become a key cog in the European energy network through the supply of compressed Hydrogen and Ammonia to that market. The demand from the European market will be orders of magnitude greater than our highest possible domestic demand, and so should be the key focus of the national Hydrogen strategy.

With large economies of scale arising from servicing the large industrial, and electricity generation, demands for Green Hydrogen Irish consumers will benefit from our European peers underwriting the creation of the infrastructure needed to capture the locally produced renewable energy and the supporting infrastructure that a Hydrogen industry will need.

Accelerating this transition is the Russian war on Ukraine which has created an energy-shock that is driving short-run inflation but is also likely to lead to a medium to long-run increase in the cost of fossil fuels as counties and businesses are forced to diversify their energy sources. Ireland has long been navigating its course in an increasingly shock-prone world. The need to build resilient

[1] The Chambers Ireland SDGs. Available at: https://www.chambers.ie/policy/sustainable-development-goals/chambers-ireland-sdgs/

networks that can continue to deliver, and that can continue to support the needs of everyone on this island, is becoming ever-more apparent.

Chambers Ireland looks forward to future engagement with the Department to highlight the opportunities that are before us.

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Key Points

- We have enormous opportunities to benefit from the exploitation of our renewable offshore energy resources, but we need far greater ambition to expand capacity, and a Green Hydrogen industry that operates at scale is critical to store this energy over periods of weeks and months

- Green Hydrogen is a storage medium that allows us to transport unusable electrical energy to a place, and a point in time where it can be of value

- The focus for our National Hydrogen Strategy should be generating the Hydrogen creation capacity to reliable service the demand of our more highly industrialised European peers

- An export focus industry will facilitate economies of scale which will allow Irish consumers greater access to greater quantities of Green Hydrogen at lower prices that a domestically focused supply industry

- The goal for hydrogen production in Ireland should be net reduction in CO2 equivalent emissions, and individual use cases should be considered according to that aim

- Ireland's competitive advantage in Green Hydrogen is a consequence of our extremely large territorial waters and our relatively low capacity to use the electricity which can be generated in those waters

- Our national hydrogen strategy should be flexible, being careful in the early stages to avoid making decisions which lock the island into narrow path dependent trajectories – usage cases for green hydrogen will expand in line it's availability as the technology improves. It is also likely to act as a substitute for other technologies where supply constraints emerge

- We must use the REPowerEU decision regarding 'overriding public interest' to fast track the grid upgrades, and the construction of renewable generation projects, that are needed to make our electricity networks more resilient and effective

- Existing Marine Area Consents are contingent upon receiving a Grid Connection Assessment. It may be necessary to create an alternate route to planning and deployment for offshore windfarms which are feeding Hydrogen electrolysis projects where there is no existing transmission capacity for integrating the electrical potential of the windfarms onto the grid

- There is no form of renewable energy capacity that will not be useful when it comes to our decarbonisation, our approach will need to be flexible to ensure that, as we encounter the novel problems that will emerge over the next fifteen years, we will have access to all the tools that can address those challenges best

- Developing a "Hydrogen Ready" terminal that allows for shipping to load compressed/liquified Hydrogen for export will be a critical signal to the market regarding our ambition for this industry in Ireland

Chambers Ireland's Perspective on Hydrogen

Ireland has enormous untapped green energy resources, and we have the potential to benefit from "second mover advantage". While electrical security of supply is a key concern for businesses, it need not be. Had we engaged with the potential of our offshore energy resources in a timely manner we would not be as vulnerable as we are today to the energy shock that is being delivered by Russia.

We urgently need to become much more ambitious with respect to our offshore energy generation. At a time when Scotland is, by 2033, increasing their offshore energy capacity from 15GW to almost 40GW and including 17GW of floating offshore wind, our national objective is 7GW by 2030 (including 0GW of floating offshore wind).

We should utilise the REPowerEU decision regarding 'overriding public interest' to fast track the grid upgrades that are needed to make our electricity networks more resilient and effective. We must upgrade our electricity grid around the objective of becoming net exporters of green energy to the European continent. We have the potential to produce orders of magnitude more electricity than we will ever need, but we need to smooth out the intertemporal volatility of our production.

There are three primary ways to do this: exporting directly to the European Grid (but this is an infrastructure-heavy solution, that would lead to most of that capacity being unused most of the time (because we'd need to deliver the electricity as the wind generation was peaking, and peak Irish demand will never compare to peak production volumes). Alternatively, we could store the electricity in batteries, but this is a relatively short-run option (it helps flatten out the inter-temporal variation over timelines of days, but not weeks, never mind inter-seasonal variation), or chemically which will allow for smoothing out the curve over significantly longer timelines.

Given that our nearest EU neighbour has a low carbon electricity network, the limited capacity to connect into the EU grid, and the variability of wind, Ireland would be best suited to focus on chemically exporting our excess energy through a medium such as Hydrogen.

As wave energy becomes more commercially feasible, we are likely to be generating ever increasing amounts of electricity which will incidentally result in Ireland being as energy-secure as we are food-secure.

We need to use our excellent and underutilised natural harbours to export Compressed Green Hydrogen and green ammonia to continental Europe to facilitate their transition to a net zero economy. In the short-run port terminal capacity that can be used for Hydrogen export could also be used for temporary liquified natural gas (LNG) importation, which may allow us to limit the use of coal as a source of energy. A nascent Green Hydrogen industry could also supply into our existing gas-fired thermal plants which will reduce our CO2 impact on the environment, even as we help our emergent energy sector to grow. As the energy generation technology develops

Similarly, large energy users (particularly those in industries like aluminum smelting, cement manufacturing and agrifood) could be incentivised to transition to hydrogen (or a hydrogen/methane mix) to reduce our dependence on imported fossil fuels while also catalysing a Green Hydrogen industry.

Aside from the indirect benefits of supplying large volumes of clean energy to the Irish population, at scale, there is also the regional development role that will be served with the expansion of offshore wind to the Atlantic coast.

Hundreds of billions of euros of infrastructure are needed to harness the energy of the Atlantic, there will be a generation of work involved in building it and the efforts of generations more will be required to ensure that the value of this capital is maintained. Only a tiny share of the cost of renewable energy is captured in the build cost. Over the lifetime of these projects most of the spend will be on the Operations and Maintenance that is needed to ensure the efficient operation of the turbines. Each and every turbine will need to be inspected four times a year, and each of them will require a longer refitting to happen on an annual basis. This will translate into thousands of highly-paid jobs in many of the most disadvantaged regions of the country.

Offshore energy will become an industry that will be larger than the entirety of the agricultural sector, and likely even the construction sector by 2050. There are no good reasons for not accelerating this transition, even if it was not also necessary.

To make this opportunity a reality, Government needs to ensure that MARA, when it is founded, operates as an IDA for the sea – as a one-stop-shop agency that delivers the quickest path to operation for everyone who seeks to invest in our offshore energy potential. MARA needs to be the single point of contact that liaises with planners, agencies, departments, and semi-state bodies to ensure that Ireland can decarbonise at the greatest pace. We have, as a direct result of an inadequate regulatory regime significantly delayed on our decarbonisation – we need to make good on the 15 years of delay that was caused by the lack of an adequate offshore planning regime.

Finally, the existing method of creating nitrogen fertiliser is dependent on superheating methane using the Haber-Bosch process. Green Hydrogen can be an alternative zero-carbon feedstock for this process for fixing nitrogen, which would not only facilitate the creation of a more environmentally sensitive fertiliser industry, but also one which does not carry the same geopolitical and price risks of our existing source of nitrate fertiliser.

Ammonia is not only relatively stable and energy dense, it can be used in both jet turbine and diesel engines as fuel which can help decarbonise the international transport sector.

Hydrogen will be a key part of the solution to the highly variable availability of renewable energy in Ireland, and the wider EU.

The opportunity for Ireland will not be in local usage (although there are numerous benefits to using Green Hydrogen vs fossil fuels) it is as an exporter of energy that we will reap the greatest benefits. Foreign capital will facilitate the creation of our Green Hydrogen infrastructure, meanwhile international demand will reduce the share of the overheads which Irish consumers will pay.

Hydrogen Research

Which areas of hydrogen research require further examination?

Ireland, with its late entry into the Hydrogen conversation, will be small player in the field of research in the short. Where we do have a natural competitive advantage is in the relationship between our potential renewable energy supply, and our low absolute demand. This will facilitate us in becoming a key link in the hydrogen chain as it will allow us to fix renewable energy in stable chemistry that can be exploited elsewhere.

Just as Ireland is not a research powerhouse when it comes to the development of new pharmaceuticals, we can still carve out a space for ourselves in the broader industry. In pharmaceuticals our specialism is in manufacturing, in Hydrogen – having abundant supplies of Green Hydrogen will make Ireland a natural locus for research in the technologies that concentrate, store and ship Hydrogen and downstream products (such as Green Ammonia).

Furthermore, having a large supply of Green Hydrogen feeding the EU will mean that Ireland will have a very low domestic price for Hydrogen and this will facilitate investment in usage cases.

What can an Irish hydrogen strategy could do to drive innovation?

The focus needs to be on delivering the infrastructure that will be required to service EU demand for large volumes of Green Hydrogen. Our electricity networks will need to be developed to facilitate this, and so too will our shipping and port infrastructure.

Demonstrating that Ireland is a source of a secure Green Hydrogen is the best way to ensure that public and private bodies will have the confidence to invest in research activities here.

What are the research priorities for the development of each hydrogen end-use (demand) in Ireland?

End use cases in Ireland are not likely to play a significant role in our research strategies over the short term. If 2030 is a timeline milestone for hydrogen (given the recent Government target of 2GW of Green Hydrogen electricity generation capacity) it is unlikely that researchers that are not active in the field will be delivering research compatible with end use cases by then. Ireland's capacity to engage in such research will largely depend on the availability of large volumes of Green Hydrogen, and so is contingent on a significant increase in the offshore wind (likely floating offshore wind) production capacity in Irish waters.

Hydrogen Demand

What end-uses are there for hydrogen in Ireland (i.e. where hydrogen will be used)?

In the short run, industry that needs high quality heat (the time when we can be burning used tires to create cement is likely to be drawing to a close). Pharmaceuticals will be another area, industry where they are using combined heat and power will likely benefit. Large transport vehicles, HGVs, Aviation are all likely to need Green Hydrogen. Depending on the supply constraints for batteries (total global demand for batteries is set to quintuple by 2030) there may be demand for Green Hydrogen in the personal transport sector.

Electricity production is likely to be another strong area of domestic consumption, initially in gas fired thermal sites, latterly in pure Hydrogen thermal plants but ultimately fuel cells will likely provide for local and regional demand while larger generation bidirectional electrolysis units will support the base load.

Fixing nitrogen for fertiliser will be an enormous international business – the current global demand for fertiliser would outstrip the world's total renewable energy capacity if all of it were to go Green today.

How much hydrogen would be anticipated for use in each (in low, medium and high demand scenarios)? At what rate might that increase? What current evidence supports these projections?

This is an area of speculation. Hydrogen is fungible and will act as a substitute for electricity in many areas (other than the Hydrogen that passes along the ammonia/industrial track). Whether it is appropriate for a particular use case will depend on the relative marginal cost of using Hydrogen versus electricity (assuming there are not infrastructure deficits which exclude particular use cases). Whether a use case is rational

will be determined by the availability of electricity (and the available battery storage capacity) at a given place and time.

These technologies are in flux. However, if we focus on where there is known demand – European industrial and electricity generation networks – then Irish consumers will benefit from lower marginal costs than we would experience if we were to focus primarily on domestic demand.

How might the combined deployment of green hydrogen across multiple sectors synergies facilitate the development of hydrogen in Ireland?

The key industry is offshore renewable energy (fixed and floating offshore will be critical, but over a longer timeline wave will likely be the most important energy source for the island).

How does hydrogen compare to competing technologies (direct electrification and other decarbonisation options) for each of these end-uses?

Effectiveness and efficiency will be key tradeoffs in our decarbonisation process, direct electricity may often be the ideal, however certain projects may not be feasible over shorter timelines i.e. decarbonising the train network may require total electrification, however diesel engines can be converted to hydrogen which would allow for incremental gains to be achieved without needing billions of euros of investment. Alternatively parallel high-speed electrified trains could be created using EU rail-gauges while the older lines could be retained for commuter rail with Hydrogen fueled trains. Alternatively, we could find that battery constraints could limit the market for eVs leading to a choice regarding the continued sale of internal combustion engine cars or the introduction of Hydrogen fueled cars.

The use cases will emerge as the technologies mature, which is why Chambers Ireland is calling on the National Hydrogen Strategy to be flexible and open towards the kind of market that develops in Ireland.

What are the competing fossil fuels that are sought to be displaced?

This is too broad a question, much will be determined by whether there are alternative technologies that Green Hydrogen can act as a substitute to. Given the last few years, supposing that supply chain constraints will not be affecting the delivery of technologies to the market is unwise.

There is no form of renewable energy capacity that will not be useful when it comes to our decarbonisation, our approach will need to be flexible to ensure that, as we encounter the novel problems that will emerge over the next fifteen years, we will have access to all the tools that can address those challenges best.

How can Ireland avoid hydrogen use that increase the overall level of energy used in the economy versus other decarbonisation pathways?

We should be much bolder in our ambitions for offshore renewables. The point at which Hydrogen will be most profitable will be where we have excess supply over demand. Hydrogen will capture energy that would otherwise be curtailed. Hydrogen creates a market for a resource that would otherwise be wasted. The viability of Hydrogen electrolysis will be a function of the marginal price of electricity, this will not be low in the case that we are using fossil fuels for generating electricity, it will only be reasonable when we have renewable energy generation which is in excess of our domestic usage, and our direct cable export potential (circa 1.3GW).

Hydrogen supply

What is the renewable electricity potential that does not have a route to market from conventional grid connections? Could this be used for green hydrogen production?

Renewable energy supply is highly correlated (within source type). Solar in any part of the country is correlated with solar production everywhere else but Solar is most available when there is low demand. Similarly, Wind availability is tightly correlated across the county while Wind and Solar are negatively correlated (as it is windier in Winter than Summer). Wave is more independent, but when it is windy there are also waves. All this points to an electricity supply system that will at times be producing far in excess of what we need. All of that excess can provide the electrons that Hydrogen electrolysis needs.

Dedicated Green Hydrogen production seems unwise unless there is no available transmission capacity to feed the electricity onto the national grid. However, weaknesses in the national transmission grid should not act as a bottleneck on maximising potential renewables. Existing Marine Area Consents are contingent upon receiving a Grid Connection Assessment. It may be necessary to create an alternate route to planning and deployment for offshore windfarms which are feeding Hydrogen electrolysis projects where there is no existing transmission capacity for integrating the electrical potential of the windfarms onto the grid.

There are some novel use cases (such as the pyrolysis of plastics and bioplastics) that can also produce hydrogen (and syn-fuels for aviation) as an alternative to burning waste in thermals plants which may have potential to reduce emissions by creating other fuels that are alternatives to fossil fuels, or mitigate other environmental problems.

However, other uses (such as biomass-> Hydrogen) are likely to be highly inefficient uses of the material).

What are the most cost-effective ways of utilising potentially curtailed renewable electricity output for hydrogen production?

Electrolysis

What should government do to de-risk efficient investment in green hydrogen production to supply Ireland's demand?

Facilitate the suppliers that are seeking to sell into the German market by expanding the ambition for offshore renewables.

Where would it be best to locate hydrogen production? Should there be specific government policy to locate hydrogen production facilities where too much energy being generated for the electricity grid to manage (i.e. grid constraints)?

The current grid constraints are largely a function of inadequate renewables policies over the last number of decades. If we focus on our export potential we will naturally see that the best locations will be those places where offshore renewables are landed. This should be combined with existing thermal generation sites to ensure that the minimum amount of new transmission infrastructure is needed. We should be facilitating the creation of electrolysis units wherever offshore energy is landed, and therefore minimise the burden on the transmission network.

Furthermore, it may be useful to create planning pathways to facilitate the development of offshore windfarms which are dedicated to the production of Green Hydrogen even if there is no grid capacity in a particular area. It is important that the limitations of the transmission network do not act as a constrain on the national objective of maximising the potential energy generation capacity of our marine territory.

What spatial planning considerations should be factored into this? What role might ports play in the production and transportation of hydrogen?

Not having a Hydrogen terminal will completely undermine our capacity to be a supplier of Green Hydrogen to the European market. How to transport Hydrogen to such a terminal will be a business decision, for many locations it may be useful to have direct pipelines, for others trucks or rail might be most appropriate. But a national policy document is not the appropriate place to decide that. Flexibility will be important so that the Irish Hydrogen industry can develop organically.

What minimum sustainability criteria should apply to hydrogen produced in Ireland?

We should avoid cracking fossil fuels to create hydrogen. It is a wasteful and expensive enterprise. Carbon Capture Technologies are still attempting to achieve sufficient capacity and efficiency to make such fuels carbon neutral, meanwhile the supply chains to the fossil fuel feedstock for the various colours of Hydrogen are polluting, and the greenhouse gases associated with leaks, refining, and evaporation are never captured.

Biomethane and Hydrogen production can have some value where the feedstocks are waste (as the alternative is to allow the waste to decompose into methane) and the process of burning the biomethane, or pyrolysis, lessens the damage that may otherwise be done.

Growing biomass as a feedstock, to then turn to a fuel, that is then broken down into hydrogen (and C02) seems to involve unnecessary steps. There might be better uses for the biomass.

The goal for hydrogen production in Ireland should be net reduction in CO2 equivalent emissions, and individual use cases should be considered according to that aim.

What policy mechanisms could be used to ensure that competition between green hydrogen production and other direct uses of renewable electricity is managed such that there are no negative impacts on emissions reductions or consumer costs?

This question is about five years too early. It is not likely that we will have a significant Hydrogen industry by 2027 meanwhile the technologies that support use cases are still developing.

What contribution could domestic green hydrogen supply make towards Ireland's energy security?

Hydrogen is the solution to the intertemporal problem that we have with our renewable energy resources – we tend to have far more than we need, or much less than we need, at any given time.

By harnessing these renewable energies and converting them to Hydrogen with the primary customer being the European market Ireland will also be able to fuel itself directly whenever needed.

The best way to become energy secure is to be a net producer, and this is the opportunity that extensive offshore wind fleets, combined with Green Hydrogen, offers the country.

What strengths does Ireland have in hydrogen supply chains?

Ireland's competitive advantage lies not in Hydrogen, but in Green Hydrogen. Existing Hydrogen suppliers will be extracting the remaining value in their existing infrastructure and will therefore be able to supply Hydrogen at a price that we will not be able to compete with (until we are exporting very large volumes).

Ireland's competitive advantage is a consequence of our extremely large territorial waters and our relatively low capacity to use the electricity which can be generated in those waters. Green Hydrogen offers us a means to capture energy that would otherwise be

curtailed and wasted so that we can use it at a later point, and at a place, where we would otherwise be using fossil fuel.

What potential uses are there for the oxygen by-product of hydrogen production?

This question is likely to be too focused for a national Hydrogen Strategy. The price for oxygen is cents per kilo. While there may be some marginal uses for it, the shipping cost will be higher than the retained value in most cases.

Hydrogen Transportation and Storage

What methods of transporting hydrogen are best suited to meet the needs of hydrogen end-use in each sector?

This depends on the context and quantity involved. It may be that pipes will be most useful at sites near the sea which can link to ports. Whereas trucks will be most useful in other areas as they will not require construction works. Again, this question may be a little premature.

Whether hydrogen blends injected into the gas network is considered to be a good use of green hydrogen?

This depends largely on what the substitute use would be. If the alternative is that the Green Hydrogen isn't electrolysed, and the energy that went into it was curtailed instead, then yes, injection is a good use because it will reduce our GHG emissions in absolute terms.

If the trade off is between using it in vehicles vs a thermal plant, then possibly not as significant amounts of fossil fuels would be burnt instead.

In the short run, the quickest route to market is the injection of Green Hydrogen into the gas network, but in the longer run it will be more efficient and effective to deliver this to networks capable of using pure Hydrogen or direct Hydrogen -> electricity fuel cells.

Would hydrogen blends in the gas network be a viable way to underpin investment and ensure lack of demand risk is mitigated in the event that hydrogen demand fails to adequately materialise in end-use sectors?

Yes, because it will, in absolute terms reduce the amount of fossil fuels we would otherwise be using.

Should there be a long-term plan for a transition of the natural gas network to 100% green hydrogen? How much of the network should be repurposed? Should it be the transmission pipelines only or include some of the distribution network? Should the existing gas grid be broken up into smaller segregated sections to carry 100% hydrogen in some areas? How would this meet needs of end-use sectors? What should be the timeline for this?

Yes. Ultimately all of it. But in the short run creating local Hydrogen networks will allow an incremental shift to occur. This should start as early as possible, with towns such as Sligo, Shannon, Galway and Limerick acting as pilot areas.

What role could hydrogen storage play in Ireland's energy system?

Hydrogen storage is the fundamental element to our national Green Hydrogen industry. Storage is the only reason why we should be considering the development of Green Hydrogen. Hydrogen is a storage medium, it allows us to take unused electricity and bring it to that place and point in time when it is useful. Hydrogen storage will be the foundation that Ireland's post-carbon economy will be founded on.

What level of hydrogen storage should Ireland have? Where would it be best to locate hydrogen storage?

The easiest to deliver would be floating terminals which would allow ships to dock, load and allow trans-shipments from vessel to vessel, without meeting the same planning challenges that large landbased storage units might face.

Undersea storage is likely to be necessary as, even if liquified, a tonne of Hydrogen will need 15 m^2 of storage. With a huge volume of space needed to store Hydrogen, much will need geological storage.

What is the potential acceptance of or resistance to hydrogen storage facilities in communities? What public engagement might be required?

There will be considerable scare stories and lobbying by fossil fuel and battery storage agents. But these are industrial units, they are best suited to industrial areas and ports. This may limit where it is feasible to have electrolysis sites. There is also likely to be considerable resistance to creating new pipelines that are dedicated to Hydrogen, so usage of the existing gas infrastructure will need to be optimised to minimise need to create new infrastructure.

What regulatory and statutory framework should be put in place to allow for geoscientific investigation of the potential for geological storage of hydrogen in the future?

We should look to what other nations are doing. The US Department of Energy is financing a $500m project to store 300 GWh of Hydrogen. The science is well settled on this, what we need is an assessment and Environmental Impact Analysis process to determine which sites in Ireland are viable.

What specific aspects would be needed for any research and development to test the feasibility of storing hydrogen underground, particularly in respect of depleted gas fields?

Research and development is not needed, what is needed is that assessments of proposed locations can be scrutinised by officials with sufficient expertise to understand the scientific and engineering challenges involved.

Are there any predefined geographical areas of interest in relation to potential hydrogen storage?

Too early to determine this. Sites will need to be assessed on a case-by-case basis.

What types of technologies, including any existing infrastructure, could be put in place to facilitate hydrogen storage?

Too early to determine this, the technologies are still in flux.

What would be the major challenges and opportunities presented by the possibility of storing hydrogen underground for the long term, particularly so as to be able to effectively balance consumer demand and supply during peak periods and to address seasonal demand?

This is too narrow a focus, we need to be looking to the European market for scale, at which point total domestic demand will be only a small percentage of what we produce.

That said, the primary benefit of Hydrogen is that it allows us to store energy. It is a solution to the intertemporal challenge that besets renewable fuels and the management of electricity networks that are dependent on them.

What new environmental considerations should be considered in relation to hydrogen storage?

It is a hazardous liquid or gas which is explosive. But so too are other fuels, it should sit within the existing legislative framework, albeit with greater pressure and temperature tolerances.

Export opportunity

What is Ireland's potential opportunity to export green hydrogen? What are the impacts of this on consumers and the economy?

Germany is targeting 110 TWh of Hydrogen Consumption in 2030, with 680-750 TWh of total electricity consumption by 2030. The primary constraint is the sourcing and supply of Green Hydrogen. All future Gas Thermal Plants have to be "Hydrogen-Ready" when constructed.

110 TWh more than four times Ireland's total electricity usage, upon developing the supply chains Ireland will quickly become capable of exporting more energy than we could ever use.

How does export of green hydrogen compare with the direct export of renewable electricity through electricity HVDC interconnection?

They are different products. We can supply electricity internationally through HVDC, however there needs to be an existing customer for it. If we are creating electricity during the holiday month of August when there is exceptional solar energy availability, we will not be guaranteed a buyer for our electricity.

The principle benefit of Hydrogen is not that it can be moved from place to place, but that it can be moved from time to time, so that stored 'electricity' can be moved to a place where it will be useful, in a week, or a month, or a year. HVDC is only relevant where there is energy demand now. Furthermore, if we are to have 70-100 GW of floating offshore Atlantic wind we would need to have at least a 100 HVDC cables, equivalent to the Celtic Interconnector, to export that electricity (assuming there was demand for that energy in Britain and France at the time).

What methods and volumes of exportation are likely to be viable by 2030 and in the period to 2035?

Shipping will be the primary route. As time progresses, and British/French gas networks shift to Hydrogen further gas interconnectors could be developed, but that is unlikely before 2035

How should Ireland support the development of green hydrogen exports?

The first step is to create a Hydrogen Ready terminal for fuel shipments.

Safety and regulation

What is the appropriate safety framework for the future hydrogen economy?

The existing framework for fuel oils should be expanded to include Hydrogen gas, compressed Hydrogen, and liquid ammonia.

What state body should be nominated as the hydrogen safety regulator, charged with responsibility for the development, implementation and oversight of the hydrogen safety framework for the various elements of the future hydrogen economy?

The CRU oversees the existing fuel oil Safety Frameworks, while also regulating the Gas and Electricity networks

What international standards will be necessary for products and processes used in the hydrogen industry, particularly in regard to safety? What standards should be adopted in Ireland and why?

We should follow the European Standards as that is where our primary clients will be.

Supports and targets

What scale of ambition is right for Ireland regarding hydrogen production targets?

The primary constraint on the industry is the poor delivery of renewable energy onto the national electricity network. Ambition for renewables of all types needs to be increased and the capacity of the transmission network needs to be improved so that it is commensurate with our national potential.

However, our national production targets and our national consumption targets should be decoupled. There is far greater demand for Hydrogen off the island than on it, meanwhile the lower priced Hydrogen that will be a consequence of exporting to a deep market will allow us a competitive advantage (in terms of both security of supply, and price) for consumers of Green Hydrogen that decide to be Irish based.

What timelines should set for these targets?

2030 should be the base target, it aligns with national and European environmental and energy targets.

How should the deployment of hydrogen in Ireland be funded/supported?

Government should create floor prices, through auctioning off tranches of futures contracts where the government buys the gas that is to be produced at a guaranteed price. Then should the price of hydrogen exceed that floor price then Government can benefit, meanwhile the suppliers will be able to use the contracts to support the financing of their investments.

What are the potential policy options for incentivising for hydrogen end-uses?

It is too early to determine.

How should green hydrogen be incentivised in the electricity market?

Green Hydrogen would ideally be used inefficient fuel cells that can strip the electrons back off the atoms and onto the grid without wasting the unused heat which is inevitable with thermal processes.

If that is to be the case, then energy providers will need to be paid for the stored energy which they will be obliged to return to the network when variable renewable energy sources are unavailable.

If they are only paid for the watts which they produce, then it is likely that suppliers will minimise their production to the network to only those times when it is most profitable.

What policies should be put in place to develop further hydrogen based enterprises?

It is too early to determine. Until there is a robust Green Hydrogen supply chain secondary industries will be impossible to incentivised (as they will be forced to source their Hydrogen from abroad and ship it here).

How could supports and targets account for cross sectoral deployment of hydrogen?

The best help the Government could offer, beyond accelerating the connection of Atlantic offshore renewable energy, is through taking the role of a customer with guaranteed demand through offering futures contracts to Hydrogen production firms. The State is often the largest single customer in many areas, and so is in a position to guarantee demand for hydrogen by, for example, converting the bus fleet from Diesel to Hydrogen. By mandating that all state bodies will have converted from diesel backup generators to Hydrogen fueled ones by 2030. And ultimately if there is insufficient demand, the excess Green Hydrogen can be used to reduce our C02 emmisions if it is fired in thermals plants.

Energy Security

What contribution could domestic green hydrogen supply make towards Ireland's energy security?

Ireland's total energy consumption, of all kinds, is approximately 170TWh p.a.

We can achieve that with 30GW of wind (onshore and offshore) combined with Solar and storage. Assuming that we achieve the current government targets we will be halfway towards being completely energy independent by 2030. However, given the 5Mt hole in the Carbon budgets it is likely that we will have to increase those 2030 targets over the next two-three years.

It is unlikely that we will have electrified our society to the point that we will be able to use that much electricity without having long-term storage. At this point the constraint will be the scale of our storage facilities rather than our appetite for energy.

With reasonable estimates for offshore renewables tending to between 60GW and 100GW along with the considerably greater potential of wave energy, we are likely (by 2040) to be a net energy exporter.

Given that our connection to our storage will be piped directly into our energy networks it is likely that the price that Irish consumers will be paying of fixed Hydrogen will always be less than clients in other jurisdictions that will also have to pay for transport.

What role could hydrogen storage play regarding security of supply?

The availability of hydrogen, when it is needed, is the fundamental selling point of the technology. While considerable storage capacity will be needed if we are to have a two-month strategic reserve of Green Hydrogen (circa 600k tonnes or 100m cubic meters of liquified hydrogen) that is less than 4% of the capacity of the Kinsale gas field. We could reasonably store several years of energy in just that area, even as other sites become viable.