# Integrating Green Hydrogen Production with Greening Oil & Gas: Policy choices for Scotland to compete as a major hydrogen economy

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**Integrating Green Hydrogen Production with Greening Oil & Gas: Policy Choices for Scotland to Compete as a Major Hydrogen Economy**

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## Transitioning from Hydrocarbon Fuels to Hydrogen as a Fuel

Central to the ability of Scotland to compete as a major hydrogen economy is that it be based not just on hydrogen, but green hydrogen (GH) produced using renewable energy. Ramping up its prospects is the wide acceptance that replacing the use of oil & gas (O&G) by GH as a fuel will make a significant contribution to achieving the Paris climate agreement targets to reduce global warming. Emitting only water when used, GH obviates the profoundly adverse health and existential climate impacts of greenhouse gases, chiefly CO2 and methane (CH4), emitted by the use of O&G in transportation, manufacturing and heating. Gaining the benefits of such sweeping decarbonisation of economies and societies is emerging as a reality among many in policy circles.

Scotland is clearly already a world leader in the transition to renewable energy-based electrification, is almost self-sufficient in renewable energy and has vast potential to expand its production of renewable energy in areas such as the North Sea. Given the maturity of the North Sea hydrocarbon sector, and its further increased fragility as a result of the price falls arising during the pandemic, the need to replace this sector with an alternative, given its immense contribution to the Scottish and wider UK economy, has never been greater. The adoption of the hydrogen economy would seem to offer the ideal opportunity to do so. Given this, what are the policy choices propelling Scotland to compete as a major hydrogen economy? What choices will govern investment and financing of enabling R&D and commercialised ecosystems?

## Another Mojo

First, it is essential that the development of Scotland's hydrogen sector mirrors the multi-faceted development of the North Sea hydrocarbon basin. Beyond the profound UK-wide economic benefits of extracting hydrocarbons has been the spin-offs for Scottish industry from the innovation and development of breakthrough enabling technologies and

the attendant global reach of the myriad services Scottish companies have delivered to the O&G world. A mojo that says we've done it once and we can do it again.

Accordingly, if hydrogen is to be a key driver of the Scottish economy, as the oil sector has been in the past 50 years, it is vital that Scotland invests in achieving technological leadership to reap the advantages of agglomeration effects and the creation of new supply chains within the Scottish economy. This can only be achieved if the thinking and strategy with respect to renewable energy moves beyond the generation of renewable energy from wind and wave power, which is of course crucially important in itself, to a focus on hydrogen as a commodity that can be traded on international markets.

Innovation focussed on producing green hydrogen competitively from Scotland's superabundance of wind and wave power resources will deliver a headstart that can be further capitalised by also investing in innovation to drive down the costs of operating and maintaining enabling supply chains.

This would include reducing the costs of generating and transmitting renewable power to optimise, the production, storage, distribution of green hydrogen and its conversion to power through advances in fuel-cell technology. This will require strategic targeting of the financing of public and private investment in R&D, kickstarted by seedcorn funding from public sector sources. Where might this R&D be targeted?

In terms of the generation of renewable power, Scotland's leadership in renewable energy has already afforded vanguard opportunities in the development and installation of innovative renewable energy technologies. Notable advancements in Scotland include siting of the world's first floating wind farm. Add to this the world's first commercial applications in harnessing wave and tidal energy for hydrogen production, kite-generated electricity, commercialising lighter and more controllable wind turbine blades, and the establishment 13 years ago of the Scottish Hydrogen and Fuel Cell Association as the main driver of the hydrogen and fuel cell industry in Scotland. It's important that such developments and initiatives are capitalised on going forward with the creation of many renewable related investments such as outlined in the following.

## Formidable Challenges

As we outline elsewhere, generating and distributing electrical energy from North Sea based floating wind farms could be scaled to deliver prodigious inputs to a European supergrid. Whether at this scale or meeting a great deal of UK needs, the distribution needs to be supported by a baseload capacity. This could be achieved virtually through AI-blockchain based smart grid-wide operations or by the operation of offshore batteries throughout the grid. As lithium-ion/polymer batteries are not likely to be practical offshore, a candidate solution has emerged in the form of storing green hydrogen-dense ammonia (NH3) as a battery. This would require producing green ammonia offshore (or transporting by existing pipelines from onshore production facilities) from nitrogen extracted from air, hydrogen from electrolysis of water and renewable energy.

An exciting and innovative recent breakthrough in plasma technology bypasses the need for electrolysis and electrolysers for hydrogen separation in producing green ammonia. It is proposed that Scotland should participate in current efforts to commercialise this and related technologies and an earlier breakthrough technology for low cost extraction of hydrogen from ammonia. Add to this the challenge of being first to apply these technologies for offshore production and storage of green ammonia thus enabling hydrogen fuel cell distribution of electricity. Ammonia in excess of baseload needs could be exported through the global supply chain of ammonia as a green hydrogen commodity or its traditional use as a fertiliser by shipping directly from offshore facilities, in and of itself having a significant impact on CO2 reduction.

To this challenge add the reconfiguring of existing and disused rigs to use renewable energy for offshore processing of O&G in manufacturing hydrogen, olefins and hydrocarbon aromatics with captured CO2 being used as considered below. To this add the offshore extraction of

hydrogen and graphite (the main material used in lithium-ion batteries) from methane by adapting the Hazer technology for offshore operation. These offshore initiatives can grow and grow in profits and employment as O&G is used less and less for transportation, manufacturing and heating.

A third proposed offshore challenge involves the growth, harvesting and offshore processing of seaweed on a vast scale into myriad products (using O&G hydrogen fuel-cell electricity) initially on disused rigs and integrated with the structures of floating wind farms also operating on a vast scale. Integration with offshore green O&G processing could also result in seaweed bio-sequestration of captured CO2 to accelerate its growth. Other uses of captured CO2 include:

(1) boosting O&G recovery from existing wells;

(2) combining with offshore green ammonia production to produce urea (CH4N2O) for export as a high value fertiliser;

(3) converting to carbon nanotudes /carbon fibre for manufacturing myriad products onshore.

While all of this sounds hugely challenging it pales against the technological challenges met by Scottish development of the North Sea O&G industry.

## Green Hydrogen for Energy Storage, Transportation, Manufacturing and Heating

The existence of a capacity to store hydrogen produced by electrolysis provides a means of avoiding hefty compensation payments made to wind farm owners when there is a drop in energy demand (such as during covid lockdowns) and a surplus of renewable energy is being generated. In addition, stored hydrogen as well as hydrogen generated in real time by electrolysers can be used in all forms of transportation, steelmaking, cement production and provide heating to households and industry.

While electric vehicles (EVs) powered by batteries have several advantages over GH fuel cell EVs, the latter technology may become competitive in powering zero-emission heavy vehicles, trains, ships/ferries and planes in much the same way as it has powered rockets for decades. GH is currently being trialled as a source of thermal heat for steelmaking which requires a source of thermal heat to fuel iron smelters. It is also being trialled as a replacement for natural gas in the kiln combustion system required for cement production. And recently the Heating and Hot Water Industry Council reached an agreement with UK boiler manufacturers to support legislation mandating all models of boilers to be GH ready from 2025, several years in advance of the EU.

All this adds to a potentially burgeoning demand for electrolysers at a scale that is likely to require gigafactory supply solutions worldwide. Accordingly, those leading in the establishment of such capacities will be well placed to deliver engineering and enabling financing and engineering services worldwide, perhaps in collaboration with Germany who is already marching in this direction and Denmark who are building the World's first large-scale SOE electrolyser factory." It is also worth noting that the manufacture of Ultra High Voltage Direct Current (UHVDC) cables on the scale envisage for building continental scale electric supergrids will require gigafactory supply solutions. This could encompass zero losses in transmitting electricity if graphene can be produced at the scale required to replace copper in UHVDC cables. The Hazer Group are working on the production of graphene from graphite through their process for extracting graphite and GH from methane. If this can eventually be achieved at scale then the prospects for zero loss transmission will be markedly enhanced.

## To Decommission or not to Decommission

It should be noted that the foregoing eschews the decommissioning of O&G rigs, notwithstanding the need to change the international legislation requiring decommissioning of North Sea rigs. In addition to the foregoing proposed uses of disused rigs it is worth noting the success stories of rigs being used as biotic reefs in the US, Brunei and Malaysia.

It may be that the optimal strategy regarding decommissioning going forward is a blended approach with decommissioning occurring where it is demonstrated to add maximum value and the approach advocated here in instances where this would offer a higher value added.

## Need for Hydrogen Economy Roadmap

A roadmap focussed on policy choices that would enable Scotland to compete as a major hydrogen economy by financing investment in R&D, commercialisation and start up initiatives to support delivery of the foregoing should also spell out how employment impacts will be assessed. Many countries have already produced a hydrogen roadmap for the future of planning and development of the hydrogen economy and we have argued elsewhere that it is important that Scotland produces its own roadmap.

## Scotland as a Global Centre for Financing Progressive Initiatives

Further massive financing of investment in renewable technology could also provide a significant opportunity for Scotland's financial sector to reposition itself towards investment in natural capital and indeed become a world leading sector for the investment in such capital. Such a move would chime with COP25 where more than 630 institutional investors, managing more than $37 trillion in assets, jointly urged radical change to tackle the global climate crisis and the HSBC Pollination Climate Asset Management fund, the first large-scale venture to mainstream natural capital as an asset class, with an initial investment tranche of $1 billion, perhaps offers a template of how this could be achieved. The newly created Scottish Investment Bank could play a leading role in creating the environment for this to happen along perhaps with the Scottish Funding Council and the University sector. As a word of caution on this front, it will be crucial that big finance is not allowed to game the carbon offsetting markets to achieve 'net zero' emissions. Add to this the need to neutralise the proclivity for big oil to feign progressive action while vigorously and surreptitiously lobbying for the "hang the consequences" of further O&G exploration and growth in production. Big oil's recognition that they are uniquely suited to be prime movers in the integration of producing GH and greening O&G could be an effective "hang the consequences" antidote, reinforced by (a) expunging the half trillion dollars per annum elicited from the public purse and (b) following the UK lead in mandating the disclosure of financial risks as per the framework set out by the Taskforce on Climate-related Financial Disclosures: see also "Global oil companies have committed to 'net zero' emissions. It's a sham".

ScotlandCan aims to set out fresh thinking and new ideas on how Scotland can become fairer, greener and deliver social justice to our most deprived communities, now.

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