Biofuelwatch Response to the Draft Hydrogen Action Plan

17th January 2022 - Biofuelwatch is a non-profit organisation undertaking research, campaigning and policy advocacy in relation to the impacts of large-scale bioenergy.

General comments on hydrogen:

Climate science clearly shows that rapid near-term GHG emission cuts are essential if we want to have any hope of avoiding 1.5 or even 2 degrees of warming. For Scotland, this must mean that energy policy needs to focus support schemes and other incentives on measures most effective at phasing out the burning of fossil fuels and other high-carbon energy sources, such burning forest wood. We are deeply concerned that the Scottish Government's Hydrogen Strategy and the Draft Hydrogen Action Plan distract from the most effective and urgent measures required, and that they carry a high risk of further entrenching fossil fuel burning, given that hydrogen is far cheaper and easier to produce from natural gas than from (renewable) electricity.

While it is good news that wind energy has become the single largest source of electricity in Scotland, the latest, 2020, statistics, show that 74.6% of final energy use is still met from burning fossil fuels combined with a small proportion of nuclear energy.[1] Furthermore, Scotland shares the electricity grid with England and Wales, where the proportion of renewable and especially wind energy in electricity generation is significantly lower than it is here.

> Producing hydrogen from electricity is a highly energy-intensive process. According to the Potsdam Institute for Climate Impact Research, PIK:
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> "*Producing these fuels is too inefficient, costly and their availability too uncertain, to broadly replace fossil fuels for instance in cars or heating houses. For most sectors, directly using electricity for instance in battery electric cars or heat pumps makes more economic sense. Universally relying on hydrogen-based fuels instead and keeping combustion technologies threatens to lock in a further fossil fuel dependency and greenhouse gas emissions*".[2]

In relation to road transport, PIK points out: "*Driving a car with hydrogen-based fuels needs five times more energy than a battery-electric car.*"

We would like to add here that we consider modal shift from cars to public transport and active travel to be the top priority and the most effective way of reducing greenhouse gas emissions in the transport sector. However, opting for hydrogen instead of electrification makes no sense in terms of climate change mitigation, energy balances or economics.

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1 https://scotland.shinyapps.io/sg-energy/?Section=WholeSystem&Chart=RenEnTgt

2 https://www.pik-potsdam.de/en/news/latest-news/hydrogen-instead-of-electrification-potentials-and-risks-for-climate-targets

In relation to the heat sector, a 2021 study by the International Council on Clean Transportation[3] found that air-source heat pumps are at least 50% cheaper than hydrogen use for heating. The authors further showed that producing hydrogen from natural gas with CCS would reduce greenhouse gas emissions considerably less than operating heat pumps with renewable electricity. The ICCT report also highlights that energy conservation through home insulation is particularly vital for reducing GHG emissions.

Other European countries are now investing in the development of large heat pumps for district heating or larger industrial users.[4]

The alternatives to hydrogen listed above would help Scotland reduce its dependence on fossil fuel burning much faster than investing in 'green hydrogen', whereas investment in hydrogen from natural gas would further entrench reliance on fossil fuel burning.

Although there are some 'niche' applications where green hydrogen may indeed be the lowest carbon option, we cannot see any rationale for creating an extremely costly and resource-intensive new energy infrastructure to serve such niche uses at a time when Scotland sources just one quarter of its energy from renewables.

Hydrogen production from bioenergy:

There are three theoretical pathways for producing hydrogen from bioenergy, none of which have been demonstrated at scale anywhere in the world:

1) Using electricity from biomass combustion for hydrogen production via electrolysis;
2) Hydrogen production from biomethane;
3) Hydrogen production from biomass syngas.

The Scottish Hydrogen Action Plan specifically highlights the third of these pathways which the authors propose could be combined with carbon capture and storage.

(1) ***Electrolysis using electricity from biomass combustion***: Apart from the fundamental problems with biomass energy discussed below, this process would be extremely inefficient. Under EU Best Available Technique rules,[5] new biomass power stations are expected to achieve between 33.5 and 38% conversion efficiency (32% if high-moisture biomass is burned). Heat capture and supply raises total efficiency but reduces the amount of electricity produced in a plant, which would make it less suitable for providing energy for hydrogen production through electrolysis. According to IRENA, it takes at least 50 kWh of electricity to produce 1kg of hydrogen[6] with a useful energy content

3https://theicct.org/publications/hydrogen-heating-eu-feb2021
4https://www.ehpa.org/fileadmin/red/03._Media/03.02_Studies_and_reports/Large_heat_pumps_in_Europe_MDN_II_final4_small.pdf
5https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D1442&from=EN, Table 8
6https://irena.org/-/media/Files/IRENA/Agency/Publication/2020/Dec/IRENA_Green_hydrogen_cost_2020.pdf

of 33.33 kWh.[7] This means that another 33% of the energy contained in wood is lost, in addition to the minimum 62% lost during electricity generation in the biomass plant. If the hydrogen is then liquefied, a further 36% of energy is lost.[8] The capture of CO_2 from biomass combustion has not so far been demonstrated at scale, which means that the energy penalty for such plants remains unknown. However, carbon capture from combustion plants is an energy intensive process, which could reduce the overall efficiency of a plant as much as one-third.

2) ***Hydrogen production via steam methane reforming of biomethane***: This process is technically far simpler than the other two listed, however, it is no less problematic. As a study published by *Feedback Global* shows,[9] the potential for genuinely low-carbon biomethane, taking account of direct and indirect life cycle greenhouse gas emissions, is very limited.

Anaerobic digestion (AD) of food waste significantly reduces GHG emissions compared to landfilling it. However, demand for food waste for AD must not compete with the need to rapidly reduce the amount of food waste that arises, otherwise the climate and environmental impact will be far from positive. The same is true if food waste demand for AD competes with some of it being fed to livestock, resulting in more grains such as soy being fed instead.

Using slurry and manure as biomethane feedstock reduces GHG, especially methane emissions, compared to conventional manure treatment. However, manure and slurry have a far lower AD yield than food waste. Furthermore, incentivising AD from manure and slurry risks creating a new support mechanism for large-scale industrial livestock production which is associated with very high GHG emissions, including from the production of animal feedstock. Particularly important in industrial livestock feed is soybean meal, which is directly and/or indirectly linked to large-scale deforestation in South America, as well as to land-grabbing and other environmental injustices. Addressing the climate crisis must include significant reductions in livestock via dietary change. This means that the availability of slurry and manure for AD will have to significantly shrink. As the *Feedback Global* report illustrates, there is already clear evidence from Northern Ireland and England of AD subsidies incentivising industrial livestock farming.

Using so-called energy crops, such as maize or ryegrass for biomethane competes with other land uses, both food production and the conservation or regeneration of natural ecosystems. Displacement of food production results in indirect land use change, in turn a significant source of carbon emissions. Industrial-scale maize production is linked to soil compaction and depletion, eutrophication of freshwater, and biodiversity loss.[10] According to the RSPB, grassland management for silage (including from ryegrass) has been one of the main drivers of the steep decline in UK farmland birds since the 1970s.[11]

7https://www.idealhy.eu/index.php?page=lh2_outline
8https://www.idealhy.eu/index.php?page=lh2_outline
9https://feedbackglobal.org/wp-content/uploads/2020/09/Feedback-2020-Bad-Energy-report.pdf
10https://www.soilassociation.org/media/4671/runaway-maize-june-2015.pdf

A further serious concern is the lack of regulations and monitoring to minimise methane leakage during biogas and biomethane production. Given the potency of methane as a greenhouse gas, methane leakage can potentially lead to biomethane causing even more GHG emissions than the fossil fuels they replace, regardless of life-cycle emissions from feedstock production.

3) ***Hydrogen production from biomass syngas***:

According to the Scottish Hydrogen Action Plan, "*Biomass gasification with CCS for the production of hydrogen is a less developed negative emissions technology but nevertheless could become part of the energy mix*". This pathway would require large-scale biomass gasification or pyrolysis delivering syngas that is cleaner/more pure than any syngas ever produced from biomass in the UK so far (except possibly in laboratory experiments).

Pure syngas would contain nothing other than water and carbon monoxide, which can be converted to carbon dioxide and hydrogen in a catalytic reaction. We are not aware of any larger-scale attempts to convert biomass syngas to CO_2 and hydrogen.

However, a comparable level of syngas purity is required for biofuel production using a technology called Fischer-Tropsch (F-T) reforming. We have been following attempts to develop F-T biofuels for more than a decade and have found no evidence of it having succeeded anywhere. Liquid fuel production using F-T reforming of fossil fuels is a long-established technology. Our understanding is that the technical hurdle in relation to bioenergy relates to biomass syngas purification, which is much more challenging than coal or natural gas syngas purification.[12]

In the UK, renewable electricity subsidies have been in place for biomass gasification and pyrolysis for more than 20 years, however, there has been no successful biomass pyrolysis plant producing syngas in the UK, and none of the biomass gasification plants in operation involve any degree of syngas cleaning at all. Indeed, existing UK biomass gasification plants closely resemble conventional biomass combustion and would not be classed as 'gasification' in many other countries.

Any attempts to overcome the major technological hurdles of what is proposed in the Scottish Hydrogen Strategy would thus require very large-scale financial support and likely many years or decades of research and development. It would thus take significant resources away from measures which can and should be implemented to reduce Scottish greenhouse gas emissions quickly, and likely not deliver any results at all during the crucial few years left if we want to have any hope of avoiding warming of more than 1.5 or even 2 degrees.

11 https://www.rspb.org.uk/our-work/conservation/conservation-and-sustainability/farming/near-you/farmland-bird-declines/

12 https://www.sciencedirect.com/science/article/abs/pii/S0360319919327090

Leaving aside the technical and economic hurdles, we believe that further support for biomass energy, regardless of carbon capture, cannot be justified in terms of climate impacts, nor Scotland's commitments to biodiversity.

We have already discussed concerns around energy crops in relation to biomethane. Similar concerns extend to the land-use implications of short-rotation coppicing.

However the vast majority of (solid) biomass energy in the UK and worldwide comes from burning wood. Indeed, given the problems with obtaining high syngas purity, we would expect biomass for the proposed technology to be sourced from high-quality virgin wood, not from waste wood and not from logging residues which have a high bark content.

Procuring more high quality virgin wood will directly or indirectly lead to more wood imports into the UK. In 2020, 81% of the UK's wood consumption was met from net imports of wood and wood products.[13]

In February 2021, 500 scientists wrote an open letter warning: "*The result of this additional wood harvest [for biomass energy] is a large initial increase in carbon emissions, creating a "carbon debt," which increases over time as more trees are harvested for continuing bioenergy use. Regrowing trees and displacement of fossil fuels may eventually pay off this carbon debt, but regrowth takes time the world does not have to solve climate change. As numerous studies have shown, this burning of wood will increase warming for decades to centuries. That is true even when the wood replaces coal, oil or natural gas*".[14]

Even if large-scale carbon capture from wood combustion, gasification or pyrolysis became possible in future, it would not address the fundamental problem that forest ecosystems play a vital role in regulating the climate, including through storing and sequestering carbon.

Also in February 2021, 85 scientists and economists wrote an open letter to the UK government, stating: "*Forests lead all other ecosystems in annually removing atmospheric carbon dioxide and accumulate carbon for centuries in the biomass of living and dead trees and in soils. Without the growth of trees in forests and other terrestrial plants, the annual increase in atmospheric carbon dioxide would be approximately 31% greater than it currently is. Forest bioenergy is adding increasingly large amounts of carbon dioxide to the atmosphere and reducing the capacity of forests to absorb atmospheric carbon dioxide, making it more difficult to reach net zero carbon as the stated goal for limiting global temperature. Adding carbon capture and storage (CCS) technology to a bioenergy plant does not resolve this issue*".[15]

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13 https://www.forestresearch.gov.uk/documents/8141/Ch3_Trade_FS2021.pdf
14 https://www.woodwellclimate.org/letter-regarding-use-of-forests-for-bioenergy/
15 https://www.cutcarbonnotforests.org/wp-content/uploads/2021/04/scientist-statement-beccs-for-submission-ggr-call-for-evidence-20210226.pdf