International Association of Oil & Gas Producers

POSITION STATEMENT | JANUARY 2022

IOGP comments to R. W. Howarth and M. Z. Jacobson (2021): How Green is Blue Hydrogen?

Background

Robert W. Howarth and Mark Z. Jacobson (H&J) recently published a paper on the life-cycle GHG emissions for blue hydrogen, claiming that the GHG footprint of blue hydrogen is over 20% higher than burning natural gas for heat generation[1]. Blue hydrogen is produced by the (steam) reforming of natural gas, while the associated CO_2 emissions are captured and injected mostly back into reservoirs for safe underground storage. When used, blue hydrogen does not emit carbon. H&J analyse CO_2 and methane emissions along the life-cycle of blue hydrogen from the production and transmission of natural gas to its use for hydrogen production in steam reforming processes, including the capture and storage of the CO_2 emitted in that process.

Summary

H&J's claim is the result of an aggregation of multiple extreme assumptions:

- H&J adopt unrealistically high methane leakage rates along the natural gas value chain;
- H&J assume extremely low energy efficiency rates of steam reforming processes and extremely low capture rates of the associated CO_2 emissions which both do not reflect the state of technology, let alone future technology advancements;
- H&J use a high global warming potential (GWP) for methane which is about 3 times higher than if using the GWP based on recommendations in the Paris Agreement and as applied in the latest assessment report of the Intergovernmental Panel on Climate Change (IPCC)[2];
- H&J inconsistently use assumptions: not only green hydrogen but blue hydrogen too can be produced using low-carbon fuels or electricity from renewable sources in its reforming and carbon capture processes.

Furthermore, H&J do not take into account expected future technology advancements when blue hydrogen is developed at scale, including further increasing efficiencies in carbon capture and natural gas reforming processes. Neither do H&J take into account reducing methane leakage rates along the natural gas chain.

The important role of blue hydrogen in the energy transition

H&J's publication with its multiple extreme assumptions creates a misleading doubt about the important role blue hydrogen can have in cost-efficiently contributing to climate goals across the globe, including climate neutrality by 2050 in Europe:

- Blue hydrogen can supply demand for hydrogen from hard-to-electrify segments of the industrial, transport and heating sectors.
- Blue hydrogen can support the timely development of the markets and infrastructure necessary to achieve the EU's climate ambitions.

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[1] R. W. Howarth and M. Z. Jacobson (2021): How Green is Blue Hydrogen?

[2] IPCC (2021): Climate Change 2021

- Blue hydrogen is based on proven technologies which are available now at industrial scale and at significantly lower cost than green hydrogen, and for a long time with lower emissions than electrolysis-based hydrogen produced with average grid electricity. For example, according to the *Hydrogen for Europe* study, Europe could save more than a trillion euros over the next thirty years (representing more than €70 billion of savings per year on average) by adopting a technology-open approach with a level playing field between various hydrogen technologies as compared to a policy pathway which focuses primarily on the acceleration of renewable energy deployment[3].

IOGP's detailed comments on Howarth and Jacobson's publication (2021)

- **H&J assume unrealistically high methane leakage rates from the natural gas value chain:** The 3.5% methane leakage rate assumed in H&J's baseline seems derived from US shale data, but is multiple times higher than what has already been achieved by the US industry and more than 10 time higher than near-term industry targets. For example, the international oil and gas companies who are members of the Oil & Gas Climate Initiative (OGCI) report a methane intensity from all their operated oil and gas assets of 0.23% for the year 2019 and are on track for methane intensity of 0.2% by 2025[4]. These successful methane emission reductions are largely driven by expanded LDAR campaigns, replacement, and upgrade of high-emitting devices, as well as reduced flaring and venting. The industry also actively participates in international initiatives such as the Methane Guiding Principles (MGP), the Oil and Gas Methane Partnership (OGMP 2.0), and the World Bank's Zero Routine Flaring by 2030; as well as supports the upcoming EU legislation on methane emissions. These efforts are not recognised by H&J. As for Europe, the methane emissions intensity associated with the mix of natural gas imported to the EU are reported to be significantly lower than the 3.5% stated by H&J. For example, the gas imported from Norway, Russia and the US have an estimated upstream leakage rate of 0.03%, 0.28%, and 0.97% respectively based on a study by Rystad Energy.[5]
- **H&J use an extreme assumption regarding the Global Warming Potential (GWP) of methane over a 20-year horizon**: Rather than using the GWP of GHGs over a period of 100 years as recommended in the Paris Agreement and applying a GWP of 30 as done in the latest Assessment Report of the IPCC[6], H&J apply the GWP over a 20-year horizon, with a GWP of 86 to calculate the CO_2 equivalent global warming impact of methane. This assumption alone triples the results in H&J's analysis, and does not consider impacts that happen more than 20 years after the emissions occur.
- **H&J do not accurately reflect the current state[7] or future technology advancements of carbon capture technologies**: Steam methane reforming (SMR) of natural gas to hydrogen releases CO_2 emissions from two separate streams. H&J assume an overall CO_2 capture rate of 62% only. However, these capture rates are derived from old installations in the US which only partially capture emissions from SMR units or from the combustion of coal. H&J therefore do not reflect the current state nor the future potential of technologies for capturing CO_2 in SMR processes. The research institutes IFPEN & SINTEF find that SMR processes can achieve a capture rate of 91.2% when carbon capture is applied to both emission streams[8]. In autothermal reforming process – which release emissions in a single stream only – carbon capture rates can even be improved to above 94% as confirmed by SINTEF and IFPEN[9]. Furthermore, there are no technical barriers to eventually increase capture rates to over 99%.[10] Applying capture rates from old carbon capture installations to assess the climate impact of future blue hydrogen plants is misleading, especially because the old installations were not necessarily designed to achieve the highest possible CO_2 capture efficiencies.
- **H&J do not recognise that both natural gas reforming and CO_2 capture processes could rely on low-carbon energy**: Gas reformers could be designed to rely on low-carbon energy such as electricity,[11] or the proper application of heat recovery, instead of the combustion of natural gas to fuel the reforming and CO_2 capture processes. This allows for a lower carbon footprint. In their baseline, H&J does not take this into account, and as a result, they reach the faulty conclusion that higher capture rates would lead to higher associated emissions due to the additional input of natural gas which in their cases would be required to fuel the process.

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3 Columbia SIPA Center on Global Energy Policy (July 2020): Congressional testimony of Dr. S. Julio Friedmann
4 OGCI (2020): Reducing methane emissions to near zero is a top priority for OGCI
5 Rystad Energy (2021): Utslippseffekten av produksjonskutt på norsk sokkel (Emission effect of cutting Norwegian offshore production), p. 30
6 IPCC (2021): Climate Change 2021
7 GCCSI (2021): Blue Hydrogen
8 IFPEN & SINTEF (2019): Hydrogen for Europe – Final report of the pre-study
9 IFPEN & SINTEF (2019): Hydrogen for Europe – Final report of the pre-study, p.98-99
10 IEAGHG (2019): Towards zero emissions CCS in power plants using higher capture rates or biomass
11 S. T. Wismann et. al. (2019): Electrified methane reforming: A compact approach to greener industrial hydrogen production. *Science*, vol. 364, Issue 6442

- **H&J does not consider that green hydrogen produced with grid-based electrolysis will for a significant amount of time generate higher emissions than blue hydrogen**: If using low-carbon energy and/or heat recovery to fuel its processes, autothermal reforming process technology with carbon capture and storage results in greatly reduced supply chain emissions for the blue hydrogen produced compared to SMR technology,[12] which are estimated to be significantly lower than emissions from production of hydrogen using electrolysis with the average European grid electricity as input.[13] As the switch towards a larger share of renewables in the European electricity system progresses, the use of blue hydrogen may help ensure that emissions are cut in hard-to-electrify sectors while avoiding that renewable energy sources are diverted away from the decarbonisation of the electricity sector.

Examples of rebuttals and comments from experts:

- Jose Bermudez (IEA): https://twitter.com/Jose_EnergyCC/status/1425944565102616577
- Ted Nordhaus (BTI): https://twitter.com/TedNordhaus/status/1425970817872011270
- David Joffe (The Climate Change Committee UK): https://twitter.com/david_joffe/status/1426108192891850753
- Morgan Bazilian (Payne Institute, Colorado School of Mines): https://twitter.com/MBazilian/status/1425945203811131392
- Julio Friedman (CGEP): https://twitter.com/CarbonWrangler/status/1426177892820525058
- Nils Rokke (Forbes): https://www.forbes.com/sites/nilsrokke/2021/09/06/blue-hydrogen-isnt-the-climate-enemy-its-part-of-the-solution/?sh=4f3a113d6738
- Matteo Romano (Politecnico di Milano): https://www.linkedin.com/pulse/misleading-paper-blue-hydrogen-revised-modified-matteo-romano/

[12] Element Energy (2021): Low Carbon Hydrogen Well-to-Tank Pathways study – Full report
[13] IFPEN & SINTEF (2019): Hydrogen for Europe – Final report of the pre-study

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