Blue hydrogen is far from clean

02/03/2022 Martin Bush 1 Comment Canada, Energy policy, hydrogenEdit

Follow

Canada doesn't need a hydrogen policy crafted by the oil and gas industry in Alberta. Eastern Canada has the potential to be a global player in the production of green hydrogen.

In many respects, hydrogen is the perfect fuel: it burns with absolutely no emissions of carbon—producing only water. The gas has been used as a feedstock in the petrochemical industries for decades, but as energy-intensive industries move towards decarbonization, it is now being touted as the fuel of the future: an essential element of the roadmap that brings the world to net zero emissions by 2050.

The International Energy Agency foresees the demand for hydrogen growing sixfold from today's level of about 90 million tonnes (Mt) a year, rising to 10% of total final energy consumption by 2050. Bloomberg is even more enthusiastic: estimating that hydrogen could provide almost a quarter of global energy demand by 2050, with production rising to 700 Mt a year.

Canada is well placed to be in the vanguard of countries that will produce a large part of the future global supply of hydrogen. Alberta is lobbying hard for the federal government to support the province's Action Plan for the production of what it calls 'clean hydrogen'. The province has drafted a Hydrogen Roadmap that 'integrates hydrogen with the province's existing energy system and propels Alberta into the global hydrogen economy."

For the oil companies operating in Alberta, the production of hydrogen from natural gas is seen as a game changer. "If we turn our natural gas into hydrogen, then it is now part of the long- term future for energy," enthused Jackie Forest, executive director of ARC Energy Research Institute in Calgary, adding, "There is no need to decline our production because we have found a new product that has growing demand."

But there's a catch. The hydrogen produced in Alberta is far from clean: it is produced from natural gas by a process called Steam Methane Reforming (SMR), a chemical reaction that produces more than five times as much carbon dioxide than hydrogen. Factor in the inevitable leaks of methane from the extraction and processing of the natural gas feedstock (anywhere from 1 to 8 % of the supply) and the concept of producing clean hydrogen from natural gas looks increasingly doubtful. Globally, the emissions of carbon dioxide from the production of hydrogen using the SMR process

amounted to an astonishing 900 Mt in 2020—more than the combined emissions of Indonesia and the United Kingdom.

If the carbon dioxide produced by the SMR process could be captured and permanently sequestered, then the carbon emissions from the production of hydrogen from the SMR process can be significantly reduced. Unsurprisingly, Alberta is betting big on this carbon-capture technology. Last year, Air Products Canada announced it is going ahead with a 1.3 billion carbon capture and hydrogen production complex in Edmonton, a facility that aims to capture 95% of carbon from the natural gas used in the production of hydrogen .

But initial results from small-scale operations in the field are unconvincing. The Quest hydrogen production and carbon capture operation, managed by Shell at the Scotford Upgrader in Edmonton, claims that it has successfully captured and stored 5 million tons of carbon over a five-year period. But what Shell failed to mention is that during the same period, unregulated emissions of carbon were even larger: amounting to more than seven million tonnes of greenhouse gases .

Moreover, a peer-reviewed paper by two US academics in 2021 calculated that when all fugitive emissions of methane are accounted for in a life-cycle analysis, so-called 'blue hydrogen', the hydrogen produced from the SMR process with carbon capture and storage, in fact emits more greenhouse gases than burning natural gas without any mitigation. This is because the capture and downstream sequestration process are inherently energy intensive. They state, "Perhaps surprisingly, the greenhouse gas footprint of blue hydrogen is more than 20% greater than burning natural gas or coal for heat."

If Alberta becomes a global leader in the production of blue hydrogen, the province's emissions, already the highest in Canada, will continue to increase. In 2019, Alberta's emissions of greenhouse gases (GHG) were 276 MtCO2e/yr and still trending upwards. Alberta's hydrogen roadmap foresees the province supplying an export market of 10 million tonnes of 'clean hydrogen' a year by 2050. The emissions of greenhouse gases associated with SMR hydrogen production and carbon capture and sequestration are estimated to be between 4 and 6 tonnes of equivalent carbon dioxide for each tonne of hydrogen production. So the export scenario envisaged by Alberta would result in an additional 40 to 60 million tonnes of GHG emissions a year. This is not a scenario that the federal government should be supporting.

The sequestration of carbon dioxide underground is also a high-risk proposition. It has never been demonstrated at the scale Alberta will require if the production of blue hydrogen substantially increases. Alberta is betting big; but it's a long shot.

The only hydrogen which is genuinely clean is produced from the electrolysis of water. Called green hydrogen, it only earns this distinction if the electricity that powers the process is from sources of energy that are completely carbon free. The electricity for green hydrogen is generated either from solar energy, hydropower, or wind, or from nuclear energy.

Although costs are falling, the cost of green hydrogen at the present time is significantly higher than the cost of blue hydrogen from the SMR process with carbon capture and sequestration. However, the US Hydrogen Earthshot initiative aims to bring down the cost of hydrogen from electrolysis to $1 USD/kgH2 by 2030—which would make green hydrogen competitive with blue.

Producing green hydrogen by the electrolysis of water in Alberta is impossible: the grid relies heavily on fossil fuels. Although coal fired power plants are to be shut down by 2030, the generation of electricity in the foreseeable future will be predominantly from natural gas. Renewable energy from solar energy and wind power may make a small contribution to the province's mix of electricity generation technologies, but given the availability of low-cost natural gas, and the influence of the oil and gas industries on provincial energy policy, renewable energy's share in power generation is unlikely to grow substantially.

Alberta has championed the production of blue hydrogen because it has cheap and abundant natural gas. But this is not the resource that Canada needs to exploit if it wants to become a world leader in *green* hydrogen. For that objective to be attained, the hydrogen industry needs to be centered in a region where there are substantial resources of renewable energy and adequate supplies of fresh water. These essential attributes are found in Eastern Canada, not Alberta.

Eastern Canada has enormous resources of hydropower and wind energy, and although the water consumption of green hydrogen is substantial (it takes 9 tonnes of water to produce 1 tonne of green hydrogen from electrolysis), this is unlikely to be a constraint in Quebec. A low electricity price is also essential for reducing the cost of green hydrogen. Quebec's hydropower meets this criterion; Alberta's fossil fuel power generation does not. The export of liquified hydrogen also requires access to tidewater—an advantage which Alberta conspicuously lacks.

Moreover, the synergies between green hydrogen and renewable energy are rapidly becoming apparent. Oil major BP is planning 250 MW of green hydrogen production in the Port of Rotterdam powered by windfarms in the North Sea. In the US, Plug Power has entered into a 345 MW windpower agreement with Apex Clean Energy in Texas which will produce 30 tonnes a day of liquid hydrogen.

The Canadian government should focus on green hydrogen, not blue; and on the huge untapped resources of renewable energy in eastern Canada. The government needs to reconsider its priorities; subsidizing blue hydrogen produced from natural gas in Alberta should not be one of them.