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[Dachzeile]

Hydrogen in Canada: War in Ukraine kindles new interest

Russia's invasion of Ukraine has intensified European policymakers' interest in developing energy trade relations with Canada, as the former is seeking to identify reliable partners to swiftly diversify its fossil fuel imports. In adopting the "LNG Acceleration Act" on June 1st of this year (Bundesregierung, 2022), Germany gave Canadian companies justified hope of exporting large quantities of Liquefied Natural Gas (LNG) to Germany (Schaudwet, 2022). Could this be a precursor to increasing relations in the sphere of hydrogen as both economies decarbonize in the years to come?

Indeed, Canada has a formidable track record in the field. It boasts many firsts in hydrogen innovation, including the first patent for electrolysis technology in 1915, the first industrial-scale production of hydrogen in the 1920s, and even the first light-duty fuel cell electric vehicle in the early 2000s (Government of Canada, 2020). The release of the *Hydrogen Strategy for Canada* in 2020 already spurred a flurry of renewed interest in the nation's hydrogen industry. The *Hydrogen Strategy* provides a sequenced approach of initiatives to promote long-term growth and comes alongside federal policies which amount to $29.4 billion in committed hydrogen-related investment (authors' estimate based on current hydrogen policy interventions in Canada). The *Hydrogen Strategy* estimates that domestic revenues will grow to over $50 billion and create over 350,000 new jobs by 2050.

While most Canadians support the potential economic expansion and increased employment from hydrogen, public views on how hydrogen should be produced are far from unanimous. Canada's varied geography and natural resources allow for several types of hydrogen production processes. Canada can produce green hydrogen via electrolysis using hydro or wind power; blue hydrogen through Steam Methane reforming (SMR) with carbon capture storage (CCS) using natural gas; and even pink hydrogen via electrolysis using nuclear power (Government of Canada, 2020). Despite the options offered by Canada's geography and natural resources, as well as the government's endorsement for the development of both green and blue hydrogen, there is no consensus on which hydrogen production pathway(s) Canada should follow. As such, the debate revolving around the sustainability of each pathway, latent around the globe and among many different stakeholders, is well exemplified by the Canadian case.

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Blue hydrogen is currently the most economically feasible form of hydrogen production in Canada, though it's still more costly than traditional fossil fuels like coal, oil, or natural gas (Canadian Gas Association, 2021). In areas where natural gas has a lower cost ($3-$4 per million British thermal units (MMBTu)), like in Canada or the US, blue hydrogen could be produced at under $2 per kilogram as compared to $4 per kilogram for green hydrogen in the same locations (Bhavnagri, 2021). However, the war in Ukraine is impacting natural gas prices around the world, reducing the overall cost competitiveness of blue hydrogen – and Canada is no exception. In the province of Alberta, once a cost-competitive natural gas region, prices have increased by more than 100% compared with 2021, reaching $7.31 per MMBtu during May of this year (Jang, 2022). While green hydrogen is currently the most expensive form of production, significant cost reductions are expected in the near future, as technology improves and economies of scale can be reached (Invest Canada, 2021). According to Bhavnagri (2021), by 2030 green hydrogen costs could fall by around 75%. Moreover, there is concern that blue hydrogen could contribute to the oil industry's recovery, a major contributor to greenhouse gas emissions, and prevent Canada from meeting the emissions reduction goals it set for the near future (National Observer, 2021).

On the other hand, including blue hydrogen among Canada's hydrogen production pathways would allow the greatest number of provinces to participate, as oil-rich provinces such as Alberta and Saskatchewan are well situated for blue hydrogen production but not at all for green. Further, recent investments in carbon capture utilization and storage (CCUS) technology and blue production facilities in Canada total $8.4 billion (authors' estimate based on current hydrogen policy interventions in Canada), which demonstrates a commitment to continuing blue production. There is already significant infrastructure in place that can be utilized for blue hydrogen, such as natural gas pipelines, (that could be repurposed for transporting hydrogen) as well as vast numbers of highly skilled workers in the field (Government of Canada, 2020). With blue hydrogen, high-emitting provinces will also be able to actively participate in the new clean economy. Existing expertise and infrastructure in these provinces could be harnessed and blue hydrogen could act as a bridge in a transitional period towards green hydrogen.

The ongoing debate among the provinces makes it difficult for the federal government to mandate one specific production method for hydrogen, as they don't want to exclude any region from these economic benefits. Yet in reality, if Canada's ambition lies in exporting hydrogen, especially to the European market, it will find itself prioritizing green hydrogen production, given preferences in the EU and especially in Germany. Until exporters can verify its sustainability on the basis of international standards, blue hydrogen could be sidelined (Center for Strategic and International Studies, 2021), especially because methane is released in the production process, a reason why many researchers don't consider this type of hydrogen a low carbon option (Howarth & Jacobson, 2021).

Regardless of the production method, Europe's new imperative to diversify its energy imports has already prompted first steps in establishing the cornerstones for increased transatlantic energy trade. A meeting between Germany's Federal Minister for Economic Affairs and Climate Action, Robert Habeck, and Canada's Federal Minister for Innovation, Science and Industry, François-Philippe Champagne in May 2022, established that Canada could be one of the best alternatives to Europe's current reliance on Russian gas imports. Moreover, they declared that imports should swiftly transition to clean hydrogen (Schaudwet, 2022), a strong signal for potential hydrogen cooperation in the future.

The problem is that the transport of clean hydrogen from Canada to Europe will have to be carried out via shipping, the most expensive and technically challenging mode of transport. Currently, to ship hydrogen, it must be liquefied or converted into a synthesis product like liquid organic hydrogen

carrier (LOHC) or ammonia, and it is exactly these two processes – conversion and liquefaction – that raise the cost of transporting hydrogen via vessels by up to 25% over pipeline transport (Wietschel, et.al., 2022). Two other factors are also of key concern in shipping both hydrogen and LNG: infrastructure and sustainability. As of today, Canada doesn't have an LNG export terminal on its east coast to access the European market. Moreover, shipping hydrogen and LNG internationally poses considerable sustainability challenges. These mainly relate to the greenhouse gas (GHG) emissions associated with the operation of export and import terminals and the direct emissions that result from the transport route.

Nonetheless, Canadian projects currently being discussed could tackle some of these issues: Jim Illich, an LNG entrepreneur, is planning to build an export terminal on the east coast of Canada in the province of Quebec that would operate entirely on electricity from hydropower (Schaudwet, 2022). If ships sailing from Illich's project in Quebec run on low carbon fuels such as ammonia or hydrogen, the transport of LNG and potentially hydrogen would be considerably more sustainable.

Projects like the one mentioned above could lay the foundation for a future Canadian-European hydrogen trade. While the conversion and reconversion of hydrogen make up 60% to 80% of the total costs of transport for a 10,000 km passage, the cost increase per km is marginal. This means that shipping hydrogen over long distances is more economically feasible than it looks at first glance (Wang, et.al., 2021). Thus, the cost of shipping hydrogen over longer distances like the Canada to Europe route represents a smaller burden than to destinations within 10,000 km.

But would Canada actually want to produce hydrogen for the European market? Wouldn't it instead favor a market that is geographically closer, such as the Northeast of the United States? And on the European side, wouldn't it be worth considering other, closer partners like countries in Northern African? Proximity isn't necessarily the factor that matters most. To build strong and long-lasting energy trade relations, the stability and reliability of the partnership is key, and this is something Canada and Europe already offer each other.

The effects of the Russian war in Ukraine on the European energy system call for new players to help ease natural gas demand on the continent. Already in the first quarter of 2022, the US exported 74% of its LNG to Europe, more than double the amount registered for the same period in 2021 (EIA, 2022). This testifies to the potential for Canada's LNG exports to enter the European market. If projects were launched on the Northeast coast of Canada (like the one proposed by the company LNG Newfoundland and Labrador Ltd. on Newfoundland's coast), they would have the advantage of being half the distance to Europe than the LNG terminals in the Gulf of Mexico, and they would run on hydropower, meeting higher environmental standards (Tuttle, 2022).

Decarbonization is still at the center of both Canada's and Europe's energy policy, a fact that is recognized by Canada's Natural Resources Minister, Jonathan Wilkinson, who established that all new LNG facilities must use low emissions processes and be able to transition to hydrogen (Platt, 2022). As such, the planned LNG terminals are poised to build the foundations for projects that go beyond the effects of the war in Ukraine and bring both regions closer to achieving their climate goals.