Workshop Report

Location:	Online Zoom Conference
Date:	May 5, 2021
Starting time:	5:00pm CEST, 8:00am PDT, 11:00am EDT
Duration:	2.5 h

Please note that the report below gives a summary of the key messages and is not a full transcript of the event.

Workshop Opening:

Andreas Kuhlmann, CEO, dena

We need molecules to reach our climate targets. These will mostly be based on hydrogen. The Global Alliance Powerfuels works to foster the development of a global market for powerfuels. The three main goals of the Global Alliance Powerfuels are:

1. to **raise awareness and acceptance** of powerfuels as a missing link to reaching global climate targets
2. to support the **further enhancement of regulatory frameworks** with a first focus on Europe as demand region
3. to **stimulate project development** globally to enable production capacities at an industrial scale, thus increasing cost competitiveness with fossil fuels

In this context, the Global Alliance Powerfuels hosted a number of regional workshops in the last two years, starting in South Africa, with the most recent workshop being a digital event on powerfuels in Australia. When talking about powerfuels, which are renewable green hydrogen-derived products serving as energy carriers and/or feedstock, it is important to mention their use as chemicals (e.g. ammonia and methanol). The Global Alliance Powerfuels was one of the first initiatives to look at this use of hydrogen in a global context for the years from 2030 to 2050, in our recently published study with LUT University.

Keynotes | Policies and regulation supporting powerfuels in North America

Advancing the green hydrogen economy in North America

Janice Lin, Founder and President, Green Hydrogen Coalition (GHC)

The GHC was launched in 2019 in partnership with the largest municipal utility in the US, the Los Angeles department of water and power. The main focus of the GHC is to accelerate the green hydrogen economy, which is currently being done via three projects.

The Intermountain Power Project (IPP) is the core effort and the largest green hydrogen project under development in North America. It is an 1800 MW coal fired generator located in central Utah, which will be converted to an 840 MW combined cycle hydrogen gas turbine. A big part of GHC's core effort is to establish an appropriate legal and regulatory framework in California, to enable this conversion. The green hydrogen economy must be regionally planned and supported.

The GHC is leading two additional initiatives; the first is called the Western Green Hydrogen Initiative (WGHI). It is a public private partnership to accelerate the deployment of green hydrogen infrastructure in the west.

The second initiative is focused on regional ecosystem development. It is the GHC's commercialisation platform that will drive regional hydrogen ecosystem development at scale, called HyDeal North America. By aggregating key ecosystem stakeholders, particularly multi sectoral off takers and strategically targeted locations, the GHC aims to plan and develop the competitive high volume supply chain, necessary to achieve $1.50 per kilogram delivered for large off takers.

Take-away messages:

- Finally, the GHC sees the goal in **maximizing and comparing net benefits**, not just the costs, when considering green hydrogen as an alternative to a status quo solution based on fossil fuels – regardless of the application.
- Now, there are **many stakeholders in California that believe that hydrogen is a pathway to electrifying the fuel supply**. In addition, the Biden Administration plans to reduce the cost of green hydrogen by 80 % within a very short period.
- There are 14 politically diverse States in the United States, all with different agendas, that all support the view that **green hydrogen can either accelerate our fight against climate change or accelerate economic development**. They all agree that **collaboration is key to making progress more rapidly**.

Policy and regulation supporting powerfuels in North America

Mathieu Payeur, Director Energy Strategies, Ministère de l'énergie et des ressources naturelles Québec

Compared with Germany, twice the amount of energy per capita is used in Québec. When looking into the consumption profile, it can be seen that about 60 % of the total energy, which is consumed in Québec is used in industry and the transport sector. Additionally, most of the energy consumed is electricity, of which more than **99 % is renewable energy**. Nonetheless, **petroleum products still make of more than 40 % of the total energy consumption in Québec.**

Looking at greenhouse gas emissions, 70 % of emissions are related to the energy sector. Trying to electrify all sectors did not turn out to be cost-effective, so Québec is in need of a strategy to decarbonise all sectors by integrating renewable energy sectors beyond renewable electricity. Last year, the government of Québec announced its new plan for a green economy, which includes reducing the consumption of petroleum products by 40 %. The role of the Secteur de la transition énergétique is to provide a **masterplan for the energy transition**. In this context, all sectors are regarded, showing that in some sectors, direct application of electricity is not feasible. This is where green hydrogen comes into play.

Take-away messages:

For a successful energy transition the following steps are required:

- **Multiply the technological options** to replace fossil fuels by renewable energy.
- **Develop decision tools** to determine the best use of different renewable energy carriers.
- **Support research and innovation** through financial support schemes and demonstration projects.
- **Support the deployment of projects** in harmony with the regional carbon price.

Panel | Powerfuels Projects in North America and Europe

Moderation: **Kilian Crone**, Team Lead Global Alliance Powerfuels, dena

There has been an ongoing conversation and increasing interest in powerfuels in recent years; now the focus on both sides of the Atlantic is on accelerating action. Globally, the project pipeline for powerfuels projects is 60-140 GW, according to IRENA. In North America, California and the offshore wind areas of Québec are both characterised by a very high RES potential.

Jean Paquin, President and CEO, SAF+ Consortium

SAF+ is a consortium that includes **all aviation value chain players**, from airlines and airport OEM's to fuel suppliers, distribution, feedstock and technology providers, joining forces to build **the first commercial PtL plant**. The Montreal-based project involves the use of CCUS with renewable hydrogen to produce a drop-in jet fuel with life-cycle GHG emissions 80 % lower than conventional fossil jet fuel. Production costs are expected to be lower than those of sustainable aviation fuel from biomass. The pre-commercial plant will produce 3 million litres of synthetic jet fuel per year in 2025.

Question: If you could put one single policy tool on a wish list, what would you like to see implemented to make the business case for renewable hydrogen-based aviation fuels really work at scale?
Answer: We are currently in discussions with both the Québec provincial government and the Canadian federal government about **subsidising and supporting clean greenfield development** and both recognise the need for regulatory support for clean fuels.

Anna Stukas, VP Business Development, Carbon Engineering

Carbon Engineering (CE) offers a technology for **direct air capture of CO_2** (DAC) in combination with PtL. Using renewable CO_2 and hydrogen, drop-in-air fuels are produced that have net-zero emissions. The fuel produced is superior in terms of local pollution, as it contains no sulphur particles or aromatic hydrocarbons. CE has been capturing carbon dioxide from the atmosphere and converting it to fuel at their Squamish facility since 2015. CE is in the process of expanding this pilot plant in Squamish into a validation facility for 24/7 operation, which will become a permanent innovation centre.
CE is working with commercial plant development partners to work on the **design and deployment of commercial plants**. Firstly, the Permian Basin plant announced with partners at *1PointFive* that will capture up to one million tonnes of atmospheric carbon dioxide per year. Secondly, CE is developing a commercial scale **synthetic fuels facility** where the baseline design will produce in the order of 100 million litres per year of low carbon fuels.

The business model is a licensed process business model. CE's **expertise lays in DAC technology** as well as the ability to combine that capture technology with downstream components for the most effective production of low carbon fuels.

Question: What is the timeframe for you to offer licencing, how quickly can you deploy the technology?
Answer:

- CE is working with partners like *1PointFive* and *Pale Blue Dot Energy* that have the capacity and the ability to help CE to scale up the technology faster.
- The technology was designed **to work at a large scale from the beginning**. When choosing the technology design, CE was looking out into existing industry to find pieces of existing industrial equipment and existing industrial processes that could be combined in a novel fashion.
- This gives CE the confidence in the ability to go **directly** from the innovation centre in Squamish **all the way up to the plant** in the Permian Basin, which will produce **a million tons per year**.
- The design principle and the focus on industrial precedents is also, what leads CE to a high level of confidence in their technology costs.
- The number one factor driving the costs of producing powerfuels is the cost of renewable electricity.
- When the cost of renewable electricity comes down, CE is able to capitalize on that the cost of **capturing the carbon dioxide, which is actually a very small fraction of the overall cost** of producing carbon-based powerfuels.

Chris Norris, Director Business Development, Siemens Energy Canada

Siemens Energy manufactures PEM electrolysers and many other components in the powerfuels value chain. In the **Haru Oni project** in southern Chile, hydrogen produced from wind energy combined with carbon from the air is converted into synthetic gasoline that is exported to Europe. Another project in collaboration with *Liquid Wind* is in place in Sweden, where hydrogen is converted to **synthetic methanol** to meet the global demand.

Question: Is the production capacity of electrolysers the bottleneck to a green hydrogen economy?
Answer:

- Currently, Siemens Energy has the capacity to build in the range of **250 and 400 MW of electrolysers** in Erlangen Germany.
- Another **Giga-Factory is under development** in Germany that will be scalable to meet market demand well in excess of GW-scale projects.
- In Siemens Energy's strategy, **20 MW will be the smallest deployment**, which will then range up to two, four and six hundred MW.

Dr. Tahmid Mizan, Manager, Global Strategy & Regulatory Affairs, ExxonMobil Fuels & Lubricants Company

Low carbon fuels have the potential to **combine the convenience of conventional fuels and use the existing infrastructure**, but also provide lower life cycle greenhouse gas emissions to address society's needs to reduce greenhouse gases. These low carbon fuels will go in and compliment to electrification or battery electric technologies. Exxon's CEO advocates for policies that promote cost effective market based solutions to address the risks of climate change.

Hydrogen is essential to all of Exxon's refineries and chemical plants. **Exxon has a proprietary Fisher-Tropsch plant** that can produce diesel and other types of fuels and as well as lubricants based stocks and petrochemical feedstock. Moreover, there is additional technology that is called **methanol to gasoline**, which was commercialized in New Zealand, in the 1980s.

Together with Porsche, Exxon works to **deploy low carbon advanced biofuels and e-fuels** (produced in the Haru Oni project). In January 2021, Exxon created a new business unit called *Exxon Mobil low carbon solutions*, which aims to invest up to $3 billion in low-carbon energy solutions by 2025, including various types of carbon capture and sequestration projects.

Similar to green hydrogen hubs, Exxon looks at **hubs for CCS**, for instance in the Houston ship channel, where lots of industrial emissions are produced and. Additionally, the region offers a huge reservoir to potentially store about 500 million metric tons of CO_2 in the Gulf coast of the United States, Antonio Texas.

Breakout Sessions: Expert input presentations followed by discussion in small groups

1. Domestic North American production potential for green hydrogen and powerfuels

Input presentation and moderation: **Eric D. Larson, PhD**, Head, Energy Systems Analysis Group, Andlinger Center for Energy and the Environment, Princeton University

Focus of the discussion: What is required in the short term to achieve a longer-term hydrogen vision?

The following arguments and statements have been proposed by the audience during the discussion:

- **Standards and a common language** are required.
- **Pilot plants and scalable demonstration projects** are required.
- **Hydrogen Hubs** are an idea that is very strong in Europe, but less so in the US.
- Powerfuels are meant to be used in **no regret sectors** (where it is unavoidable) and where infrastructure already exists.
- The maxim should be **GHG emissions reduction**. This is the criterion for choosing between direct electrification and PtX use.
- **PtX export** could become an option for countries that have not yet been energy exporters, Chile shows an example.

2. Policy and technology drivers for powerfuels demand across sectors

Input presentations:
Gabriel Durany, CEO of Quebec's Association for the Production of Renewable Energy (AQPER)
Melanie Davidson, Senior Director, Business Development & Marketing, Strategen
Moderation: Johanna Friese, Friederike Altgelt, Experts, Global Alliance Powerfuels

Focus of the discussion: Policy instruments; How to advance the market ramp-up of green hydrogen?

The following arguments and statements have been proposed by the audience during the discussion:

- The establishment of **true policy to replace cheap grey hydrogen** with green hydrogen is required.

- Therefore, a **mechanism that structures demand** is required, whether it is injection blending targets for energy or biofuels.
- Mechanisms that put a **price on greenhouse gas emissions** are required. This is seen to be important in the context of using the money that comes from carbon markets or carbon taxes to users and producers to foster higher production rates.
- Building a **roadmap in order to prioritize action for policymakers** is required.
- An **industrial strategy** is required that includes a roadmap, as the success of the uptake of a powerfuels industry is all about scaling up.

3. How do politics and low prices of fossil fuels influence the market development of powerfuels in North America?

Input presentation and moderation: **Professor Jack Brouwer,** Director of the Advanced Power and Energy Program, University of California, Irvine

Focus of the discussion: Bringing renewable hydrogen-based aviation fuels into the market

The following arguments and statements have been proposed by the audience during the discussion:

- Suggestion: **Mandate a certain blending standard** for powerfuels.
- This mandate would need to be established by a **federal policy**.
- The **bottom up support from the general public** is required. Many people want to travel sustainably and will start to demand it if appropriate education and outreach is accomplished.
- This mandate would need to be **introduced globally in a coordinated manner**.
- Moreover, **environmental justice** and a just transition need to be discussed.
- **Energy resilience**: How do we create the ability to meet both thermal and electrical demands?

4. International sustainability criteria and certification for green hydrogen

Input presentations :
Prof. Pierre Bénard, Director, Hydrogen Research Institute, Université du Québec à Trois-Rivières
Pascale Lepage, Bureau de normalisation du Québec (BNQ)
Moderation: Mathieu Payeur, Director Energy Strategies, Ministère de l'énergie et des ressources naturelles Québec

Focus of the discussion: Standardisation and certification of hydrogen

The following arguments and statements have been proposed by the audience during the discussion:

- It is required to identify the correct objective for a **tool to certify the sustainability of hydrogen**.
- A **hydrogen ID** should contain information on the emissions associated with the **generation and the transport of the fuels** (as significant amounts of GHG can be released when transporting hydrogen).
- A hydrogen ID should be **recognised globally**.
- Therefore, **international standards, such as ISO**, are the best way to go as they are consensus based, thus delivering a global agreement.

Closing remarks

Kilian Crone, Team Lead Global Alliance Powerfuels, dena

- **Powerfuels are indispensable** for an integrated energy transition that targets climate neutrality as a core objective, which is now the **new political consensus**.
- What is required now is **strategies** to **address the underlying problems** in order to bring us closer to scale.
- We have learned that **physical scale does not seem to be the insurmountable bottleneck** for the technology providers, and we heard that there exist ideas on effective policies.
- In addition, we have learned about the **partnerships that already exist in business** and how these contribute to making projects happen to potentially establish global supply chains.