

How can you make more out of your biogenic CO₂ Episode 2

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INTRODUCTION:

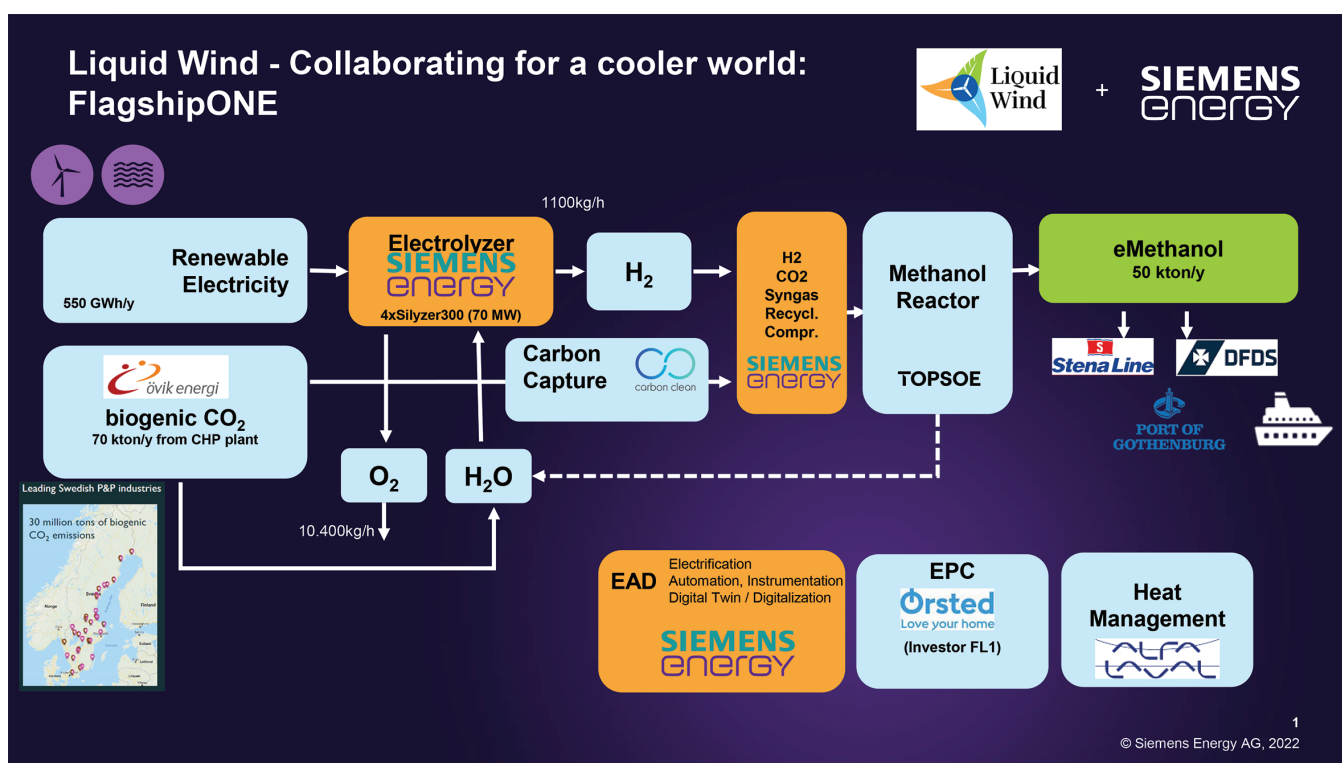
Regular readers of Paper Technology International might well remember the article I published in the 2022 edition, where I raised the question: “How can you make more out of your biogenic CO₂? The same would be the case for those who attended my presentations on the subject at the different Pulp & Paper Industry conferences last year, like the IMPS2022 in Munich or the Zellcheming in Wiesbaden. In both print and in person I have tried to give the Pulp and Paper community some “food for thought” on how and in which ways we can develop our industry to an even more sustainable footing. As well as additional benefits and business for the Pulp & Paper Industry, the environment can also be a winner.

For those who did not perhaps have access to Paper Technology International 2022 and therefore missed last year’s article “How can you make more out of your biogenic CO₂ Episode 1?”, I would like to briefly recap the content if I may.

The answer to this question is to use the biogenic CO₂ from your boilers etc., or from biomass based Combined Heat & Power Plants (as will be the case for Liquid Wind FlagshipONE) and use sustainable energy from Water, Wind and Solar Energy or your own powerplants. This electric energy feeds electrolyzers to produce Green Hydrogen. The H₂ and CO₂ moves on to Syngas

Compression and a Methanol Reactor where, under high pressure and temperature, Green Methanol will be generated. Please see below overview about the FlagshipONE project, a Green Methanol plant which is now under construction and will start to produce in Q1/2025 round about 50.000 tons of CO₂ Neutral Methanol per year. Now following this short summary about FlagshipONE I would like to tell you about the actual Status Quo of this project, as certainly a lot of things have happened in the 12 months since the last article was published.

Figure 1: Methanol synthesis based on green hydrogen and CO₂ from biomass-based flue gas raises the prospect of a carbon-neutral industrial system. As a fuel for mobility applications and feedstock for the chemical industry, green methanol can decisively drive the de-fossilization of the shipping industry and other industry sectors. At the same time, integrating green methanol production into existing industrial facilities, such as pulp mills or combined heat and power plants, creates an opportunity to re-use a valuable resource like biomass-based CO₂.



In respect of FlagshipONE some major milestones had been achieved:

- The main, and most important milestone, was that at the beginning of the year of 2022 the investor to build this first of its kind eMethanol plant stepped in: Ørsted, a multinational power company and world renowned leader for offshore wind parks, located in Fredericia/Denmark. Coming from decades developing and building mainly wind parks, like the world biggest, Hornsea 2 off the UK East Coast, Ørsted decided to make the next logical step on their sustainability roadmap: using sustainable electric energy to generate Green Hydrogen or Green Fuels, as at FlagshipONE, to produce CO₂ neutral eMethanol.

- Another important milestone was that FlagshipONE obtained, in July 2022, the building permit from a district court under the Swedish Land and Environmental Court of Appeals, approximately nine months after the application was submitted, to build the first of its kind large-scale facility for producing eMethanol (or CO₂ neutral Methanol) at Örnsköldsvik in Sweden.

- But what is a plant for producing eMethanol without the off-takers for this Green Methanol? So in September 2022 Stena Line, DFDS, Ørsted and Liquid Wind partnered with the Port of Gothenburg to establish an eMethanol (e-fuels) hub in Gothenburg. As the largest port in Scandinavia, Gothenburg is the ideal choice for the first delivery and bunkering point for green e-fuels produced from FlagshipONE.

Stena Line is a Swedish ferry line company with an extensive European route network and DFDS is a leading European shipping and logistics company.

- On 19. December 2022 Ørsted's Board of Directors took a final investment decision (FID) on the 50,000 tonnes/year FlagshipONE e-methanol project. FlagshipONE will be Ørsted's first commercial-scale Power2X facility and is an important stepping stone towards their ambition of taking a leading position in renewable hydrogen and green fuels. Reinforcing the commitment to the FID, Ørsted has taken full ownership of FlagshipONE by acquiring the remaining 55% stake in the project from Liquid Wind AB, the original developer of the project.

- Ørsted will start onsite construction of FlagshipONE in the spring of 2023. The project will be located on the grounds of the current biomass-fired combined heat and power plant Hörneborgsverket in Örnsköldsvik, which is operated by Övik Energi. The e-methanol from FlagshipONE will be produced using renewable electricity and biogenic carbon dioxide captured from Hörneborgsverket; in addition, FlagshipONE will use steam, process water, and cooling water from Hörneborgsverket. Excess heat from the e-methanol production process will be delivered back to Övik Energi and integrated in their district heating supply.

- I can also announce that Siemens Energy, as with their other OEM partners for the building of FlagshipONE, have been contracted for the delivery of the Electrolyzers, entire Electrification, Automation, Instrumentation and Digitalization equipment, including the implementation of a Digital Engineering Master and Copy Landscape as the base for the future engineering of all other Flagships to come. The respective execution of the project is, in Siemens Energy, already under full swing, plant start of operation in the first quarter of 2025.

You may ask yourself meanwhile - interesting, but what has this all got to do with the Pulp & Paper Industry? Well, despite the fact that the Pulp & Paper Industry is the biggest emitter of biogenic CO₂, which is historically more or less 100% wasted (respectively "blown into the wind"), I would like to indicate that the "Making more out of your biogenic CO₂" is becoming reality and not anymore fiction or a "future vision". I can tell you clearly - step in! - you will no longer be the "first mover", which I know is something the pulp and paper industry doesn't like to be in most cases.

To raise your curiosity even more, I would also like to address the fact that FlagshipTWO is also already well on track and on the way to realization. In June 2022 Sundsvall Energi (Sweden/ Sundsvall) partnered up with Liquid Wind to be the host and provide carbon dioxide (and other infrastructures) for the second commercial-scale electro fuel facility in Sweden. FlagshipTWO is foreseen to produce double the amount of eMethanol as FlagshipONE, round about 110.000t/year of Green Methanol. Siemens Energy and the other partners of Liquid Wind are already working intensively on the respective FEED Study, to be finalized in summer 2023.

If you are still not convinced to also become, part of this success story, with "your own CO₂", it may help if I mention that FlagshipTHREE and FlagshipFOUR are also a part of Liquid Wind's road map, to have a minimum of 10 green Methanol facilities in operation by 2030.



Figure 2: Sundsvall Energi, biogenic CO₂ supplier and host for FlagshipTWO.

Integration into Pulp & Paper Mills

Coming back to the symbiosis of the Pulp Mill and e-fuel based methanol production: It is not enough just to utilize biogenic CO₂ from the pulp mill and subsequently e-methanol for the mill's truck fleet or shipping vessels for shipment. It is a symbiosis to use the surplus of the pulp mill's biogenic electrical power and heat, the existing units for demineralized water supply and effluent treatment, also the surplus of oxygen from the electrolyzers and heat from the methanol facility. These can be used for the pulp mill's bleaching and effluent treatment process, to skip the energy intensive air liquefaction on site and to generate a net of balance, as well as the bio-methanol/methanol route as part of the black liquor evaporation refinery step ahead of the recovery boiler. With the pulp and e-methanol production symbiosis the whole production could work as carbon neutral, due to the replacement of the natural gas fired lime kiln with e-methanol. (table 1)

A pulp mill with 1.5 Million tons pulp production for instance shows that a fifth of e-methanol production, based on excess electrical power production from the pulp mill, could cover the lime kiln process (pulp mill methanol production not considered). With that move carbon credits become obsolete.

The rest of the produced eMethanol can either be used for the mill's own logistics (replacing diesel from trucks, shipping fuel, etc.) or can be sold on the rapidly growing market for eMethanol (CO₂ neutral Methanol), the demand in the shipping industry is very high indeed.

	Adiabatic Flame Temperature, °C	Flame Length, m	Feed End Temperature, °C	Flue Gas Flow Rate, Nm ³ /h	Heat Rate, GJ/T lime	Max Refractory Temperature, °C
Liquid Fuels						
Crude tall oil	2109	7.7	261	33,243	6.8	1700
Tall oil pitch	1965	8.0	325	36,833	7.3	1617
Methanol	2108	7.7	251	32,689	6.7	1694
Turpentine	2075	7.8	275	34,053	6.9	1678
Fuel oil	2068	7.8	280	34,256	6.9	1700
Solid Fuels						
Conifer bark	2005	14.7	343	36,209	7.5	1449
Biomass wood	1982	14.9	354	36,780	7.6	1439
Lignin	2127	14.1	287	33,372	7.0	1487
Peat	2007	14.8	344	36,273	7.5	1445
Gasified Fuel						
Bark syngas	2226	13.2	244	31,033	6.6	1543

Table 1: Adiabatic flame temperature, flame length, and kiln parameter for alternative fuel source (Ivarsson, C. and Svendiv, K., "Study of the lime reburning process with biofuels," TAPPI/PAPTAC Int. Chem. Recovery Conf., TAPPI/PAPTAC, Peachtree Corners/Brossard, QC, Canada, 2007.)

I hope Episode 2 of "How can you make more out of your biogenic CO₂?" and the Liquid Wind approach with their Flagships makes you curious enough to think about how you can make an already highly sustainable sector, like the Pulp & Paper Industry, even more sustainable. And not to forget the opportunity the Pulp & Paper Industry now has to become an active part of the rapidly rising market for green fuels. Last, but not least, and out of my own experience of working for the last four years in this new industry, it's a great feeling to be part of this fantastic initiative to help fight the threats of global warming, we all have to do more, and drop by drop green fuels will very much help to make a difference.

Figure 3: Carbon Neutral Fuel by using green electricity and biogenic CO₂ from almost carbon neutral pulp mills.

