



## **Decarbonizing the Gas Grid: Lessons from Denmark**

### **Final Agenda (Updated May 7, 2022)**

#### **May 8 – May 13, 2022**

Welcome to Denmark. We are looking forward to spending the next week with you, and hope you find this trip to be informative and inspiring! This agenda provides detailed information on what we will be doing for next five days.

#### **We only have two rules:**

1. Thou shall not be late! If you are, we will leave without you, and you will be responsible for getting to the next destination on your own. Addresses for each destination are included below.
2. We will order drinks, including wine, for each dinner. If you would like something else like a cocktail or a different wine, please let the wait staff know that you will be paying for this personally.

If you need to reach us for any reason, our contact info is included at the bottom of each page. However, cell service may be spotty in some areas, so if you can't reach us by phone send us a text or WhatsApp message and we'll respond as soon as we can.

We strongly encourage you to read our report, *Decarbonizing the Gas Grid: The Role of Renewable Fuels in Denmark's Path to Carbon Neutrality*, in advance of our meetings. This will provide valuable background and context, and is available on the i-SUSTAIN web site at [i-sustain.com](https://www.i-sustain.com/), under the Background Info link for this trip (or go to [https://www.i-sustain.com/files/ugd/384157\\_803bd33deebc46dda2e90ce6777a6100.pdf](https://www.i-sustain.com/files/ugd/384157_803bd33deebc46dda2e90ce6777a6100.pdf)). In case you don't have a chance to read the entire report beforehand, we have included references within the itinerary to specific sections in the paper that are most relevant for each of our activities.

#### **SUNDAY (8 May)**

*Afternoon – Check into our hotel in Copenhagen (Skt. Petri - Krystalgade 22, 1172 København)*

*5.00p to 6.00p – Introductions over Aquavit*

*6.30p – Leave the hotel to walk to the Welcome Dinner*

*7.00p – Welcome dinner at Hummer, in Nyhavn (Nyhavn 63A, 1051 København)*

## **MONDAY (9 May)**

***You must wear long pants and closed shoes. No access to the power plant in the afternoon with flip flops, sandals, or high heels.***

*9.00a – Leave from hotel lobby and walk to State of Green (Vesterbrogade 1E, 1620 København).*

*9.30a to 10.00a - State of Green in Copenhagen [Henrik Skou, State of Green, Senior Project Manager]*

State of Green is a not-for-profit, public-private partnership that seeks to foster relations with international stakeholders and strengthen awareness of the solutions and competences of Danish business and industry within energy, water, climate adaptation and environment. This presentation will provide an introduction to the Danish perspectives on the role of renewable energy and renewable fuels, with an emphasis on how Danish companies and solutions are allowing the nation to decarbonize the energy sector while achieving economic growth.

*10.00a to 10.30a – Walk to Danish Energy Agency, about 20 mins (Carsten Niebuhrs Gade 43, 1577)*

*10.30a to 12.00p – Danish Energy Agency (see report sections 3, 4 and 6)*

The Danish Energy Agency, established in 1975, is an agency of the Danish Ministry of Energy, Utilities and Climate and Energy and is responsible for activities related to energy production, supply and consumption, as well as Danish efforts to reduce carbon emissions. This includes responsibility for the regulations regarding government subsidies and other support for sustainable biogas production. Two presentations will provide an overview of national policies related to the development of biofuels, the current status of bioenergy production and use, and the projected roadmap forward.

- Overview of Danish government policies and goals related to biofuels [Lise Skovsgaard, Danish Energy Agency, Special Advisor in Center for Renewables]
- Results of the FutureGas report, which helped to develop Denmark's vision for the future role of natural gas and the natural gas infrastructure [Poul-Erik Morthorst, Professor Emeritus in Energy Economics at DTU Wind Energy, member of the Danish Climate Council]

*12.15p – leave the Danish Energy Agency and walk to lunch*

*12.30p to 2.00p – Lunch at Fleisch in the Meatpacking District (Slagterboderne 7, 1716 København)*

*2.00p to 2.30p – Travel to Copenhill (Amager Bakke - Vindmøllevej 6, 2300 København) by taxi, 20 mins.*

*2.30p to 4.30p – Copenhill CHP Plant [Flemming Nielsen, Amager Ressourcecenter, Subject Expert] (see sections 3.2 and 5.2) Participants must wear long pants and closed shoes. No access to the power plant with flip flops, sandals, or high heels.*

Copenhill, the "cleanest waste-to-energy power plant in the world", was completed in 2019. It doubles as public infrastructure, complete with tree-lined hiking trails and ski slopes on its roof along with the "tallest artificial climbing wall in the world" on its facade. Copenhill provides an opportunity to tour and understand the role of waste to energy plants and district energy in heating Danish homes and offices. The plant is also running a pilot project for CO<sub>2</sub>-capture technology. Starting in 2022 the demonstration plant will be able to capture 12 tons of CO<sub>2</sub> per day, and it has recently been decided that this pilot plant will be upscaled to capture 500,000 tons of CO<sub>2</sub> annually.

*4.30p (Optional) – At the end of the presentation and tour we'll take the elevator to the top of CopenHill for those who want to go skiing and/or have a drink at the no-host bar (see <https://www.copenhill.dk/en/info/ready-to-ski> for a sneak preview!)*

*Dinner and make your way back to the hotel on your own*

## **TUESDAY (10 May)**

*Make sure you check-out and leave your luggage in the front lobby.*

*8.45a – Leave on our group bus to go to Ørsted (Nesa Allé 1, 2820 Gentofte)*

*9.30a to 11.00a – Meetings at Ørsted (see sections 8.1.1 and 9)*

*9.30a to 9.45a – Introduction to Ørsted, including their transformation into a renewable energy and biogas/biofuels energy company [Magnus Hornø Gottlieb, Senior Advisor, Group Policy Engagement]*

*9.45a to 10.10a – Ørsted's PtX strategy and their vision for the US Market [Tommy Gerrity, Head of Business & Project Development, P2X, North America]*

*10.10a to 10.30a – Introduction to the Green Fuels for Denmark project [Lars Hansen, Program Director, Green Fuels for Denmark]*

*10.30a to 11.00a – Maersk's green fuels strategy [Jacob Sterling, Senior Director, Head of Decarbonization Innovation & Business Development]*

In 2009 DONG Energy (Danish Oil and Natural Gas) had one of the most carbon-intensive electricity-generation systems in Europe, and the world. It then launched a campaign to completely reinvent itself as Ørsted, a top-to-bottom renewable energy company. By 2018 Ørsted's green energy output was 75% of total output and the company had reduced its CO<sub>2</sub> emissions intensity per kilowatt hour by 72%. By 2025, green energy is set to account for 99% of the company's output while CO<sub>2</sub> emissions intensity is to fall by 98% of 2009's level.

Ørsted, the Copenhagen Airport, and Maersk shipping are amongst the consortium of businesses aiming to develop a hydrogen and sustainable transport fuel facility near Copenhagen, to be operational by 2023. Renewable electricity sourced from the

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Bornholm offshore wind farm will be used to produce renewable hydrogen through electrolysis, while carbon capture from the Avedøre Power Station will be used to create renewable methanol for maritime and aviation fuel. The project has the potential to [displace 30% of the fossil fuels used at the Copenhagen Airport by 2030](#).

Ørsted is also expanding its PtX activities in the US as part of its ambition to become a global leader in for renewable hydrogen and green fuels. For their first project in the US, Ørsted is partnering with Maersk to develop a 675 MW PtX plant on the Gulf Coast. The plant will produce 300,000 tons of e-methanol annually, which Maersk will purchase for its future fleet of 12 methanol-powered vessels.

*11.00a to 11.15a – Take group bus to Ordrupgaard Museum and Park (Vilvordevej 110, 2920 Charlottenlund).*

*11.15a to 12.45p – Get some fresh air in the park for about 30 minutes and then head in for lunch at the café around 11.45a so you can be back on the bus by 12.45p.*

*12.45p to 1.15p – Take group bus to EnergiNet (Pederstrupvej 76, 2750 Ballerup).*

*1.30p to 3.00p – Energinet [Jonas Jürgens, Energy Policy Advisor; Clement Ulrichsen, Director of Gas Market; and Rasmus Halfdan Sandahl Jensen, Gas Planning Engineer] (see sections 5.1, 5.2, 6.2 and 9)*

Energinet is an independent public enterprise owned by the Danish Ministry of Climate, Energy and Utilities. As the Danish national transmission system operator it owns, operates and develops the transmission systems for both electricity and natural gas in Denmark. Energinet also oversees the green certificates issued for carbon credits for biofuels, and established the quality guidelines for RNG that is injected into the national distribution system.

*3.00p to 6.30p – Travel by group bus to Hotel Royal (Store Torv 4, Aarhus)*

*7.15p – Leave the hotel to walk to dinner at our restaurant, the ARoS Orangeri, at the ARoS Art Museum (Aros Allé 2). If you want to see the exhibits, that is a separate fee which you would pay for yourself.*

## **WEDNESDAY (11 May)**

*8.30a – leave hotel lobby*

*8.30a to 9.30a – take group bus to Hybalance plant (Jyllandsvej 25, DK-9500 Hobro)*

*9.30a to 12.30p – Hydrogen Valley, series of site visits, presentations, and meetings*

*9.30a to 10.30a – site tour of Hybalance electrolyzer facility [Jakob, Plant Manager at HyBalance] (see section 8)*

The HyBalance plant uses water-based electrolysis to produce green hydrogen, making it possible to store excess power from wind energy or other renewables. The 1.2 MW plant

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opened in September 2018, and utilizes one of Europe's most advanced PEM (Proton Exchange Membrane) facilities. PEM electrolysis is compact and flexible, and the technology can handle frequent starts and stops, which makes it very suitable for balancing fluctuating energy sources. The plant contributes to the balancing of the electricity grid, and the hydrogen is utilized in industrial processes and in the mobility sector.

*10.30a to 10.45a – take group bus to GASMuseet (Gasværksvej 2, 9500 Hobro)*

*10.45a to 11.00a – break*

*11.00a to 11.30a – introduction to Hydrogen Valley [Søren Bjerregaard Pedersen, CEO, Hydrogen Valley Denmark]*

Power-to-X is a term for using electricity from renewable energy sources such as wind turbines to produce hydrogen, which can be converted into other useful products (e.g. methanol and ammonia) by adding CO<sub>2</sub> or nitrogen. It can then be stored and distributed for various purposes such as heating, transportation and industrial processes. Hydrogen Valley has more than 15 years of experience in Power-to-X related projects that bring together all core elements of the hydrogen value-chain into a fully-integrated and functioning H<sub>2</sub> valley, and can serve as a blueprint for replication elsewhere. Some of the projects they are or have been involved in include:

- The HyBalance project
- The Power2Met project
- Green Hydrogen Hub project
- Carbon capture activities (CO<sub>2</sub>Vision)
- European Hydrogen Backbone

*11.30a to 12.00p – presentation by Evida on their role in Danish gas industry, and future plans for biogas and hydrogen [Morten Poulsen, Strategic Business Development, EVIDA]*

Evida is a state-owned gas distribution system operator (DSO) that delivers natural gas to consumers. It is responsible for connecting biogas plants to the gas system. Given the increasingly decentralized nature of gas production in Denmark, Evida also plays an important role in managing flows throughout the country, and determining where there is room in the gas system for connection of new biogas capacity.

*12.00p to 12.30p – open discussion*

*12.30p to 1.45p – lunch at the GASMuseet café (Gas Museum) (Gasværksvej 2, 9500 Hobro)*

*1.45p to 2.30p – take group bus to Agro Business Park (Niels Pedersens Allé 2, 8830 Tjele)*

*2.30p to 4.30p – meetings at Agro Business Park (see sections 6.5 and 7)*

*2.30p to 3.10p – presentation on Food & Bio Cluster Denmark [Michael Støckler, Senior Innovation Manager, Food & Bio Cluster]*

Food & Bio Cluster Denmark is the nationwide organization for food and bio-resources in Denmark. It was created to strengthen knowledge-based innovation and knowledge collaboration across the entire value chain – both within Denmark and internationally. The

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Food & Bio Cluster includes the Biogas Go Global Alliance, which was created with the purpose of contributing to reciprocal knowledge sharing between Denmark and the United States on biogas production

*3.10p to 3.20p – take group bus to the Foulum biogas plant (Burrehøjvej 43, 8830 Tjele)*

*3.20p to 3.45p – tour of the Foulum biogas plant [Mogens Møller Hansen, Operations Manager]*

Aarhus University's Foulum Biogas plant is the world's largest test plant for biogas. The laboratory connected to the plant is designed to run tests in order to optimize fuel utilization. The existing plant is being expanded to include plants for the extraction of substrate for fungal production, facilities for biorefining, experimental plants using fuel cells, and associated gas storage.

*3.45p to 4.15 – presentation of Aarhus University's research activities, including PtX pilot projects [Behzad Partoon, assistant professor, Department of Biological and Chemical Engineering – Process and Materials Engineering, Aarhus University]*

Dr. Partoon's research expertise and interests include Power to X, process simulation, CO<sub>2</sub> capture, CO<sub>2</sub> utilization and hydrogen production.

*4.15p to 4.30p – take group bus to main square in Viborg (Nytorg 11, 8800 Viborg)*

*4.30p to 7.00p – explore Viborg and have dinner on your own. There will be several good restaurants near where our bus parks.*

Viborg is one of the oldest cities in Denmark, with Viking settlements dating back to the late 8th century. Its central location gave the city great strategic importance, in political and religious matters, during the Middle Ages. The nobility and Catholic bishops adorned the city with monumental buildings, including the characteristic cathedral with two towers. Today, Viborg still has cozy medieval streets and beautiful pedestrian walkways, which now have modern and unique shops.

*7.00p to 8:30p – take group bus to our hotel, The Lodge (Nordmarksvej 3, 7190 Billund)*

## **THURSDAY (12 May)**

*8.30a to 9.00a – take group bus to Billund Biorefinery (Grindsted Landevej 40, DK-7200 Grindsted)*

*9.00a to 10.30a – Billund Biorefinery, presentation and tour [Thomas Kruse Madsen, Director, Billund Vand and Energi] (see section 7.3)*

The Billund Biorefinery (BBR) has transformed the traditional concept of a municipal wastewater treatment plant into a facility that turns household and industrial waste into sustainable and profitable resource streams. The resource recovery plant integrates urban waste management and wastewater treatment within the circular economy, producing energy, clean water and

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nutrient rich natural fertilizer, while effectively cleaning all the influent waste streams and protecting the environment. The BBR produces almost twice as much energy (as biogas) as it consumes, but it is the plant's ability to monetize both the energy and the material streams it produces that drives its profitability. The approach used in this plant could provide a vision for future wastewater treatment plants in the PNW.

*10.30a to 11.30a – take group bus to Streetfood Esbjerg (Kongensgade 34, Borbergade 33, 6700 Esbjerg)*

*11.30a to 12.30p – Lunch on your own at Streetfood Esbjerg*

*12.30 to 1.00p – take group bus to Nature Energy Korskro Plant (NE Korskro, Lunde Hovedvej 51, 6705 Esbjerg Ø)*

*1.00p to 2.30p - Nature Energy Korskro Plant, presentation and site visit [Mette Smedegaard Hansen, Head of Regulatory Affairs] (see sections 5.3 and 5.4)*

Nature Energy began in 1979 as Naturgas Fyn, a natural gas distribution company. It established its first biogas plant in 2015, and today is Denmark's largest producer of biogas, and one of the leading producers of biogas in the world. Nature Energy currently has 11 operational biogas plants throughout Denmark, consuming manure and food waste, with several more under development. The Korskro plant receives manure from cattle and pigs, organic waste from industry and retail, and a small amount of energy crops (corn silage). The plant produces about 780M cf of biogas that is upgraded to RNG, and then injected and distributed via the natural gas network. They also capture carbon dioxide for use in the food and beverage industry. Nature Energy Korskro is a joint ownership between Nature Energy and the farmer-owned supplier association Sydvestjysk Biogas AMBA, which consists of approximately 100 suppliers.

*2.30p to 5.45p – take group bus to Copenhagen*

*6.00p – check-in to Hotel Skt. Petri (Krystalgade 22, 1172 København)*

*7.00p – leave lobby to walk to dinner at Restaurant Tight (Hyskenstræde 10, 1207 København)*

*7:30p – Farewell Dinner at Restaurant Tight*

## **FRIDAY (13 May)**

*8.45a – leave hotel lobby to walk to State of Green*

*9.00a to 11.00a – Study Tour Debrief Meeting at State of Green (Vesterbrogade 1E, 1620 København). (This is mandatory for all scholarship recipients)*

Facilitated meeting and group discussion: What did we learn that is applicable to Washington State? What ideas do we want to move forward, and what would the next steps be?

*11.15a to 2.15p – optional bike tour of Copenhagen with Cycling Copenhagen, leaving from State of Green*

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