MARKET CONSULTATION: HYDROGEN CONVERSION AND CAPACITIES AT ELLUND

Capacity and oxygen management at the Danish-German border

Gasunie Deutschland
Energinet

INTRODUCTION

- Gasunie and Energinet are planning to establish a cross-border hydrogen transport corridor using repurposed methane pipelines. As this usage of existing pipelines (other factors being equal) will limit the methane capacities in both directions, Gasunie and Energinet have made great efforts to find solutions to ensure that the German/Danish methane connection will have sufficient capacity for the future market needs.
- With this material, Gasunie and Energinet wish to inform and present the challenges ahead – but most importantly, we are eager to describe our preferred solution to you, the market participants, and hopefully get valuable feedback from a market perspective. That is the purpose with this consultation.
- For more details on the consultation process and contact information, please see slide [17].

GUIDING PRINCIPLES

For the cross-border cooperation between Gasunie Deutschland and Energinet in this project

ENSURE CONTINUING **ACCESS** TO BIOMETHANE IN DENMARK AND **BIOMETHANE INTEGRATION** IN GERMANY

FOCUS ON UTILIZING **EXISTING METHANE INFRASTRUCTURE** – ADJUSTING THE INFRASTRUCTURE TO MARKET NEEDS

AVOID BIG INVESTMENTS ON DANISH OR GERMAN SIDE – FIND A **COST-EFFICIENT SOLUTION**

ENSURE **SUFFICIENT CAPACITY** AVAILABLE FOR THE GAS MARKET

ENERGINET AND GASUNIE ARE WORKING ON ESTABLISHING CROSS-BORDER HYDROGEN INFRASTRUCTURE

- Energinet and Gasunie have been working together since 2020 on establishing a cross-border hydrogen interconnector via Ellund

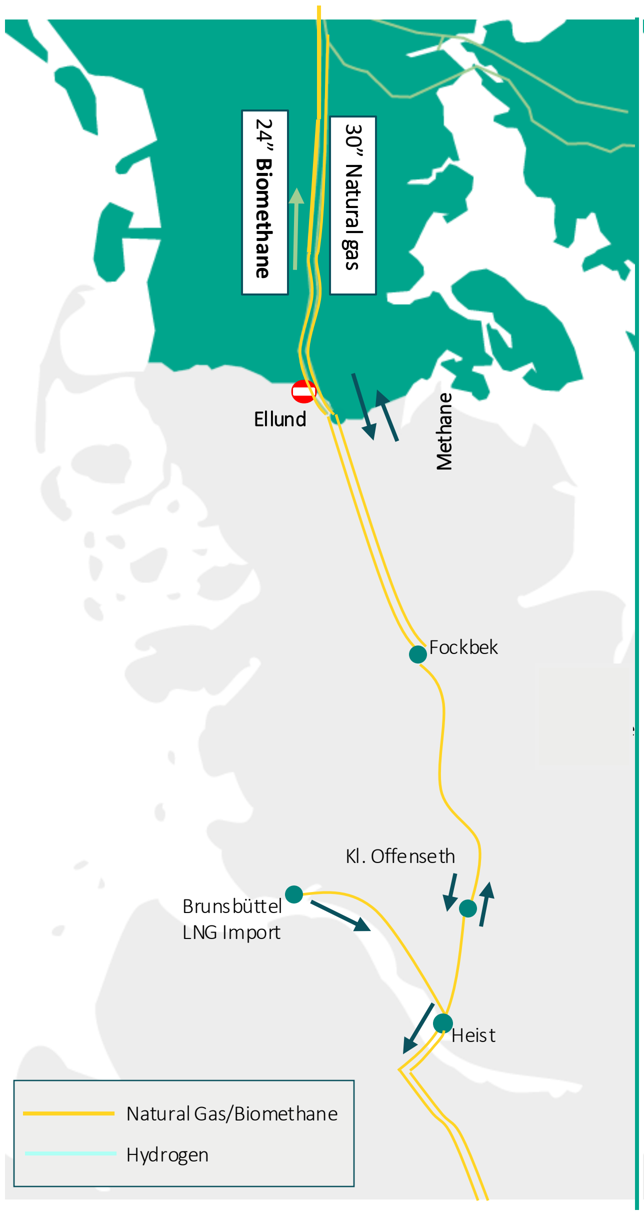
- A cross-border hydrogen infrastructure aims at connecting the two markets in Denmark (an expected large-scale producer and net exporter of green hydrogen) and Germany (an expected net importer of green hydrogen) thereby supporting the ramp-up of hydrogen markets in both countries

- The pipeline between Egtved and Ellund (on the Danish side) and from Ellund to Heidenau, south of Hamburg (on the German side) is a primarily repurposed methane pipeline.

Energinet →

← Gasunie Deutschland

Today's system



Hydrogen conversion

CHALLENGE: OXYGEN AND CAPACITY AT THE DANISH-GERMAN BORDER

Today's system

- Usage of two transmission pipelines in Denmark for separation of biomethane with higher oxygen content and natural gas towards Germany (with a lower threshold for oxygen content in methane)
- Southbound capacity limited by LNG imports, currently on a sufficient level with low usage

Post hydrogen-conversion (DK)

- Current physical separation of biomethane and natural gas is no longer possible – but in general there is sufficient capacity

Post hydrogen conversion (DE)

- The methane transport capacity north- and southbound is limited by the utilization of the pipeline for the hydrogen system

Energinet has the option of technical oxygen removal (est. 10-30 million EUR) Gasunie Deutschland has the option of building a new pipeline (est. >250 million EUR) to compensate for the conversion.

Gasunie Deutschland and Energinet have therefore jointly sought alternative and cheaper solutions, to minimize the tariff impact of such investments.

CONSEQUENCES OF CONVERSION (WITHOUT FURTHER ACTIONS)

CAPACITY ISSUE

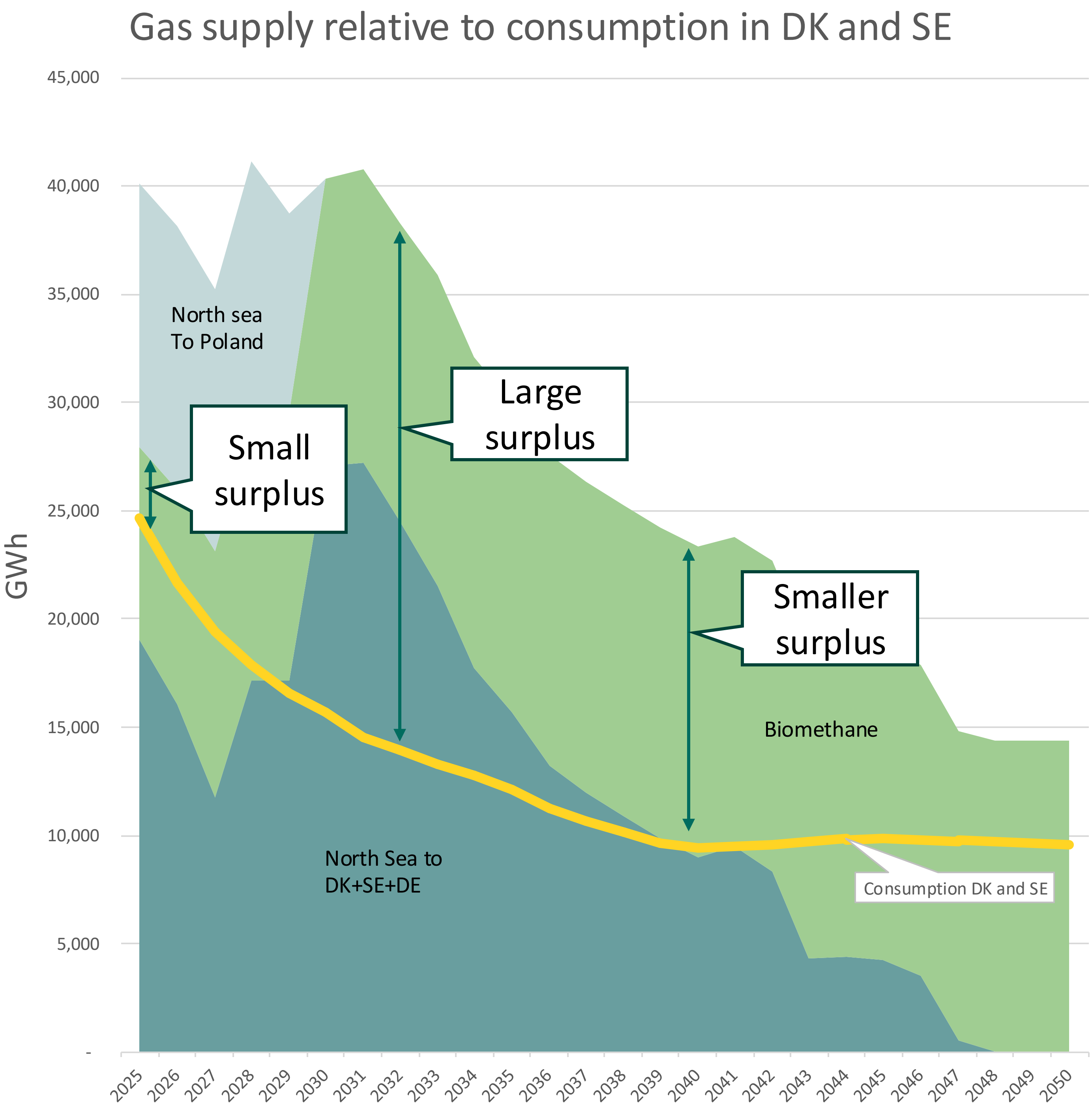
- Gasunie and Energinet have plans for a cross-border hydrogen transport corridor using repurposed pipelines. However, without further actions, this would restrict both northbound and southbound methane capacities.
- Maintaining **sufficient technical methane capacity** is crucial for Gasunie and Energinet.

OXYGEN ISSUE

- The Danish hydrogen project involves converting one of the methane pipelines running from Egtved to Frøslev/Ellund into a hydrogen pipeline. This conversion will eliminate the current solution to ensure that the oxygen content in the exporting (Danish) gas is within the German specification (DVGW G260).
- Therefore, with the pipeline converted, Gasunie and Energinet need to address and **find solutions to ensure compliance on the oxygen content** between the two markets.

Preferred solution: Pressure adjustment and ‘biomethane zone‘

OUTLOOK



NEED FOR DANISH EXPORT CAPACITY – BUT DECREASINGLY OVER TIME

Energinet's projection of the need for export capacity is based on the assumptions (AF24) from the Danish Energy Agency (DEA)*. The possible physical gas flow is a result of a balance between gas supply, from North Sea and biomethane, and the gas consumption in Denmark and Sweden. The figure illustrates the net balance between consumption and supply.

A part of the North Sea gas is in AF24 assumed to flow directly to Poland via Baltic Pipe until 2029. This reduces the gas surplus for export via Ellund. In 2032, the surplus will peak due to relatively low consumption and a peak in supply from the North Sea. Thereafter, the balance will gradually converge with the decrease in North Sea gas supply. Overall, there is no net northbound flow in the period.

The outlook has uncertainties. If Poland continues to be supplied from the North Sea or if the reduction in gas demand is less than anticipated, the net surplus is reduced. However, this picture illustrates the need for Danish export capacity. Danish export can happen via Ellund and Faxe.

*Based on the Danish Energy Agency's Analysis Assumption for Energinet 2024 (AF24)
https://ens.dk/analyser-og-statistik/analyseforudsaetninger-til-energinet

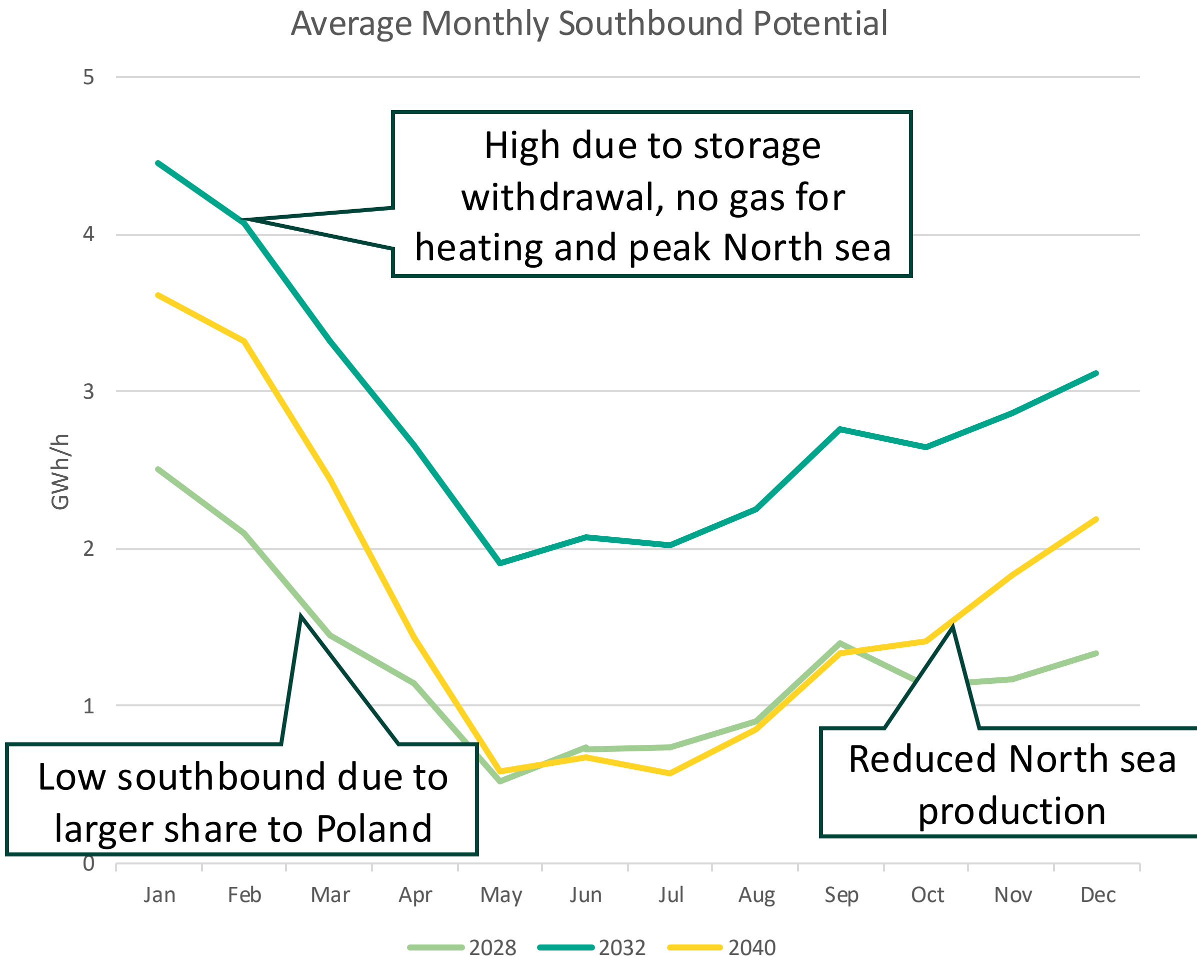
WHAT LEVEL OF SOUTHBOUND ELLUND CAPACITY IS SUFFICIENT?

Energinet have used the yearly projection to estimate the possible maximum monthly usage on the Ellund border point. This is done by applying an average monthly usage profile for gas storage and consumption for gas in Denmark and Sweden to the yearly projection from AF24.

The projection gives a strong potential for southbound transport with a peak 4,5 GWh/h in 2032. The peak will be lower the following years due to decline in North Sea gas production. This differs from historical observations, where transports above 2,5 GWh/h only happened 4% of all days between 2014 and 2018 with Tyra in operation. The explanation for the stronger southbound potential are the AF24 assumptions of phase out of gas for heating and that a majority of North sea gas is transported via Nybro and Ellund. Together with the historic profiles for gas-storage extraction, this can give a large southbound potential during the winter months.

Energinet believes that this is a peak scenario, and the actual transport demand will be much lower, e.g. due to:

- Larger share of gas from Tyra transported via Faxe to Poland or to the Netherlands via NOGAT
- Changed usage patterns of storage due to reduced gas-demand for heating
- Slower reduction of gas for heating

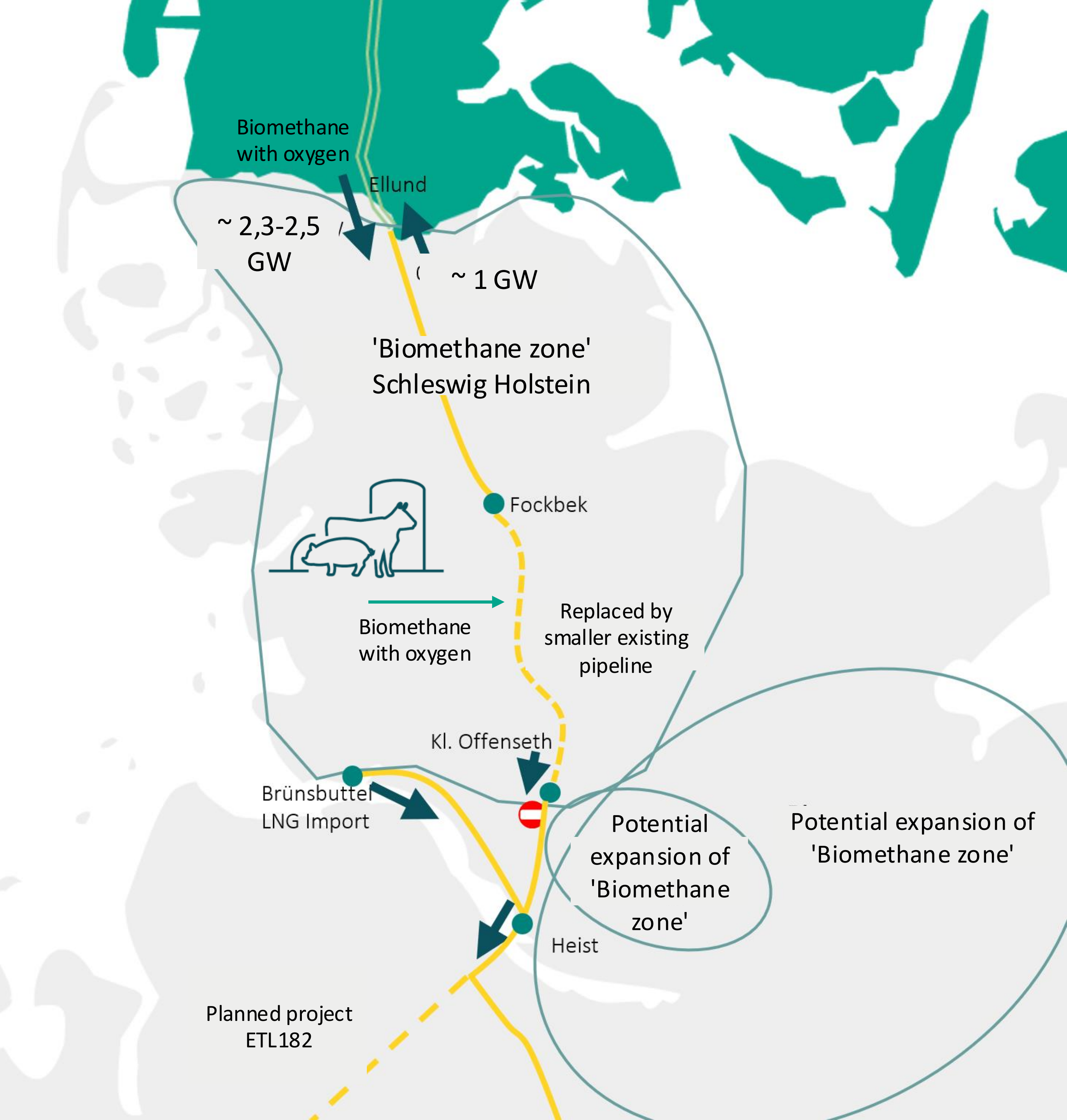


No monthly Northbound flow

OUR SOLUTION FOR CAPACITY AND OXYGEN

SOLUTION – PRESSURE ADJUSTMENT AND ‘BIOMETHANE ZONE’ [I]

- A ‘biomethane zone’ **facilitates the entry of biomethane** from Denmark and **integration** of biomethane in northern Germany.
- It is proposed to create a **zone in northern Germany** which allows higher oxygen content (within the G260 specifications p13).
- The ‘biomethane zone’ combined with adjusted pressure will ensure sufficient capacity levels (but market input on this is needed)
- Physical exports from Denmark are limited to consumption in the zone – **the zone can be expanded**



SOLUTION – PRESSURE ADJUSTMENT AND 'BIOMETHANE ZONE' [II]

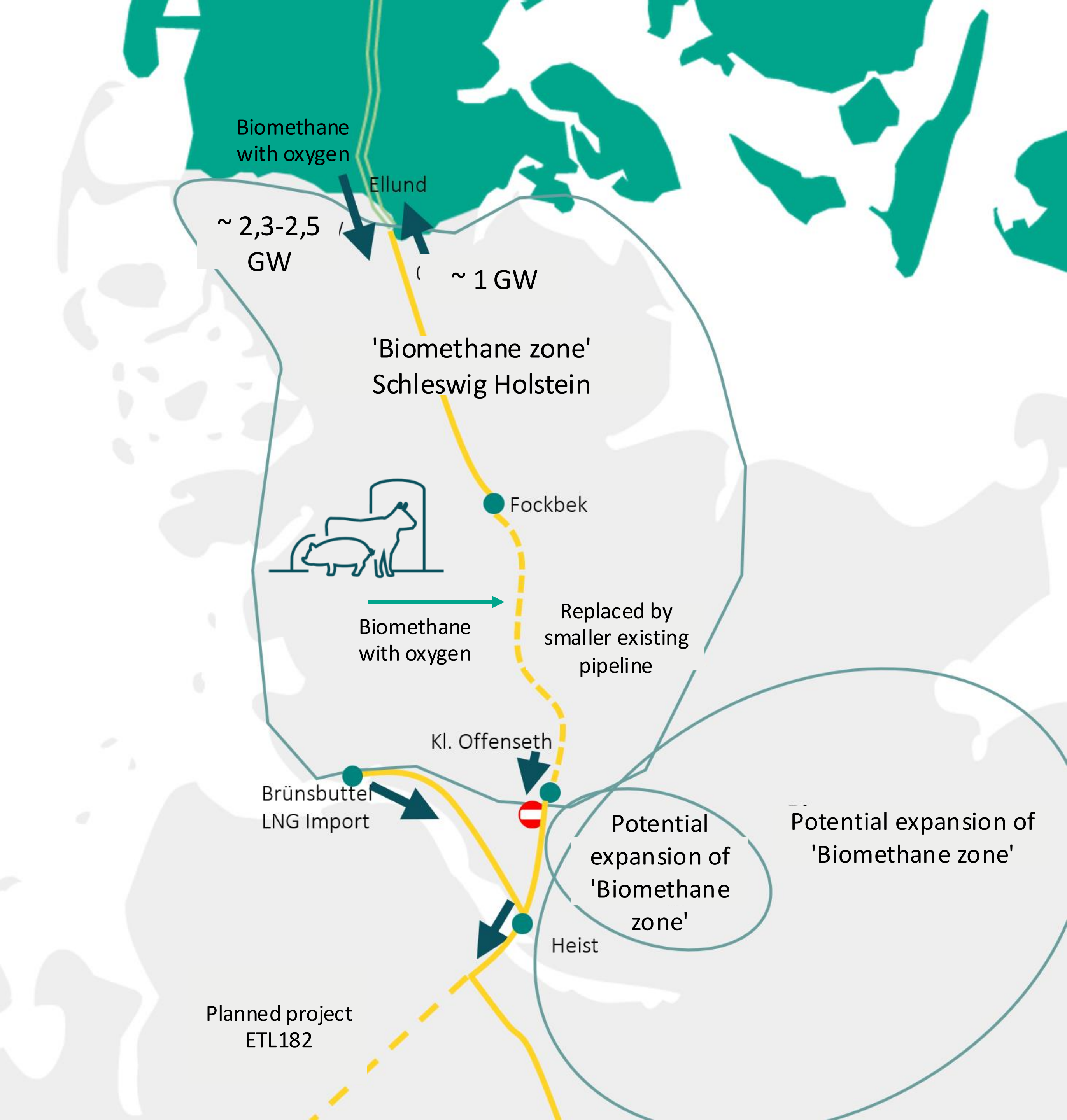
Indicative results for capacity, based on planned expansion measures:

- Southbound capacity ~ 2,3-2,5 GWh/h

  This is more than today

- Northbound capacity ~ 1 GWh/h

  This is less than today



‘BIOMETHANE ZONE’ CONTINUED

Details and way forward

- Gasunie Deutschland is having ongoing talks with connected parties in northern Germany regarding what the maximum level for oxygen can be in a potential ‘biomethane zone’ (within existing limits of German specification G260).

- In the current setup, German gas quality specifications allow higher oxygen levels than in Denmark, as long as connected parties and network operators see no negative impact from a technical point of view.

- Specifically, the German quality specifications on oxygen allows either 0,001 mol-% or 1 mol-% as a maximum oxygen level, whereas the Danish quality specifications allow 0,5 mol-%.

The ‘biomethane zone’ means that we want to apply 1 mol% as the maximum oxygen level to facilitate the physcial injection of biomethane into the northern part of the GUD-system

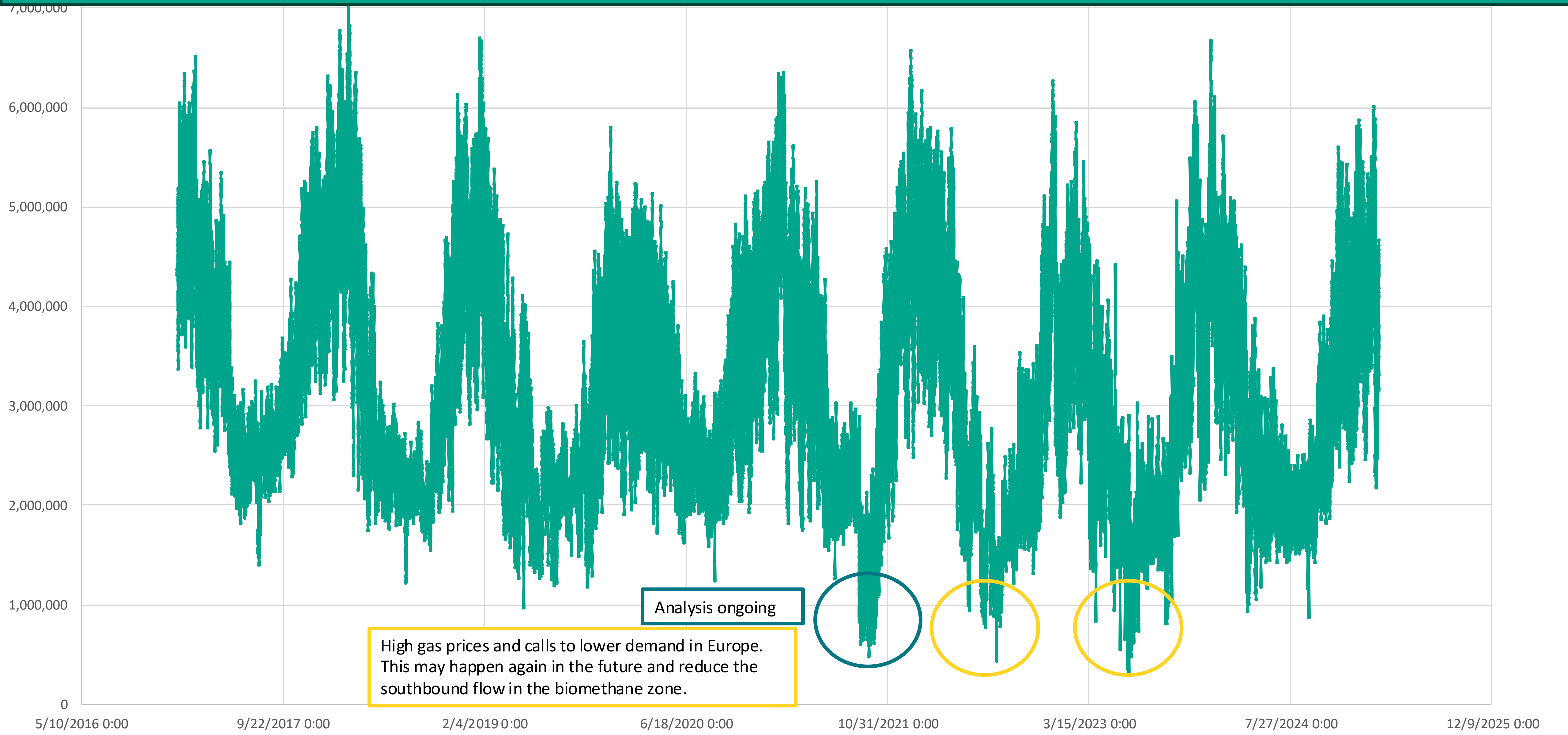
‘BIOMETHANE ZONE’ CONTINUED

Details and way forward

- Gasunie Deutschland is interested in ensuring a larger ‘biomethane zone’ than the northern part of Schleswig Holstein.
- This would increase the southbound firm capacity during the summer months.
- To address whether or not this is possible, Gasunie Deutschland is conducting an analysis on feasibility, which is currently ongoing.
- The southbound capacity will automatically be limited by the gas consumption in the ‘biomethane zone’.
- This will be seen as a mix of temperature-dependant (bFZK) and non-temperature-dependant firm products (FZK).

POTENTIAL DEMAND IN THE ZONE

(hourly base and in kWh/h)



WHY WE BELIEVE THIS IS THE BEST SOLUTION:

CONVERSION OF EXISTING METHANE PIPELINES IS KEY IN ESTABLISHING AN AMBITIOUSLY FAST AND CHEAPER HYDROGEN BACKBONE

THE SOLUTION GIVES ACCESS TO BIOMETHANE IN DENMARK, BIOMETHANE INTEGRATION IN GERMANY AND SUPPORTS DEVELOPMENT OF HYDROGEN INFRASTRUCTURE

WITH THE PROPOSED SOLUTION, WE UTILIZE REDUNDANT METHANE INFRASTRUCTURE – REMOVING A COST FROM THE METHANE SYSTEM

CREATING A BIOMETHANE ZONE IN GERMANY AND CHANGING PRESSURE FROM DK IS A COST-EFFICIENT SOLUTION – NO BIG INVESTMENTS ARE NEEDED ON EITHER DANISH OR GERMAN SIDE

BASED ON OUR BEST KNOWLEDGE AND FORECASTS, WITH THE PROPOSED SOLUTION WE OBTAIN SUFFICIENT METHANE CAPACITY BETWEEN DENMARK AND GERMANY

MARKET CONSULTATION

Following the consultation, Gasunie Deutschland and Energinet will evaluate the comments and use this in the coming work on the project

Consultation period: 2nd April – 2nd May

The consultation document is available on:

- Energinet's website (Gas News published)
- Gasunie's website

Inputs are shared between Energinet and Gasunie Deutschland.

Please send your input to gasinfo@energinet.dk and transport@gasunie.de