PORT OF SKAGEN

# DUAL PORTS
# PORT OF SKAGEN LNG PILOT

24/04/2019

**Jesper Rulffs**

PORT OF SKAGEN

# AGENDA

Interreg North Sea Region DUAL Ports
European Regional Development Fund
EUROPEAN UNION

- How far is the Port of Skagen with LNG?
- Market overview LNG in Kattegat
- Business case solutions
- Next step

# How far is the Port of Skagen with LNG

PORT OF SKAGEN

**Market overview** √

- Development in LNG fleet size
- Development in LNG fuel demand
- The LNG infrastructure in the Kattegat region

**Business case** √

**Steps chosen**

- LNG ad hoc
- LNG stationary tanks
- Small scale liquefaction

**Feasibility study**

- Economic cost and benefit
- Logistics
- LNG compared to other fuel sources

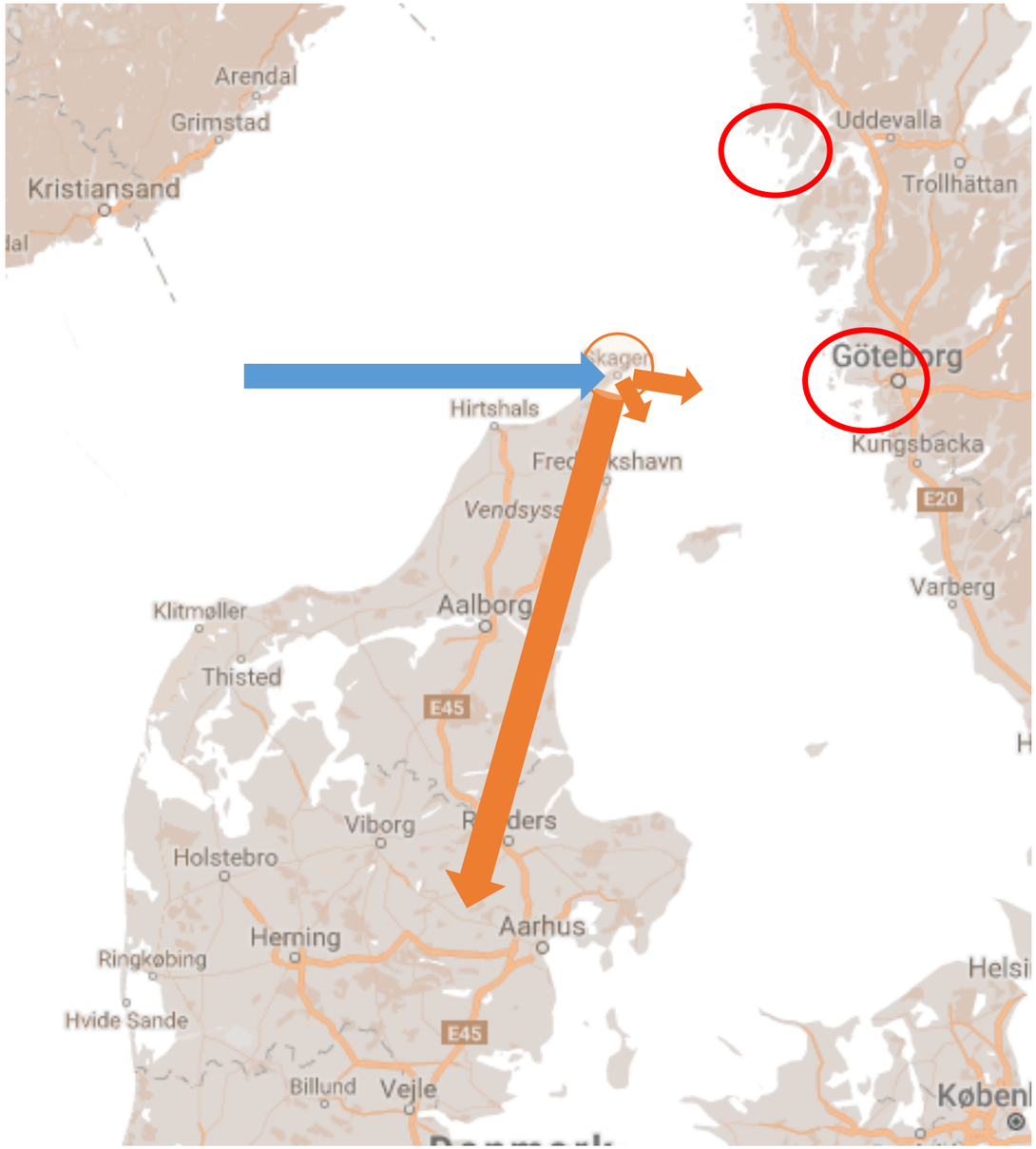
# Objectives

PORT OF SKAGEN

## How do we determined the potential?

- **The current and future level of relevant LNG vessels to**
  - Port of Skagen
  - Off Skaw
  - Traffic at the B and T route
  - Danish inland demand

- **The LNG infrastructure in the Kattegat region**



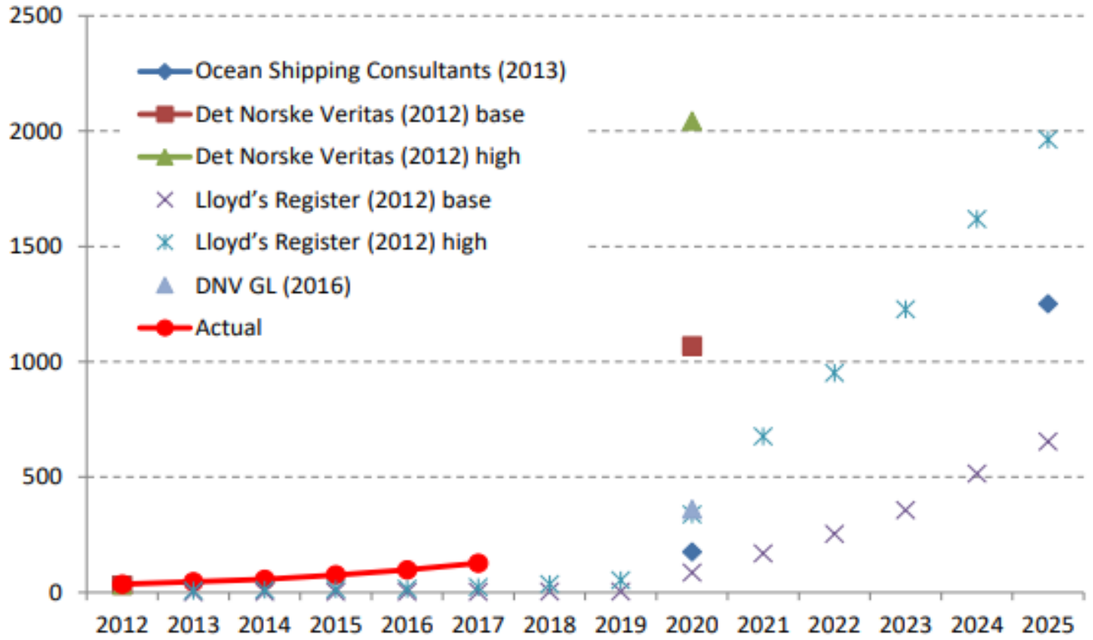
# Growth Scenarios

PORT OF SKAGEN

| LNG vessels - Global | Numbers |
|---|---|
| LNG vessels in operation, global, 2018 | 125 |
| Confirmed orders by 2025 | 136 |
| LNG ready vessels, 2018 | 111 |
| **Total by 2025 (order book)** | **372** |
| **Total by 2025 (expected, minimum)** | **800** |

Source DNV-GL

Figure 2. **Long-term forecast of LNG-fuelled fleet, number of ships**




Source: Own composition based on DNV GL (2017), Aronietis et al. (2016) and DNV GL (2016b)

## Which LNG driven vessels are relevant for the Port of Skagen?

PORT OF SKAGEN

# Development for LNG vessels in the Kattegat/Skagerrak area

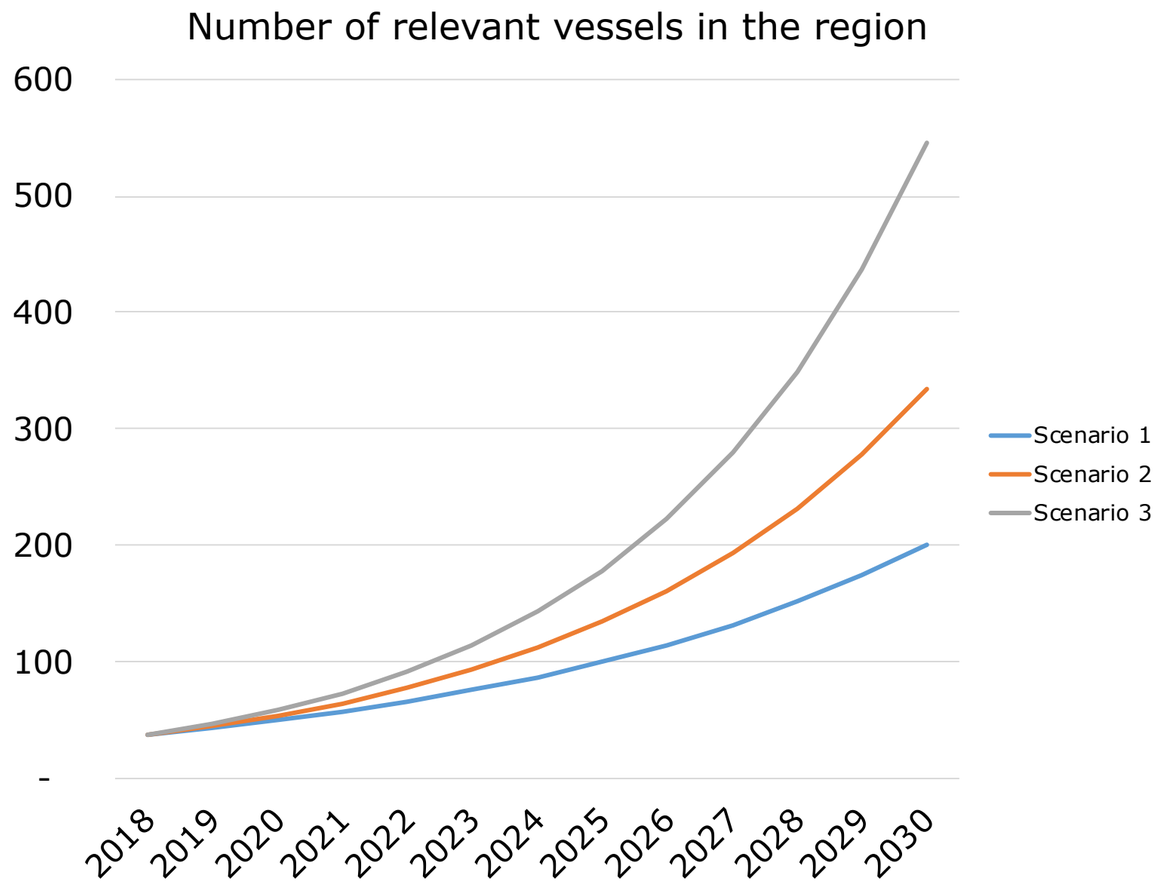
Three scenarios based on different growth assumptions about LNG fueled vessels in the Kattegat/Skagerrak area.

We looked at the growth for relevant vessels to the Port of Skagen:

- Cruise
- Oil/chemical/gas tankers
- Fishing vessels

The scenario we view as being the most probable is scenario 2 with 334 LNG fueled vessels in the region by 2030.

Of these, it's expected that 54 vessels in the scenario 2 could be using the Port of Skagen in 2020 for their LNG needs.



PORT OF SKAGEN

# Demand for LNG (Tonnes)

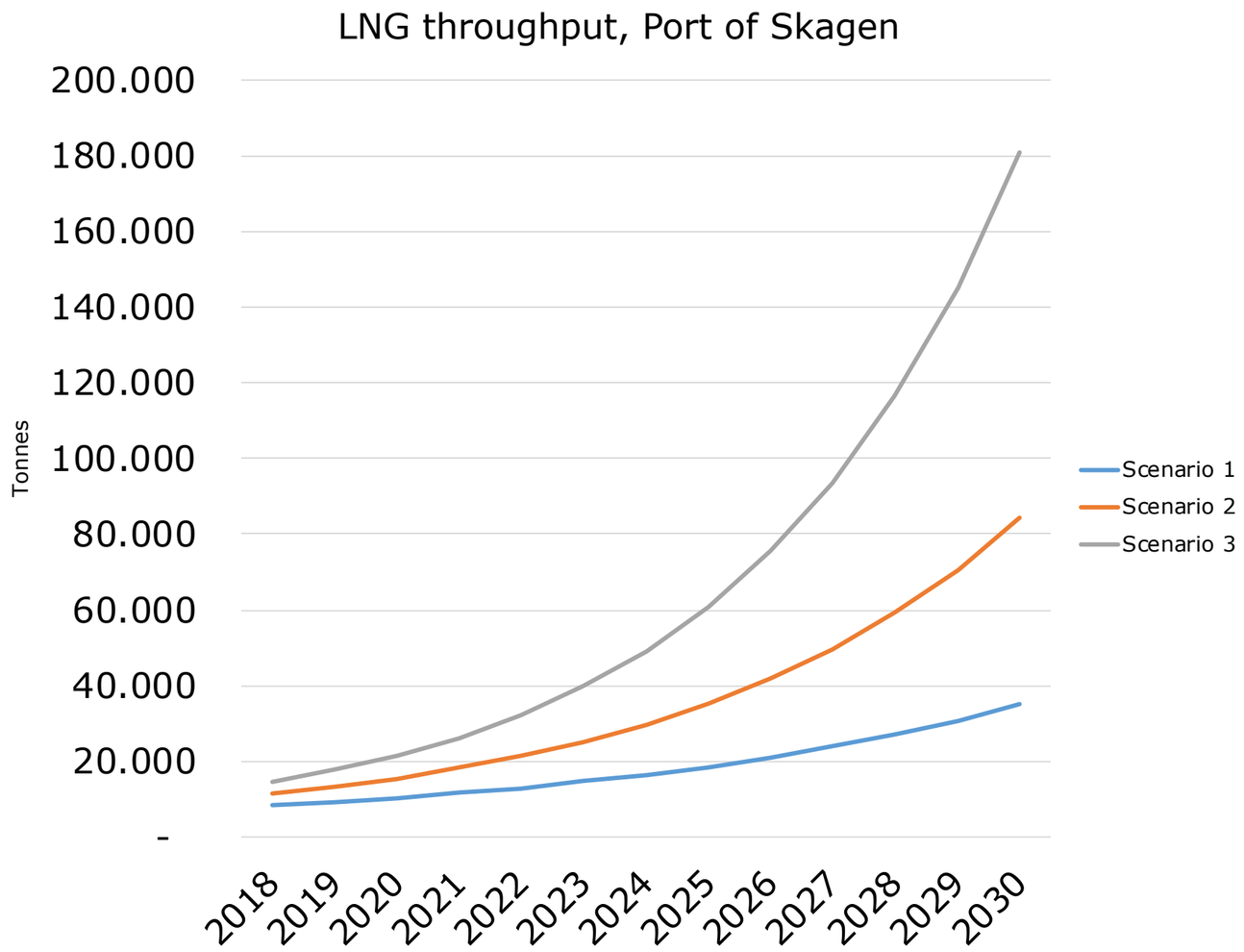
Three scenarios based on different assumptions about LNG demand in the Kattegat/Skagerrak area.

It is expected that LNG from the Port of Skagen will have a smaller market share than the current LNG supply ports or STS providers.

- Market share is set to 15% in scenario 2

This means that of the 54 LNG vessels that could be using the Port of Skagen in 2020, 8 vessels are expected to do so regularly.

The total yearly demand in 2020 for these vessels would be 15,500 tonnes LNG.



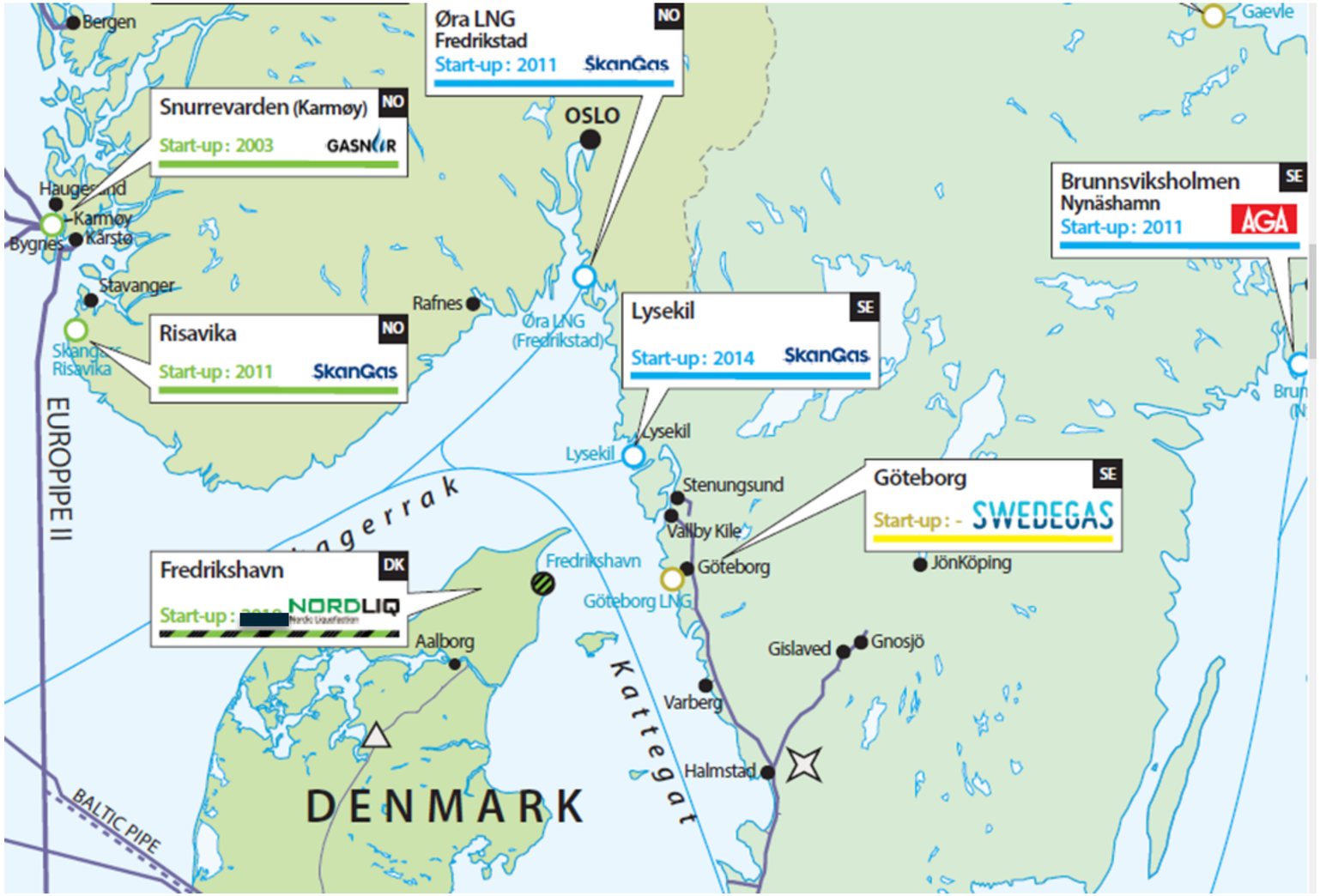
PORT OF SKAGEN

# Relevant LNG driven Vessels to bunker in the Port of Skagen

- **By 2020 an estimated 54 LNG vessels could use the Port of Skagen or Off Skaw for LNG refueling services.**
  (This does not includes returns or multiple entries to the Port of Skagen by a single vessel)
- **The most realistic potential in relation to port entry is the Cruise segment.**
- **The oil/chemical segment becomes a potential if the LNG Price from PTS can compete with STS Off Skaw.**
- **The most realistic potential in relation to Off Skaw is the oil/chemical segment.**


# LNG infrastructure in the Kattegat/Skagerrak area

PORT OF SKAGEN




https://www.gie.eu/index.php/gie-publications/maps-data/lng-map

**There is an establish LNG infrastructure in the Kattegat/Skagerrak area.**

**<u>LNG Ports in the region</u>**

- **Frederikstad**
- **Lysekil**
- **Gothenburg**
- **Risavika**

**Lack of competition in the region. Most of the LNG supply chain is operated by Skangas (part of Gasum group)**

# LNG infrastructure in the area - LNG bunker vessels

PORT OF SKAGEN

Meeting the ship owner's preference for STS

But, LNG bunker vessels will only provide their service at a minimum order (Cardissa: 250-300 m³).

The LNG bunker vessel segment is set to grow to 12 ships over the coming years (DNV-GL)

Currently 4 LNG bunker vessels are in operation in Northern Europe

| Ship name | LNG bunker capacity m³ |
|---|---|
| **Coral Methane** | 7.500 |
| **ENGIE Zeebrugge** | 5.000 |
| **Coralius** | 5.400 |
| **Cardissa** | 6.500 |


PORT OF SKAGEN

# The LNG storage capacity in the ports of the Kattegat/Skagerrak area

Very few dedicated refueling points for LNG vessels

A market that currently is centered around Gothenburg Port, which houses the largest LNG storage capacity in the Kattegat/Skagerrak region

| Operator and port | LNG bunker capacity $m^3$ |
|---|---|
| **Swedegas LNG bunker terminal Port of Gothenburg** | 33,000, when scaled up! |
| **Skangas, Terminal at Øra, Frederikstad** | 6,400 |
| **Skangas, Terminal at Lysekil** | 30,000 |
| **Skangas, Terminal at Risavika** | 28,000 |
| **Coral Methane** | 7,500 |
| **ENGIE Zeebrugge** | 5,000 |
| **Skangas Coralius** | 5,400 |
| **Shells Cardissa** | 6,500 |

# LNG price compared to traditional maritime fuel sources

PORT OF SKAGEN

In March 2019.

The cost of producing 1 tonnes of LNG (Skagen): 380 EURO/ton – 14,47 MWh – 52.092 MJ
LNG price pr. MJ: 0,0073 EURO/MJ

The cost of 1 tonnes of MGO (Rotterdam): 513 EURO/ton – 11,9 MWh – 42.840 MJ
MGO price pr. MJ: 0,0119 EURO/MJ

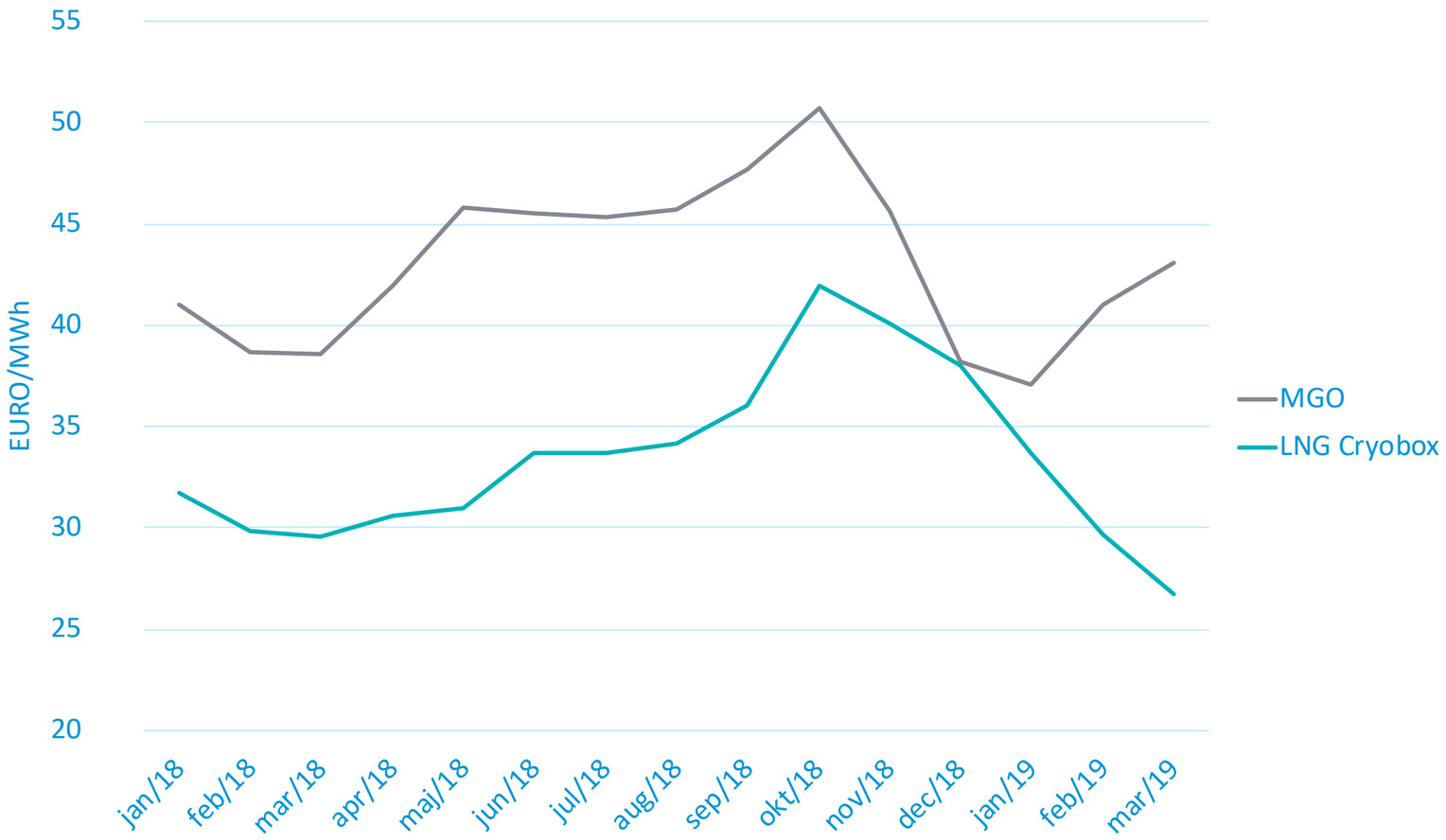
Economic factor: 1,63 in favor of LNG as fuel

BUT!
Design for tanks ($m^3$ density) factor: 1,58 in favor of MGO

If gas prices in Europe continues to decrease, the economic factor for LNG would improve and make LNG the preferred fuel source.

PORT OF SKAGEN

# LNG price compared to traditional maritime fuel sources




In 2018 gas prices soared due to the expectation of a long and cold winter.

Prices for MGO have started to increase due to OPEC agreements on limiting productions.

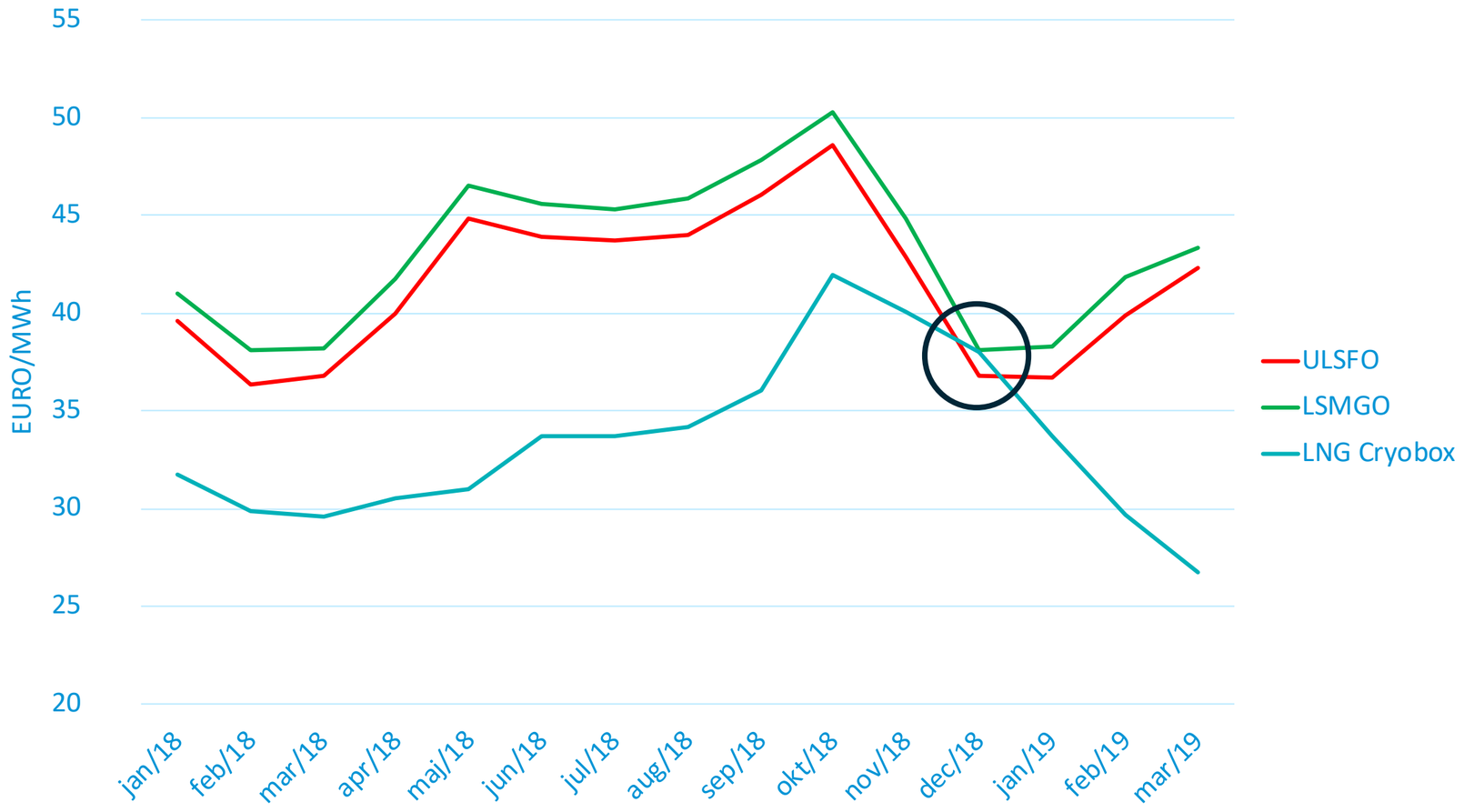
Natural gas prices in Denmark are returning to normal levels after a high 2018 with a gas price average of 0.26 €/Nm$^3$.

The normal yearly average for natural gas in Denmark since 2013 is around 0.17 €/Nm$^3$.

**BUT! Difference in density!**
LNG: 14,47 Mwh/ton – 6,75 Mwh/m$^3$
MGO: 11,9 Mwh/ton – 10,70 Mwh/m$^3$

# LNG VS. LSMGO/ULSFO

PORT OF SKAGEN




The low price in ULSFO and LSMGO in late 2018 is due to two factors

1: Low demand

2: OPEC dissagreement on production volumens.

Prices are expected to increase as 2020 regulatives will drive up demand.

# LNG price structure in the Kattegat/Skagerrak area

PORT OF SKAGEN

| STS-Ship/port | LNG delivery | Price 2018 average EURO/MWh |
|---|---|---|
| Risavika | PTS (on-site Liquefaction) | 34 |
| Coralius | STS | More than 37 |
| Cardissia | STS | More than 37 |
| Rotterdam | STS (barge) | 37 |
| Samsø | Truck (import from Rotterdam) | 45 |
| Skagen | PTS (on-site Liquefaction) | 35 |

Prices in the existing LNG infrastructure in the region is tied to the LNG prices found at the TTF gas exchange.

- Operators then add other OPEX and profit margin to the price charged to shippers.

Prices for STS operations are expected to be higher than the cost for LNG with a bunker badge in port.

- Awaiting confirmation from interviews.

It is expected that the prices in Risavika will continue to be the most competitive due to the large scale production (300.000 tons/year) and its status as a hub for LNG activities in the North Sea.

# Business Case

PORT OF SKAGEN

**A step by step methodology - four different steps that builds on top of each other**

- **Ad hoc - truck based solution**
- **LNG stationary tanks**
- **Liquefaction**
- **STS operations from or in the Port of Skagen**

**Current option that is being investigated further is the feasibility of a Liquefaction solution.**


# Liquefaction

PORT OF SKAGEN

**Costs:** Liquefaction plants comes in many different sizes.

- Kosan Crisplant can deliver a 625 tonnes/h plant with 1,000m$^3$ storage for app. 35 million Euro.
- Galileo has a 610 kg/h Cryobox production unit for app. 4 million Euro – will need additional storage

**Demand from Port of Skagen:** Secure area for a plant depending on the liquefaction solution from 1,000m$^2$ to 10,000m$^2$.

**Potential providers:** Kosan Crisplant, Nærenergi/Galileo (Cryobox), HMN naturgas


# The Strengths - Liquefaction

PORT OF SKAGEN

- An advantage for DK as LNG production country is the relatively large percentage of the biogas (from agriculture, sewage etc.)in the gas-grid

- On average 10% of DK gas is biogas and, in some regions with large agricultural activities, such as Northern Jutland, the amount of biogas in the grid is on average more than 20%.

- If the small scale option – such as Cryobox - is chosen it is an easily scalable solution.

- LNG vessels tend to bunker more often than ordinary vessels, because operating on topped off tanks are more profitable (low temp, less boil-off)

# The Weakness – Liquefaction

PORT OF SKAGEN

- Existing LNG production and bunker-network in Northern Europe
- Several large corporations are engaged - driving prices down
- The uncertainty of the Natural gas price in Denmark.
  - Some years the average is 0.20 €/$Nm^3$, in 2018 its was 0,26 €/$Nm^3$
  - The Tyra field will go offline from Nov. 2019-Jul. 2022 due to maintenance. May result in higher Danish gas price for the period.
- The social impact – large liquefication plant might spark protests from the local community.

# Local Liquefaction compared to LNG Bunker Barge

PORT OF SKAGEN

- Calculations are based on the economic of a Cryobox solution.
  - No loans or depreciations are calculated in this example.
- Average price for LNG with a LNG bunker barge in the Port of Rotterdam
  - 37 €/MWh

- Average cost of LNG at the natural gas price average of 0.26 €/$Nm^3$ in Denmark 2018.
  - 35 €/MWh at 80 % production time pr. year
- Enables a max profit margin of 5% for an operator
- Max ROI of 2,4% at a prospected LNG demand of 13,318 ton in 2018

- Had the Natural gas price been a average of 0.20 €/$Nm^3$ as in 2017:
  - 29 €/MWh
  - Max Profit margin: 26%
  - Max ROI: 11.3%

# Local Liquefaction compared to LNG Bunker Barge

PORT OF SKAGEN

- Calculations are based on the economic of a Cryobox solution.
  - No loans or depreciations are calculated in this example.
- Average price for LNG with a LNG bunker barge in the Port of Rotterdam
  - 37 €/MWh

- Cost of LNG at the natural gas price of 0.18 €/$Nm^3$ in Denmark March 2019.
  - 27 €/MWh at 80 % production time pr. year
- Enables a max profit margin of 35% for an operator
- Max ROI of 14.3% at a prospected LNG demand of 13,318 ton

- Had the Natural gas price been a average of 0.20 €/$Nm^3$ as in 2017:
  - 29 €/MWh
  - Max Profit margin: 26%
  - Max ROI: 11.3%

# Sum Up - Feasibility of LNG at the Port of Skagen

PORT OF SKAGEN

- Expected to be price competitive to STS options in the Kattegat/Skagerrak region
- Would be hard pressed on the LNG price if competition is sought directly with the Port of Risavika.
- Scalability in the small scale liquefaction options provides flexibility and reduces the risk tied to the investment.
- Feasibility is highly depended on the Natural Gas prices in Denmark

# Next Step

PORT OF SKAGEN

- **Feasibility study finalized –**
  - Cost and benefit
  - Environmental
  - Socio-economical analysis.

- **Interviews with potential operators and investors finalized**

- **How the Port of Skagen becomes LNG ready**

PORT OF SKAGEN

# THANK YOU

Jesper K. Rulffs
Business Development Manager
T: +45 9844 6911
M: +45 2429 4391
E: JKR@portofskagen.com