Modern fleet of 4 vessels
Operation @ 7 ports in NO, DK & SE
What is a green ship?
It is hard to be a pioneer
Business case (2009)

- Regulations to comply with or not?
  - SOLAS
  - EEDI?
  - Marked based instruments tax (CO2)?
  - Nox emission tax domestic trade Norway (NOX)?
  - Nox emission tax EU waters/ ECA?
  - Upcoming MARPOL annex VI regulation (ECA/SOX)?
  - Shore based rules for LNG?

- Investment BNOK 1.76 / MEUR 220
- LNG Investment Plus MNOK 400 / MEUR 50?
- Scrubber / SCR as alternatives?

- Prices of HFO/MGO as Fuel?
- Price of LNG and availability?

- Financial support from Nox Fund, to be continued?
- Financial support from EU / TEN-T / MoS?
Vessel Data LNG Ferries (Design/Installations)

**MS Stavangerfjord / MS Bergensfjord**

- Ordered 03.2010
- Converted 06.2012+
- Delivered: July 2013 & Feb. 2014
- In traffic: July 2013 & March 2014
- Length: 170 meter
- Width: 27.5 meter
- Engines: 4 x RR B25/40 PLNG
  - Engines output: 21.600 kW
  - app. 30,000 HP
- Powered by LNG
- LNG capacity 2 x 316 m3

Cruise speed: 21.5 knots
Max speed 25.0 knots
Max pax: 1 500
Crew cabins 67 (100 beds)
Passengers cabins 306 (1188 beds)
DWT: 3500
Cargo Lane meters: Up to 1600 meter
(4,5 meter free height – Reefer capacity of 30)
Cars/trailers capacity 550/90
Conference capacity: approx. 350 persons (488 m2)
Shopping area: 600 m2
Café, Skybar, Cafeteria, Restaurants & Lounge

Co-financed by the European Union
Trans-European Transport Network (TEN-T)

Supported by Norwegian NOx Fund

fjordline.com
Concept basic propulsion solution
2 x GAS Mechanical shaft lines 10.8 MW each.

10.8 MW

Consumers

Shinko (STG) 1.23 MW

2 x MAN 6L 21/33 2.4 MW

4 x Rolls-Royce B35/40 21.6 MW

PTO (SG) 1.85 MW

2 x 1.6 MW

MAN 7L 21/33 1.4 MW

Supported by Norwegian NOx Fund
Concept 2 x 316 m3 LNG tanks
Cross over system – one system able to run 4 M/E @ 85%MCR
Other fuel/gas saving & environmental installations

Rolls – Royce Promas Twisted flap rudder with hub-cap
Propeller blades and aft hull optimized

Tank tests performed at Marintek Trondheim

Waste Heat recovery 1.250 kW Shinko steam generator
CPP/Shaft generators with variable frequency for optimized PTO
Ballast Water treatment system installed
Food waste system installed
Recycling of all plastic, glass, metals, oils and cartoon.
Operational experience with LNG

**MS Stavangerfjord**
- Start service 14.07.2014
- > 350 bunker operations
- 9,300 running hours
- 181,000 nautical miles
- PBU capacity / Splashing

**MS Bergensfjord**
- Start service 17.03.2014
- > 200 bunker operations
- 5,300 running hours
- 93,500 nautical miles
- One bunker incident

Very good course keeping, manoeuvrability incl. response time, sea keeping & low LNG consumption with no smoke!
Operational experience with LNG cont.

- NOx tax reduced with 90%
- Comply to ECA & Tier III
- 50% lube oil consumption compared to HFO
- Sludge more or less ”0”
- Longer service interval on ME components (25-50%)
- Exhaust boilers free of soot
- More energy per kg/fuel
- Better environment in engine rooms
- Promas CPP/Rudder system
- WHR system production 350 - 400,000 kW/Month
- Longer bunker times at present

 Supported by Norwegian NOx Fund
Operational experience with LNG cont.

The design of the bunkering line in Risavika, Norway is shown in the schematic picture below:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bunker presentation flange</td>
</tr>
<tr>
<td>2</td>
<td>DCC tank unit</td>
</tr>
<tr>
<td>3</td>
<td>DCC hose unit</td>
</tr>
<tr>
<td>4</td>
<td>Bunker hose</td>
</tr>
<tr>
<td>5</td>
<td>Cryogenic Safety Break Away Coupling (CBC)</td>
</tr>
<tr>
<td>6</td>
<td>Pipe line flange</td>
</tr>
<tr>
<td>7</td>
<td>Crane wire (handling support)</td>
</tr>
<tr>
<td>8</td>
<td>Bunker port</td>
</tr>
</tbody>
</table>
## Environmental benefits

<table>
<thead>
<tr>
<th></th>
<th>SOX</th>
<th>NOX</th>
<th>CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ton</td>
<td>Ton</td>
<td>Ton</td>
</tr>
<tr>
<td>Estimated emission</td>
<td>452</td>
<td>1.090</td>
<td>67.000</td>
</tr>
<tr>
<td>with HFO/MGO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emissions converted</td>
<td>0</td>
<td>109</td>
<td>50.000</td>
</tr>
<tr>
<td>to LNG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less emission per</td>
<td>452</td>
<td>982</td>
<td>17.000</td>
</tr>
<tr>
<td>year per vessel</td>
<td>100%</td>
<td>90%</td>
<td>25%</td>
</tr>
<tr>
<td>Less emission &amp;</td>
<td>904</td>
<td>1.964</td>
<td>34.000</td>
</tr>
<tr>
<td>reduction 2 vessels</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supported by Norwegian NOx Fund
LNG for future
CAPEX – AVAILIABLITY - PRICE – SUPPORT – BENCHMARK ALTERNATIVES

IT’s all about money!

Who benefits most from lower oil prices trucks or short-sea shipping?
Will lower fuel prices compensate for extra fuel costs for ships from January 2015 due to SECA?
Is LNG less competitive?

The simple answer is that trucks gain most since they consume more energy.
The price of natural gas drops less than oil. This has a negative effect on the competitiveness of LNG.

Co-financed by the European Union
Trans-European Transport Network (TEN-T)

Supported by
Norwegian NOx Fund

fjordline.com
Class & Authorities @ sea/land

- Rules still under development, smaller tanks below deck?
- BDN, a commercial question?
- Focus on time – quick bunkering – good idea?
- Design of bunker stations – in respect to working environment, structure, positions of equipment as detectors, cameras and why not temp. sensors?
- Closing time of valves & Surge?
- ESD Automatically and/or manually, what’s best/quickest?
- Common cross boarder rules?
LNG Bunkring small tank Port of Hirtshals, Denmark

200 tonnes/445m³ tank capacity
Capacity of 200m³/hour
Ready for operation Q1/Q2.2015.

Supported & Co-Financed by INEA (TEN-T)
LNG Bunkering Fixed Pipe/Loading Arm Port of Risavika

6” pipe from factory storage tank
Capacity of 350m3/hour
Ready for operation Q1.2015
Support programmes are existing and available within the EU. Support program exists also for domestic trade in Norway.

Both MS Bergensfjord & MS Stavangerfjord have received support from EU/TEN-T & the NOx Fund.
ECA 2015 - one month ahead!

We’re ready
Thx 4Y Attention