LNG application for Modern ROPAX Ferries
Content:

- Presentation of Brittany Ferries.
- Presentation of STX France.
- Why looking at LNG?
  - New rules coming into force
  - Technical and economical impacts
  - What are the technical solutions for existing fleet and new-built ferries?
- Presentation of PEGASIS project
Presentation of Brittany Ferries – Key Figures

• Since 1972
• 2,400 employees
• 10 Routes
• 9 Ferries
• 2,500,000 paxs
• 200,000 freight units
• 344,000,000 € total turnover
<table>
<thead>
<tr>
<th>Ship Name</th>
<th>LOA x BOA</th>
<th>Tonnage UMS</th>
<th>Speed</th>
<th>Passenger Capacity</th>
<th>Garage Capacity</th>
<th>Year of Built</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRETAGNE</td>
<td>151 x 26  m.</td>
<td>24 534</td>
<td>21 kts.</td>
<td>2056 paxs</td>
<td>554 cars or 40 lorries</td>
<td>1989</td>
<td>HFO/MGO</td>
</tr>
<tr>
<td>BARFLEUR</td>
<td>158 x 24  m.</td>
<td>20 133</td>
<td>19.5 kts.</td>
<td>1200 paxs</td>
<td>547 cars or 75 lorries</td>
<td>1992</td>
<td>HFO/MGO</td>
</tr>
<tr>
<td>NORMANDIE</td>
<td>161 x 26  m.</td>
<td>27 541</td>
<td>20.5 kts.</td>
<td>2100 paxs</td>
<td>648 cars or 85 lorries</td>
<td>1992</td>
<td>HFO/MGO</td>
</tr>
<tr>
<td>MONT St MICHEL</td>
<td>173 x 28.5M</td>
<td>35 586</td>
<td>21 kts</td>
<td>2170 paxs</td>
<td>830 cars or 125 lorries</td>
<td>2002</td>
<td>HFO/MGO</td>
</tr>
<tr>
<td>Ship Name</td>
<td>LOA x BOA</td>
<td>Tonnage UMS</td>
<td>Speed</td>
<td>Passenger Capacity</td>
<td>Garage Capacity</td>
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<tr>
<td>FINISTERE</td>
<td>204 x 25 m</td>
<td>32 728</td>
<td>28 kts</td>
<td>1500 paxs</td>
<td>85 cars &amp; 110 lorries</td>
<td>2001</td>
<td>HFO/MGO</td>
</tr>
<tr>
<td>PONT AVEN</td>
<td>185 x 31 m</td>
<td>40 859</td>
<td>26 kts</td>
<td>2400 paxs</td>
<td>650 cars or 60 lorries</td>
<td>2004</td>
<td>HFO/MGO</td>
</tr>
<tr>
<td>COTENTIN</td>
<td>165 x 26.8</td>
<td>19 909</td>
<td>24 kts</td>
<td>213 paxs</td>
<td>120 lorries</td>
<td>2007</td>
<td>HFO/MGO</td>
</tr>
<tr>
<td>ARMORIQUE</td>
<td>165 x 26.8</td>
<td>29 468</td>
<td>24 kts.</td>
<td>1500 paxs</td>
<td>470 cars or 60 lorries</td>
<td>2009</td>
<td>HFO/MGO</td>
</tr>
<tr>
<td>NORMANDIE EXPRESS</td>
<td>98 x 28</td>
<td>6581</td>
<td>42 kts</td>
<td>860 paxs</td>
<td>280 cars</td>
<td>1999</td>
<td>MGO only</td>
</tr>
</tbody>
</table>
SHIPBUILDING AND NEW MARKETS: STX FRANCE SA

MAIN FIGURES

✓ Work Force: 2100 persons
- Managers: 20%
- White collars: 37%
- Blue collars: 43%
- Average age: 41 years
- Women: 15% of the workforce
✓ Area: 1.08 sq m
✓ Average revenue: €500 to 800

ACTIVITIES & PRODUCTS

✓ Design and fabrication of high added value ships
  - Cruise ships from 30,000 to 160,000 UMS
  - Navy ships (LHD – Logistic Support Vessels – Aircraft carriers)
  - Ferries

Saint-Nazaire
The new environmental rules coming into force

- **SOx** emissions come from Sulphur contained in Marine Fuels.
- **NOx** emissions result from internal combustion quality within the engine.

SOx and NOx have negative impact over environment, that have pushed the States to issue the following rules:

- MARPOL Annex VI from IMO
- Directive 1999/32/CE from the European Parliament
Definition of conventional Marine Fuels:

Heavy fuel oils (HFO):

- Produced from the blending of petroleum derived products based on the residues from various refinery distillation and cracking processes.
- Heavy fuel oils is used extensively in Shipping industry, because of its low cost. For Brittany Ferries, it represents 93% of the fuel used today.
- Because of its low refining level, it contains sulphur.

Marine Gas Oil (MGO):

- Petroleum derived liquid of distillate type.
- Widely used in small shipping industry and fast ships.
- It contains very little sulphur.
- Today it is about 30% more expansive than HFO.
Maximum Sulphur content in Marine fuels

**Milestones:**

1.5% ➔ 4.5% ➔ 3.5% ➔ 0.5% ➔ 0.1%

- 1st July 2010: Worldwide
- 1st July 2012: Worldwide
- 1st January 2015: Worldwide
- 1st January 2020: Worldwide

**Worldwide**

**ECA* only**

**EU waters, Pass. Ships**

**IMO**

**EU**

**EU harbours***

**EU harbours***: During calls of more than 2 hours.

*: Emission control area as defined in Marpol annex VI see next slide for EU.

**: Passenger Ships doing regular service coming from or going to an EU harbour

***: During calls of more than 2 hours.
Directive 2005/33/CE - Passengers ships - 1.5% - already applicable from 11/08/2006

Directive 2005/33/CE - All ships in EU harbour - 0.1% - already applicable from 01/01/2010

Marpol Annex VI - All Ships - SECA 0.1% starting from 01/01/2015

Maximum Fuel Sulphur content EU map
• SOx emissions are purely linked to the fuel quality

• 1.0% HFO is already made available

• 0.1% HFO will not be made available from 2015.

• 0.1% Sulphur content restriction means use of MGO.

• This rule is applicable to our existing ships sailing in ECA.

• The technology to comply with the 0.1% sulphur content by burning cheap HFO with sulphur requires extensive modifications.
### NOx limitation milestones

<table>
<thead>
<tr>
<th>Tier</th>
<th>Ships constructed on or after</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>January 1&lt;sup&gt;st&lt;/sup&gt; 2000</td>
<td>Global</td>
</tr>
<tr>
<td>II</td>
<td>January 1&lt;sup&gt;st&lt;/sup&gt; 2011</td>
<td>Global</td>
</tr>
<tr>
<td>III</td>
<td>January 1&lt;sup&gt;st&lt;/sup&gt; 2016 (*)</td>
<td>NOx ECA (*)</td>
</tr>
</tbody>
</table>

(*) To be confirmed after review in 2012
• NOx emissions are linked to the fuel combustion quality within the engine.

• The Tier III 80% NOx reduction is applicable to new built ship sailing in ECA starting from 01/01/2016.

• BF existing ships are not concerned.

• Removal of NOx remains an easier technology than removing the SOx.
Operators concerned by ECA in northern Europe
HFO = Heavy Fuel Oil, widely used in shipping industry
MGO = Marine Gas Oil, mainly used for smaller/Fast ships
Impact for Brittany Ferries caused by SOx reduction:

After 2015:

- Depending upon MGO future cost evolution, the Fuel Budget for Brittany Ferries could be:

  ➢ BETWEEN 40% and 80% COST INCREASE!!!!
Technical solution to reduce the impact

Exhaust gas cleaning (scrubber):

Principles:

• Spray of exhaust gas fume with alkaline water solution having a capacity to neutralise the acids and capture the SOx.

• Spray alkaline liquid can be sea water or fresh water mixed with caustic soda.
Technical solution to reduce the impact cont...

- Exhaust gas cleaning (scrubber)

枷Advantages:

✓ Fuel remains HFO
✓ It solves the matter for SOx emissions
✓ Retrofit on existing vessels is feasible

枷Disadvantage:

✓ Recent technology not yet proven on large units
✓ Increase of the electrical consumption
✓ Impact on the ship’s upper level arrangement
✓ Impact on ship’s stability
✓ Storage and cost of caustic soda (dangerous good)
✓ Alkaline waters are highly corrosive.
✓ Production of wastes not easy to recycle
✓ For tier III NOx reduction an additional device SCR (selective catalytic reduction) is to be fitted.
Technical solution to reduce the impact cont...

• Use of Natural Gas as marine fuel:
  
  • Made possible with recent development on Dual fuel engines, allowing flexibility to choose between gas or conventional liquid fuel without interruption of power generation.
· Use of Natural Gas as fuel:

➢ Advantages:

✓ It complies with both SOx & NOx coming legislation.
✓ It produces about 20% less CO2 for equivalent power.
✓ Design impact in the vessel upper part is minimum.
✓ No production of wastes.
✓ No additional consumables.
✓ Price of LNG expected to be comparable with HFO

➢ Disadvantage:

✓ LNG distribution network is not yet existing.
✓ Gas needs to be stored in liquefied state (−162°C)
✓ Ship’s autonomy is reduced under LNG.
✓ New rules applying to LNG passenger ships are still under development.
✓ Extremely difficult to carry out a LNG retrofit on existing ships
LNG can be seen as a best long term solution for new-built

• 5 % project cost increase for a 210m long ferry.
• Realistic providing LNG becomes available with comparable cost to HFO.

Scrubbers can be seen as best alternative for:

• Existing Ships providing scrubber unit can be reasonably well integrated.
• New-built if LNG cannot be made available.
PEGASIS PROJECT

- **Pegasus project**

  - History of the project initiated by STX France

  - Input data from Brittany ferries

  - Main Characteristics

  - Rules development for LNG passenger ships
Origin of PEGASIS project:

- PEGASIS: Power Efficient GAS Innovative Ship

- STX France has an extensive experience with LNG ships:
  
  - Between 1972 & 2006, 15 LNG carriers were built.
  
  - The three last ones built for Gaz de France, ENERGY, PROVALYS & GASELYS were the very first diesel electric gas carrier ever built.

  - In 2009, three LNG diesel electric small ferries were delivered to Norwegian company Tide Sjø.
PEGASIS PROJECT

LNG carrier PROVALYS 154 000 m³ capacity, among the very first LNG diesel propulsion gas carrier ever built in the world.

Ferry Nessoden built for Tide Sjø, powered by both diesel and gas.
In 2010 a research program was initiated by STX France for a LNG application on larger passenger vessel sailing in ECA.

Brittany Ferries became a partner for that study.

The idea of that pre-project is to develop a ferry project able to sail on short international voyage within ECA, on our most demanding commercial routes in terms of speed and autonomy.

- Check the feasibility of LNG delivery and running cost at full scale.
- Develop a design with available existing gas rules and participate actively with regulatory bodies to the issue of the new coming IGF.
- By doing the development on the most demanding criteria, it will push the design far enough to make the ship’s platform easily adaptable for other less demanding routes.
PEGASIS PROJECT

- **Design input data from Brittany Ferries**

  - PEGASIS is to be designed to sail on the same routes as PONT AVEN. U.K, Spain, France, and Ireland.

  - PEGASIS should have the same hotel capacity as PONT AVEN, but with larger garage.

  - PEGASIS should accommodate to double link span.

  - PEGASIS should have better energy efficiency, same speed for less power.

  - PEGASIS should offer improved seaworthiness and comfort at sea.
### General Characteristics PONT–AVEN Vs PEGASIS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>PONT AVEN</th>
<th>PEGASIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Tonnage</td>
<td>40859 GT</td>
<td>52500 GT</td>
</tr>
<tr>
<td>Length Over All</td>
<td>185 m</td>
<td>210 m</td>
</tr>
<tr>
<td>Moulded beam</td>
<td>30,9 m</td>
<td>31 m</td>
</tr>
<tr>
<td>Draft</td>
<td>6,8 m</td>
<td>6,8 m</td>
</tr>
<tr>
<td>Service speed</td>
<td>25 knts</td>
<td>25 knts</td>
</tr>
<tr>
<td>Propulsive power</td>
<td>43 MW</td>
<td>34 MW</td>
</tr>
<tr>
<td>Garage capacity</td>
<td>650 cars + 12 UF</td>
<td>650 cars + 40 UF</td>
</tr>
<tr>
<td>Passengers</td>
<td>2400</td>
<td>2400</td>
</tr>
<tr>
<td>Pax Cabins</td>
<td>652</td>
<td>649</td>
</tr>
<tr>
<td>Public spaces</td>
<td>4900 m² env.</td>
<td>4500 m²</td>
</tr>
</tbody>
</table>
Rules development for LNG passenger ships

- Code IGF (international gas code for ships)
  - Passenger LNG vessel will be considered.
  - We foresee application for SOLAS 2014.

- Main outlines:
  - LNG is to be stored within B/5
  - Storage of LNG on outside deck
  - Possibility to use mobile LNG containers
  - Application of Gas Safe Machinery Spaces:
    » Gas pipes are to be completely enclosed by double pipe or duct.
THANK YOU FOR YOUR ATTENTION