NYK’s Activities in Pursuing LNG Fuel Supply

February 20th, 2020

NYK ENERGY TRANSPORT (USA) INC.
1. Trends in Environmental Regulations

2. NYK’s View of the LNG-Fuel Market

3. NYK’s Activities in the LNG-Fuel Market
Environmental Merit of LNG fuel

SOx 100%

CO2 20-30%

NOx 80%

PM 100%

EGR: Exhaust Gas Recirculation
Environmental Regulation in Shipping

**Agreed in IMO MEPC 72 (Apr 2018)**
- To reduce **CO2** emissions per transport work by 40% by 2030, pursuing efforts towards 70% by 2050.
- To reduce the total annual **GHG** emissions by 50% by 2050

**Proposed in IMO MEPC 73 (Oct 2018)**
- To accelerate application of **EEDI Phase 3** to Jan 2022 for general cargo ships and container ships
- To increase the threshold of **EEDI Phase 3** to 40% for container ships

**Agreed in IMO MEPC 74 (May 2019)**
- To accelerate application of **EEDI Phase 3** to Jan 2022 for general cargo ships and container ships
- For larger container ships, the EEDI reduction rate is enhanced to max. 50%.

ECA: Emission Control Areas
EEDI: Energy Efficiency Design Index
MEPC: Marine Environment Protection Committee
LNG – Best Choice to Reduce Emissions

LNG Fuel is a Valuable & Long-lasting Option for the Maritime Industry

**Year 2022-2025:**
**EEDI Phase 3**
LNG: Best alternative to comply with EEDI Phase 3 (Reduce CO2 by 20-30%)

**Toward 2050**
IMO’s Target: Reduce Total Emissions by 50%

**Year 2020:**
**Global Sulfur Cap**
LNG: No SOx or Particular (plus reduce NOx by 80%)

**Beyond 2030:**
LNG: Bridging solution to New Alternatives
(e.g. Co-combustion of LNG and Hydrogen, Natural gas reforming)
1. Trends in Environmental Regulations

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Supply side is ready to cover major ports by 2020-2021
# List of LNG Bunkering Vessels

## In Operation – Total 12 vessels

<table>
<thead>
<tr>
<th>Year</th>
<th>Vessel Name</th>
<th>Operator</th>
<th>Main Port</th>
<th>Tank (M3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>Seagas</td>
<td>Nauticor</td>
<td>Stockholm</td>
<td>180</td>
</tr>
<tr>
<td>2017</td>
<td>Engie Zeebrugge</td>
<td>Gas4Sea</td>
<td>Zeebrugge</td>
<td>5,100</td>
</tr>
<tr>
<td>2017</td>
<td>Cardissa</td>
<td>Shell</td>
<td>Rotterdam</td>
<td>6,500</td>
</tr>
<tr>
<td>2017</td>
<td>Coralius</td>
<td>Gasum</td>
<td>Baltic Sea</td>
<td>5,800</td>
</tr>
<tr>
<td>2018</td>
<td>Oizmendi</td>
<td>Cepsa</td>
<td>Bilbao</td>
<td>600</td>
</tr>
<tr>
<td>2018</td>
<td>Coral Methane</td>
<td>Shell</td>
<td>North Sea</td>
<td>7,500</td>
</tr>
<tr>
<td>2018</td>
<td>Clean Jacksonville</td>
<td>JAX LNG</td>
<td>Jacksonville</td>
<td>2,200</td>
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<tr>
<td>2018</td>
<td>Kairos</td>
<td>Nauticor</td>
<td>Baltic Sea</td>
<td>7,500</td>
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<tr>
<td>2018</td>
<td>FlexFueler 001</td>
<td>Titan LNG</td>
<td>Amsterdam</td>
<td>1,480</td>
</tr>
<tr>
<td>2019</td>
<td>LNG London</td>
<td>Shell</td>
<td>Rotterdam</td>
<td>3,000</td>
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<tr>
<td>2019</td>
<td>Jeju LNG 1</td>
<td>KOGAS</td>
<td>Busan</td>
<td>7,500</td>
</tr>
<tr>
<td>2020</td>
<td>FlexFueler 002</td>
<td>Titan LNG</td>
<td>Antwerp</td>
<td>1,480</td>
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</tbody>
</table>

## Under Construction – Total 16 vessels

<table>
<thead>
<tr>
<th>Year</th>
<th>Vessel Name</th>
<th>Operator</th>
<th>Main Port</th>
<th>Tank (M3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>Q-LNG 4000</td>
<td>Q-LNG / Shell</td>
<td>Elba-Florida</td>
<td>4,000</td>
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<tr>
<td>2020</td>
<td>TBN</td>
<td>TOTAL</td>
<td>*ARA</td>
<td>18,600</td>
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<tr>
<td>2020</td>
<td>TBN</td>
<td>Gazpromneft</td>
<td>Baltic Sea</td>
<td>5,800</td>
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<tr>
<td>2020</td>
<td>TBN</td>
<td>ENN</td>
<td>Zhoushan</td>
<td>8,500</td>
</tr>
<tr>
<td>2020</td>
<td>TBN</td>
<td>Central LNG</td>
<td>Nagoya, Japan</td>
<td>3,500</td>
</tr>
<tr>
<td>2020</td>
<td>TBN</td>
<td>Ecobunker</td>
<td>Yokohama, Japan</td>
<td>2,500</td>
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<tr>
<td>2020</td>
<td>TBN</td>
<td>Eesti Gas</td>
<td>Baltic Sea</td>
<td>6,000</td>
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<tr>
<td>2020</td>
<td>TBN</td>
<td>Petronas (from Avenir)</td>
<td>Pengerang</td>
<td>7,500</td>
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<tr>
<td>2020</td>
<td>TBN</td>
<td>FueLNG</td>
<td>Singapore</td>
<td>7,500</td>
</tr>
<tr>
<td>2021</td>
<td>TBN</td>
<td>Pavilion/TOTAL</td>
<td>Singapore</td>
<td>12,000</td>
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<tr>
<td>2021</td>
<td>TBN</td>
<td>Avenir LNG</td>
<td>Oristano</td>
<td>7,500</td>
</tr>
<tr>
<td>2021</td>
<td>TBN</td>
<td>CNOOC</td>
<td>China</td>
<td>6,000</td>
</tr>
<tr>
<td>2021</td>
<td>TBN</td>
<td>CNOOC</td>
<td>China</td>
<td>12,000</td>
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<tr>
<td>2021</td>
<td>TBN</td>
<td>TOTAL</td>
<td>Marseille</td>
<td>18,600</td>
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<tr>
<td>2021</td>
<td>TBN</td>
<td>Titan LNG</td>
<td>ARA</td>
<td>8,000</td>
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<tr>
<td>2022</td>
<td>TBN</td>
<td>Shell</td>
<td>Med Sea</td>
<td>18,000</td>
</tr>
</tbody>
</table>

Source: Made by NYK based on public information

*ARA: Amsterdam, Rotterdam, Antwerp
LNG-fueled Vessels Delivered or On Order

100 new ships have been added over the 2018 year

Source: Japan Marine Science Inc.

+ 140 "LNG Ready" Ships (as of March 2019)
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Multifaceted NYK: An LNG-fuel Supplier and Consumer

Pursuing LNG Fuel Supply is in line with NYK’s Corporate Strategy: Expanding new businesses and implementing Digitalization and Green Initiatives

Consumer: Buying fuel for more than 700 ships

Supplier: Developing LNG-fuel supply projects since Oct. 2011
LNG-Fuel Project Development Timetable

Two Regions are the Basis for the Next Step

- **North Europe**: Launched a project in Zeebrugge, Belgium together with Mitsubishi Corporation and Engie, capturing the demand in the market for LNG as a marine fuel
- **Japan**: The first LNG-fuel-supply project in Nagoya, starting operation in 2020

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<tbody>
<tr>
<td><strong>North Europe</strong></td>
<td>Zeebrugge Project</td>
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<td></td>
<td></td>
<td>Establishe d JV</td>
<td>UECC's Car Carriers deliv ered</td>
<td>Engine Zeebrugge delivered</td>
<td>Start LNG supply to Equinor</td>
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<tr>
<td><strong>Japan</strong></td>
<td>1. LNG Fueled Tug &quot;Sakigake&quot;</td>
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<td></td>
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<tr>
<td></td>
<td>2. Nagoya Project</td>
<td>Ship Construction</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>Ship Construction</td>
<td>1. LNG Fueled Tug &quot;Sakigake&quot; delivered</td>
<td></td>
<td>2. Start New Project in Nagoya</td>
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World’s 1st LNG-fueled Pure Car and Truck Carriers (PCTC)

- **1st Vessel Name:** AUTO ECO
- **2nd Vessel Name:** AUTO ENERGY
- **Owner:** United European Car Carriers (Owned by Wallenius Lines and NYK)
- **Delivery:** 2016 from NACKS shipyard in China
- **LNG Tank:** 800m³ (Type-C)
- **LOA:** 181m
- **Beam:** 30m
- **Depth:** 30.22m
- **Draft:** 9.6m
- **GRT:** 42,424ton
- **Car Capacity:** 3,985 units
- United European Car Carriers (UECC), jointly owned by Wallenius Lines and NYK, has signed a contract to construct two new generation PCTCs with China Ship Building Trading Co., Ltd and Jiangnan Shipyard Group Co. Ltd. The new building contract also has options for two additional vessels, and the first vessel is planned for delivery in 2021. (March, 2019)

- UECC goes for third battery hybrid LNG PCTC
Close on the heels of their call for two new battery hybrid LNG PCTCs, UECC has confirmed an option with China Ship Building Trading Co., Ltd and Jiangnan Shipyard Group Co. Ltd. for a third battery hybrid LNG vessel, this time slated for UECC’s Atlantic short sea trade. (October, 2019)
LNG Bunkering Vessel - ENGIE ZEEBRUGGE

ENGIE ZEEBRUGGE is jointly owned by ENGIE, Mitsubishi Corporation, Fluxys and NYK. With an LNG capacity of 5,000 m³, she services all types of shipping customers in Northern Europe from her home port of Zeebrugge, under the brand **GAS4SEA**.

- **Delivery:** February 2017
- **Yard:** Hanjin Heavy Industries
- **Port of Registry:** Zeebrugge
- **Flag:** Belgium
- **Classification:** Bureau Veritas

**Principal Particulars**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Length o.a.</td>
<td>107.6 m</td>
</tr>
<tr>
<td>Breadth</td>
<td>18.4 m</td>
</tr>
<tr>
<td>Draft</td>
<td>4.7 m</td>
</tr>
<tr>
<td>Gross Ton</td>
<td>7,403 ton</td>
</tr>
</tbody>
</table>

**Main Propulsion**

- Engines: 2 x Wärtsila 9L20DF
- 2 x controllable pitch propellers
- 2 bow thrusters

**Cargo**

- 2 IMO type C LNG tanks for a **total capacity of 5,100 m³**
- LNG pumps: 2 per tank
- Max. discharge rate: 600 m³/h
LNG Transfer System

- 2 sets of manifolds (midship and fore parts) with a L-V-L configuration to avoid crossing lines in any configuration

- 2 cargo hose handling cranes

- Flexible hoses: 6” liquid and vapor return lines, with ERC (Emergency Release Coupling) and QCDC (Quick Connect / Disconnect Couplings)

- Max bunkering rate is 600 m³/h, but it is highly dependent on the client vessel piping and conditions

- Redundancy of the pumps (2 per tank)
Zeebrugge Project

As of 2017:
Start of ship-to-ship operations for UECC vessels in the port of Zeebrugge (Belgium)

February 2017: Delivery of LBV

June 2014: Order of first purpose-built, 5,000 cm capacity LNG bunkering vessel (LBV) from Hanjin Heavy Industries & Construction Co. Ltd. (Korea)

2014: “Framework Agreement” between Engie, Mitsubishi Corporation, and NYK Line for LNG bunker supply business development

September 2016: Launch of Gas4Sea Brand

October 2017: Gas4Sea selected by Equinor for LNG bunkering in Rotterdam

As of 2020: Start LNG Fuel Supply to Equinor Vessels
Japan’s 1st LNG-fueled Tugboat “Sakigake”

The project is subsidized by the Japanese Government (*MLIT) and Class NK

- **Built**: 31st August 2015
- **Yard**: Keihin Dock K.K. (an affiliate company of NYK)
- **Engine**: Niigata Power Systems Dual Fuel engine
- **Operator**: Wing Maritime Service K.K. (an affiliate company of NYK)
- **Operating Area**: Yokohama, Kawasaki
- **Bunkering Operation**: Half-monthly, Truck to Ship

*MLIT: Ministry of Land, Infrastructure, Transport and Tourism
Nagoya Project – History

NYK and partner companies established Central LNG Marine Fuel Japan and Central LNG Shipping Japan in 2018.

Joint Study
26 Jan 2018
Commenced joint study of ship-to-ship bunkering biz in Chubu area of Japan

Foundation
10 May 2018
Founded two JVs, Central LNG Marine Fuel, Central LNG Shipping

Shipbuilding Contract
6 July 2018
JV signed a shipbuilding contract with Kawasaki Heavy Industry (“KHI”)
This LNG Bunkering Vessel, which is scheduled to be delivered around September to December 2020, will become the first to be operated in Japan.

- LOA: 81.7 m
- Beam: 18 m
- Depth: 7.8 m
- Draft: 4.8 m
- GT: 4,100
- Registration: Japan
- Tank Capacity: 3,500 m³
- ME Power: 770 kw
- Transfer Rate: 500 m³/h

Presented by Kawasaki Heavy Industries
Nagoya Project – Bunkering Image

① LNG Loading at JERA Kawagoe Plant
   • Takes around 7 hours including cool down

② Navigation from Kawagoe to client vessels
   (④ From client vessels to Kawagoe)

③ Ship-to-ship bunkering during loading/discharging of client vessels
Nagoya Project – Bunkering Image

- ESD (Emergency Shut Down) Valve
- Hose (6”) 15m
- ERC (Emergency Release Coupling)
- Reducer 8”⇒6”
- QCDC (Quick Connect / Disconnect Couplings)
NYK Places Order for World’s Largest LNG-fueled PCTC

“NYK has placed an order for the world’s largest pure car and truck carrier (PCTC) capable of navigating oceans with only LNG as the main fuel. A keel laying ceremony was held on September 20 at Shin Kurushima Toyohashi Shipbuilding Co. Ltd. The ship is scheduled to be delivered in 2020 and will be the first large LNG-fueled PCTC to be built in Japan.

To minimize a reduction in vehicle loading capacity caused by the installation of LNG fuel tanks, in addition to optimizing major items such as ship width, several designs for maximizing the cargo loading space will be implemented, and the new vessel will be able to transport approximately 7,000 units (standard vehicle equivalent) per voyage.
Kyuden signs agreements with NYK for the World’s First LNG-fueled Large Coal Carrier

Kyushu Electric Power Co., Inc. (“Kyuden”) has engaged in long term transport agreements by deploying the world’s first LNG-fueled large coal carriers with NYK to import coal to Kyuden’s coal-fired power plants.

The LNG used for Kyuden’s thermal power plants will be supplied to the vessels as fuel at Kyuden’s loading facility, in other words on a shore-to-ship basis.

<LNG fuel supply overview>
The LNG will be supplied using shore LNG loading facility.
Thank You!

Please send your inquiries about LNG Fuel to:

NYK Line
Green Business Group, Clean Fuel Business Team
Email: NYKJP.Green.Business-G.Clean.Fuel.Business-T@nykgroup.com