Small scale LNG chains

Björn Munko
TGE Marine Gas Engineering is one of the world’s leading engineering contractors specialising in gas carriers, offshore units and LNG fuel gas systems.

Almost 40 years of experience with more than 200 gas carrier systems contracted.

The Group History:
- 1980: founded as “Liquid Gas International” (LGI)
- 1993: acquired by Tractebel/Suez, renamed to “Tractebel Gas Engineering”
- 2006: MBO supported by Caledonia Investment and Gasfin Investment, renamed to “TGE Marine Gas Engineering” (Holding: “TGE Marine AG”).
- 2015: Mitsui E&S (MES-S) acquired TGE Marine

Shareholder: Mitsui E&S (MES-S)

Address: Mildred-Scheel-Straße 1, 53175 Bonn, Germany

Web: [www.tge-marine.com](http://www.tge-marine.com)
### Small LNG carriers - History

<table>
<thead>
<tr>
<th>Carrier Size</th>
<th>Owner</th>
<th>Yard</th>
<th>Classification</th>
<th>Completion</th>
<th>TGE’s Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7,500 m³ LNG/LEG carrier:</strong></td>
<td>Anthony Veder</td>
<td>Remontowa</td>
<td>BV</td>
<td>2009</td>
<td>- cargo system</td>
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<td>- fuel gas system</td>
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<td>- cargo tanks</td>
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<td></td>
<td></td>
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<td>- ship design</td>
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<td><strong>16,500 m³ LNG carrier:</strong></td>
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<td>BV</td>
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<td>- fuel gas system</td>
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<td><strong>30,000 m³ LNG carrier:</strong></td>
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<td>CCS</td>
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<td></td>
<td></td>
<td>- fuel gas system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- cargo tanks</td>
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</table>
### LNG bunker vessels

<table>
<thead>
<tr>
<th>Owner</th>
<th>Cardissa</th>
<th>Engie Zeebruegge</th>
<th>Coralius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard</td>
<td>STX, Korea</td>
<td>Hanjin, Korea</td>
<td>Royal Bodewes, The Netherlands</td>
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<tr>
<td>Classification</td>
<td>LR</td>
<td>BV</td>
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<tr>
<td>Completion</td>
<td>2017</td>
<td>2017</td>
<td>2017</td>
</tr>
</tbody>
</table>
| TGE’s Scope            | - gas handling system  
- fuel supply system  
- complete tanks | - gas handling system  
- fuel supply system  
- complete tanks | - gas handling system  
- fuel supply system  
- complete tanks |

- **Cardissa**
  - Owner: Shell
  - Yard: STX, Korea
  - Classification: LR
  - Completion: 2017
  - TGE’s Scope: - gas handling system  
    - fuel supply system  
    - complete tanks

- **Engie Zeebruegge**
  - Owner: Engie, Mitsubishi, NYK
  - Yard: Hanjin, Korea
  - Classification: BV
  - Completion: 2017
  - TGE’s Scope: - gas handling system  
    - fuel supply system  
    - complete tanks

- **Coralius**
  - Owner: Sirius Veder Gas AB
  - Yard: Royal Bodewes, The Netherlands
  - Classification: BV
  - Completion: 2017
  - TGE’s Scope: - gas handling system  
    - fuel supply system  
    - complete tanks
### The Small Scale LNG Fleet

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Capacity</th>
<th>Year</th>
<th>Owner/Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kayoh Maru</td>
<td>1,517</td>
<td>1988</td>
<td>Daiichi Tanker Co.</td>
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<tr>
<td>Aman Bintulu</td>
<td>18,928</td>
<td>1993</td>
<td>MISC</td>
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<tr>
<td>Surya Aki</td>
<td>19,474</td>
<td>1996</td>
<td>MOL</td>
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<tr>
<td>Aman Sendai</td>
<td>18,928</td>
<td>1997</td>
<td>MISC</td>
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<tr>
<td>Aman Hakata</td>
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<td>1998</td>
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<td>Surya Satsuma</td>
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<td>2000</td>
<td>MOL</td>
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<tr>
<td>Shinju Maru No.1</td>
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<td>Shinwa Marine</td>
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<td>Pioneer Kutsen</td>
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<td>2004</td>
<td>Knutsen Shipping</td>
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<td>North Pioneer</td>
<td>2,512</td>
<td>2005</td>
<td>Japan Liquid Gas</td>
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<td>Sun Arrows</td>
<td>19,100</td>
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<td>Kakurei Maru</td>
<td>2,536</td>
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<td>Shinju Maru No.2</td>
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<td>Norgas Unikum</td>
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<td>Engie Zebrugge</td>
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<td>Clean Jacksonville</td>
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<td>Flex-Fueler</td>
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<tr>
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<td>Stolt</td>
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<tr>
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<td>NB Hudong</td>
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<tr>
<td>VT Halter</td>
<td>4,000</td>
<td>2020</td>
<td>QLNG</td>
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</tbody>
</table>

**- LNG carriers with type C cargo tanks – (25 out of 36)**
Small Scale LNG

- Oversupply of LNG paves the way for new market opportunities
- Oil price is rising
- Small scale LNG structures are emerging
- Distribution to previously unexploited markets
  - by small size LNG carriers
  - Large parcels to FSU’s
- LNG molecule owners = electrical power suppliers (LNG to power)
16,000 m³ LNG-FLSU:
- Owner: Exmar Group, Belgium
- Yard: Wison Offshore & Marine Ltd, China
- Classification: BV
- Completion: 2016
- Scope: Complete gas handling system for loading and unloading, cargo tanks
- Process liquefaction package: Contracted to Black & Veatch by Wison

126,000 m³ LNG FSRU (conversion):
- Conversion of LNGC ‘Suez Matthew’ to an FSRU with 250 t/h send-out capacity at 90 bar send-out pressure
- Owner: GDF Suez, France
- Classification: LR
- Scope: Design and supply of the regasification system and integration into the cargo system
- Status: Project has been put hold after completion of the detail design and order of long lead items
- Year: 2006
Small Scale LNG FS(R)Us

- Complete FEED Study for a 25,000 cbm LNG FSRU for the Caribbean with ambient air vaporizers for GASFIN and GDF-Suez

- FEED Study and tender design for a 20,000 cbm LNG FRU with possible FSU application for GASFIN and Trafigura

- Involvement in the majority of Re-gas barge tenders for small to mid-scale LNG applications

- FEED study and tender design for a 28,000 cbm LNG FSRU for African coast

- Sizes from 5,000 cbm up to 80,000 cbm
• Peak send-out: 200 t/h
• Nominal send-out: 150 t/h
• Max. send-out pressure: 100 bar g
• Min. send-out pressure: 20 bar g
• Design sea water temp.: 11°C
• Send out at low SW temperatures with additional boilers
• Electricity generated with natural gas fuelled gensets
• Tank design (pressure vessels) increases operational flexibility
• Liquid send-out to shore or other ship
Sea Water Intermediate Cycle

- High flexibility
- Integration of additional heat source
- Low risk of freezing
- Combination of standard components
- Additional trains for future expansion can be considered
25,000 cbm – FSRU

- Send out to subsea pipeline via flexible risers
- Regasification using air vaporizers (no environmental impact)
- Electricity generated with natural gas fuelled gensets
- 20+ year docking interval, designed to remain on site during severe weather conditions
- Tank design (pressure vessels) increases operational flexibility
- High redundancy with minimal maintenance
- Length: 106m; width: 39m; depth: 20m; draft 7m
- Send out: max. 50t/h, normal 25t/h @ 14 bar (battery limit)
- Size of shuttle tanker: Min. 20,000 m³ (and backup option)

TGE Marine performed the FEED for the shuttle tankers and the FSRU (hull, marine and cargo systems)
Type C tanks

- Self supporting pressure vessel
- Cylindrical or bilobe with outside insulation
- No secondary barrier required
- No restriction concerning partial filling
- Design pressure: 3 – 5 barg
- Pressure built up capacity as back up for BOG handling during no-send-out case
- Tank design temperature -163°C
- Tank material
  - 9% Ni-steel
  - SS AISI 304L
- Delivery of complete tanks ready for installation by TGE → high flexibility on yard selection

TGE Marine Gas Engineering
Flexibility - Mooring and Storage

- Pile moored with FSU
- Pile moored without FSU
- Jetty moored with FSU
- Jetty moored without FSU
Combining LNG FSRU’s with floating power barges

Flexible solutions for areas with limited access to gas

Can serve as a quick interim solution for developing energy markets

Minor environmental impact

Waste heat from the power barge can be utilized on the FSRU

Moored as unit or remotely (suitable solution for shallow draft areas)

Design can be adapted according to the needs of the customer
• TGE’s sister Company “BWSC”
• Natural Gas, Dual-Fuel or HFO/LFO fuels
• 60-150 MW
• Industrial installation on marine classed deck barge
• Radiator cooling instead of SW cooling to minimise environmental impact and improve the reliability of power supply
• Oily water treatment on-board
• Shallow draft
• From stand-by to full load in less than 7 minutes
LNG is a versatile resource

New technical solutions enable the wider use of LNG and open new markets

Environmental friendly solutions are chosen in order to promote the idea of green energy

Regulations will push the demand for "cleaner" energy further

FSRUs and power barges will provide flexible and clean solutions to create electrical power

TGE Marine is the market leader for tanks and cargo handling system for LNG bunker vessels based on number of vessels & diversity of Systems
Thank you for your kind attention
For further information please email:

sales@tge-marine.com

www.tge-marine.com