Shipping LNG from a Remote Arctic Plant

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YAMAL LNG, a Pilot Project in the Arctic – Some Key Features

- LNG Plant located in Sabetta, North-East of the Yamal Peninsula, Russia
- Arctic conditions (Temperatures -52°C / 3 months of polar night)
- Ice free port: 5 months
- South Tambey Gas-Condensate Field: exploration and development license until 2045
- Reservoirs: 1000–3500 m deep
- Proved & Probable Reserves: 926 billion cubic meters of natural gas

Source: Public information

<table>
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<tr>
<th>Shareholders</th>
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<td>Silk Road Fund 9.9%</td>
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<td>TOTAL 20.0%</td>
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<td>CNPC 20.0%</td>
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<td>NOVATEK 50.1%</td>
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- Wells: 208 directional and horizontal
- Capacity: 3 x 5.5 MMtpa + 1 x 0.94 MMtpa LNG, 1.2 MMtpa Condensates
- Capex: 27 G$ (Yamal LNG)
- Construction Status: Trains 1,2,3 started (nameplate 16.5 Mtpa) T4 pilot under construction
- Shipping: 15 ARC7 LNG Carriers, 11 Conventional LNGCs, 2 ARC7 Condensate tankers
- Trans-shipment capacity in Zeebrugge and Ship-to-Ship Transfers
- LNG Deliveries: Asia, Europe
An Integrated Project:

- Presidential decree on October 10th, 2010
- Final Investment Decision on December 13th, 2013

with Pioneering Solutions in field of logistics and transportation schemes:
The Shipping Scheme for the Export of LNG

**Westbound**: annual ice
Average ice extension: 830 Nmiles / 2,900 Nm – 7/9 days

**Year Round Route**

**Eastbound**: pluri-annual ice
Average ice extension 2,100 Nm / 4,900 Nm – 14/16 days

**Sabetta**
16.5 mtpa LNG / # 220 cargoes / year

**Ice class ship # 15 Arc 7 LNG Carriers**
**Conventional ship # 11 LNG Carriers**

**Summer Route**
**Northern Sea Route**

**Winter Route**
Route of conventional LNG Carriers
11,200 Nm / 25 days
The Shipping Scheme for the Logistics of modules for LNG Plant

- Ten assembly yards in China and Indonesia for modules
- Modules overall weight > 500,000 tons
- 152 large modules
- 77 shipments (22 through Bering Strait)
- Use of about 50% of worldwide Heavy Lift vessels Fleet
- Fleet Operations Center
- Modules Intermediate Storage Yard (MISY)
- Building of 2 Arc7 Module Carriers (China)
- Ice training of crews
- Design of Port of Sabetta encompassing the SIMOPS
- Building of additional finger pier for unloading
- 25 Winterized Self Propelled Modular Transporters
The Sabetta Port: an accessible port year-round – the dredging challenges

- **Ob River North Access Channel**: 50 km x 350 m, -15 m depth → 46 Mm³ dredging
- **Sabetta Port Access Channel**: 6 km x 420 m, turning basin and MOF → 34 Mm³ dredging
- Dredging works started in 2013 with various companies during five seasons

**Main challenges**
- Design for several winter tracks
- Dredging works only possible in the summer for about 10 weeks
- Environmental rules
The Sabetta Port: an accessible port year-round

Sabetta Port Hub

- **First step**: Marine Offloading Facilities: 6 different quays for RO-RO, Heavy Lift vessels, Module Carriers, Multipurpose vessels, Bunkering vessels, Port Support Fleet
- **Second step**: 2 LNG and Condensate jetties – 1.3 km LNG loading trestle
  - 2 ice protection barriers (2.2 km length/unit)
  - Ice management with ice breakers, tugboats and with heated water/air bubbling system

Sabetta Port Support Fleet
- 1 Port Icebreaker
- 2 Icebreaking Tugboats
- 2 Ice-Classed Escort Tugboats
The Ice-Breaking LNG carrier: Main Innovations

Main particulars: Arc7 LNG Carrier with Double Acting System / Length Overall All: 300 m - Breadth: 50 m - Draft: 12 m - Cargo Capacity: 172,600 m³ - 4 Tanks Membrane - Boil Off Rate: 0.13%/vol/day - Propulsion Power: 45 MW by Dual Fuel Diesel Electric engines
The Ice-Breaking LNG carrier: Building the First Double Acting System LNG Carrier

A few milestones
- **Slot Reservation Agreement with Shipyard for up to 15 ships**: July 2013
For the first unit: the LNG Carrier « SCF Christophe de Margerie »
- **Shipbuilding Contract**: February 2014
- **Keel laying**: 23d March 2015
- **Sea Trials /Gas Trials**: October 2016
- **Ice Trials**: March - April 2017
- **Naming Ceremony**: 3d June 2017

15 Arc7 Ice Breaking LNG Carriers originally to be delivered in phase with the Plant Trains start-up
- 1 Sovcomflot
- 5 Dynagas / Sinotrans
- 6 Teekay / China LNG
- 3 MOL / China Shipping LNG

2 Arc7 Condensate Tankers
- Dynacom
The Ice-Breaking ARC7 LNG Carrier: High Performances in Ice

First campaign of Ice Trials in February / March 2017 in Kara and Lapvev seas
The Trans-shipment Terminals in Europe: Re-loading of Yamal LNG Cargoes from Ice-Breaking LNG Carrier to Conventional LNG Carriers / Ship To Ship Transfers

Zeebrugge Terminal

Ship-To-Ship Transfers offshore Norway: 160 STS planned in Q4-2018/Q2-2019
An Accelerated Completion: A Giant Running Fast

- MOF
- EPC Contracts
- FID (December 2013)

- 4 Drilling rigs in operation
- 1st Plant module delivered
- LLI Train delivered

- All Trains 2 & 3 modules delivered.
- Start-Up Train 1 (Sept)
- 1st LNG Cargo loaded (8 December)

- 1st Flight to Sabetta
- First Piles for Storage Tanks
- Start Shipbuilding Fleet
- Sanctions US/EU.

- Delivery of all vessels
- Completion of Transshipment Terminal

- Financing secured
- All Train #1 modules delivered on site

- 10Mt de GNL in December
- Start Up Trains 2 (Aug) et 3 (Dec)
- Train 1 at 110% nominal capacity
- First Ship-To-Ship Transfers in Norway

- Start-Up Train 4
- Beginning of Long Term Contracts
YAMAL LNG: from an artist rendition…
...to reality! The first LNG Train officially started on December 8th, 2017

...followed by Train 2 in July 2018 and Train 3 in November 2018, one year ahead of the initial planning
… and the milestone of 10 Million tons of LNG has been reached on February 4th, 2019 with the 136th cargo offloaded from Sabetta

Photo credits: many thanks to YAMAL LNG, Novatek, TOTAL, DSME, AARI, AKER ARCTIC, etc.

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