Monetizing Gas of a Giant High Helium and Nitrogen Gas Reservoir – Amur Gas Processing Plant

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Unconventional gas:
• natural gas which cannot be produced, processed or used in a conventional manner

Inert Limits (N₂ and CO₂)
• most North American and European pipeline systems require a maximum inert content of 3% in order to ensure a stable Wobbe-Index and proper performance of burners and gas turbines operated from the pipeline system. The Russian norm specifies a maximum of 2.5%.

Main Options to Monetize High Nitrogen Reservoir
• dedicated pipeline system (e.g. Groningen, NL) or dedicated consumer (e.g. power plant, NH₄ plant)
• blending with other low N₂ gas sources
• nitrogen rejection

Nitrogen Rejection Technology
• cryogenic technology is only referenced choice for large scale N₂-rejection. Membrane or adsorptive technology not feasible.
• inlet gas of cryogenic processes normally needs to be virtually free of H₂O (< 1 ppm), CO₂ (< 50 ppm) and tolerates only small amounts of H₂S, HHC’s
Power of Siberia Pipeline
• connects gas rich Eastern Siberia with Far East and populous China
• link between high N₂ Chayanda field in Yakutia and the border crossing near Blagoveshchensk (1ˢᵗ section)
• tie-back the Kovykta field in Irkutsk Region (2ⁿᵈ section)
• pipeline, Amur Gas Processing Plant and a new nearby gas petrochemical complex are key elements of Gazprom’s Eastern Gas Program to boost the economic development of the Russian Far East.
Unusual Process challenge

- **Rejection of** $N_2$ from app. 8% to less than 2% in **large diameter international gas transmission line** (38 million m³/year)

Building Blocks and Commercial Products of Amur GPP

- **cryogenic rectification**: liquid CH$_4$ is produced at the bottom of a large column (implicit LNG plant) and vaporized against other process streams to obtain sales gas
- options: integration of $N_2$-rejection into a LNG plant or (if not feasible) **separation of commercial co-products** rather than selling at zero or heating value with sales gas
- production of C$_2$H$_6$, NGL’s and liquid helium is synergetic compared to stand-alone production, $N_2$ used as utility or vented with less than 100 ppm CH$_4$
- **development of a world-scale gas based petrochemical complex**

Dominant cost drivers

- compression
- removal of H$_2$O, CO$_2$< and S
Excursion: Helium

- **exclusively produced from natural gas**, coincides with high N₂, however N₂ not necessarily coincides with He
- economically producible concentrations of He natural gas range from 0.05 to 0.30 mol-%
- 2\textsuperscript{nd} lightest element to H₂
- smallest atomic radius
- lowest boiling point at 4.2 K
- high thermal conductivity
- most stable inert gas
- current global He market ≈ 170 million m\textsuperscript{3}/a (6.500 bcf/a), growth rate 1.5-2% p.a.
- presently three sources (BLM, Exxon Wyoming, Qatar) represent 80% of global production

![Applications Pie Chart](chart.png)
Minimize Compression
- feed and sales gas tie-in at similar pressure, need of a sales gas compression apparent
- no further compression in sales gas and He-path
- max. pressure at the inlet of the sales gas compression
- single column N₂-rejection process transfers N₂/He concentrate at a significantly higher pressure compared to double column, overcompensating thermodynamic malus
- external heat pump system for cryogenic duty and integration of duties

Minimize Pre-treatment
- feed gas free of H₂O and CO₂ to avoid freeze out
- specific proprietary process design to prevent freeze-out of CO₂ up to 3.000 ppm and hereby avoiding amine wash units and large dryer units
Project Status

- selection of Linde technology by Gazprom and award of EPSS-contract for **five construction phases** by NIPIGaz Pererabotka (general contractor) in 2015
- 1st phase: **two gas processing** (C₂H₆/NGL/NRU) **trains and one Helium train**
- 2nd to 5th phase: **additional four gas processing and two Helium trains**
- 1st phase engineering works beyond 90% model review, first documents issued for construction
- PO’s for major equipment/material placed, fabrication of key equipment advanced
- first material arriving in summer 2017
- 2nd phase started with **time-lag to optimize** engineering, procurement, transport resources, construction work
- When completed **Amur GPP will be one of the world's largest gas processing and the world's largest He-plant** with nameplate capacities of 42 billion m³/a of natural gas, 60 million m³/a of He respectively
Site and Logistic

- **remote greenfield area**, entailing construction of jetty, roads, warehouses and rail access to site
- **transport** of oversize & heavy lifts across Amur and Zeya river within limited navigation window
- **draft of 110 cm** requires a special design barges, tugs and floater system
- Linde site services during construction, commissioning, start-up
Conclusions

• **Development and production of a large high N₂ gas reservoir and export** to a natural gas market with infrastructure designed to low inert levels **poses a particular technical challenge**

• **Industrial scale nitrogen rejection requires methane condensation** (implicit LNG plant) and entails significant investments

• **Synergies through co-production of C₂H₆, NGL’s and He** as a starting point of **high value chains for the benefit of the national and regional economy**, such as the petrochemical and helium value chain

• **Pioneering natural gas export from Russia to China** – connecting the resource rich Russian Far East with the populous Chinese mainland – represents a **historic milestone in the history of natural gas infrastructure** and will have **long-lasting economic and environmental benefits**