Expanding the World's Natural Gas Pipeline Networks: Economics and Geopolitics

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~70% OF THE GAS IN THE WORLD IS CONSUMED DOMESTICALLY AND DELIVERED VIA PIPELINES

Global Gas Trade, 2000–2016

Note: CAGR = Compound Annual Growth Rate
Sources: IHS Markit, BP Statistical Review of World Energy
HISTORICALLY NATURAL GAS MARKETS DEVELOPMENT WAS DRIVEN BY PIPELINE INFRASTRUCTURE EXPANSION
TRANSACTION COSTS IN PIPELINE GAS TRADE DEFINE INSTITUTIONAL STRUCTURES OF THE GAS MARKETS

- High specificity of assets and high probability of opportunistic behavior
- Long character of relationship between counterparts with strong interdependence
- High degree of uncertainty due to long investment cycle and long period of the subsequent operation of specific assets
- Strategic, social and infrastructural importance of gas industry as well as its role in formation of the state budgets, which causes active intervention of the state in its institutional structure
- International gas trade is often linked with geopolitical relationship between countries, which increases state involvement
- Transaction cost economics suggests that these characteristics of transactions favor mechanisms allowing to save on transaction costs (vertical integration or when vertical integration is impossible – for example in international relations - its substitutes – long term contracts with rigid obligations of the parties).
## EVOLUTION OF NATURAL GAS MARKETS

<table>
<thead>
<tr>
<th>Features</th>
<th>Local</th>
<th>National</th>
<th>International</th>
<th>Transcontinental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main product</td>
<td>Pipeline gas</td>
<td>Pipeline gas</td>
<td>Pipeline gas, LNG</td>
<td>Pipeline gas, LNG, GTL</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Few unlinked gas pipelines</td>
<td>National gas supply systems</td>
<td>Development of huge long-distance cross-border pipelines</td>
<td>LNG and pipeline gas supply from several countries</td>
</tr>
<tr>
<td></td>
<td>between producer and consumer</td>
<td></td>
<td>and bilateral LNG supply</td>
<td>development of international pipeline systems</td>
</tr>
<tr>
<td>Market volume</td>
<td>Few BCM</td>
<td>10-10² BCM</td>
<td>Few hundreds BCM</td>
<td>More than TCM</td>
</tr>
<tr>
<td>Institutional gas market</td>
<td>Local vertically integrated</td>
<td>National vertically integrated</td>
<td>Bilateral international contracts</td>
<td>Multiply contracts between many</td>
</tr>
<tr>
<td>structure</td>
<td>monopolies</td>
<td>monopolies, independent gas production</td>
<td>between two national companies,</td>
<td>companies, transnational vertically</td>
</tr>
<tr>
<td></td>
<td></td>
<td>companies, intergovernmental agreements</td>
<td>intergovernmental agreements</td>
<td>integrated energy companies</td>
</tr>
<tr>
<td>Competition</td>
<td>No</td>
<td>In certain conditions competition in gas</td>
<td>Competition between domestic production and imports</td>
<td>Competition between domestic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>production is possible</td>
<td></td>
<td>production and multiply import sources</td>
</tr>
<tr>
<td>Aspects of energy security</td>
<td>Physical Investment</td>
<td>Physical Investment</td>
<td>Physical Investment</td>
<td>Physical Investment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Price and volume</td>
<td>Price and volume</td>
<td>Price and volume</td>
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<td></td>
<td></td>
<td></td>
<td>Geopolitical</td>
<td>Geopolitical</td>
</tr>
<tr>
<td>Mechanisms of transaction</td>
<td>Local monopoly, super-long-</td>
<td>National monopoly, long-term</td>
<td>National monopoly, long-term inter-governmental agreements</td>
<td>Multilateral international agreements, swaps of assets,</td>
</tr>
<tr>
<td>costs reduction</td>
<td>term contracts</td>
<td>contracts</td>
<td></td>
<td>consortiums</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>
PIPELINE GAS VS LNG TRANSPORTATION COSTS
DURING THE LAST DECADE GLOBAL LNG TRADE WAS GROWING MUCH FASTER THAN INTERNATIONAL PIPELINE GAS TRADE

Source: BP Statistical Review of World Energy 2018
BY 2040 THE SHARE OF LNG IN THE GLOBAL GAS TRADE WILL REACH 60%

Global net-export of LNG and pipeline gas

Global liquefaction capacities addition (compared to 2015) by the region

Source: Global and Russian Energy Outlook, ERI RAS-AC
THE WORLD’S LARGEST NET EXPORTERS OF GAS

Main net exporters of gas (pipeline and LNG) in 2017, bcm

Source: BP Statistical Review of World Energy 2018
PIPELINE GAS INVESTMENTS REMAIN EXTREMELY IMPORTANT FOR THE INDUSTRY (BUT LESS FOR POLITICIANS)

Which infrastructure investments are most critical for growth in the natural gas market? (Select up to three)

<table>
<thead>
<tr>
<th>Investment</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipeline capacity</td>
<td>71.9%</td>
</tr>
<tr>
<td>LNG liquefaction</td>
<td>42.0%</td>
</tr>
<tr>
<td>Upstream investments</td>
<td>40.5%</td>
</tr>
<tr>
<td>Gas processing</td>
<td>32.0%</td>
</tr>
<tr>
<td>Petrochemicals</td>
<td>19.2%</td>
</tr>
<tr>
<td>Gas to liquids</td>
<td>14.8%</td>
</tr>
<tr>
<td>LNG regasification</td>
<td>12.4%</td>
</tr>
<tr>
<td>Other</td>
<td>5.6%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
GLOBAL GAS TRADE OUTLOOK: DEMAND GROWTH IS MOVING TO ASIA

Pipeline gas and LNG export and import by the main countries, Probable Scenario

Source: Global and Russian Energy Outlook, ERI RAS-AC
INTERNATIONAL ENERGY TRADE IN 2000: FORMER “GLOBAL ENERGY ORDER” WITH THREE MAJOR HYDROCARBON SUPPLIERS

Source: ERI RAS
“REPARTITION OF THE MARKETS”: INCREASING NUMBER OF PRODUCERS AND SHRINKING OECD MARKETS

Source: ERI RAS
AND THERE ARE 4 MAJOR LNG PRODUCERS EXPANDING THEIR LNG CAPACITIES...

USA

Qatar

Australia

Russia
CHANGING GLOBAL ENERGY LANDSCAPE: “REPARTITION” OF THE SHRINKING NICHES IN THE BUYERS` MARKET AND CHANGING ENERGY FLOWS
CENTRAL ASIAN GAS KNOT

[Map showing the Central Asian Gas Knot, with various countries and cities labeled.]
EMERGING EURASIAN GAS MARKET

[Map of gas pipelines and routes in Eurasia]
THE EMERGING EURASIAN GAS MARKET AND ITS MAIN PRINCIPLES

▪ Single pipeline gas pricing mechanism (net-back pricing from the major consumer markets in Europa and in Asia) with the lowest prices in the heart of Eurasia.

▪ Single gas pricing mechanism is supported by competition with LNG. Alternative fuels – coal, RES and nuclear – will limit any attempts of monopolistic pricing.

▪ Variety of contract terms (long-term/ spot; bilateral/multilateral)

▪ Hub development (TTF, NBP, NCG, Saint-Petersburg, Turkey, Shanghai, JKM, Singapore, ...)

European gas market consists of two segments: LTCs and spot, Gazprom has secured impressive portfolio of LTCs…

European gas balance

Sources: Nexant WGM 2017, IEA World Energy Balances 2017, IEA Natural Gas Information 2017

* Europe-41 without Turkey
PIPELINE GAS IS WELL PLACED IN EUROPE TO COMPETE ON SPOT WITH LNG

Long run marginal supply costs to Europe (Russian pipeline gas and US LNG)

<table>
<thead>
<tr>
<th>Country</th>
<th>Production and Upstream Taxes</th>
<th>Liquefaction</th>
<th>Export duty</th>
<th>Regas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique LNG</td>
<td>2.1</td>
<td>4.7</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>US LNG</td>
<td>3.5</td>
<td>2.9</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Algeria LNG</td>
<td>3.4</td>
<td>1.9</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Qatar LNG</td>
<td>1.2</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nigeria LNG</td>
<td>0.7</td>
<td>1.7</td>
<td>0.9</td>
<td></td>
</tr>
</tbody>
</table>

Short run marginal costs to Europe (Russian pipeline gas and US LNG)

<table>
<thead>
<tr>
<th>Country</th>
<th>Production</th>
<th>Liquefaction</th>
<th>Export duty</th>
<th>Regas</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Siberia-Europe</td>
<td>1.5</td>
<td>0.4</td>
<td>0.5</td>
<td>0.45</td>
</tr>
<tr>
<td>US LNG-Europe</td>
<td>1.2</td>
<td>0.4</td>
<td>0.45</td>
<td>0.53</td>
</tr>
</tbody>
</table>

- Production and Upstream Taxes
- Liquefaction
- Export duty
- Regas

- Production
- Liquefaction
- Export duty
- Regas

- Transportation to the Russian border
- 15% Henry Hub
- Henry Hub
- Upstream Taxes
**GLOBAL OIL PRICES AND ASIAN GAS DEMAND WILL DEFINE COMPETITION BETWEEN PIPELINE GAS AND LNG IN EUROPE**

**European scenario matrix**

<table>
<thead>
<tr>
<th></th>
<th>Low oil price</th>
<th>High oil price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Asian demand</strong></td>
<td>Low LNG availability</td>
<td>Increasing competition for LNG with Asia/</td>
</tr>
<tr>
<td>(no LNG glut)</td>
<td>Gazprom expanding gas exports</td>
<td>Further contract revisions by Gazprom</td>
</tr>
<tr>
<td></td>
<td>NO CHANGE</td>
<td></td>
</tr>
<tr>
<td><strong>Weak Asian demand</strong></td>
<td>Increasing competition between pipeline gas and LNG</td>
<td>Tough competition between pipeline gas and LNG</td>
</tr>
<tr>
<td>(LNG glut)</td>
<td>Gazprom voluntarily decreasing contractual prices</td>
<td>PRICE WAR (voluntarily increasing supply in order to drop prices and crowd away competitors)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
EASTERN PIPELINES IN EURASIA

Source: OIES
PIPELINE GAS IS AMONG THE CHEAPEST OPTIONS IN ASIA

SRMC vs LRMC in Asia

- Export duty
- Regas
- LNG transportation
- Liquefaction
- Transportation to the Russian border
- 15% Henry Hub
- Henry Hub
- Production (including taxes)
RUSSIA’S ROLE AS A KEY MARKET ARBITRAGE POINT AS A SUPPLIER TO EUROPE AND ASIA
NEW TRANSITIONAL PERIOD

- Need for huge investments to produce and transport more gas from remote areas
- Growing number of parties involved in each transaction increase geopolitical concerns and also complicate transactions
- Growing number of market participants with different institutional frameworks
- Growing number of transit countries increase transit risks
- Fast regulatory reforms in many countries create additional uncertainties and decrease trust to the state guarantees
- Growing competition increases producers` risks
- “Energy nationalism” and increasing national security-of-supply concerns
- Changing markets and growing uncertainties lead to higher transaction costs and demand multilateral institutional changes and development of new instruments
NEW BUSINESS MODELS?

- Shorter contracts, higher flexibility, “uberization”, new trading platforms
- Portfolio optimization (aggregators with cheap capital)
- Demand creation
- Enhanced vertical integration (cost control in the upstream supply chain, integrated complex solutions for the final consumers)
- “Green gas”
CONCLUSIONS

- Pipeline gas still is the backbone of the international gas trade development and its role should not be underestimated.
- Pipeline gas trade is associated with higher asset specificity, higher transaction costs and vertical structures.
- Economics of the pipeline projects is driven by the economy of scale.
- It is increasingly difficult for develop pipeline projects in the stagnant or declining markets.
- Pipeline projects are associated with much higher geopolitical risks.
- In the future new global framework, involving both pipeline gas and LNG trading and portfolio optimization, could evolve.
- Hydrogen could play a role.