The Unconventional Gas Revolution and the Perspectives for Europe and Asia

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Maintaining the Balance within the EU’s Energy Triangle and between its Three Objectives

FOCUS of EU-Energy and Environmental Policies:
- on GHGE produced domestically;
- outsourced emissions by including ‘life-cycle’ and ‘wells-to-wheels’ approaches for rising energy imports from outside Europe not included;
- In this case: the EU’s carbon footprint may have increased up to 47% since 1990, instead of the officially declared reduction of 3%.
Global Conventional and Unconventional Gas Pyramid

Global Dimensions of Shale Gas I

Gas overtakes coal before 2030 and meets one quarter of global energy demand by 2035 – demand grows by 2% annually, compared with just 1.2% for total energy
Global Dimensions of Gas II

Non-OECD-Countries 2008-2035:
- 84% of the increase;
- Largest demand increase in China and the MENA-Region.

IEA - Asia:
- China: gas demand rising to 260 bcm in 2015 with a domestic production planned at 170 bcm.
- India: gas demand expanding from 63 bcm in 2010 up to 88 bcm in 2016 and 132 bcm by 2030.
- SEA: becoming a major importer of natural gas.

Comparison of 1990 and 2009 Global Gas Production Levels by Countries

Source: MIT and EIA.
Global Dimensions of Shale Gas

Estimates - IEA, USGS, BGR:
- Recoverable Conventional Gas Resources: 404 tcm (120 years of production at 2010 levels);
- Total Unconventional Gas Resources: 909 tcm;
- Recoverable Unconventional Resources: 380 tcm;
- Total Conv. and Unconv. Gas Resources: 800 tcm

250 Years of Current Production!

IEA:
- 39% of the Incremental Increase in Global Gas Production till 2035 from Unconventional Sources;
- Total UG production will almost double to 22% by 2035 (shale gas: 9%).

Middle East and North Africa (MENA-Region) – Comparison of Availability:
- Global Conventional Gas Resources: Concentrated geographically with 70% in just three countries: Russia, Iran and Qatar;
- Tight and Shale Gas Resources: ~ 14% of Global Resources.
Global Remaining Recoverable Conventional and Unconventional Gas Resources

- North America/U.S.: may become a Net Gas Exporter in 2016;
- Australia: becoming a bigger LNG producer than Qatar by 2018/2019 (the world’s largest one since 2006 ahead of Indonesia, Malaysia and Algeria).

Source: MIT 2011

Global Unconventional Drilling Forecast 2011-2020

- Asian growth of UG will outpace all other regions;
- Asian UG production is forecasted to increase to more than 65 bcm by 2020;
- Australian UG production reaching over 69 bcm by 2020.

Source: Douglas-Westwood 2011

Global Dimensions of Shale Gas

- **Pricing – Impact of Unconventional Gas Additions:**
  - **Present Gas Flut 2009-2010 and Beyond:**
    - Result of Worldwide Economic Crisis (weaker demand) and the „Gas Revolution“ in the US;
    - Decoupling from the Oil Prices;
    - Albeit largely dissipating at the end of 2010;
    - But New LNG Wave Arriving 2013 (Australia, Qatar etc.)
    - Gas Glut May Last Longer than 2015/2017;
  - **Impacts:**
    - More Suppliers and Competition;
    - Long-Term Contracts even under more pressure;
    - Strengthening Global, Regional and National Supply Security.
Political Risks and Instabilities in the Middle East

"Arab Spring" of 2011:
- Political revolutions in Tunisia, Egypt, Libya, Yemen, Bahrain and Syria have led to more bloody struggles, outside intervention and civil strife – causing new and additional investment risks in the short- and mid-term future;
- Fiscal costs: ~US$56 bn;
- Worsening the already massive unemployment problem.
- But none of the uprisings led by Islamist movements and predominantly Islamist agendas;
- "Arab world" not a unified entity.

Structural Challenges & Problems:
- combination of high unemployment (i.e. youth and even educated youth), rampant corruption, internal regional and social inequalities, high population increases, failing or low education of women;
- Failing democratization and political liberalization;
- Weakness of state institutions and civil societies;
- Social and political stability uncertain.

Source: Interfaxenergy.com

2011:
- 11 attacks on the Egyptian gas pipeline to Israel and Jordan;
- Only 30-40% of the contracted gas volumes have been delivered Israel, Jordan, Lebanon and Syria;
- Egyptian gas: covering 80% of Jordan’s electricity demand.
EU-Oil and Gas Imports: Comparison of Diversification Sources (2008)

Pipeline - versus Tanker Import Dependencies: Factor Crisis Stability!

2009 Breakdown of EU27 LNG Supplies

*Including supplies from sources which cannot be identified.
**EU-Gas Forecast of 2010**

<table>
<thead>
<tr>
<th>EU 27 Bcm</th>
<th>2005</th>
<th>2020 Baseline* scenario, oil price $88/bbl</th>
<th>2020 Reference* scenario, oil price $88/bbl</th>
<th>2030 Baseline* scenario, oil price $106/bbl</th>
<th>2030 Reference* scenario, oil price $106/bbl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand for natural gas</td>
<td>519</td>
<td>538</td>
<td>479</td>
<td>511</td>
<td>457</td>
</tr>
<tr>
<td>Natural gas production</td>
<td>219</td>
<td>130</td>
<td>129</td>
<td>88</td>
<td>87</td>
</tr>
<tr>
<td>Natural gas imports</td>
<td>299</td>
<td>408</td>
<td>349</td>
<td>423</td>
<td>370</td>
</tr>
</tbody>
</table>

Table: EU-Gas Forecast of 2010


* includes energy policy measures implemented until April 2009
** includes 20% renewables in energy consumption, 20% less CO2 emissions, and policy measures implemented until the end of 2009 and a few energy efficiency measures.

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**Diversification of Non-Russian Gas Pipeline Projects:**

<table>
<thead>
<tr>
<th>Project</th>
<th>Supplier</th>
<th>From</th>
<th>To</th>
<th>Capacity (Bcm)</th>
<th>Investment (M €)</th>
<th>Foreseen Start-Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medgaz</td>
<td>Algeria</td>
<td>Hassi R’Mel</td>
<td>Spain</td>
<td>8-10</td>
<td>1300</td>
<td>End 2008</td>
</tr>
<tr>
<td>Galsi</td>
<td>Algeria</td>
<td>Hassi R’Mel</td>
<td>Italy</td>
<td>8-10</td>
<td>1200</td>
<td>2009-2010</td>
</tr>
<tr>
<td>ITG-IGI</td>
<td>Caspian</td>
<td>Greece</td>
<td>Italy</td>
<td>8-10</td>
<td>950 (IGI)</td>
<td>2011</td>
</tr>
<tr>
<td>Nabucco</td>
<td>Caspian</td>
<td>Turkish Border</td>
<td>Austria</td>
<td>31</td>
<td>4600</td>
<td>2010</td>
</tr>
</tbody>
</table>

Total additional non-Russian gas supply capacity via pipelines to Europe: 71 – 84 bcm + 120 bcm LNG in 2020 + <120 bcm from Norway = < 310 bcm; gas import demand of the EU?
LNG-Expansion in the EU Gas Market

Source: Deutsche Bank Resource

Source: E.ON Ruhrgas
New Gas Import Options for Europe

Global Gas Market:
- North America/U.S.: may become a Net Gas Exporter in 2016;
- Australia: becoming a bigger LNG producer than Qatar by 2018/2019 (the world's largest one since 2006 ahead of Indonesia, Malaysia and Algeria).
- Brazil: LNG-Exporter?

Europe/Eurasia:
- North Sea gas supplies will play a longer and more important source of supply for EU gas imports than it was forecasted just two years ago:
  - new large oil and gas discoveries in Norway;
  - record capital investment, new field allowances and decommissioning cost tax relief for investors in the United Kingdom.
- CACR: Azerbaijan and Turkmenistan;
- Kurdistan;
- New Potential Offshore Gas Exports from Offshore Gas Fields in the EEZ of Bulgaria, Romania, Greece and The East Mediterranean Sea.

Gas exports are forecasted to grow rapidly from 63 bcm in 2008 to 100 bcm in 2020 and more than 130 bcm by 2035.;
- But Turkmenistan’s government expects a total gas production to reach up even to 230 bcm annually by 2030.
Another Potential Gas Import Source?: Offshore Gas Finds in the East Mediterranean Sea/Levant Region

Leviathan Gas Field (Basin):
- Encompasses around 83,000 sq km, stretching from Israel to Lebanon, Syria, and Cyprus
- Almost twice the size of Tamar
- USGS: recoverable 1.7 bnbl oil and 122 Tcf /3.5 tcm gas
- Israeli gas field production can be used for exports

Israel: From Gas Importer to Exporter?
- Tamar gas field production will start in 2013; will satisfy most of its domestic demand for the next 20-25 years
- Domestic gas production declining sharply in 2013
- Presently 40% of its gas supplies from Egypt through the Eastern Mediterranean Gas pipeline
- Domestic gas consumption will double between 2010-2015
- Share of gas for electricity production will increase from 33% in 2009 to 50% in 2013
- Floating LNG terminal at the end of 2012

Leviathan Basin – Resource Conflict:
- Includes EEZ of Israel, Cyprus, Sriia, and Lebanon
- New significant gas finds off the coast of Cyprus and Lebanon in Q1/2012
- Maritime agreement between Cyprus and Israel in 2010 (Leviathan and Tamar fall in Israel's EEZ); Turkey opposition to Cyprus gas projects
- But official complaint by Lebanon to the UN against this agreement; maritime boundaries not defined and agreed by all parties

Source: Interfaxenergy.com

Europe’s Potential

IEA/European Potential:
- Recoverable reserves of shale gas: 33-38 tcm (BP: total proven conventional gas reserves at 2.42 tcm)
  - 12 tcm tight gas
  - 15 tcm shale gas
  - 8 tcm coalbed methane
- Getting access to just 10% of its estimated recoverable shale gas reserves = 1/3 of Russia’s total gas reserves.; or 60 years of pre-crisis level
- Only concrete test drilling data can lead to specific conclusions of the recoverable unconventional gas reserves (taking 2-5 years ahead);
- Technological innovation: increasing the number of laterals per well decreases environmental impacts and increases output

Environmental Challenges and Concerns:
- Public Acceptance: Need to be taken seriously, but mostly overstated; not bigger than conventional gas drilling
Forecasts and Prospects of UG in Europe

European shale market still in its infancy: „easy to find, but hard to get“?

Douglas Westwood Study of October 2011:
- Shale gas production: ~ 35 bcm by 2020, led by Poland and UK;
- Coal-bed methane production: up to 22 bcm by 2020;
- Almost 4,000 wells need to be drilled annually by 2020;
- Germany, France and Netherlands to reach commercial production by 2020;

Pre-Conditions for a Positive UG Development in Europe:
- But public acceptance and pro-active political leadership will be keys challenge for the industry and the development of UG;
- European gas demand;
- Competitive price towards LNG-imports and new pipeline gas from Russia, Norway, Central Asia and North Africa.

Differences to the U.S.
- US landowners directly benefit from all fossil fuels found on their land;
- Population density and, accordingly, higher environmental regulation;
- Higher Costs of Production.

France (with 5 tcm the second-largest shale-gas reserves in EU-27):
- Parliament has prohibited all UG production for the time being.
- But Total (investing in shale gas production in the U.S.) wants to persuade the government to repeal its ban on fracking of unconventional gas deposits.

Developments of UG in Europe

At Present:
- Proven reserves and commitment from major Western energy companies such as Shell, Exxon-Mobil, Chevron etc. give at least supply leverage for contract pricing negotiations with Gazprom.
- „Sense of Economic Sovereignty“ and reducing gas import dependency from Russia.

Poland:
- New Estimate: 768 bcm-1.9 tcm (rather than EIA’s 1.4-5.3 tcm of recoverable shale gas);
- Two exploratory wells drilled commercially by ExxonMobil not viable at the end of 2011.

Bulgaria:
- consuming 4 bcm natural gas a year; depending on Gazprom for over 90%.
- Parliament (166 votes against 6) banned hydraulic fracturing (fracking) and revoked a 5-year exploration permit to Chevron last January;
- But majority of public opinion (75%) in favor as long as environmental risks are minimal and substantial economic benefits are given (Movement for Energy Independence/DEN).

Ukraine:
- Came late to the shale gas game; but vast reserves (covering at least 50 years of its natural gas supply);
- Little price incentive & insufficient investment climate
- But politically supported increasingly to reduce gas import dependence from Russia;
- Plans to produce 15 bcm in 5 years (first commercial shale gas by 2015);

Romania, Hungary and Lithuania: still at an embryonic stage; no detailed estimated reserves.
**Australia’s Gas Outlook**

**Key Facts:**
- The world’s fourth largest gas exporter;
- Exports may even quadruple in the future, making it globally the largest LNG producer.
- 70% of the global LNG capacity under construction taking place in Australia.
- In the next five years, gas production will rise by 144% to around 137 bcm over the next five years.
- In 2018, it may even overtake Qatar as the world’s largest LNG supplier.

**Australia’s unconventional reserves**

<table>
<thead>
<tr>
<th></th>
<th>CBM reserves (bcm)</th>
<th>CBM production (bcm)</th>
<th>CBM share of total gas production</th>
<th>Tight gas reserves (bcm)</th>
<th>Shale gas reserves (bcm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>12.3***</td>
<td>6.4</td>
<td>10%</td>
<td>0.8*</td>
<td>11.7*</td>
</tr>
<tr>
<td>World</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
China's Primary Energy Demand 2008-2035 (based on three IEA-Scenarios)

- **Kohle**
  - 2008: 66%
  - 2035 NPS: 61%
  - 2035 CPS: 53%
  - 2035-450 PS: 38%

- **Öl**
  - 2008: 19%
  - 2035 NPS: 17%
  - 2035 CPS: 18%
  - 2035-450 PS: 20%

- **Gas**
  - 2008: 9%
  - 2035 NPS: 10%
  - 2035 CPS: 11%
  - 2035-450 PS: 10%

- **Kernenergie**
  - 2008: 6%
  - 2035 NPS: 4%
  - 2035 CPS: 2%
  - 2035-450 PS: 3%

- **Wasserkraft**
  - 2008: 6%
  - 2035 NPS: 4%
  - 2035 CPS: 3%
  - 2035-450 PS: 5%

- **Biomasse und Müll**
  - 2008: 1%
  - 2035 NPS: 0%
  - 2035 CPS: 0%
  - 2035-450 PS: 0%

- **Andere Erneuerbare**
  - 2008: 3%
  - 2035 NPS: 4%
  - 2035 CPS: 8%
  - 2035-450 PS: 7%

**Share of Fossil Fuels:**
- **NPS**: New Policy Scenario: 81%
- **CPS**: Current Policy Scenario: 87%
- **450 PS**: Climate Policy Scenario (>2°C): 68%

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China’s Balance 2015 and 2020

**China’s gas balance**
- **2015E**
  - Consumption: 247 billion cubic metres
  - Production: 137
  - Imports: 54
  - LNC: 15
  - Central Asia: 40
  - Remaining: 4

- **2020E**
  - Consumption: 335
  - Production: 150
  - Imports: 54
  - LNC: 15
  - Central Asia: 36
  - Remaining: 20
China – Unconventional Gas Production Forecasts by 2020

Unconventional gas production in China 2012-2020 forecasts

Source: Interfaxenergy.com

US and Asian LNG Prices in Comparison

Source: Interfaxenergy.com
**Natural Gas Import Prices – Assumptions of Scenarios of the IEA 2011 (in 2009-US$-Prices per Mbtu)**

<table>
<thead>
<tr>
<th>GAS-Scenario</th>
<th>„New Policy“-Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>4.1</td>
</tr>
<tr>
<td>Europe</td>
<td>7.4</td>
</tr>
<tr>
<td>Japan</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Source: IEA, WEO 2011.

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**Summary and Perspectives I**

- **EU:**
  - Its increasing dependence on energy imports and external suppliers will make it more vulnerable to unpredictable changes and uncertain developments on global markets in a new age when it relative importance as a global energy consumer (presently 17%) will rapidly decrease (less than 10% by 2030);
  - EU-gas markets becoming increasingly united, liberalized and integrated with growing competition:
    - Spot Markets and Spot Markets Prices Becoming More and More Important – even Russia’s Deputy Finance Minister Sergei Shatalov admitted: „Long-term contracts hold less meaning. The spot market is becoming more significant“ (March 2012).
    - New transnational energy infrastructures (pipelines, grids etc.) demand a common energy (foreign) policy towards third energy partners outside of the EU.
    - New Gas Import Options (prospects different and more positive than in 2006 during the first gas crisis).
Summary and Perspectives II

- **Unconventional Gas in Europe and Asia: a “Game Changer”:**
  - fullfills all three objectives of the “Energy Triangle/Energy Trilemma”: (a) economic competitiveness; (b) supply security, and (c) environmental/climate change mitigation.
  - **Supply Security:**
    - Domestically produced resource, reducing gas imports from unstable countries/regions and problematic exporters;
    - Diversifying the national and EU energy mix and gas imports (even when no UG is being produced in Europe);
  - **Economic Competitiveness:**
    - unit supply costs probably higher in Europe than in U.S., but also much lower than Russia’s future long-distance pipeline gas from new and very expensive gas fields in the high north (like Yamal) or even the Barents Sea and the Arctic, based on long-term contracts with inflexible price adaptation mechanism and highly problematic third-party clauses.
    - Historical experiences: production costs will always go down with new energy resources and further innovations of drilling technologies;

Summary and Perspectives III

- **Environmental/Climate Change Mitigation:**
  - shale gas - like conventional gas - produces equally much lower CO$_2$ emissions than coal.
  - *Polish Geological Institute and other new research analyses:*
    - risks yes, but not higher than for conventional gas drilling;
    - can be regulated and controlled,
    - won't damage water supply, cause seismic shocks or have other environmental consequences;
  - full life-cycle emissions: carbon footprint of domestically produced UG is approx. 30% lower than long-distance Russian pipeline gas (life-cycle and wells-to-wheel analyses).
  - Negating domestically produced UG gas means higher imports of pipeline gas and LNG with higher CO$_2$ and methane emissions;
  - domestically produced unconventional gas is both techno-logically and environmentally less risky than the increased drilling of conventional gas resources in ever more deeper offshore seas or in the environmentally most sensitive Arctic and Antarctic regions.
Summary and Perspectives IV
Unconventional Gas (UG):

- The most important energy revolution of fossil fuels during the last 40 years; in Europe: progress evolutionary rather than revolutionary (U.S.A.)
- Far-Reaching Global Impacts:
  - **Geo-economic**: international gas markets, gas prices, LNG versus Pipeline-rivalry; international competition; energy mix ("Golden Age of Gas"?), diversification;
  - **Prices**: weakening of the oil-linkages and the traditional long-term contracts (adaptation of prices and 3-year price regulations needed);
  - **Gas Market Liberalisation**: US-UG-revolution only possible without (the European) pipeline monopolies;
  - **Geopolitical**: domestic source; diversification options; strengthening of regional and global energy supply security and importers (negotiation power); weakening of political instrumentalisation of energy and pipeline dependencies; or gas cartels (GECF);
  - **Game Changer**: regardless of a European UG revolution, shale gas has already changed the European market (much more than the Asian gas market), even before a single well has been drilled, or a single molecule of unconventional gas has been extracted from the European basins.