Freedom Gas to Europe?
Scenario Analyses with the Global Gas Model

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Paper

• Draft paper available upon request (do not cite)
• Submitted to RIBAF Special Issue „Energy- and commodity-market research: A need for new directions?“
• Some results in a July 2020 policy brief (https://www.diw.de/de/diw_01.c.794645.de/publikationen/diw_focus/2020_0005/no_need_for_new_natural_gas_pipelines_and_lng_terminals_in_europe.html)
Freedom gas?

- Coined by the U.S. Department of Energy in May 2019

Source: https://southfront.org/wp-content/uploads/2019/05/sticky_62.jpg
European LNG Import Terminals

Large EU LNG import capacities of ~200 bcm

<table>
<thead>
<tr>
<th>Region</th>
<th>Pipeline</th>
<th>LNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe imports</td>
<td>78%</td>
<td>22%</td>
</tr>
<tr>
<td>Asia imports</td>
<td>14%</td>
<td>86%</td>
</tr>
<tr>
<td>Global</td>
<td>54,3%</td>
<td>45,7%</td>
</tr>
</tbody>
</table>

Source: BP 2019

Most EU imports arrive via pipeline

Figure: LNG imports terminals in Europe, which are "operational", "under construction" and "planned".

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European natural gas pipeline infrastructure very dense

Figure: cross-border pipeline capacities into and within Europe
Source: DIW Weekly Report 27-2018
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The role of LNG in Europe in the last decade

- Small share of total imports (<25%)
- Main problem: pipeline transport from LNG import terminals to consumers across Europe
- National natural gas markets in Europe are still quite segmented
- However, hub development in some places has increased liquidity and made these markets attractive to LNG suppliers, in particular TTF in NW-Europe

Figure 3: LNG exports to the EU 2010–2018, in bcm per year
U.S. LNG exports: Recent developments

Figure 1: Existing U.S. LNG export terminals and their capacities in bcm/year

Figure 2: US LNG exports 2015-2019, in bcm/year
Note: Countries receiving largest U.S. LNG exports are indicated in the chart.
Source: Own figure based on EIA U.S. Natural Gas Exports by Country (Released May 29, 2020) www.eia.gov
Research question

• Which role for U.S. LNG in Europe until 2050?
  • Are the very large U.S. LNG exports to Europe in 2019/2020 the „new normal“ or an exception?
  • Is it rational to build new LNG terminals in Europe, e.g. in Germany?
  • Does the long-term role of U.S. LNG change under some specific scenarios?
  • Which role for Asian markets (in particular China) for U.S. LNG?
Global Gas Model

- Multiple players:
  - Producers
  - Traders
  - Pipeline operators
  - LNG liquefiers
  - LNG regasifiers
  - Storage operators
- Net present value optimization 2015-2050
- Profit maximization problems under constraints, linked by market-clearing conditions

Available open source: https://www.ntnu.edu/iot/energy/energy-models-hub/ggm
Modeling approach

• Original model: mixed complementarity model (MCP), solved in GAMS

• MCP allows to ...
  • ... solve optimization problems of multiple players types simultaneously
  • ... include market power by suppliers (traders)

• Yet, large model size made reformulation as convex optimization problem more attractive (run time, solvability) while advantages of MCP approach remain

• Cf. Egging-Bratseth et al. (2020, EJOR) and Egging and Ansari (2019, SET-Nav Discussion Paper)
Global Gas Model

Figure: Countries included in GGM
(light green: consumption only)
Our scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Scenario description</th>
<th>Scenario implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>„Base Case“</td>
<td>Stable natural gas demand in Europe and continuous demand increase elsewhere</td>
<td>IEA New Policies Scenario 2018 (World Energy Outlook) demand growth rates in the world regions, EU Reference Scenario 2016 for European countries</td>
</tr>
<tr>
<td>“Trump”</td>
<td>Financial support to U.S. LNG exports to Europe and sanctions on finishing Nordstream 2 pipeline</td>
<td>Shipping costs U.S. to Europe decreased by 0-100%; Nordstream 2 delayed by ten years</td>
</tr>
<tr>
<td>“Putin”</td>
<td>Disruption of all Russian exports to Europe</td>
<td>Russian trader not allowed to sell gas to EU and Switzerland</td>
</tr>
<tr>
<td>“Altmaier”</td>
<td>Support to LNG import terminals in Germany</td>
<td>Capital costs and/or operational costs of regasification terminals in Germany decreased by 0-100%</td>
</tr>
<tr>
<td>“Jinping”</td>
<td>Support to LNG import terminals in China</td>
<td>Capital costs and/or operational costs of regasification terminals in China decreased by 0-100%</td>
</tr>
</tbody>
</table>
Results: EU supply is diversified and hardly affected by restrictions/subsidies

Figure 6: EU supply mix by supplying region, Base Case and selected scenarios 2020-2050, in bcm per year

Note: The numbers succeeding the scenario name indicate the applied percentage of the Base Case cost data (i.e., the opposite of the subsidy rate). In the Altmaier and Jinping scenarios, the first number refers to the operational costs; the second number refers to the investment costs in regasification capacity. In the Trump scenarios, the number is the share of Base Case LNG transportation costs between U.S. liquefaction and European regasification nodes. E.g., “100” means 100% of the Base Case cost, hence, a 0% subsidy on the costs.
Europe in a global competition for U.S. LNG

Figure 7: North American exports and their destination regions in selected scenarios 2020-2050, in bcm per year

Note: The numbers succeeding the scenario name indicate the applied percentage of the Base Case cost data (i.e., the opposite of the subsidy rate). In the Altmaier and Jinping scenarios, the first number refers to the operational costs; the second number refers to the investment costs in regasification capacity. In the Trump scenarios, the number is the share of Base Case LNG transportation costs between U.S. liquefaction and European regasification nodes. E.g., "100" means 100% of the Base Case cost, hence, a 0% subsidy on the costs.
Global price divergence

- Price divergence between Europe and (East) Asia persists
- The widening price gap makes Asia relatively more attractive for global LNG supplies than Europe over time
- Due to strongly increasing demand in China, Chinese prices catch up with East Asian prices over time

Figure. Price trends for selected countries in the Base Case (€/1000 cm)
U.S. LNG to Europe

Figure 5: LNG exports from the U.S. to various destinations in Europe in the Base Case and selected scenarios in bcm/year

Note: The numbers succeeding the scenario name indicate the applied percentage of the Base Case cost data (i.e., the opposite of the subsidy rate). In the Altmaier and Jinping scenarios, the first number refers to the operational costs; the second number refers to the investment costs in regasification capacity. In the Trump scenarios, the number is the share of Base Case LNG transportation costs between U.S. liquefaction and European regasification nodes. E.g., “100” means 100% of the Base Case cost, hence, a 0% subsidy on the costs.
U.S. LNG to Europe („Trump“ scenarios)

- Little effect in Trump 100 scenario (no subsidies, delay of Nordstream2 by 10 years): slightly higher LNG imports to Northwest Europe

→ This result questions the effectiveness of current U.S. sanction policy
U.S. LNG subsidies lead to higher gas consumption in Europe

Figure 13: Total EU consumption Base Case and selected scenarios in bcm/year
Note: The vertical axis is truncated at the lower end at 300 bcm per year.
LNG terminals in Germany? Only with subsidies and...

... at the expense of Norway

Figure 11: German LNG imports from the U.S. in different scenarios in bcm per year

Note: The numbers succeeding the scenario name indicate the applied percentage of the Base Case cost data (i.e., the opposite of the subsidy rate). In the Altmaier scenarios, the first number refers to the operational costs; the second number refers to the investment costs in regasification capacity.

Figure 12: Germany Supply Breakdown in the Base Case and selected scenarios in bcm/year
Conclusions

- U.S. (and other) LNG can serve as „insurance“ for European natural gas consumers, i.e. as gap filler when there is a disruption
- In the long run, Asian markets are more attractive for U.S. LNG
- Liquid spot markets and liberalized storage capacities in Europe make it a destination „of last resort“ in the current times of overcapacities
- U.S. LNG has increased flexibility on natural gas markets globally
- There is no economic rationale for new LNG terminals in Europe, unless they are strongly subsidized
Thank you

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https://www.diw.de/de/diw_01.c.11032.de/personen/holz__franziska.html
https://www.ntnu.edu/energytransition/franziska-holz