The Role of Natural Gas in a Low-Carbon Europe: Infrastructure and Regional Supply

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Agenda

1. Natural gas consumption in Europe will decrease with ambitious climate policies
   - Investment requirements will become smaller despite competition for gas with Asia
2. Supply concerns in the Russia-Ukraine crisis
   - Modeling of disruptions scenarios in the short and long run
   - Role of LNG and cross-border pipeline bottlenecks within Europe
3. Conclusions: reverse flows investments needed in the short-term despite long-term reduction of natural gas demand in Europe

Natural gas perspectives

in a climate-constrained world

1 What role for natural gas in a low-carbon energy system?

"Gas will be critical for the transformation of the energy system. Substitution of coal (and oil) with gas in the short to medium term could help to reduce emissions with existing technologies until at least 2030 or 2035."

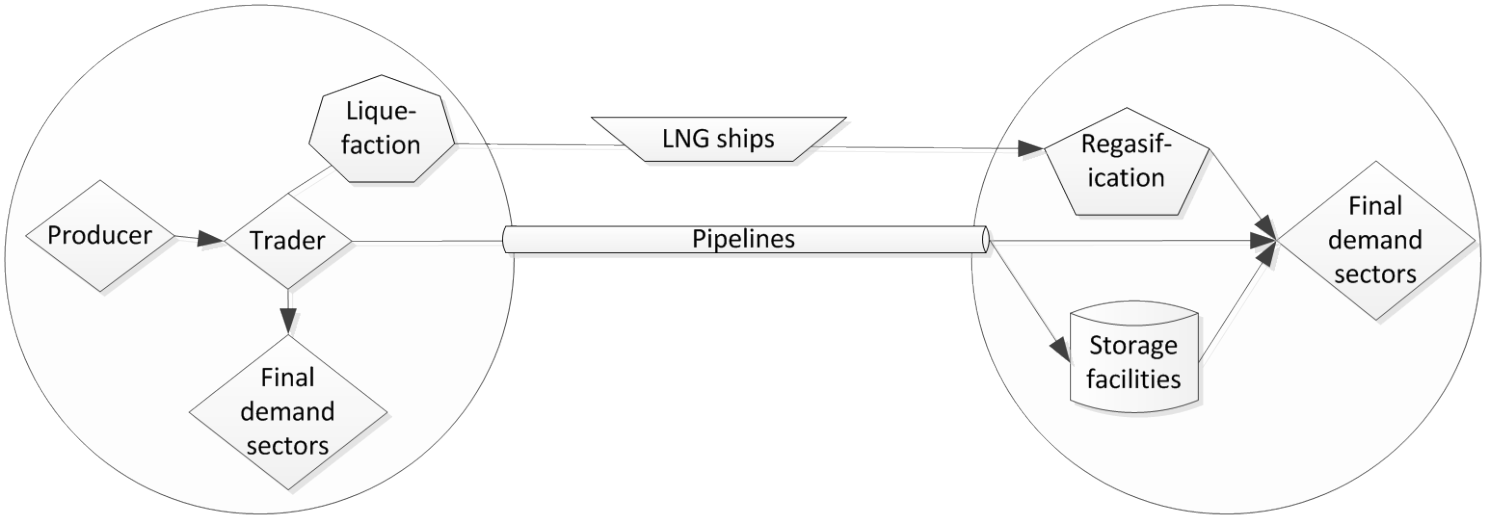
EC (2011) - Energy Roadmap 2050

- Several possible pathways for the role of natural gas depending on the available set of technologies & the strictness of climate policy
  - Gas is relatively less carbon-intensive compared to oil and coal (56 $kgCO_2$/GJ for gas vs. 98 $kgCO_2$/GJ for hard coal)
  - Advantageous balancing properties
  - But: w/o CCS, leads to substantial CO_2 emissions
- Since 2011 EC Energy Roadmap to 2050: focus on a low-carbon Europe
  - Analysis of different possible GHG mitigation pathways until 2050
  - Optimal choice of the energy mix under GHG constraints
- Detailed look at the gas sector, at trade and infrastructure

1 Application of the Global Gas Model (GGM)

"Multi-agent economic game on an underlying transportation network"

- Partial equilibrium model of the global natural gas market
- Optimization problems of different players along the value chain
- Market power for selected trade relations
- Endogenous investment in storage and transportation infrastructure
- Model equilibria in 5-years-steps until 2040 with 2 seasons per year
- 94 regional nodes in 74 countries



Representation of the natural gas market and supply chain in GGM (joint work with R. Egging)

1 Underlying Climate Policy Assumption in the scenarios

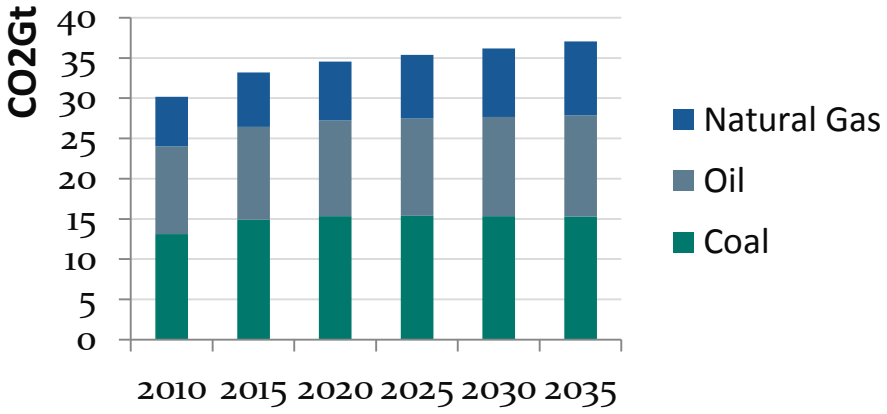
Base Case:

- Follows *"IEA WEO 2012 New Policies Scenario" (NPS)*
- Moderate climate policies, concentrated in Europe and OECD
- Global CO_2 emissions 20% higher in 2035 relative to 2010
- 50% higher NG consumption; 20% higher coal consumption

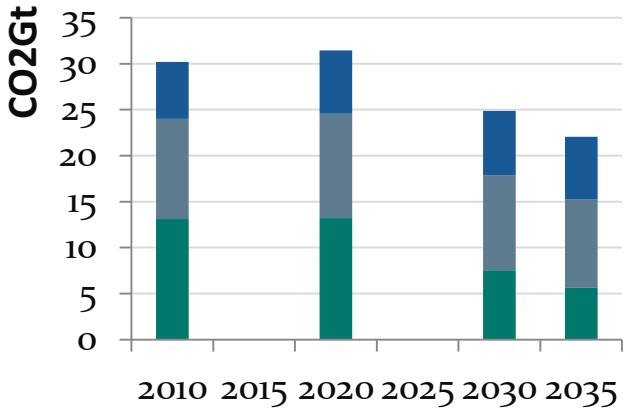
Climate Scenario:

- Follows *"IEA WEO 2012 450ppm"*
- Global climate policies implemented in line with 2 degree target
- Global CO_2 emissions 27% lower in 2035 relative to 2010
- 20% higher NG consumption; 30% lower coal consumption

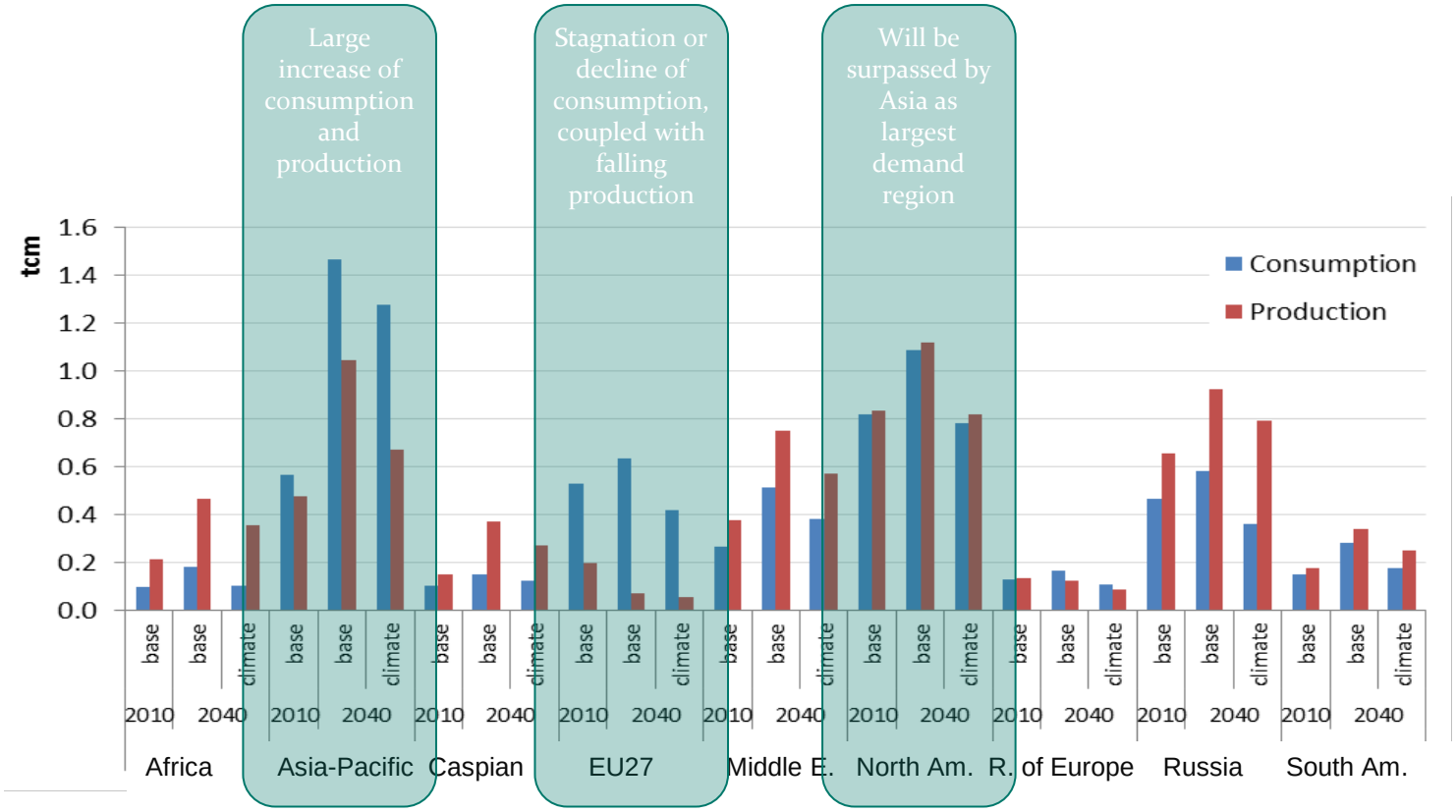
CO_2 emissions by fuel (NPS)



CO_2 emissions by fuel (450ppm)

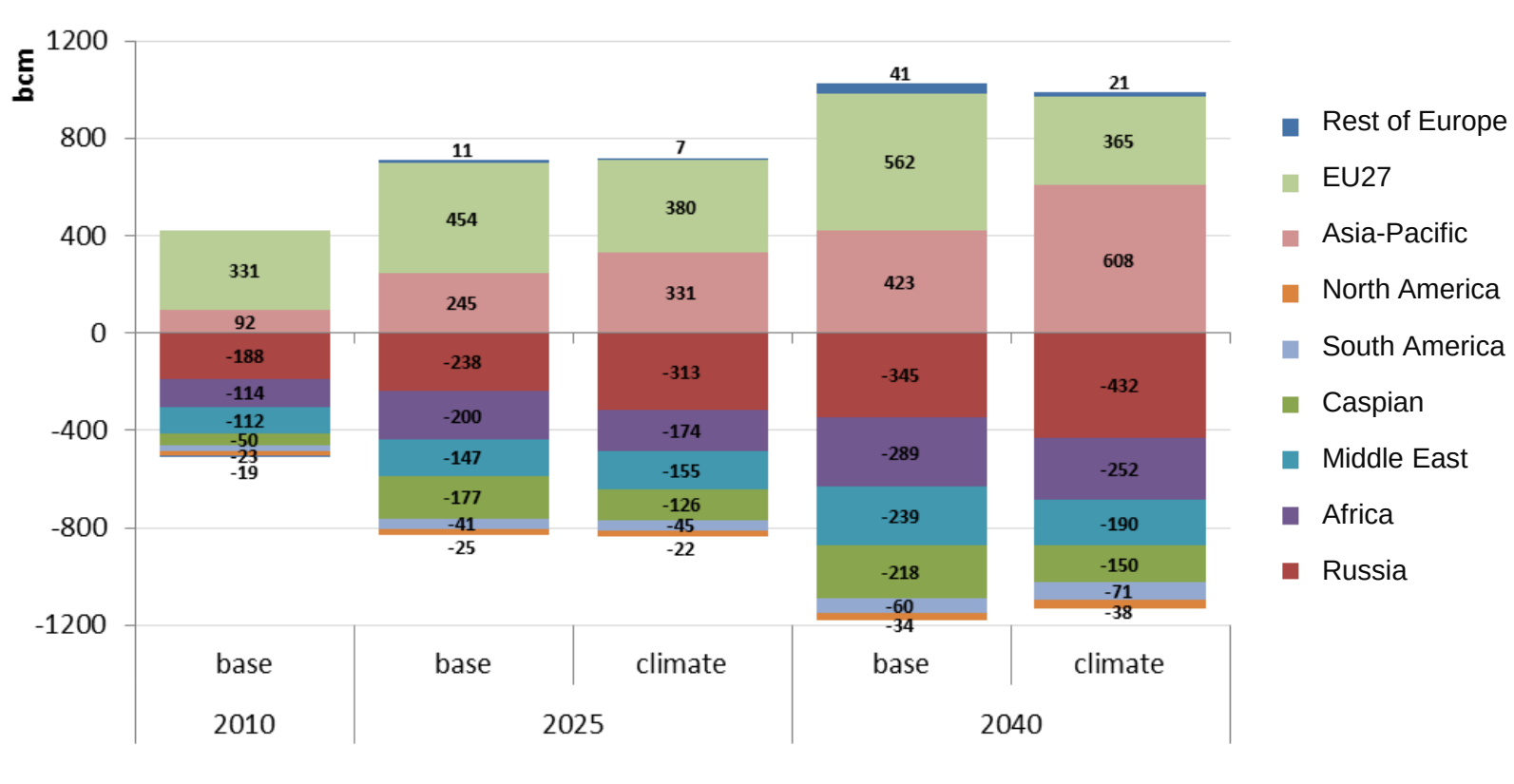


1 Natural Gas Consumption and Production by Region



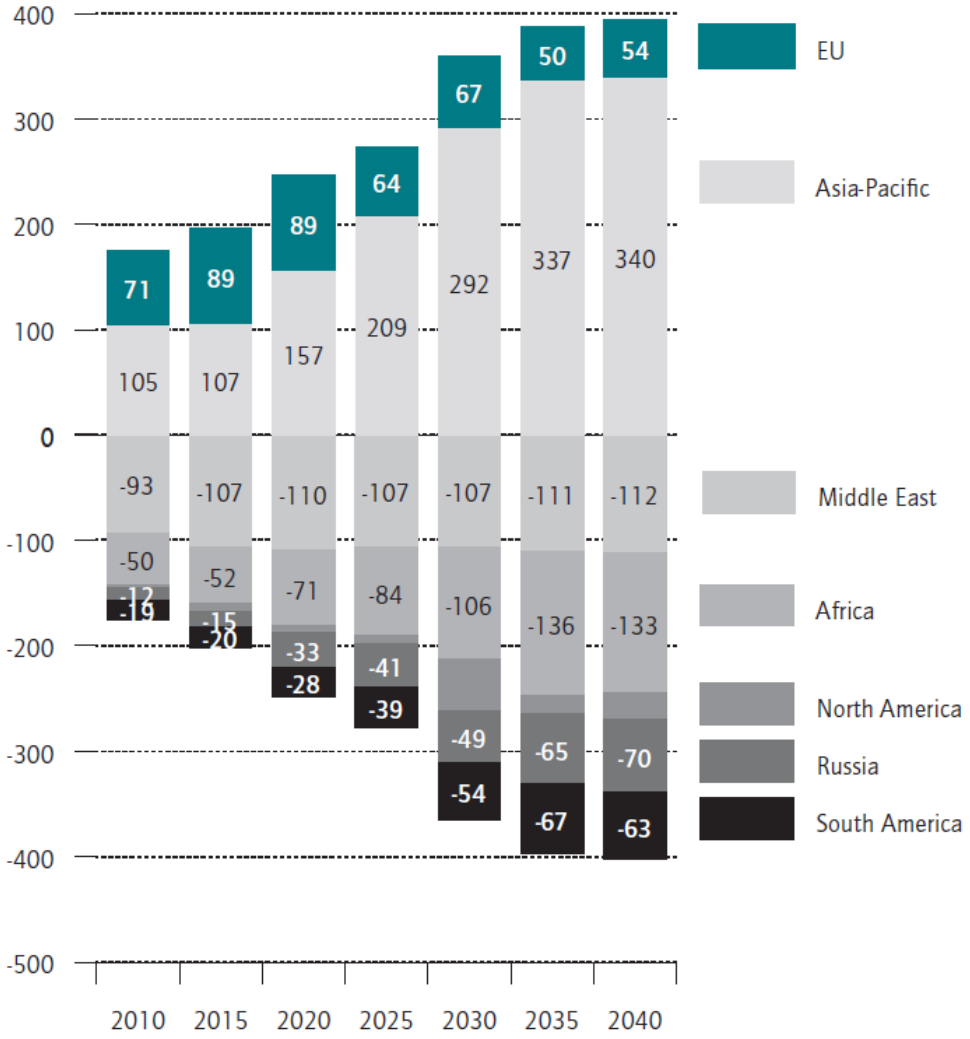
World gas consumption and production by region and scenario in 2010 and 2040, in tcm

1 Regional Supply Patterns: Increasing Import Dependency in Europe



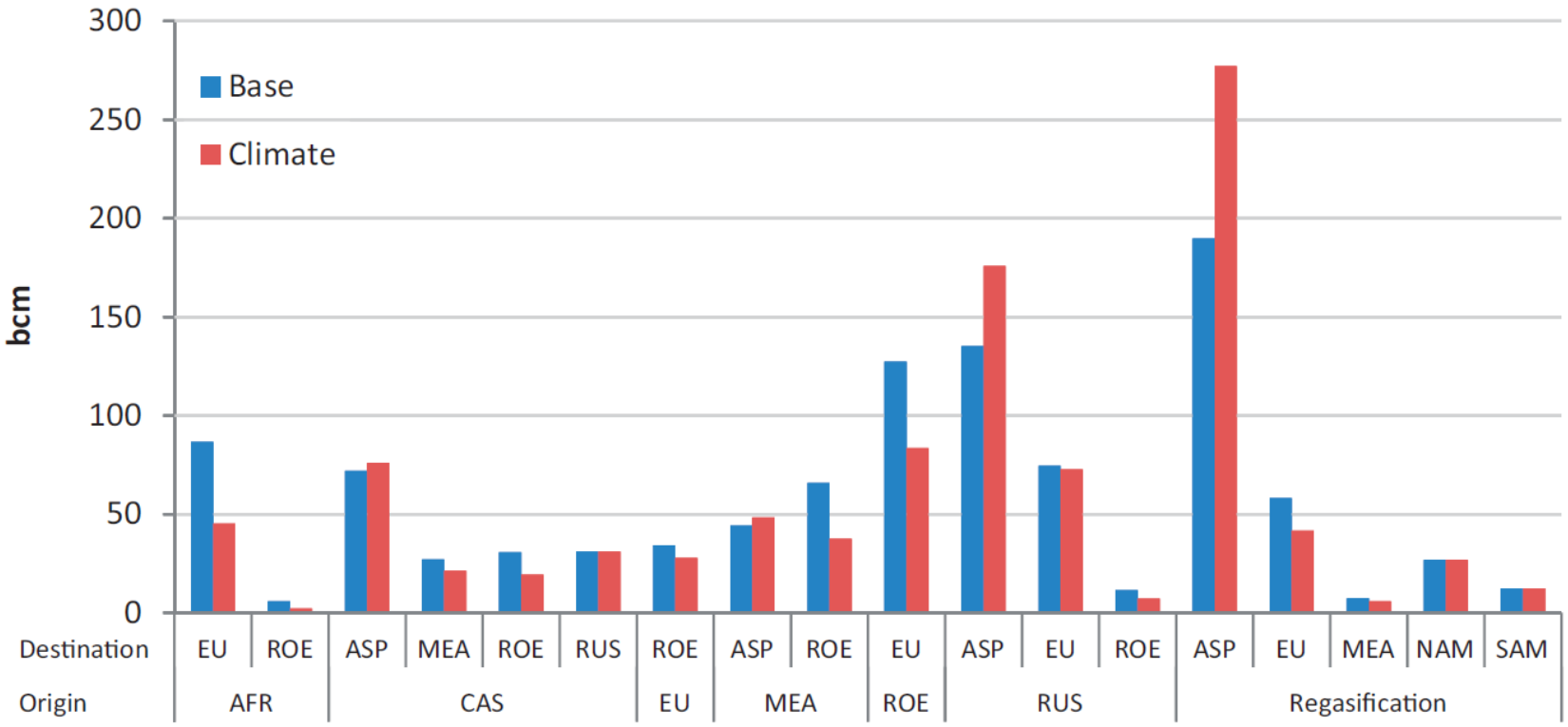
Regional supply balances in both scenarios, in tcm
Positive values in the upper part are net imports, negative values in the lower part net exports; differences in the aggregates are due to transportation losses.

1 LNG Trade: Europe keeps a small role



Net Trade Flows for Liquefied Natural Gas (LNG) in Climate Scenario

1 Import capacity expansions for inter-regional trade: Less infrastructure expansion to Europe in Climate scenario



Worldwide inter-regional import capacity expansions (pipelines and regasification) until 2040 by origin (lower part of horizontal axis) and destination, in bcm

Security of Supply in Europe:

Russian-Ukrainian Crisis

2 Ukraine-Russian crisis – The same (gas) risk for Europe as 2009?

Security of Russian natural gas supplies is high on the agenda – once more, but the situation has changed since 2009 (cf. Behrens & Wieczorkiewicz, 2014) :

1. Less Russian transits to Europe via Ukraine (Nord Stream)
2. Lower share of EU imports from Russia
3. Expanded intra-European interconnectors (EC 994/2010)
4. Expanded EU LNG import capacity by 15%
5. Reduced EU consumption of natural gas by 6%
6. Natural gas production boom in the USA
7. Increased Asian LNG imports (Fukushima disaster)

2 Dependency from Russian Natural Gas Supplies: Concentrated in East Europe

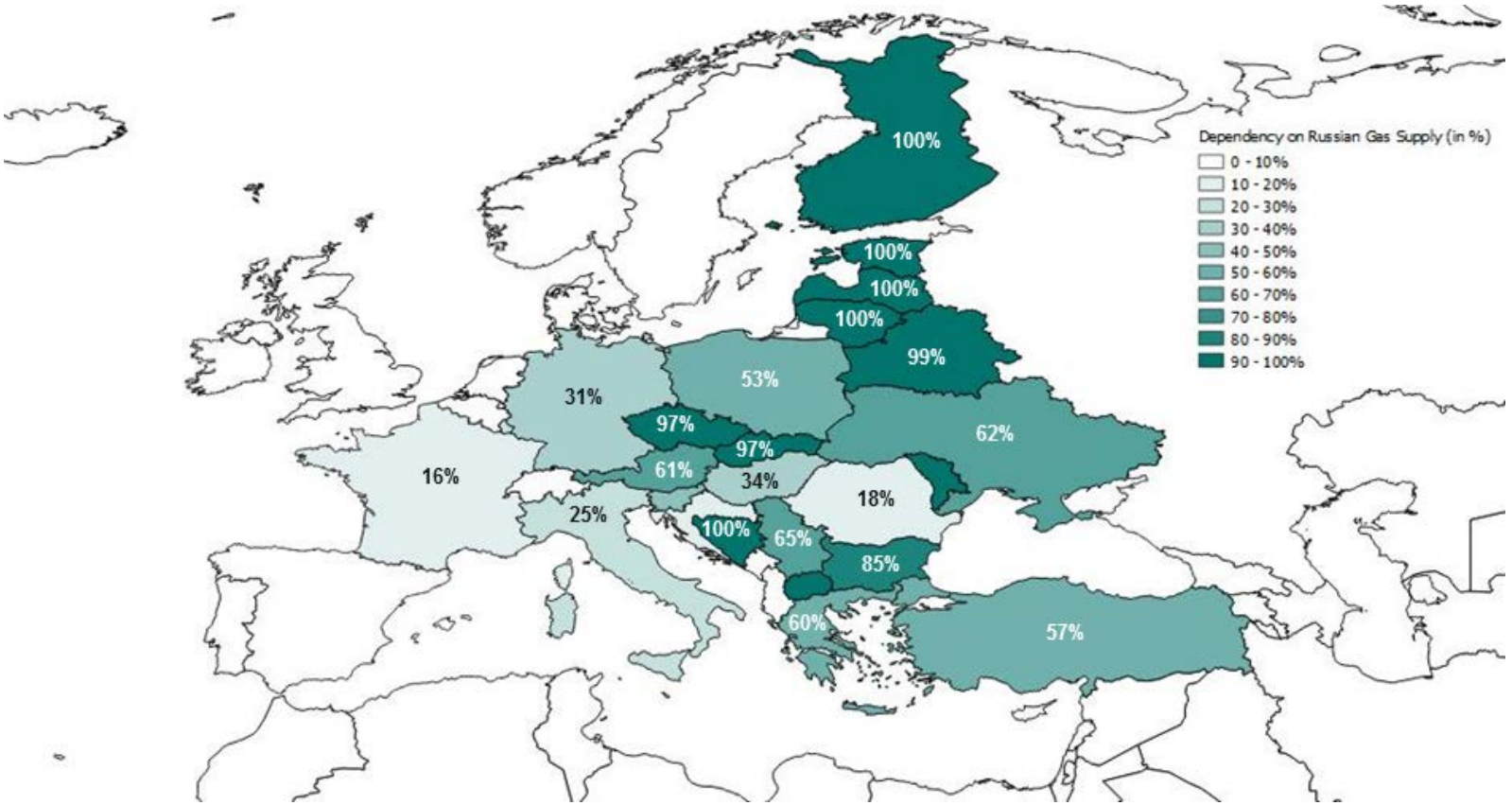


Figure: Dependency on Russian Natural Gas in 2012, calculated by the share of imports from Russia in total supply (domestic production and total imports), in percentages.

2 European Import Infrastructure

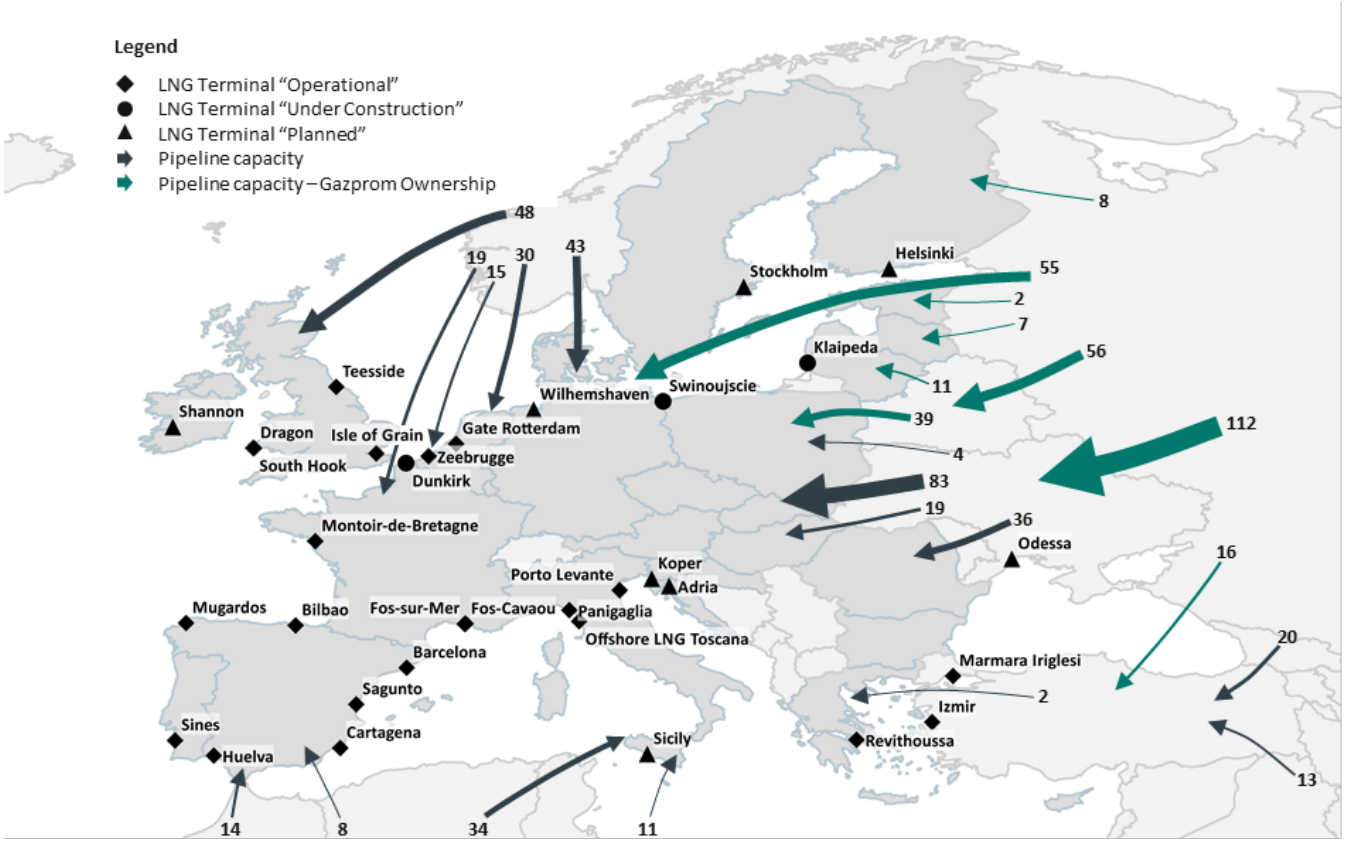
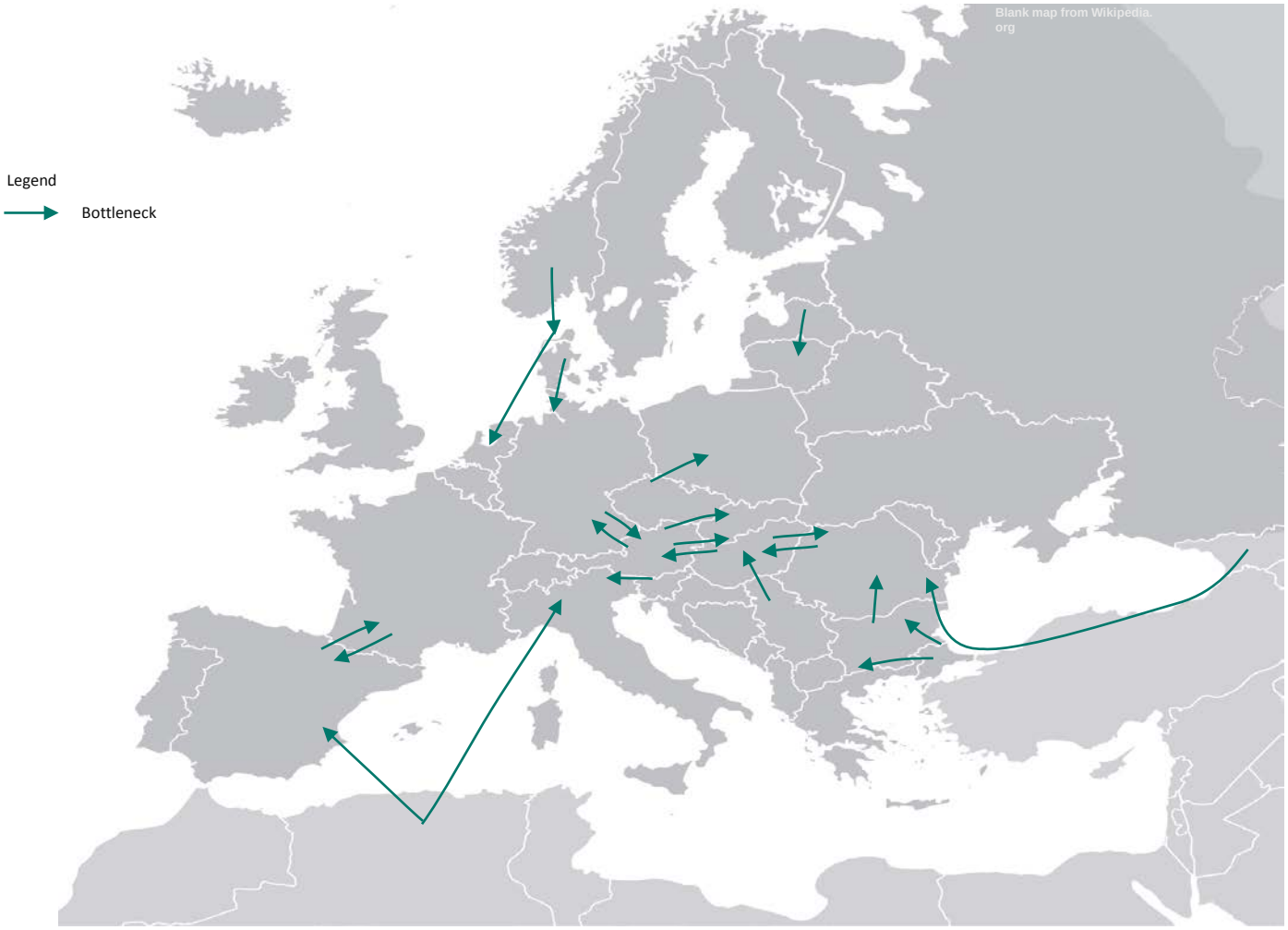


Figure: European LNG and pipeline import infrastructure from external suppliers in 2013.

- EU LNG import capacities of 195 bcm
- Pipeline capacity towards Europe mainly from Russia and Gazprom-owned

2 Bottlenecks in the European Pipeline Network



Model results with the Global Gas Model, Business-as-usual case 2015 (DIW DP 1273)

2 Russian Disruption Scenarios for Europe

Scenario Name	Description
Base	Base Case: • Projections of natural gas production and consumption based on the New Policies Scenario of the WEO 2012 (IEA, 2012)
UKR Disruption 2015	Ukrainian Disruption: • Interruption of Russian pipeline connection to Ukraine in 2015 (direct and via Belarus)
Gazprom 2015	Disruption of Gazprom infrastructure to Europe (incl. Turkey): • Reduction of total cross-country pipeline and storage capacity in 2015 that is currently majority-owned directly and indirectly by Gazprom (exception for Belarus) Affected pipelines: • Nord Stream • Brotherhood • Yamal Europe • Blue Stream • South Stream • OPAL Affected storage facilities: • Rehden in Germany • Haidach in Austria • Incukalns in Latvia • Banatski Dvor in Serbia
Long Disruption ≥ 2015	Same coverage as in „Gazprom“ From 2015 to 2040

2 Consumption effects in a short-term disruption *(both scenarios)*

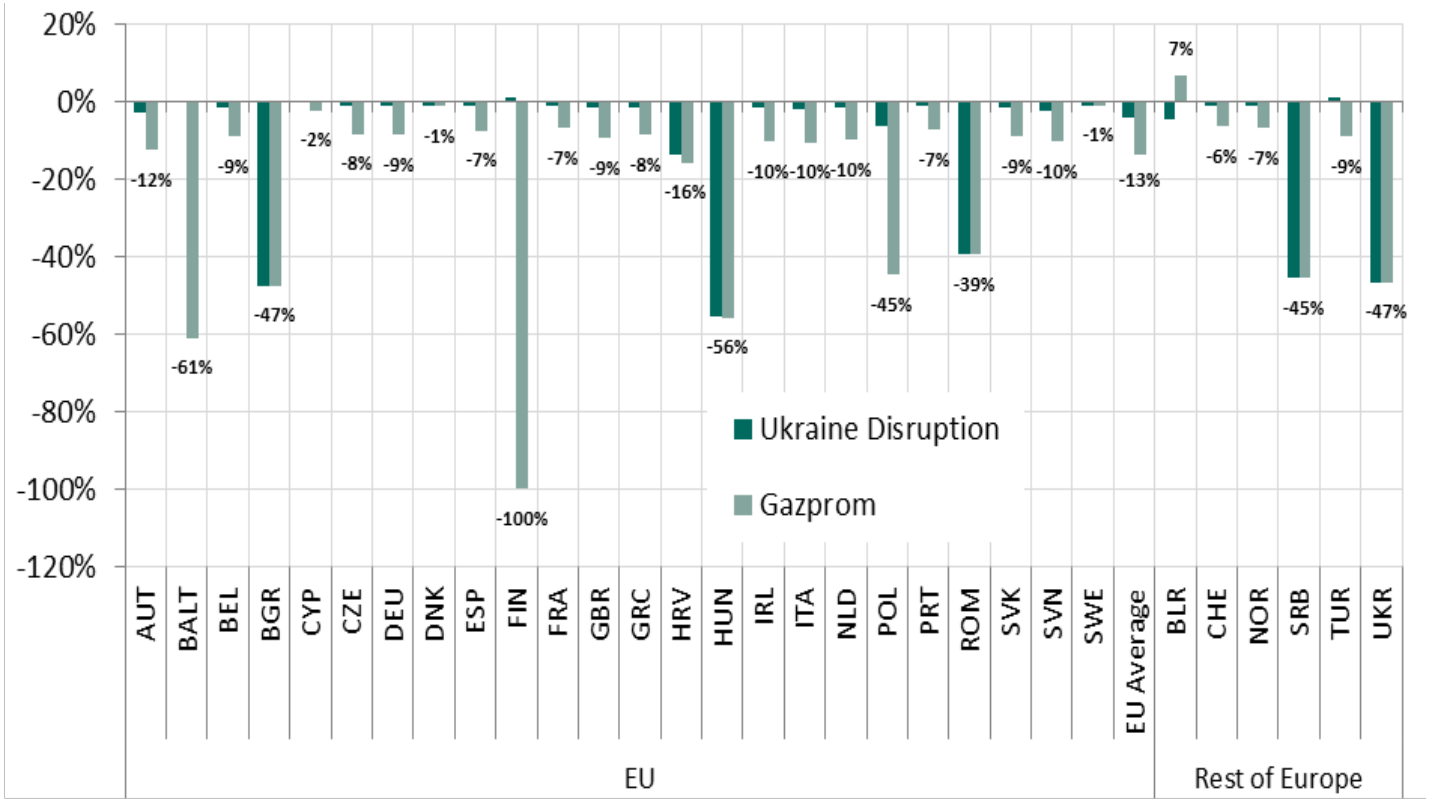


Figure: Changes in 2015 consumption levels relative to the Base Case, in percentages. Percentage values for the *Gazprom* scenario are provided next to the respective bars.

- Average effect on Europe is small
- Some countries are heavily hit:
  - Ukraine, Hungary, Bulgaria, Romania, the Baltics & Finland

2 Price effect of a short-term disruption of the Ukrainian transit

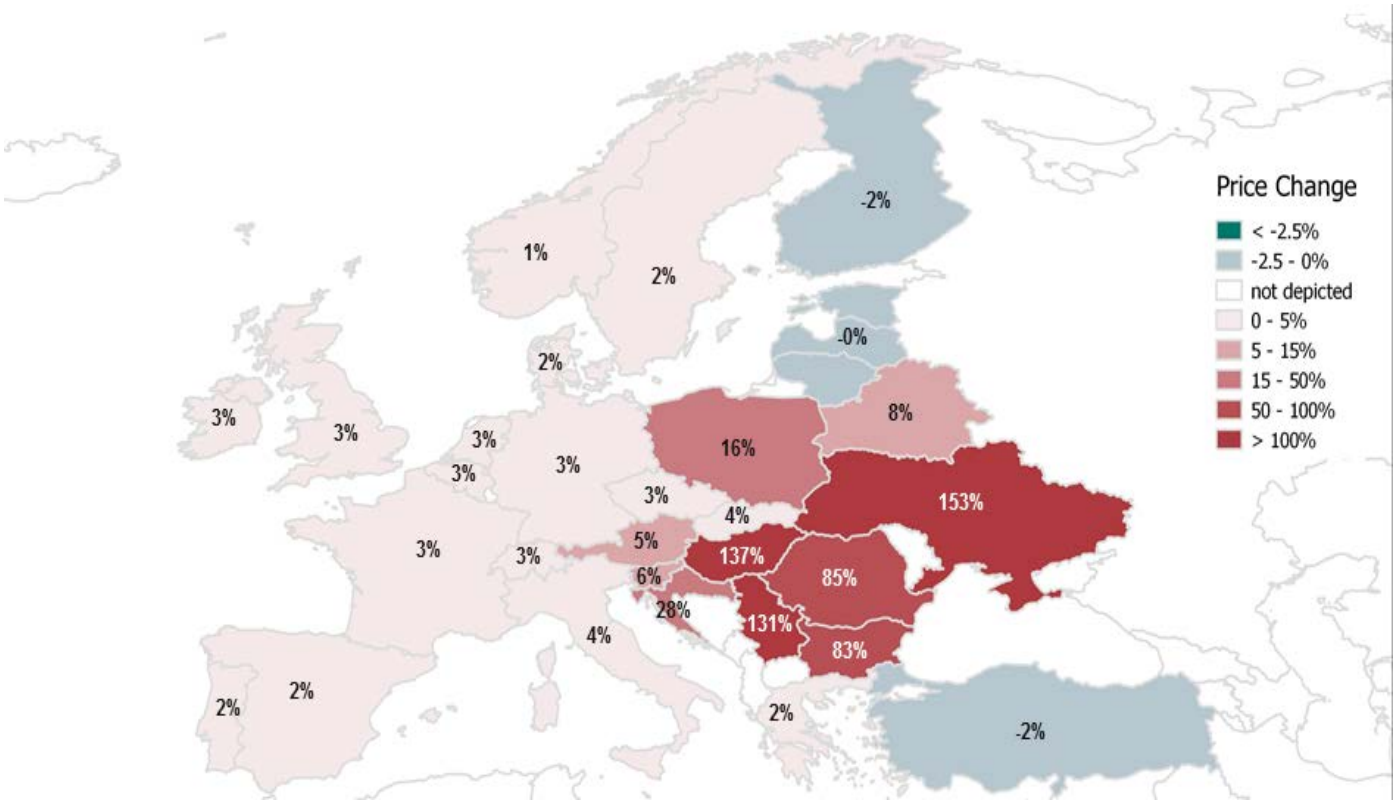


Figure: *Ukrainian Disruption* price changes in 2015 relative to the Base Case, in percentages.

- Equilibrium price-quantity pair computed by the model
- Effect concentrates on Ukraine and its neighbors

2 Price effect of a short-term disruption of the Russian supplies

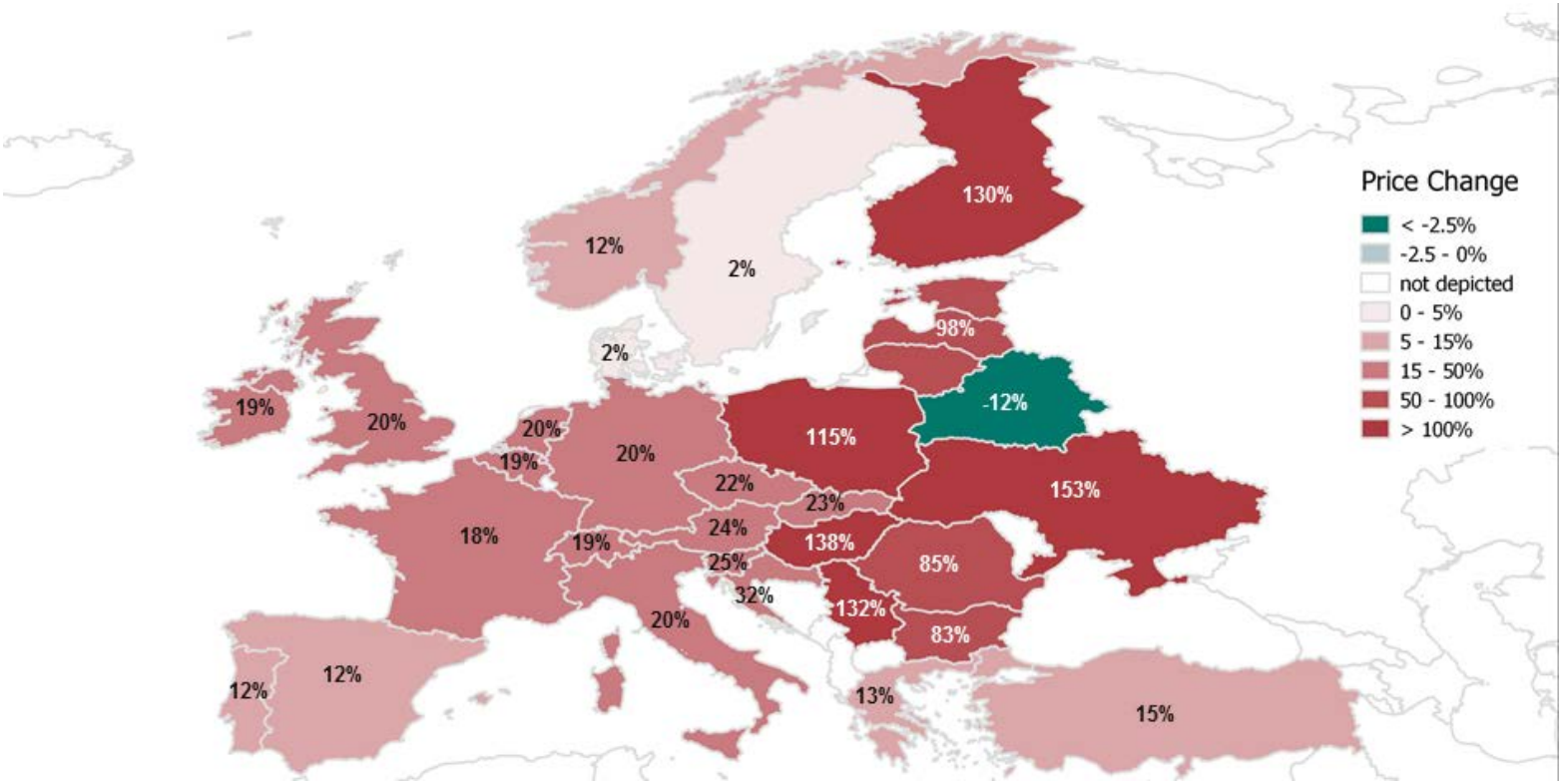


Figure: *Gazprom scenario* price changes in 2015 relative to the *Base Case*, in percentages.

- Consequences felt across Europe
- Displacement effects in countries that do not import from Russia in the Base Case (e.g., Spain, UK)

LNG – An alternative supply source?

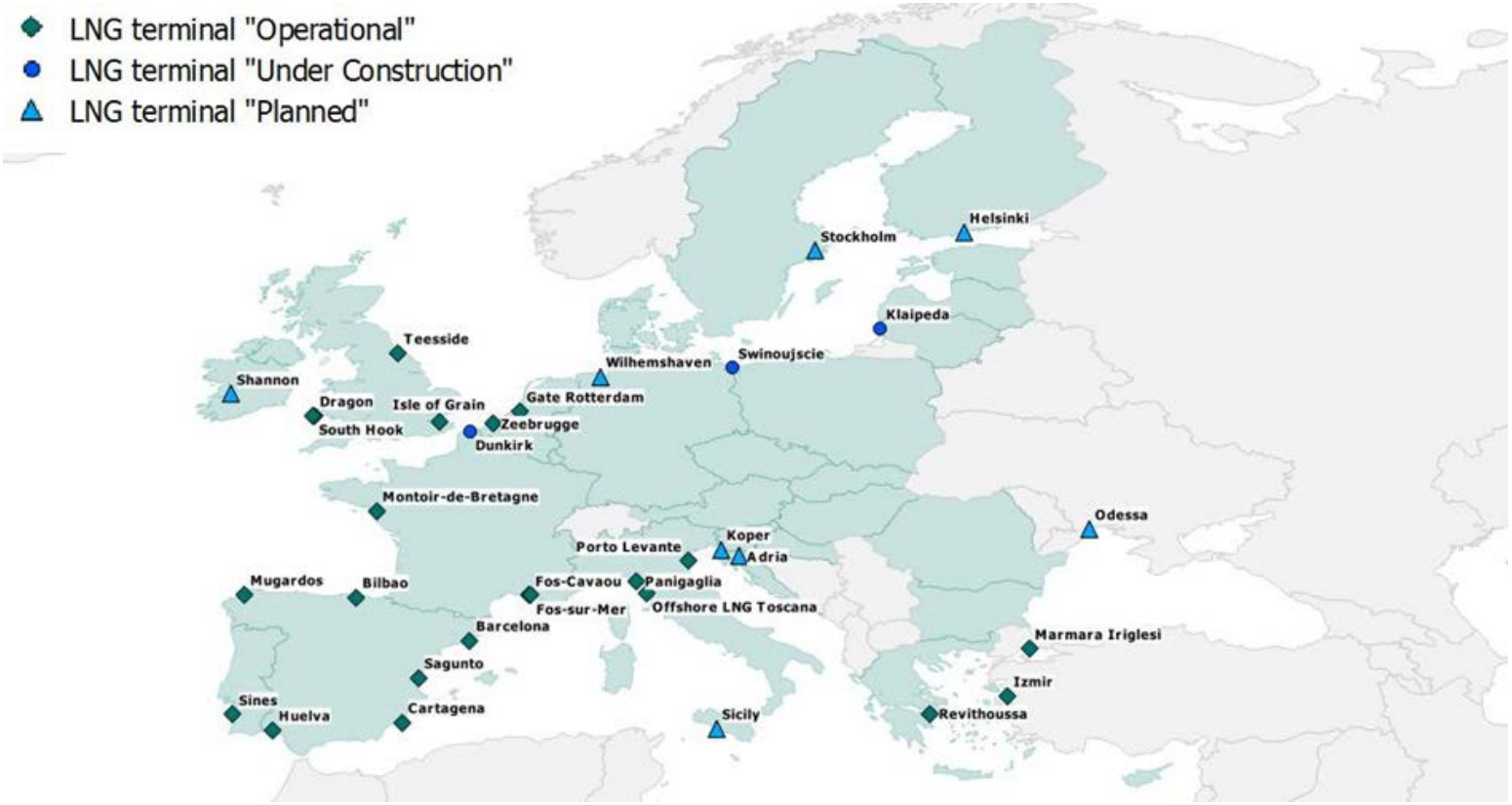


Figure: LNG imports terminals in Europe, which are "operational", "under construction" and "planned".

- High cumulated import capacity in Europe: 195 bcm per year
- Mostly in countries that are hardly dependent on Russian supplies

2 EU-Imports: Partly Substituted Russian Supply

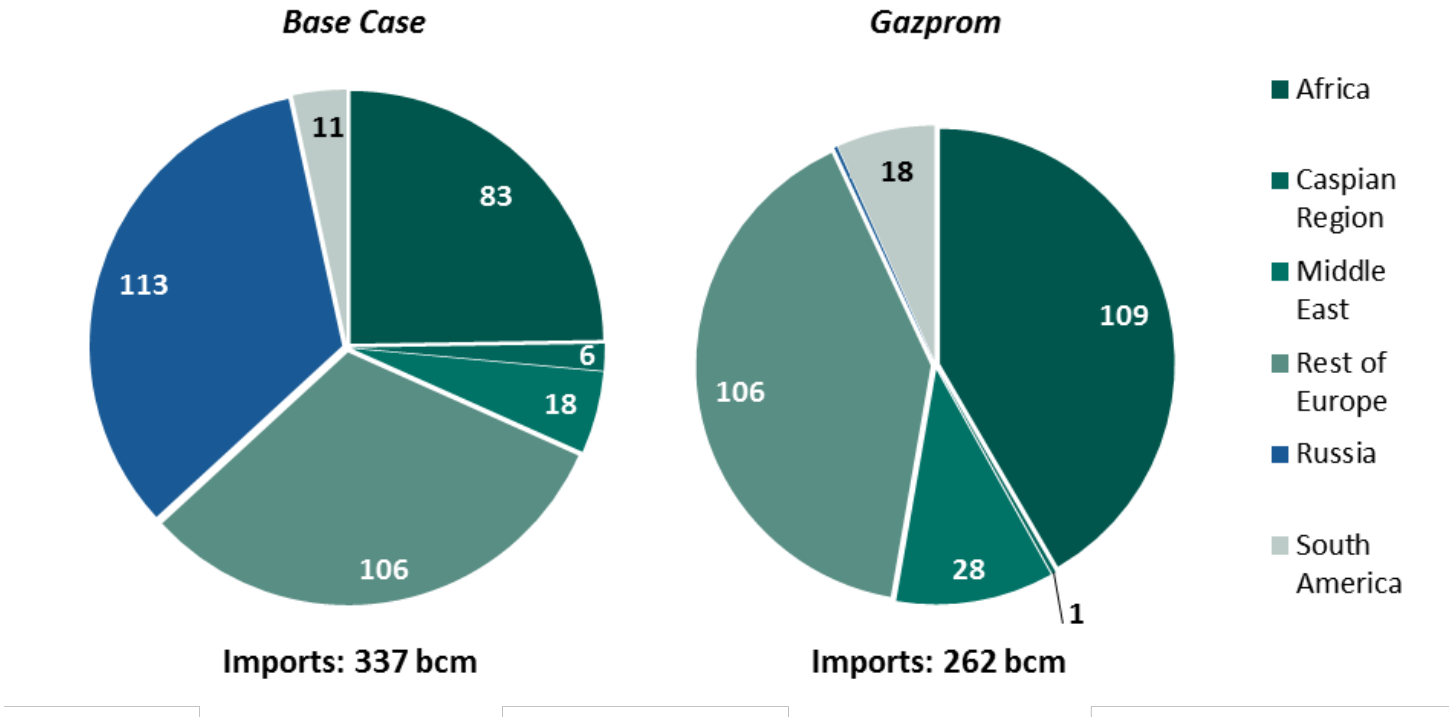


Figure: EU import structure in 2015 by supplier, in bcm.

- Russia and the Caspian region cannot supply Europe because pipelines via Russia and/or Ukraine are not available
- Increasing imports from Norway, (North) Africa and the Middle East (LNG)

2 EU imports: by pipeline and LNG

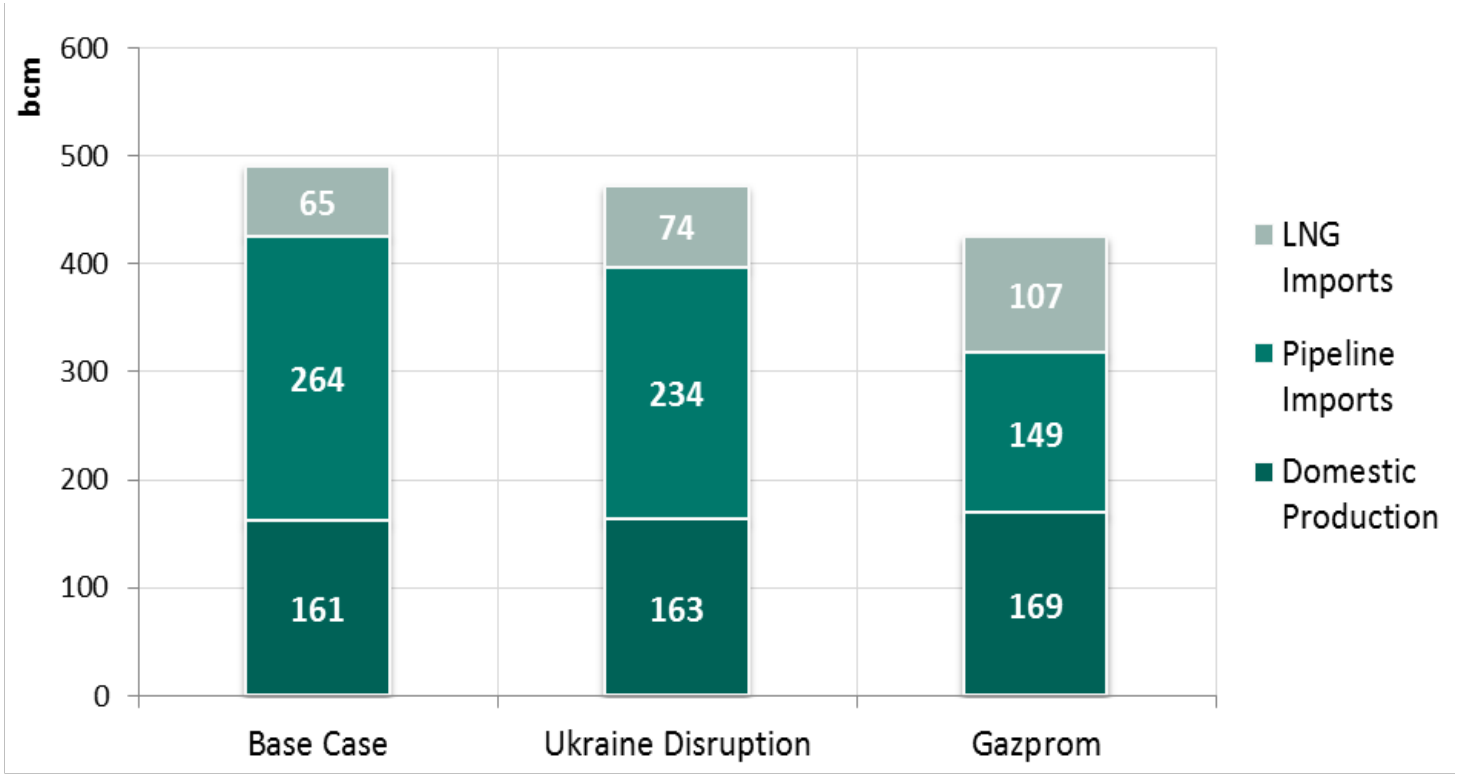


Figure: EU supply structure in 2015 across scenarios, in bcm.

- Disruption of Russian supplies can only partially be offset because domestic production can hardly react and there is too little reverse flow capacity
- Additional LNG has to be obtained in competition with Asian importers

2 Utilization rates of LNG terminal in disruption scenarios

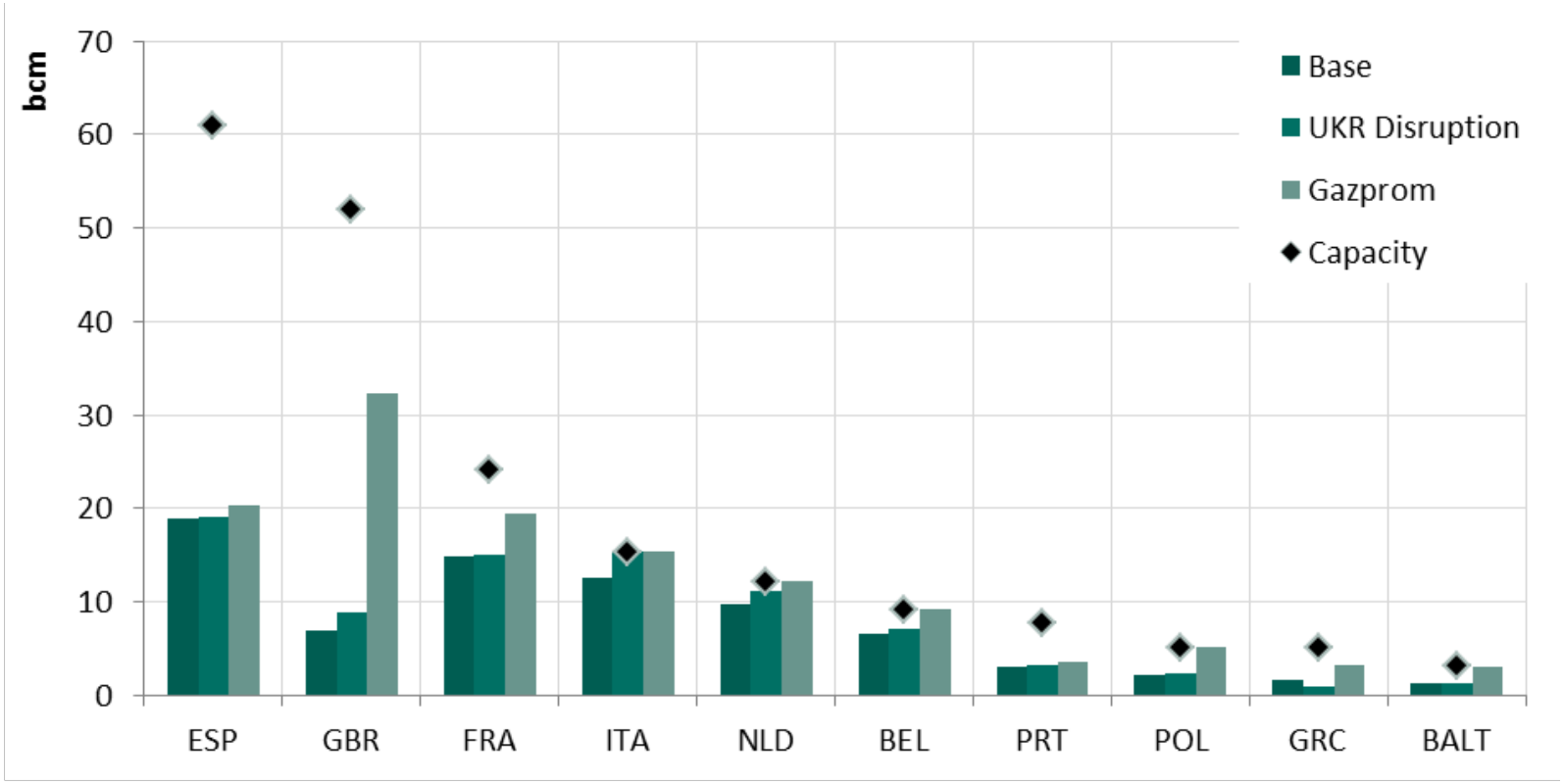


Figure: EU LNG imports in 2015 by countries compared to potential regasification capacity (bcm).

- LNG imports increase particularly in the UK and Italy
- Low utilization rates in several countries, especially in Spain (33%)
- Intra-European pipeline bottlenecks hamper efficient import balancing

2 Selected Pipeline Capacities and Utilization Rates

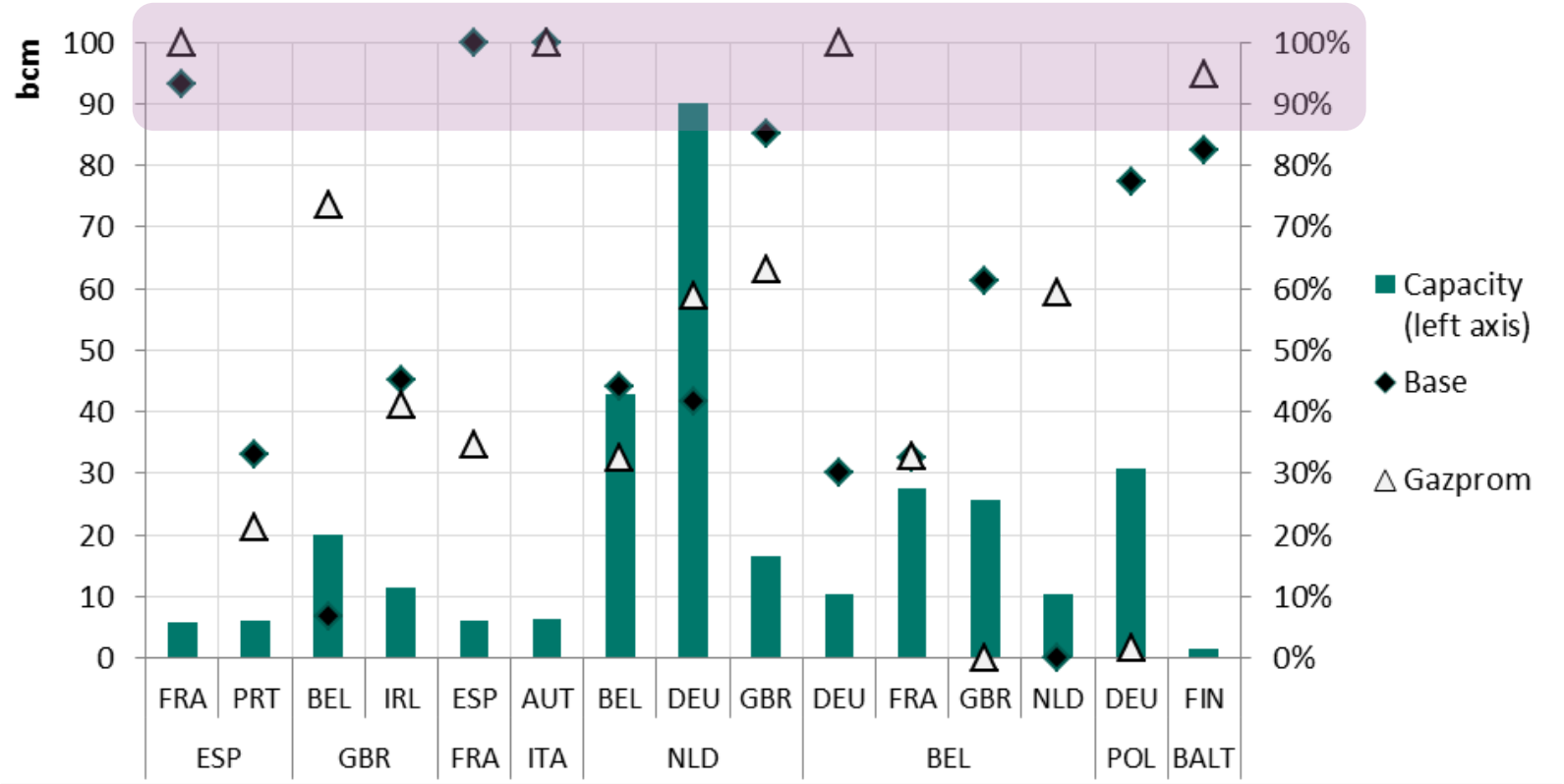


Figure: Pipeline capacities (left axis) and export utilization rates from LNG importing countries, in bcm and percent

- Pipeline bottlenecks prohibiting LNG imports to be exported within the EU
  - Spain >France > Italy / Germany
  - Italy > Austria / Switzerland > Germany

3

Conclusions

3 Conclusions

- Climate policies in the natural gas market are likely to be the strongest effect in Europe; the smallest in Asia
- Investment requirements in import infrastructure will become smaller in Europe with ambitious climate policy
- Further relaxation of intra-European pipeline bottlenecks could reduce the negative impact of disruption
  - Reverse flows toward Eastern Europe, connection of the Baltics and Finland to Central Europe
  - Pipeline capacities from Spain via France and from Italy toward Central Europe for LNG imports and North African Gas
- Reverse flows investments needed in the short-term despite long-term reduction of natural gas demand in Europe
- Outlook: impact of additional uncertainties, e.g. of Dutch production and fracking?

Thank you for your attention.

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