



Energy Corridor Optimisation for the European Markets of Gas, Electricity and Hydrogen

Analysis of the optimal gas corridors and infrastructure to secure supply in Europe in the long term - Model based analysis-

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Overview

Scope of the analysis:

- Convergence towards liberalized market with few players in the long run,
- Prices established via demand/supply equilibrium,
- Seasonal flexibility and sectoral demand,
- Production capacity is exogenous,
- Investment in transport corridors (pipelines, LNG, storage) is endogenous.

Main conclusion:

- Substantial investments needed in corridors towards EU,
- Especially the East–West route influence future gas prices.

Outline:

1. GASTALE model presentation,
2. Results.

GASTALE model and input data assumptions

The GASTALE model version 4.4

Overview of actors in GASTALE 4.4

Demand and supply side

Model calibration

Gas corridors: transmission

Investment considerations and dynamics

The GASTALE model version 4.4

GASTALE distinguishes between:

Producers with market power: decide on production, transport to country border, earning a border price.

Transmission system operators (TSO): regulates transport through pipeline network & LNG shipping.

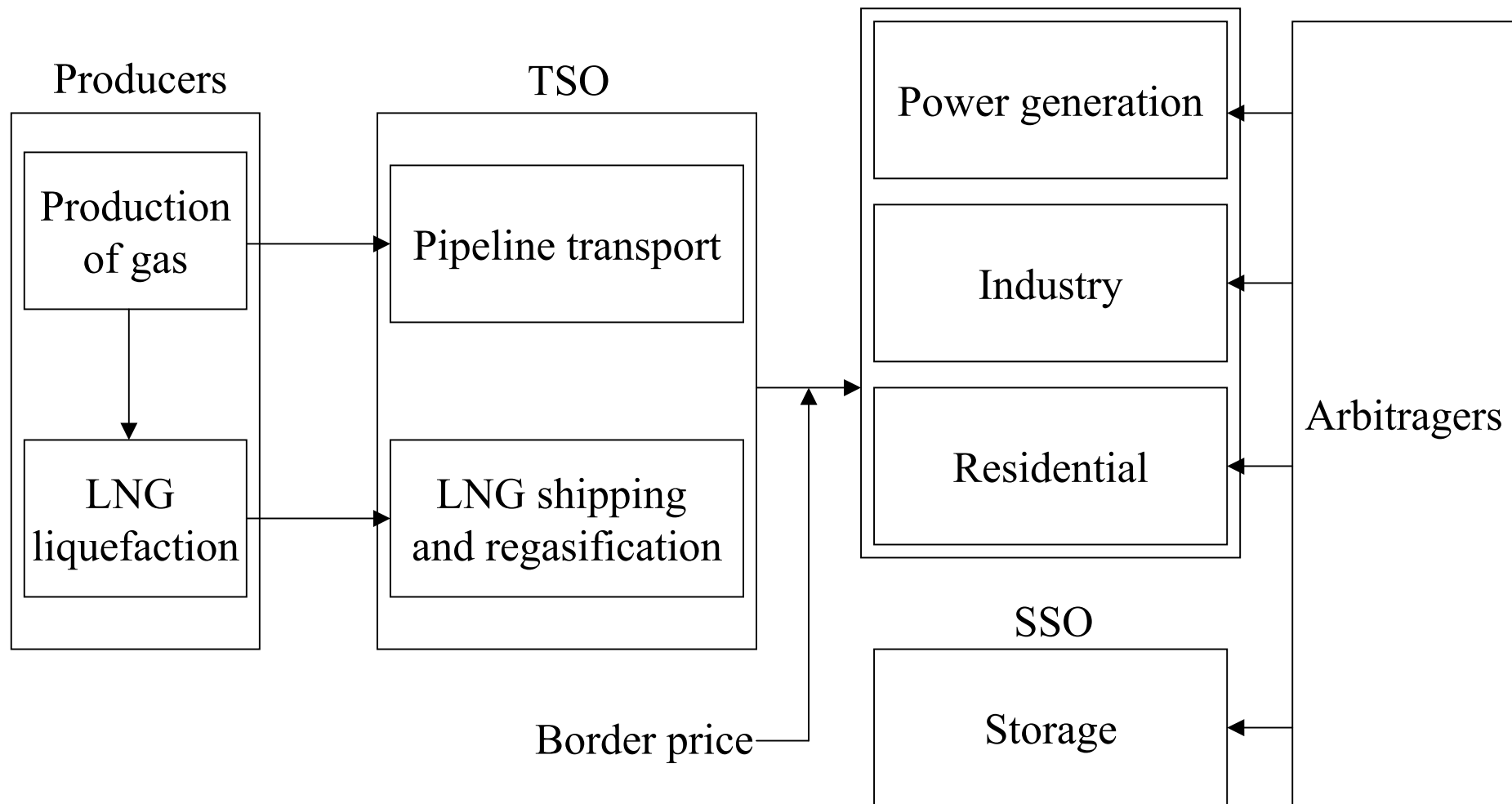
Arbitragers without market power: trade gas among power generation, industries, residents & storage.

Storage system operators (SSO): regulates injection during the warm season and extraction from storage facilities during the cold season.

Consumer prices clear the market.

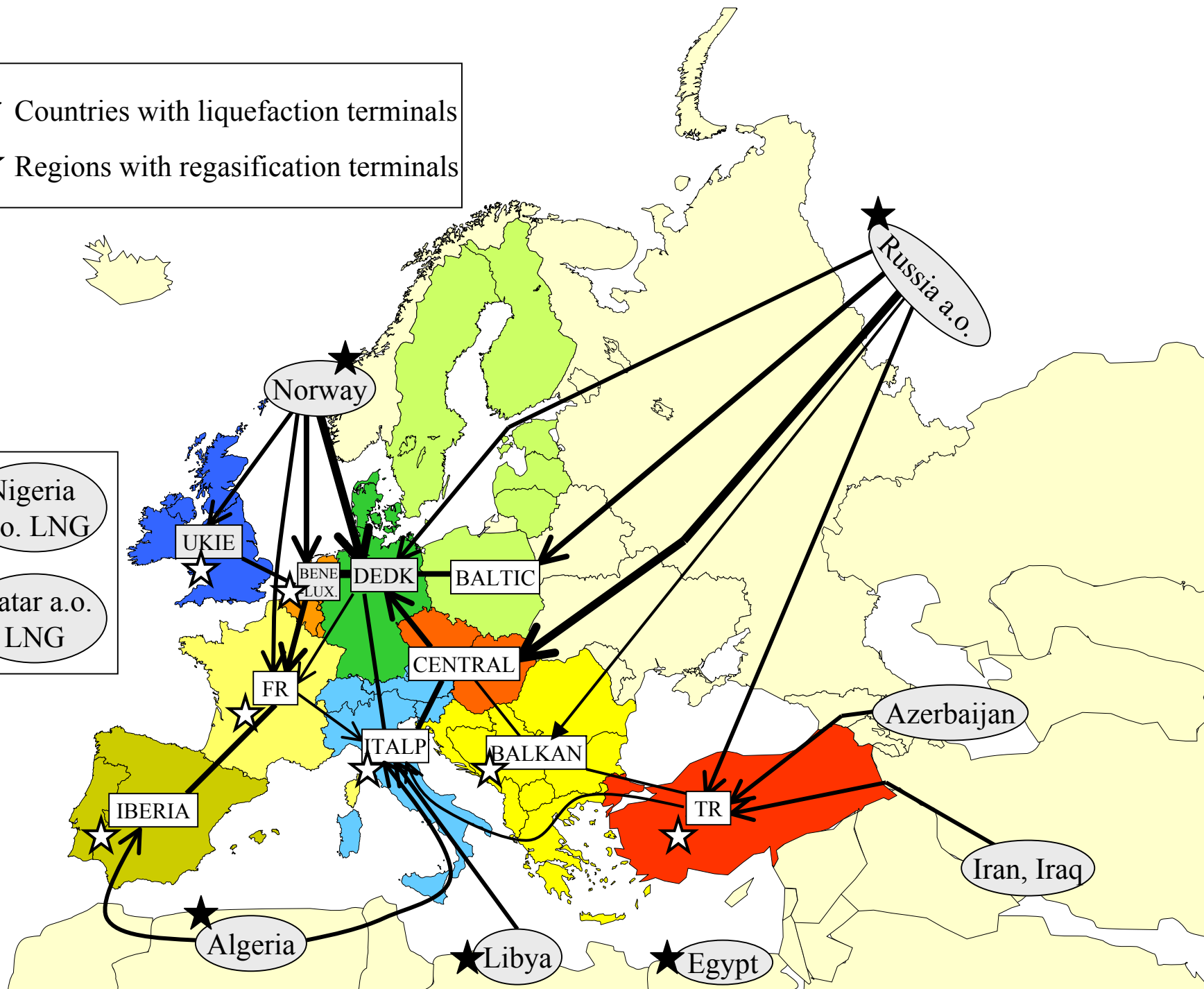
Investments in storage, pipeline, liquefaction and regasification, capacities.

Overview of actors in GASTALE 4.4



- ★ Countries with liquefaction terminals
- ☆ Regions with regasification terminals

- ★ Nigeria a.o. LNG
- ★ Qatar a.o. LNG



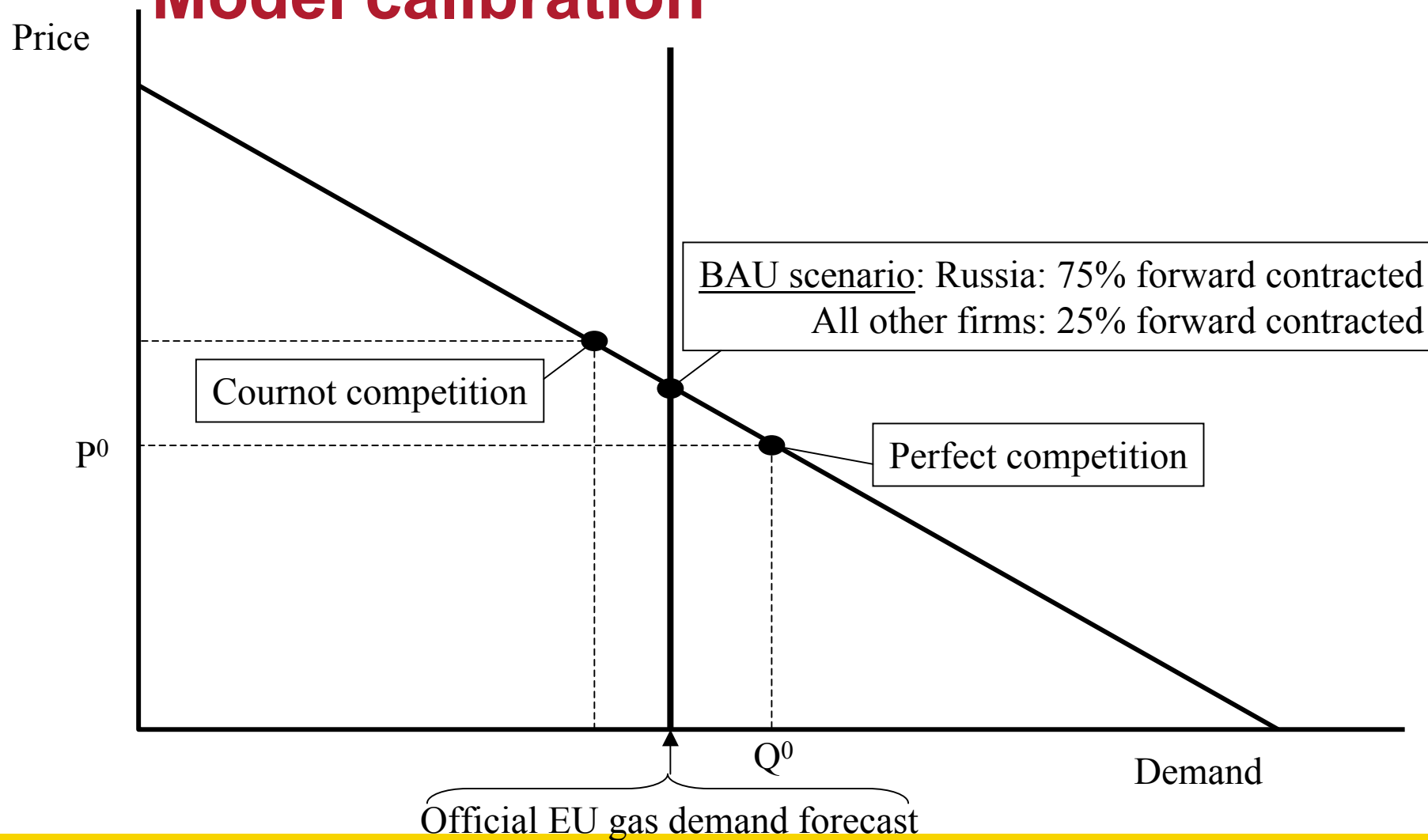
Demand and supply side

GASTALE has **ten consumers**: UKIE, BENELUX, DEDK, BALKAN, BALTIC, CENTRAL, FR, IBERIA, ITALP, TR

- Model is calibrated to a fixed level of demand in 2005 (+12%) under **perfect competition**
- Market power mark-ups are set to realistic values to derive the **BAU case** to match desired level of demand.
- Demand is elastic and the demand curve is linear

GASTALE has **twelve producers**: Algeria, Caspian, Egypt, Iran, Libya, Nigeria, Norway, Qatar, Russia, UKIE, BENELUX, DEDK

Model calibration

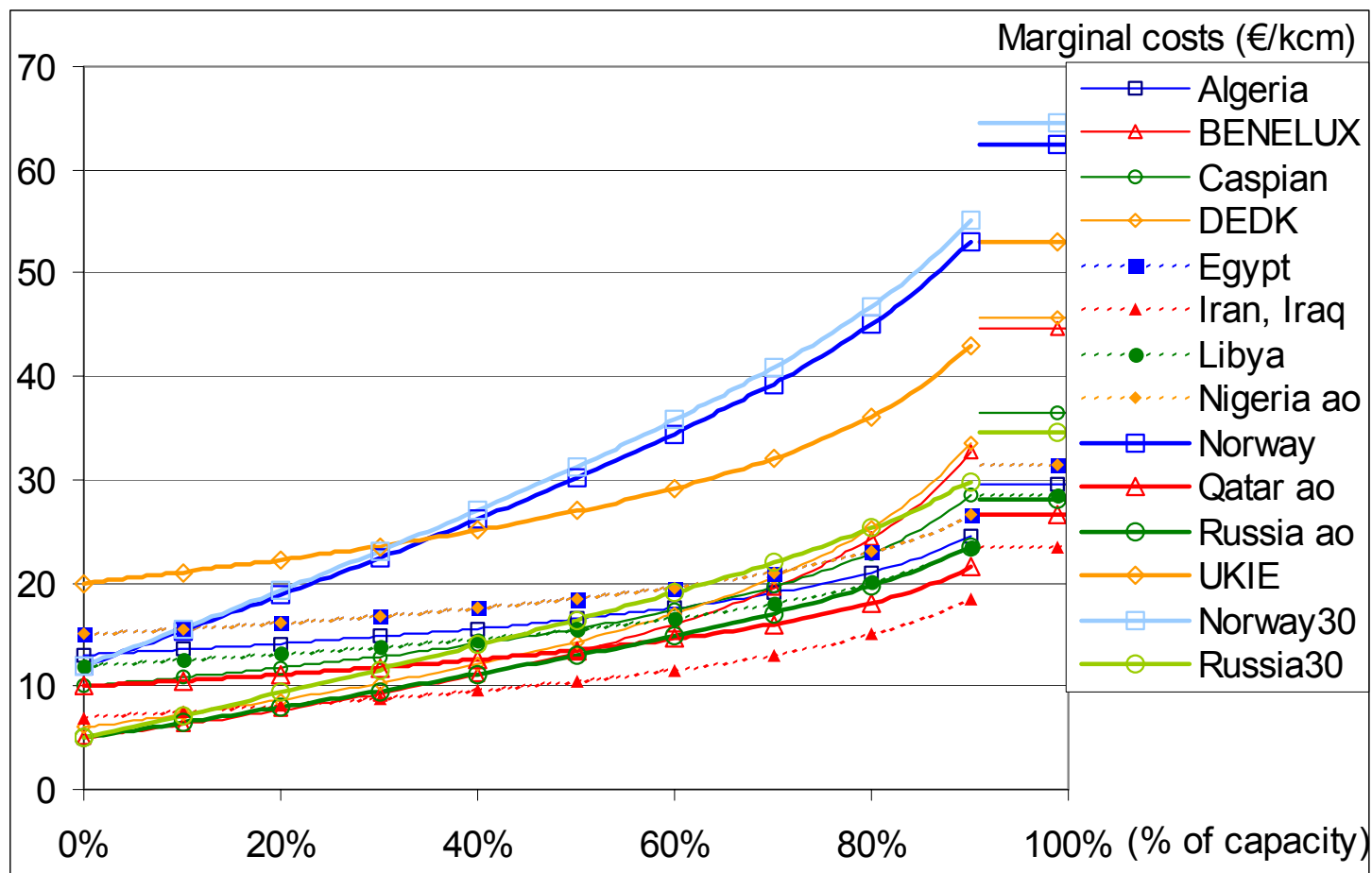


Gas corridors: transmission

Transmission of gas can take place in two manners from producers to consumers:

1. **Pipeline network:** involves transport costs and pipeline capacity.
 - Throughput is a possibility, for instance from Russia via CENTRAL to DEDK.
2. **LNG shipping:** involves transport costs, liquefaction and regasification capacities

Marginal production cost



Investment considerations & dynamics

We also made assumptions on the value of capital:

- The additional investment cost of pipeline transport, liquefaction and regasification capacity, and storage capacity is assumed to be 20% on top of the LRMC.
- Economic lifetime of pipeline, liquefaction and regasification capacity is 30 years, while storage has a lifetime of 60 years.
- The effective interest rate (for new investments) is set at 10% (real) per year.



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Results

Eight policy scenarios

Demand

Prices

Investments

EMF scenarios 1/2

BAU case:

driven by official EU gas demand/supply/prices forecast,
forward contracts: Russia 75%, other countries 25%

Low demand case:

driven by high oil prices etc.,
demand more elastic +20%, World LNG export –20%

High demand case:

driven by low oil prices etc.,
demand less elastic –20%, World LNG export +20%

Deferral case:

driven by market risks for banks etc.,
resulting in 30% additional investment costs

EMF scenarios 2/2

Constrained Russia:

The pipelines running out of Russia into Europe cannot be expanded

Constrained LNG:

Production of Qatar(+Oman & Yemen) constant at 2010 levels of 134;

Production of Nigeria(+Angola & Trinidad-Tobago) constant at 2010 levels of 77 mcm/day after 2010

Constrained Gulf:

Production of Qatar(+Oman & Yemen) constant at 2010 levels of 134;

Production of Iran(+Iraq) constant at 2010 levels of 80

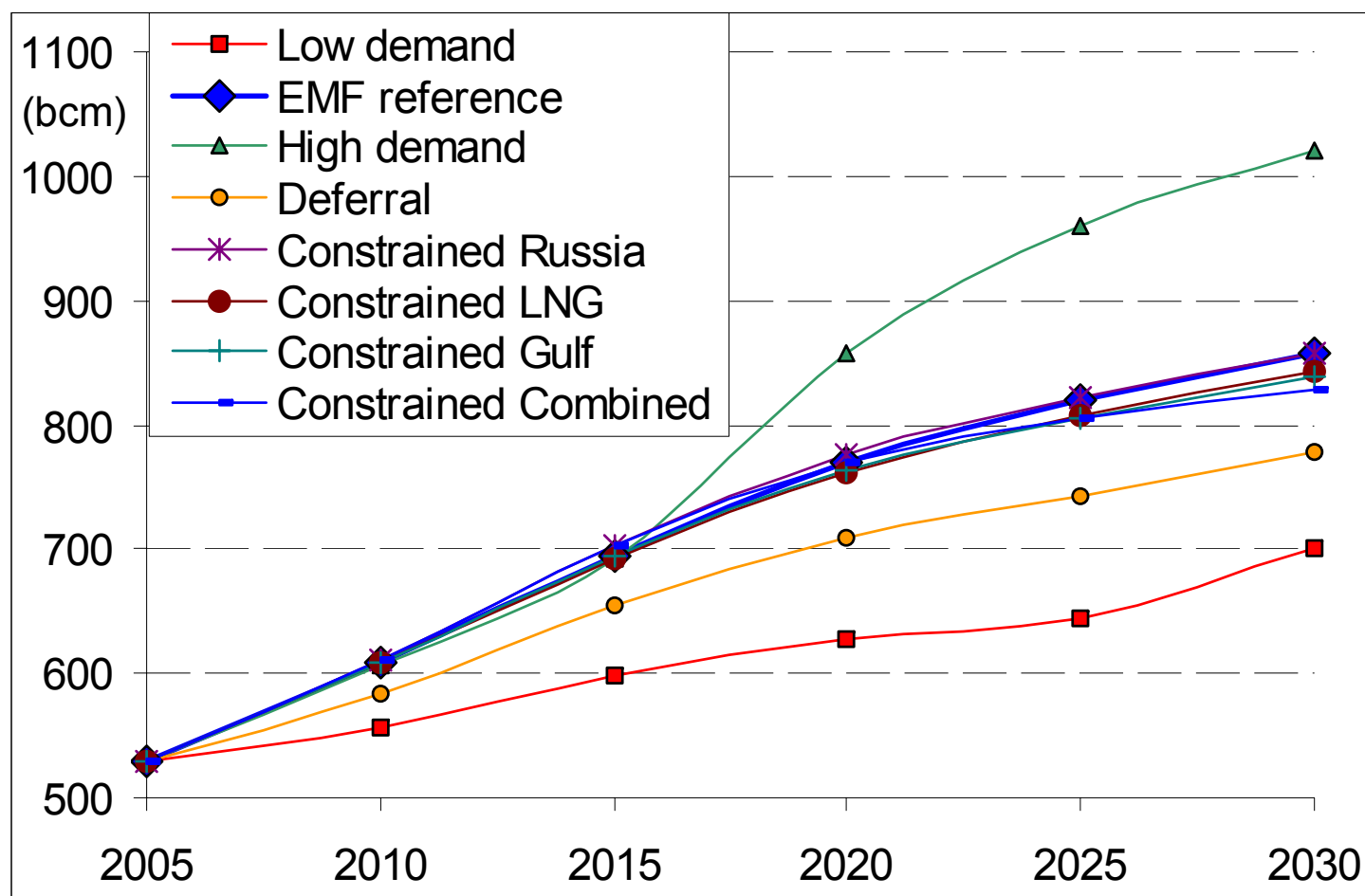
Constrained Combined:

The pipelines running out of Russia into Europe cannot be expanded;

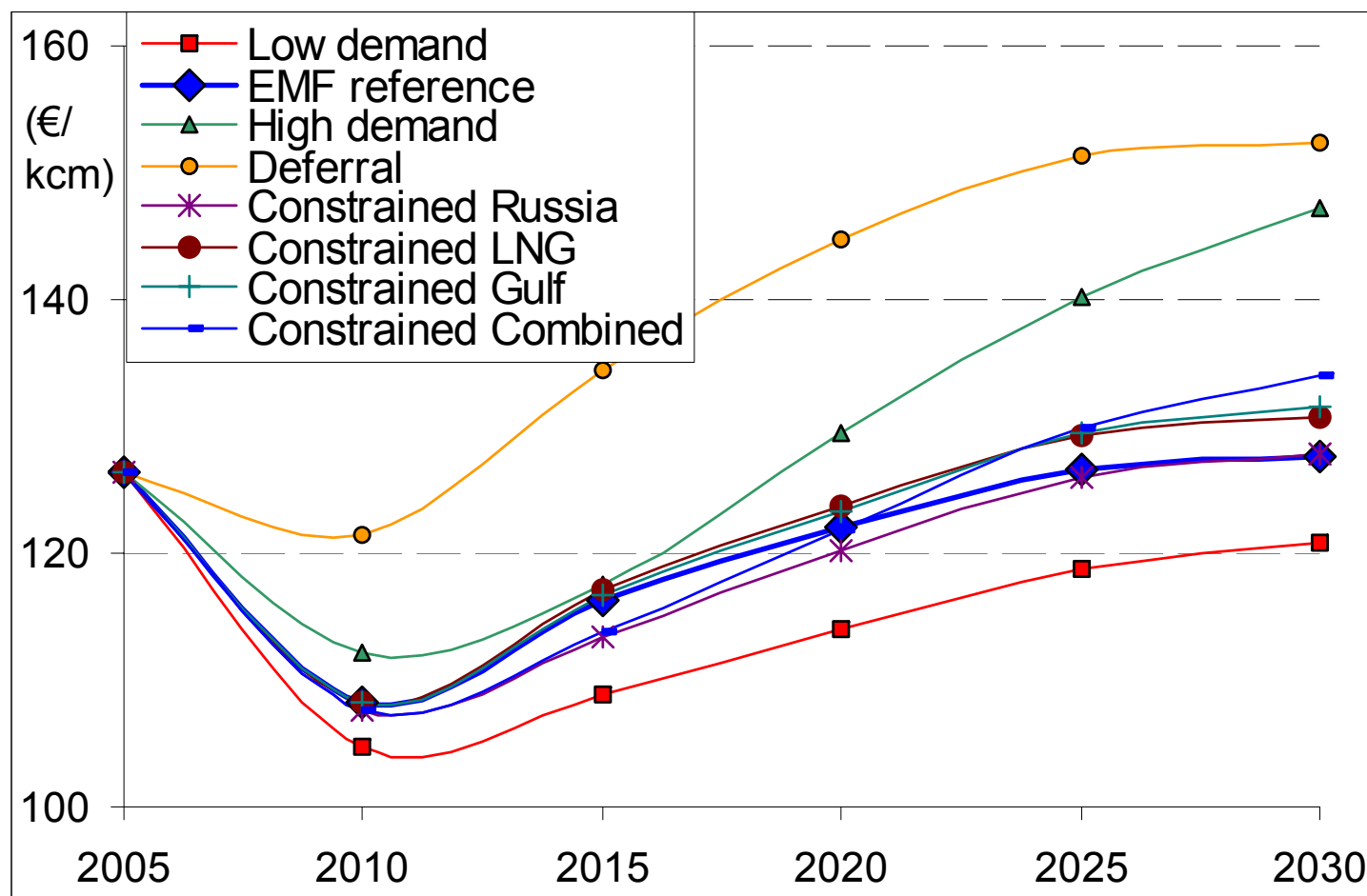
Production of Qatar(+Oman & Yemen) constant at 2010 levels of 134;

Production of Iran(+Iraq) constant at 2010 levels of 80

Expected EU gas demand



Projected gas prices at EU border



Total investment costs

