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Natural Gas Storages in Competition with Alternative Flexibility Sources

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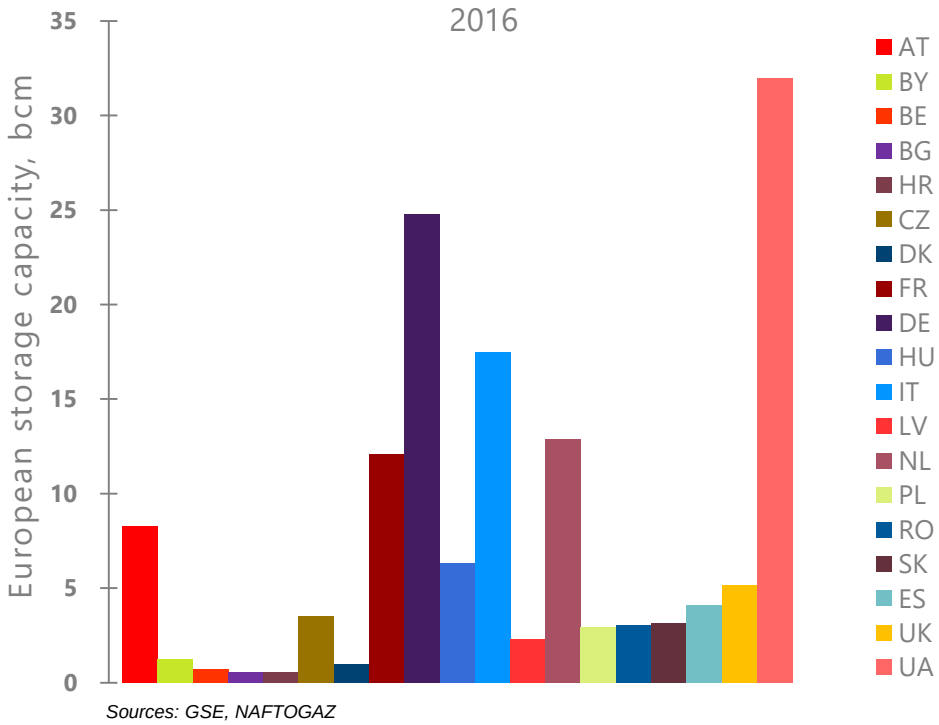
Contents:

Background

Gas storages were always considered a key factor in the provision of flexibility and security for gas supplies. Storage capacities in EU28 reached 94.5 BCM on Jan 2016. This amounts to a raise of about 40 % over the last 10 years.



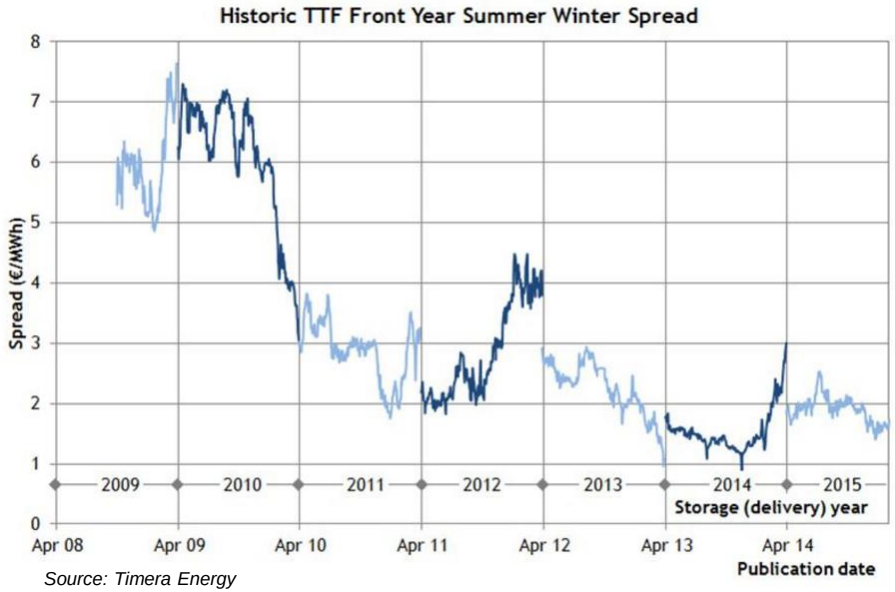
Sources: GSE, NAFTOGAZ

However, storages compete with other flexibility options such as:

- ✓ Flexible domestic production
- ✓ Variation in pipeline imports (pipeline swing)
- ✓ Variation in supply by LNG imports
- ✓ Demand side response (e.g. by interruptible customers)

Background

Research question: may storage capacity utilization be on a declining path, as its main economic driver (W-S spread) has significantly dropped and other competing flexibility tools, like pipeline/LNG imports may be on the rise?



Source: Timera Energy

The objective of this work is to analyze the future role of storages and their position in competition with other flexibility sources to meet European countries' specific demand fluctuations.

Contents:

General information: employed gas market model

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Model focus

- The model simulates operation of European gas sector in a middle- and long terms

Model formulation

- Model is formulated as a social-welfare optimization problem*
- Mathematical framework: nonlinear programming
- Implemented in the General Algebraic Modeling System (GAMS)

Major model output

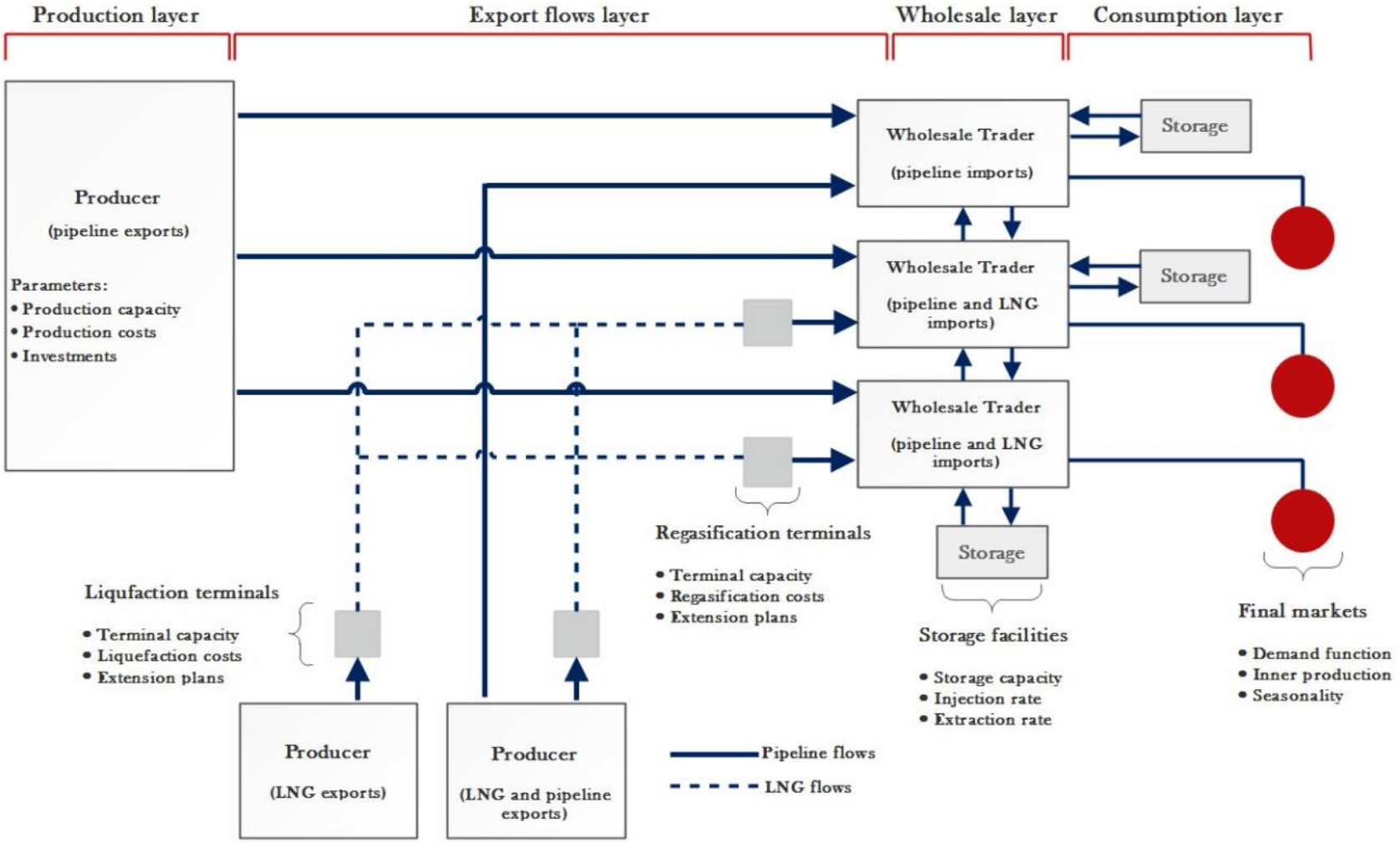
- Gas production & consumption volumes
- Gas traded & physical gas flow volumes
- Price levels for natural gas
- Gas storage dispatch
- Investments in gas infrastructure

Model major input data

- Geographical scope: Europe, FSU, North Africa and Qatar*
- Natural gas pipeline infrastructure (sources: ENTSOG, NAFTOGAZ, GAZPROM)
- LNG liquefaction and regasification terminals (source: GIE)
- Gas storage facilities (source: GSE)
- Long-term contracts (source: DIW Berlin, GIIGNL)
- General market information (major sources in Appendix A)

** Model formulation and geographical scope may vary with the research objectives. The model package allows Mixed Complementarity Problem (MCP) formulation.*

Model structure: schematic overview



Contents:

Results: demand fluctuations for selected countries

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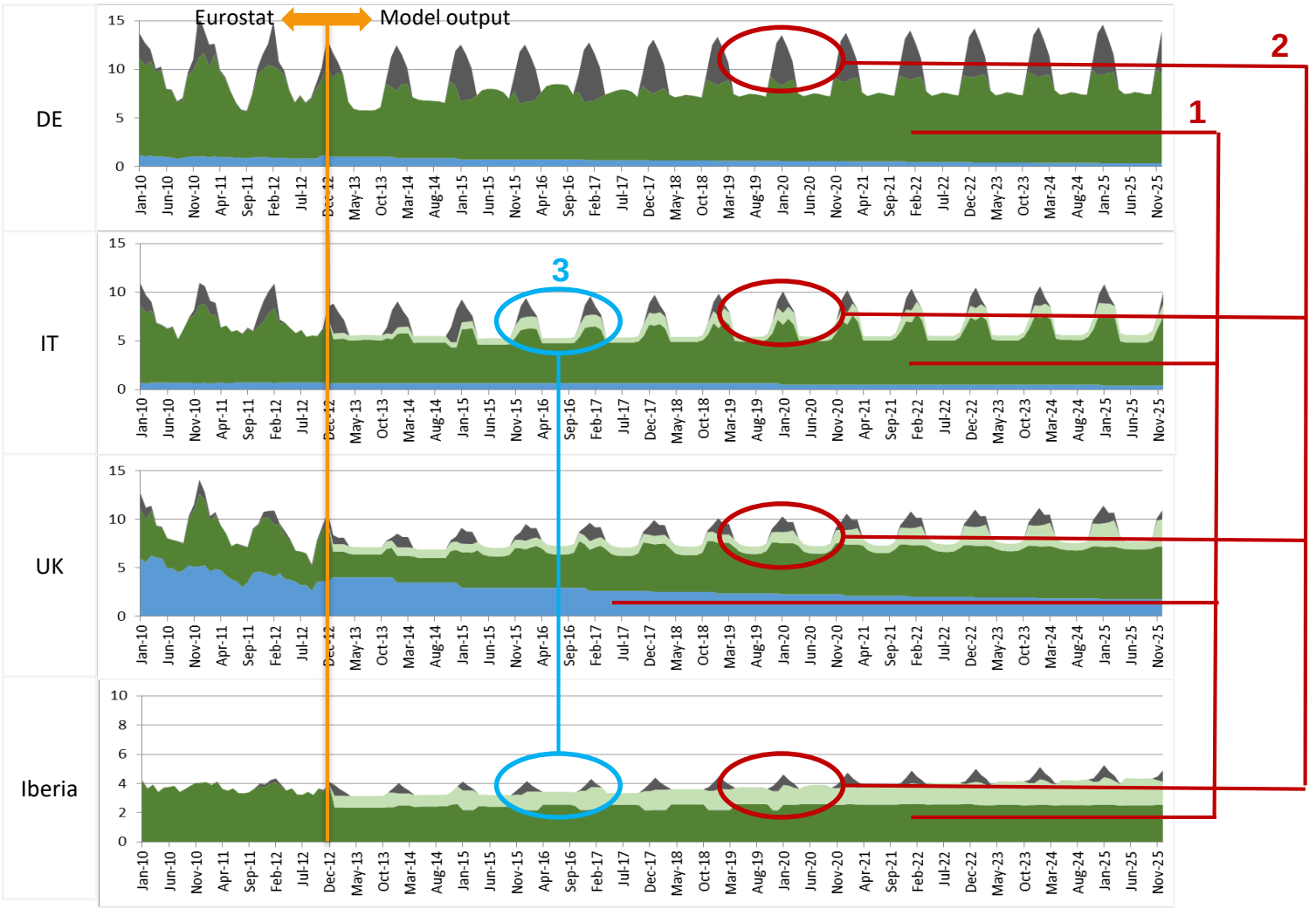

Coefficient of variation

The coefficient of variation (CV or RSD) is defined as the ratio of the standard deviation to the mean:

$$C_v = \frac{\sigma}{\mu}$$

- It shows the extent of variability in relation to the mean.
- Coefficient of variation allows for meaningful comparisons between two or more magnitudes of variation, even if they have different means or different scales of measurement.
- In our case, it helps to answer the question: which source brings most flexibility to meet demand fluctuations?

Coefficient of variation for selected countries

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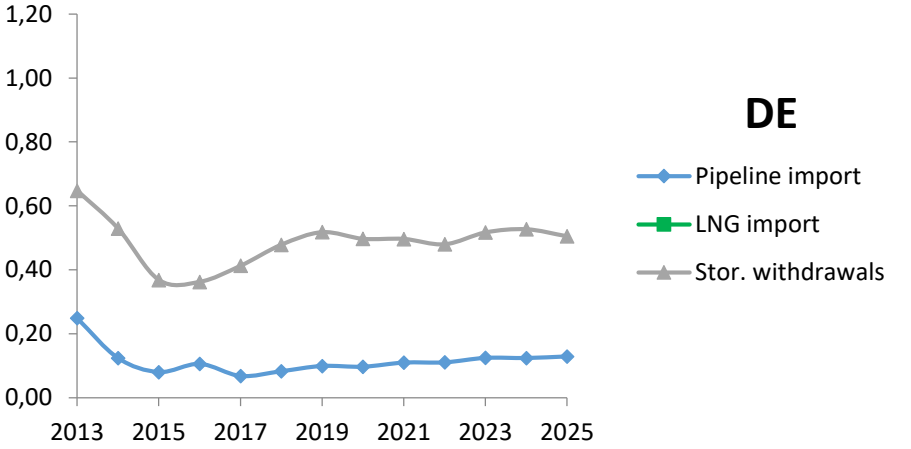
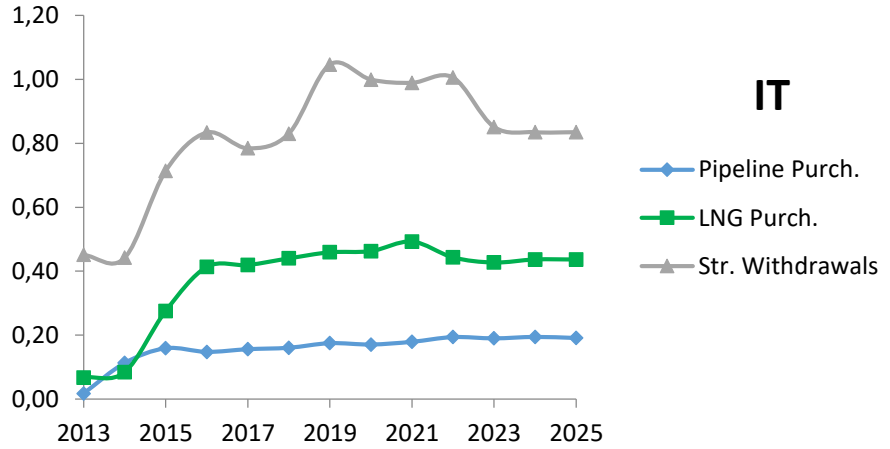
In our case, C_v helps to answer the question: which source brings most flexibility to meet demand fluctuations?

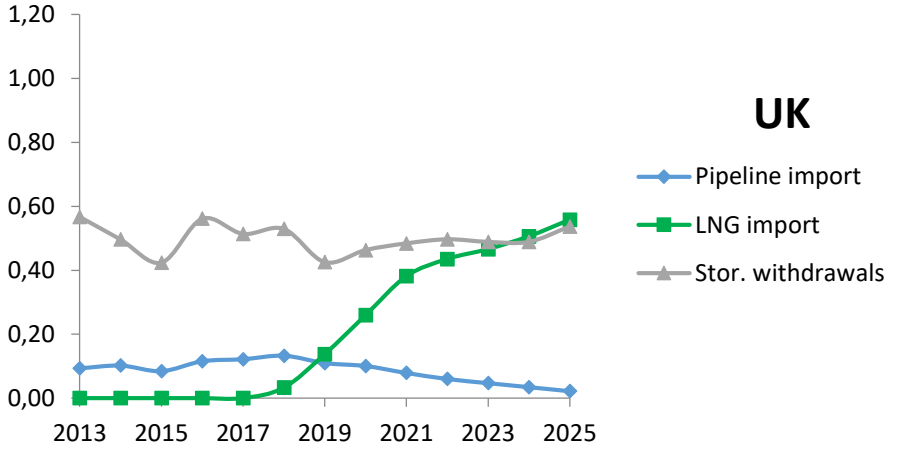
Country	Inner production*	Pipeline import	LNG import	Stor. withdrawals
DE	0,11	0,17		0,77
FR		0,33	0,75	0,43
IT	0,04	0,19	0,41	0,86
PL	0,08	0,18		0,49
CZ		0,33		0,44
AT		0,19		0,35
BE		0,44	0,73	0,38
UK	0,20	0,23	0,46	0,52
HU	0,07	0,41		0,63
RO	0,05	0,36		0,43
Iberia		0,06	0,26	0,55

** Based on Eurostat data*

Coefficient of variation yearly for selected countries







- Contribution of LNG import fluctuations to the coverage of demand swing tend to increase over time, displacing some pipeline imports flexibility.
- The role of storage flexibility in meeting seasonal demand is either stable (DE, UK) or increasing (IT), while seasonal flexibility of pipeline imports may even decrease (UK).

Load duration curves for selected countries

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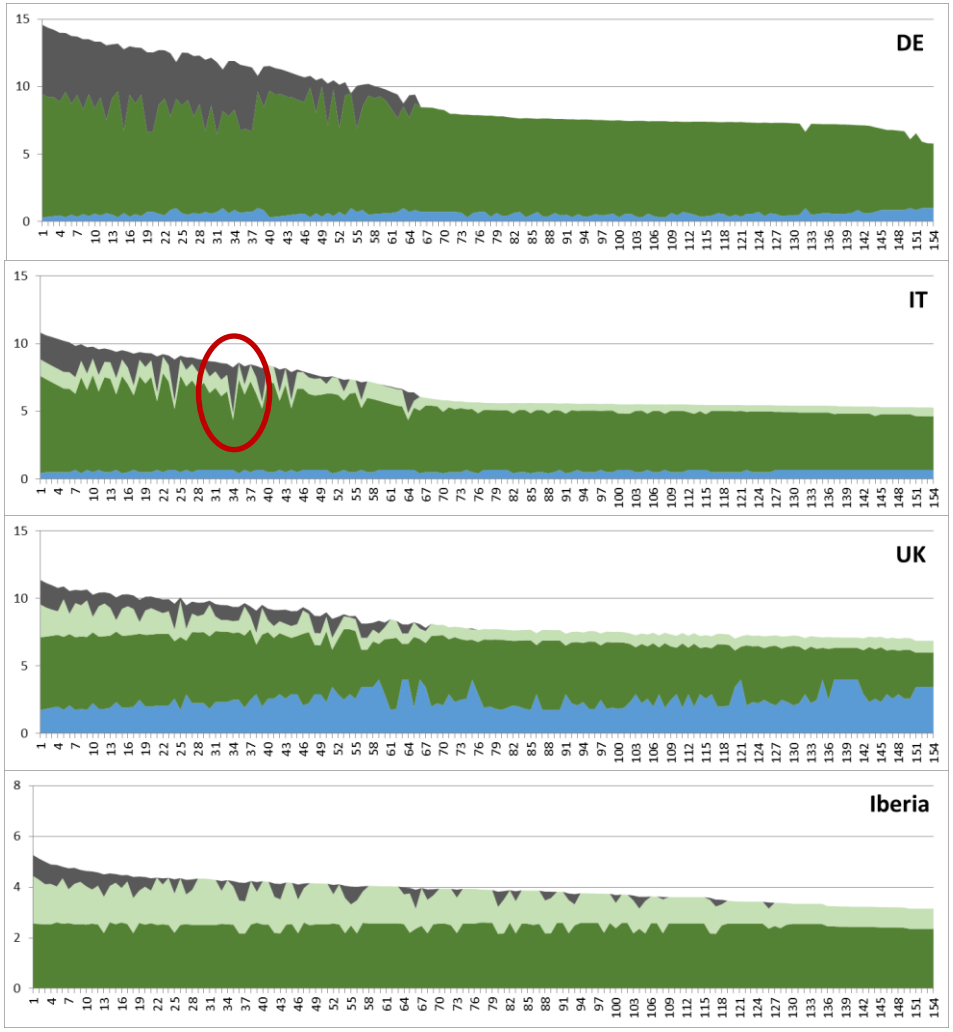

DE	Max	Average
Inner production	17,35%	6,97%
Pipeline import	95,96%	82,17%
LNG import	0,00%	0,00%
Stor. withdrawals	47,39%	10,86%

IT	Max	Average
Inner production	12,71%	9,12%
Pipeline import	82,96%	75,18%
LNG import	18,43%	11,21%
Stor. withdrawals	40,94%	4,49%

UK	Max	Average
Inner production	60,98%	33,33%
Pipeline import	65,80%	50,31%
LNG import	26,27%	12,09%
Stor. withdrawals	20,68%	4,27%

Iberia	Max	Average
Inner production	0,00%	0,00%
Pipeline import	76,27%	64,35%
LNG import	42,49%	31,43%
Stor. withdrawals	19,57%	4,22%

Summing up:

- Indigenous natural gas production and pipeline imports have relatively low contribution to provision of seasonal flexibility
- Increasing competition in the market for flexibility did not result in storage being significantly underutilized: storages have been constantly refilled with high rates over the whole modelling period
- Storage importance in fulfilling demand fluctuations remain on a high level over the whole modelling period.
- The value of seasonal flexibility provided by storage facilities differ broadly across European countries and depends on energy mix, consumption structure, macroeconomics and political decisions.

THANK YOU!

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Appendix A: major data sources

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http://www.entsog.eu/

http://www.gie.eu.com/

http://www.naturalgaseurope.com/

http://www.iea.org/

http://www.bp.com/en/global/corporate/energy-economics/

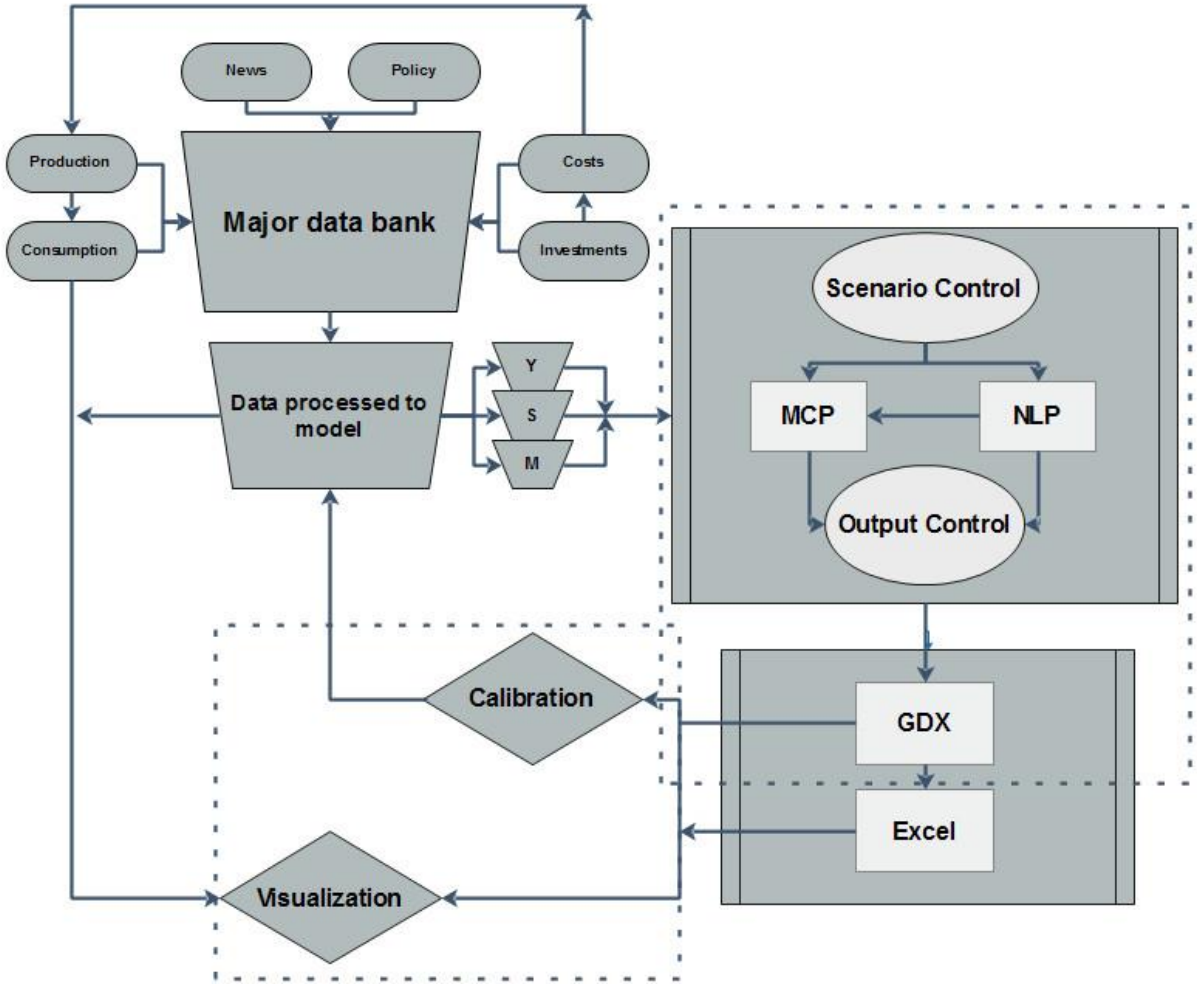
http://www.eia.gov/

http://ec.europa.eu/eurostat/web/energy/data/database

http://www.sea-distances.org/

http://www.timera-energy.com/

Appendix B: model architecture



Appendix C: maximum & average monthly contributions of different flexibility sources to the fulfilling of demand

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Maximum contributions of different flexibility sources

Country	Inner production	Pipeline import	LNG import	Stor. withdrawals
DE	17%	96%	0%	47%
FR	0%	99%	50%	57%
IT	13%	83%	18%	41%
PL	45%	67%	0%	60%
CZ	0%	100%	0%	69%
AT	0%	100%	0%	65%
BE	0%	100%	67%	10%
UK	61%	66%	26%	21%
HU	53%	89%	0%	61%
RO	84%	57%	0%	40%
Iberia	0%	76%	42%	20%

Average contributions of different flexibility sources

Country	Inner production	Pipeline import	LNG import	Stor. withdrawals
DE	7%	82%	0%	11%
FR	0%	60%	24%	16%
IT	9%	75%	11%	4%
PL	37%	53%	0%	10%
CZ	0%	80%	0%	20%
AT	0%	80%	0%	20%
BE	0%	80%	18%	2%
UK	33%	50%	12%	4%
HU	29%	68%	0%	3%
RO	62%	33%	0%	5%
Iberia	0%	64%	31%	4%