Some Economics of Natural Gas Storage in North West Europe

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- The analytical framework
- The modelling tool – gas market simulation model & assumptions
- Base case scenario results for storage markets in UK and DE
- Sources of seasonal flexibility in 2019/20
- Some conclusions

The analytical framework

- Useful to think in terms of competition analysis – defining product and geographic markets for the interested storage assets
  - Product market: storage asset value depends on (i) predictable price variations (seasonality, or S/W spreads), and (ii) unpredictable price variations (volatility)

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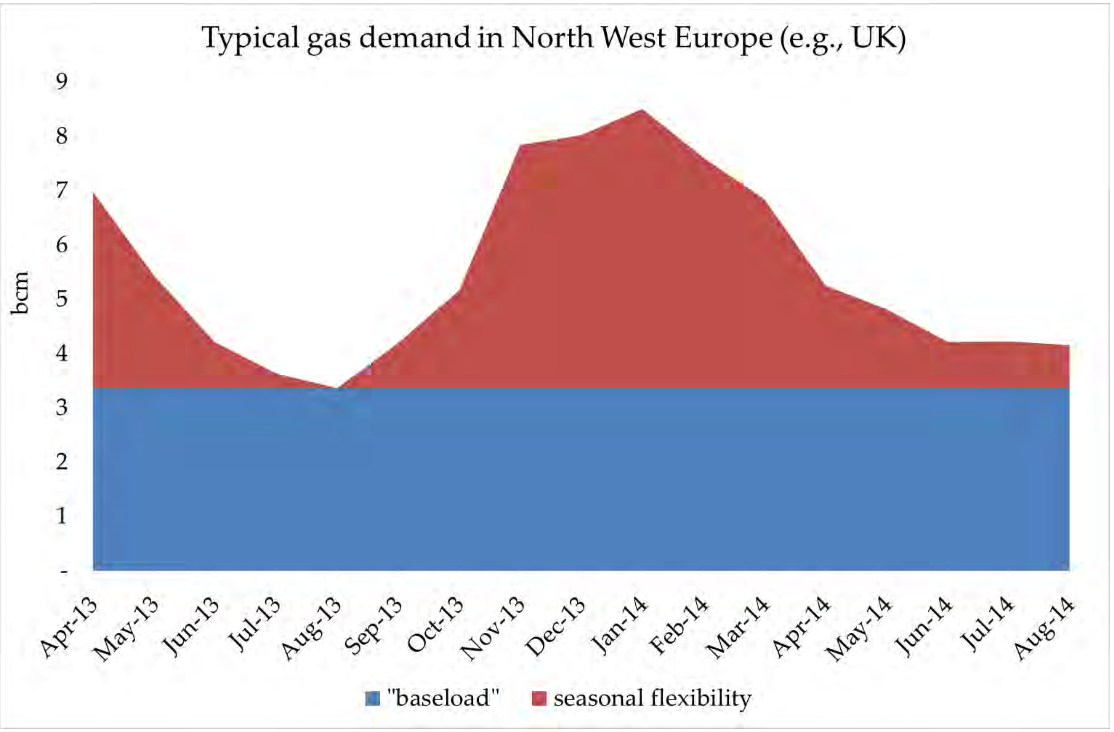
- A typical gas demand can be decomposed:
  - **Baseload = lowest monthly demand in the year**
  - **Seasonal flexibility = monthly total demand - baseload**
- Seasonal flexibility can be met from various sources e.g., direct supplies from LNG, pipelines or seasonal storage facilities.
- Depending on time resolution, market for gas flexibility can be split further…



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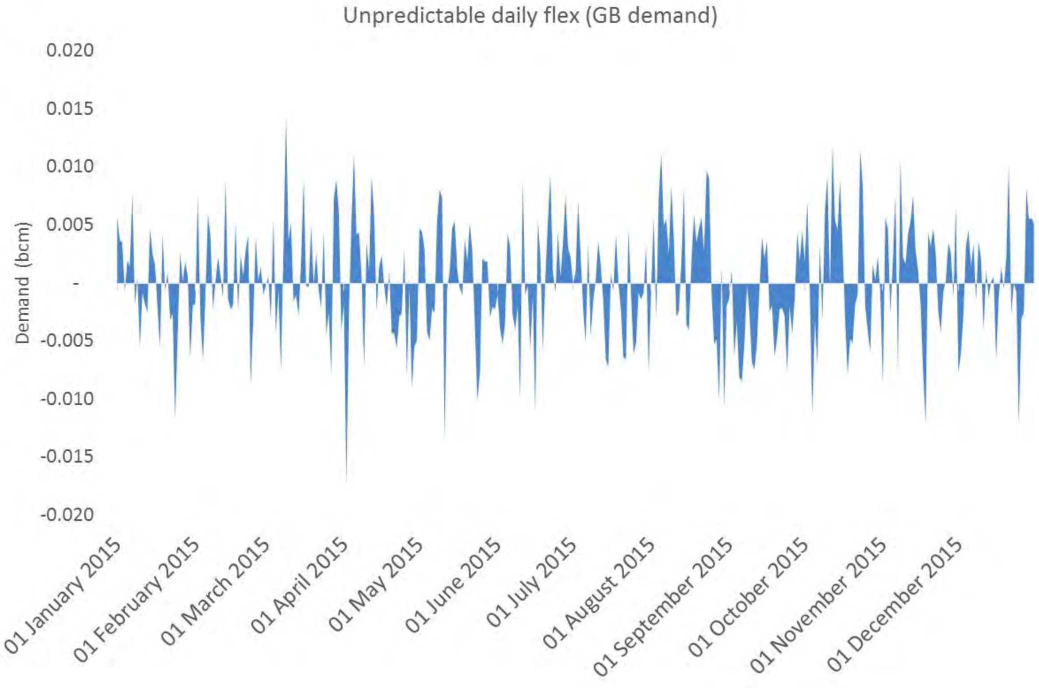
- For example, daily flexibility = actual realization of gas demand on the day, *D* – forecast at *D-1*
- 'mismatches' impact price volatility
- fast cycle storage facilities are well placed to 'monetise' this daily price volatility
- However, in oversupplied markets, all types of storage are competing with direct supplies from LNG, pipelines or even demand-side response (fuel switching in powergen & interruptible contracts)



Source: National Grid forecast vs actual demand

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  - Product market: storage asset value depends on (i) predictable price variations (seasonality, or S/W spreads), and (ii) unpredictable price variations (volatility)
  - Geographic scope of storage assets providing seasonal flexibility is potentially wider than NW Europe
    - Given the imminent oversupply in the coming years, seasonal storage is competing directly with (i) gas pipeline supplies and overseas LNG, and (ii) demand-side response

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  - Geographic scope of storage assets who provide seasonal flex is wider than NW Europe and covers the whole continent and possibly beyond…
- Main components of storage capacity value:
  - Intrinsic value - - > predictable price variations (S/W spreads or **seasonal flexibility market**)
  - Extrinsic value (incl. insurance value against SoS-type of events) - - > unpredictable price variations (volatility or **monthly/daily flexibility market**)

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  - Extrinsic value (incl. insurance value against SoS-type of events) - - > unpredictable price variations (volatility or **monthly/daily flex market**)
- I will investigate the intrinsic value of storage assets in NW Europe, i.e., I will analyse the economics of storage assets to provide seasonal flexibility (buy in the low demand and sell in the high demand season) – **the analysis of seasonal flexibility market**
- I will not analyse the extrinsic value of storage assets – i.e., I will not analyse the economics of fast cycle storage (e.g., salt caverns) and associated trading strategies and optionality valuation

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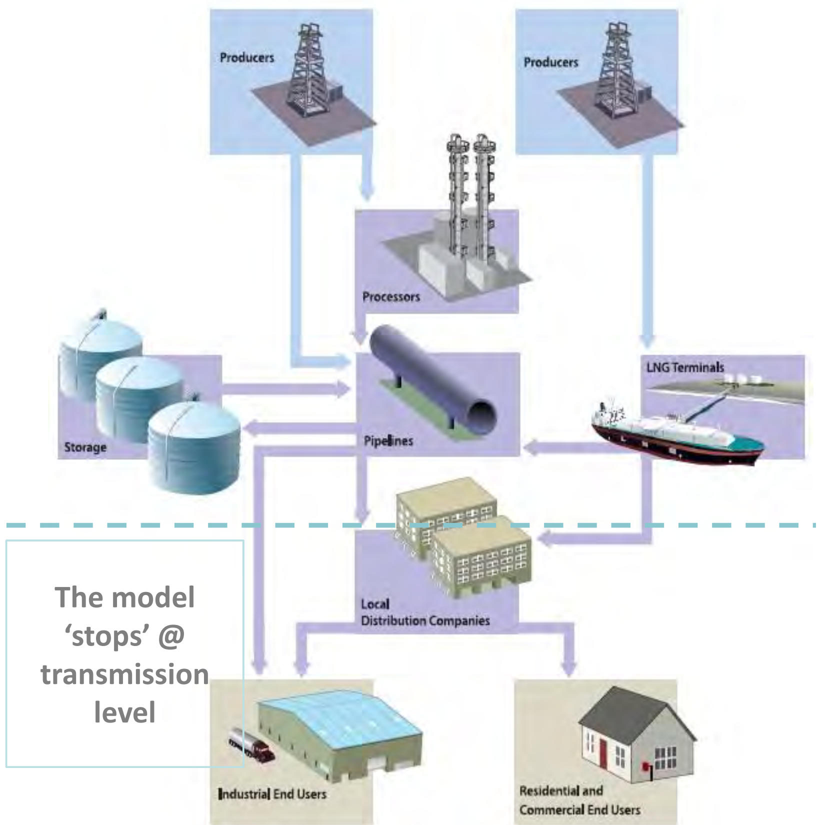
The gas market model

- **Geographic scope - Global**
  - Main producing countries, such as Russia and Qatar are explicitly represented in the model as separate supply 'nodes'
  - Other producers are aggregated into regions, e.g., North America (USA, Canada and Mexico) etc.
  - Europe (EU27+GB) disaggregated into national MS markets (wholesale level)
  - Other demand centers are aggregated to regional level, such as Middle East, or JKT (Japan, S. Korea & Taiwan)
- **Time Resolution - Daily**
  - We run the daily model for 365 time periods (days) for representative years
- **Supply chain**
  - Covers entire supply chain down to the transmission level, i.e., distribution is not taken into account
  - Represents production, transit, demand, LNG and gas storage facilities



Representing the European transmission network

- **EU cross-border transmission capacities & tariffs**
  - The model incorporates ALL existing cross-border interconnector points (IP), as they are reported by ENTSO-G '2015 Capacity Map'
  - New cross-border capacities and LNG regas capacities in EU were added in the model based on their FID status - those projects which took FID as outlined in ENTSOG's 2015 TYNDP report were added in the model with start time & capacities as reported by these projects.
  - For the transmission cost structure we assume existing tariffs as reported in ACER's latest Market Monitoring Report (2015)
- **Storage capacities & costs**
  - All existing storage sites were aggregated to country level (i.e., each country/market area has one storage 'node' and hence no differentiation between types of storage; further disaggregation down to individual storage site is possible, but not necessary, as such, for the purpose of this analysis - -> see next slide)
  - New storage facilities will also be taken into account according to their FID status (as reported in ENTSOG's 2015 TYNDP)
  - Marginal cost of different types of storage is based on public information

Important assumptions

- Assume that all NWE storage facilities have cost structure similar to seasonal storages (depleted fields) - - > will show sensitivity analysis regarding this assumption
  - OPEX for fast cycle storages are said to be relatively cheap if they cycle 5-10 times their working capacity. This should approach OPEX (per unit of capacity) of depleted fields
- New production and non-EU pipeline and LNG capacities
  - All LNG and pipeline projects that took FID before 2016 are in the model
  - All other projects are obtained from running another model (economic model with endogenous capacity expansion capability), with annual time resolution to 2035
  - This annual capacity expansion model was calibrated to run based largely on IEA WEO15 '450/CPS' scenarios to account for high-level energy policies and general equilibrium effects (i.e., inter-fuel competition, income effect etc.)
- Entry-exit charges for European cross-border and to/from storage sites
  - These are annual tariffs for 2015 (latest available) hence flows should be viewed as based on annual shipping and storage capacity contracts (in reality there are different transport and storage products – daily, monthly etc. with corresponding multipliers)
- SoS-related measures
  - as applied to storages in Europe are ignored, assuming that all capacities are available to the market for booking at the beginning of the storage year (non-TPA related capacities are implicitly in the model)

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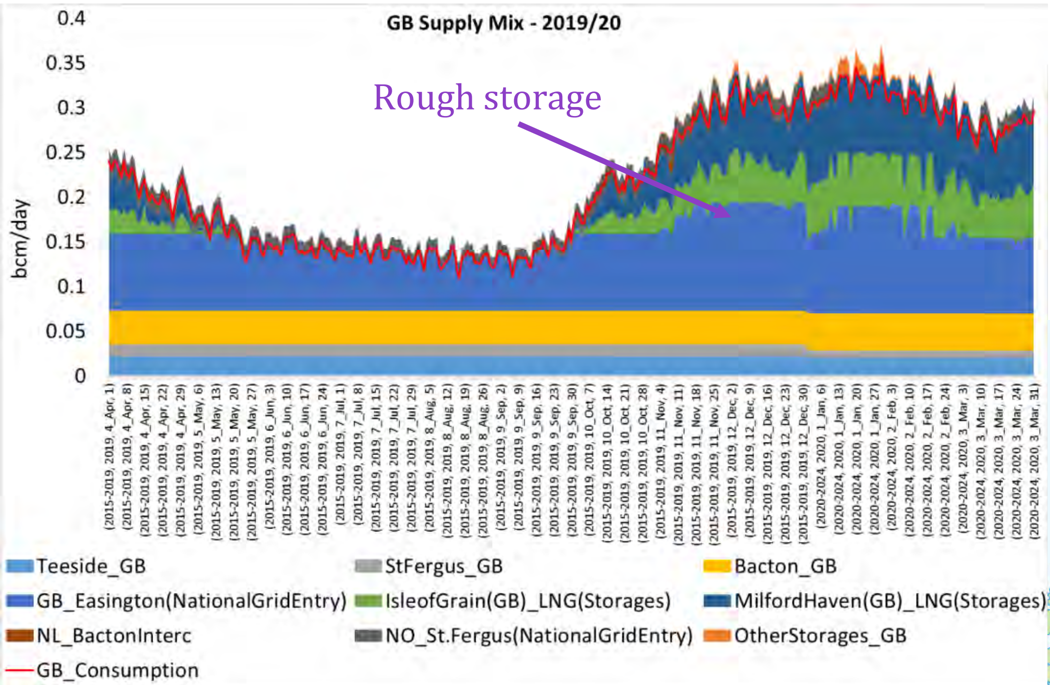
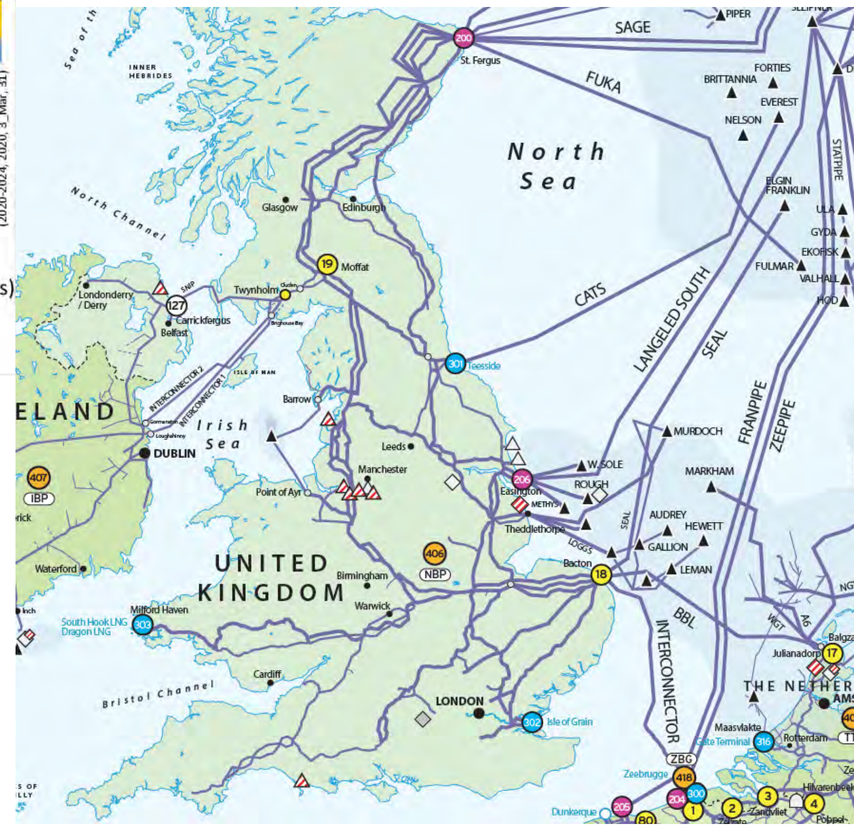
Results from the model for 2019/20 storage year - GB



- UKCS & NCS are baseload
- LNG, imports from the continent (Netherlands) and storages as peaking options



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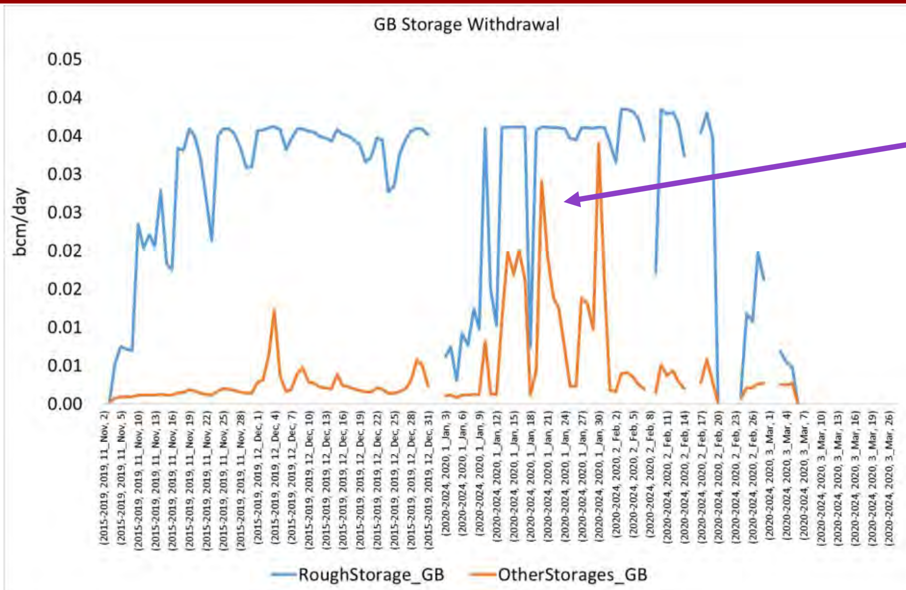
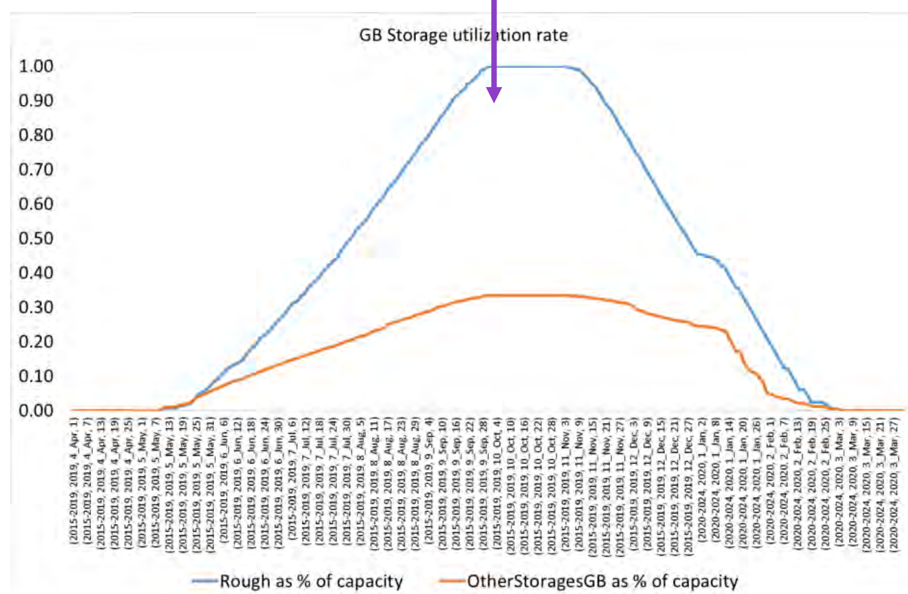


- Entry/exist charges to/from Rough storage is lower than for other storage assets therefore
- Rough is being called first before relying on other storage facilities in GB (mid and fast cycle storage)



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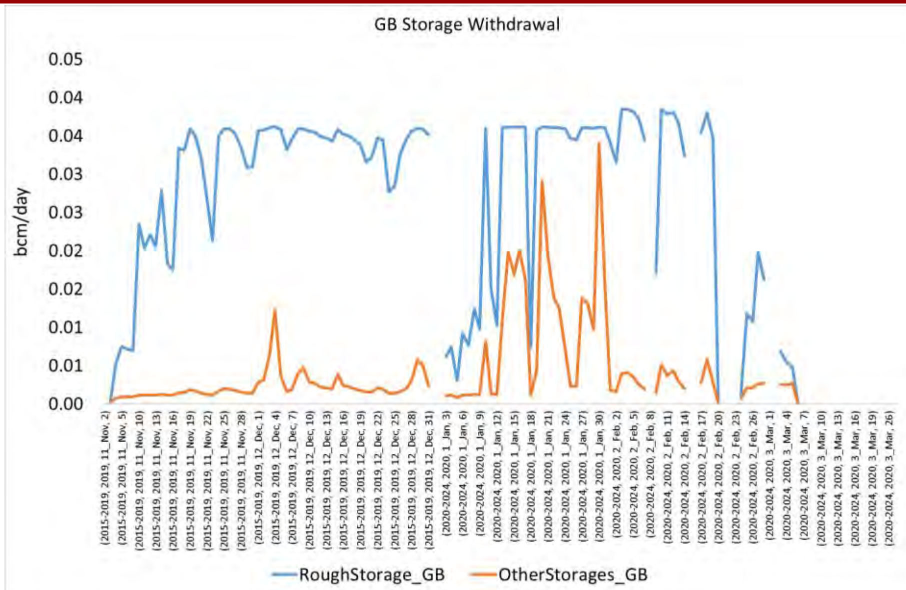
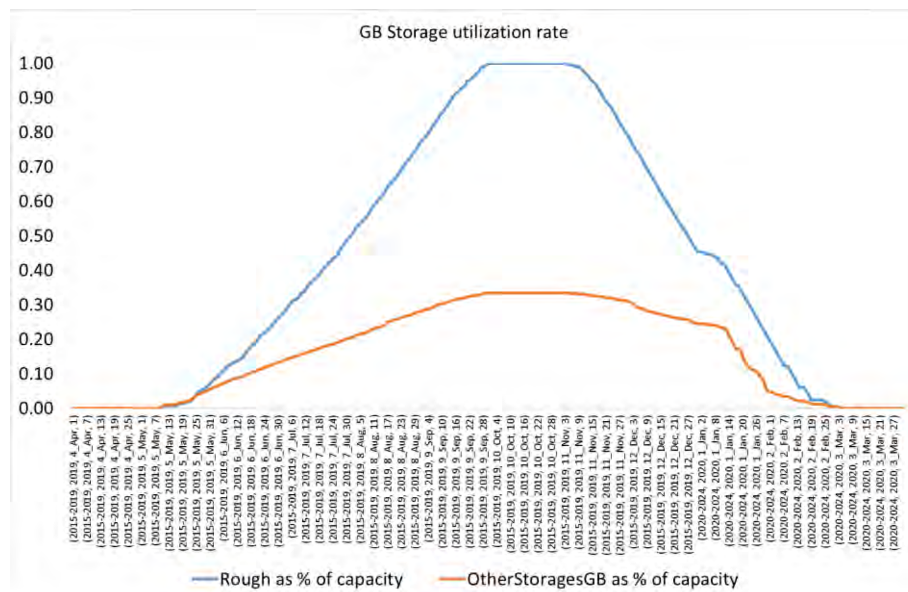
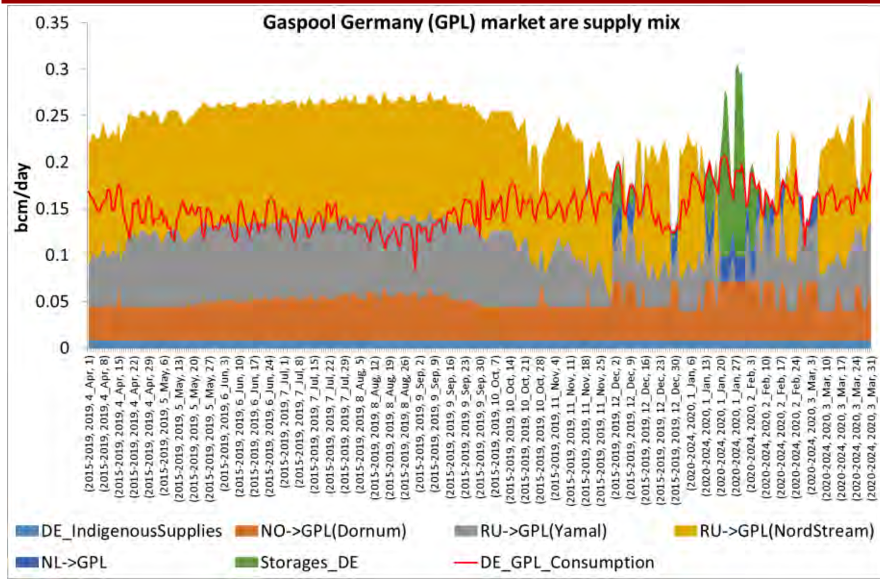


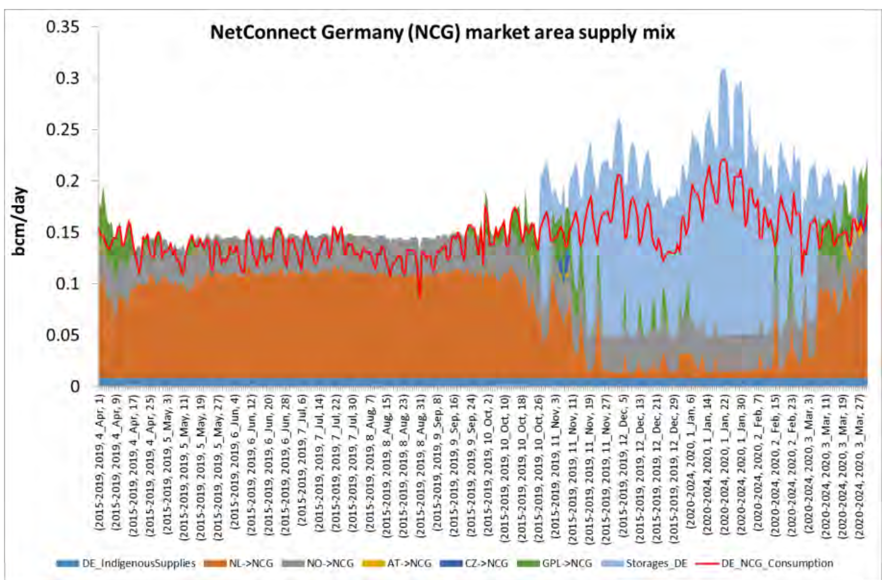
Summary:

- Not all storage capacity (esp. short/mid range storage) will be fully utilised EVEN when reservation price = *SRMC+ existing entry/exit charges* → not all storage sites are able to recover capacity cost



Results from the model for 2019/20 storage year - DE





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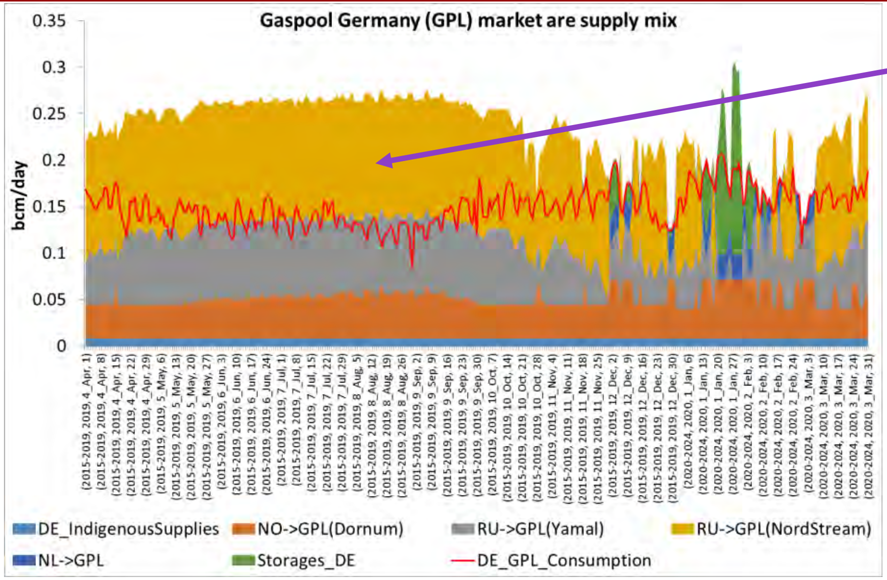
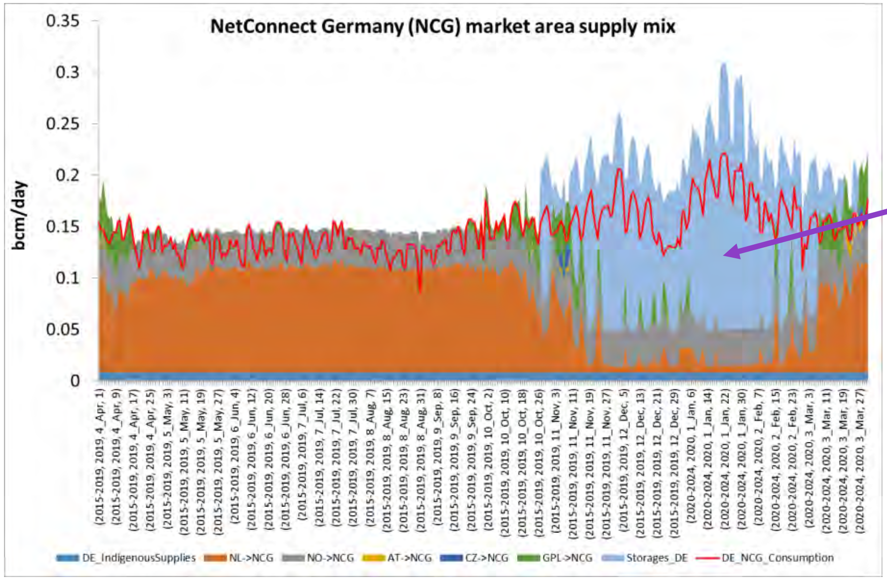
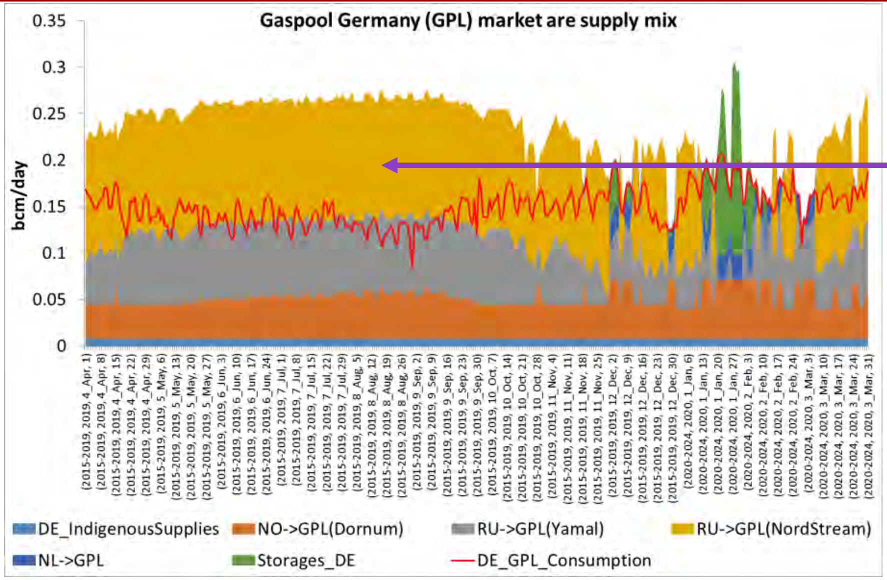


1) RU gas is flowing in the summer to fill up storage in GPL

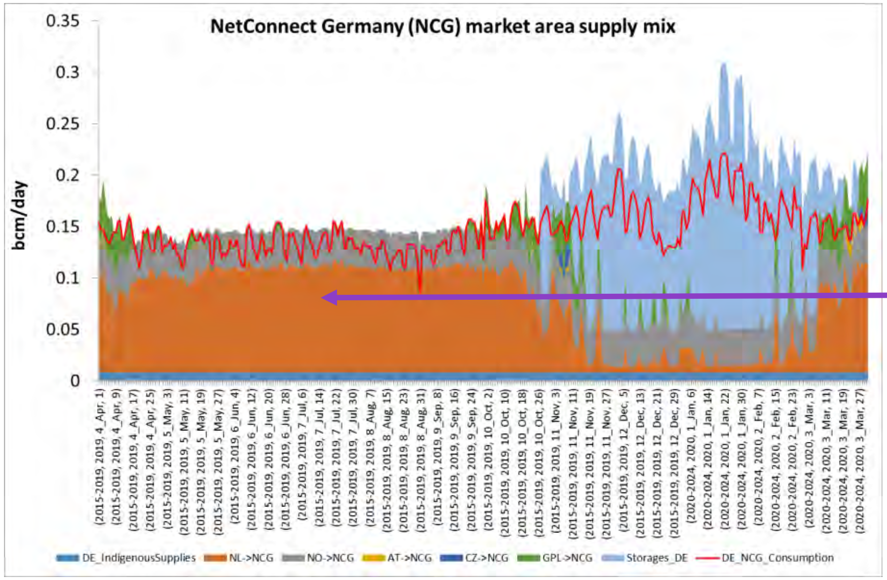


2) Then this gas is used during the winter season in NCG

Results from the model for 2019/20 storage year - DE



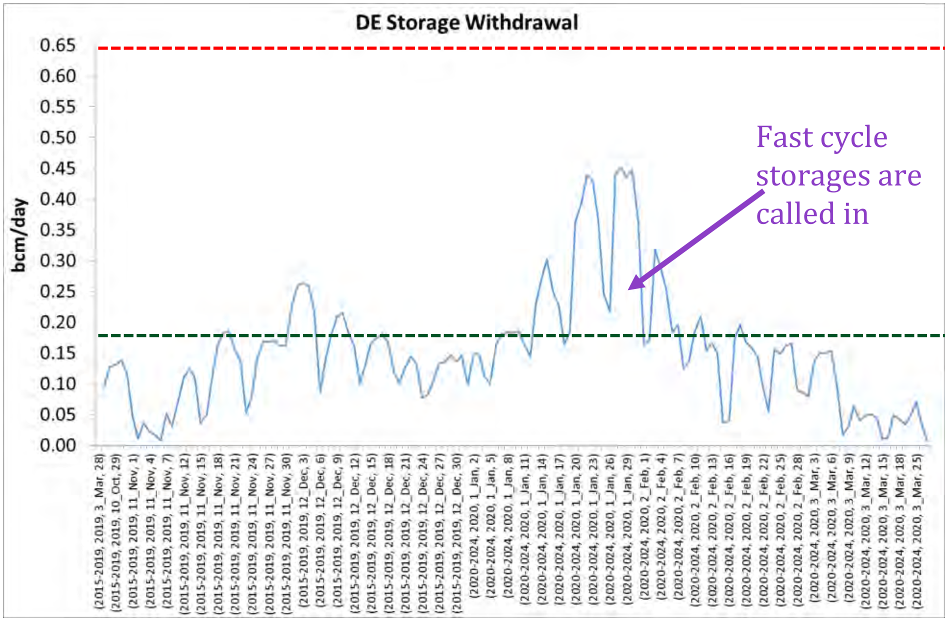
1) Russian gas is going to come from the North – Yamal/Nord Stream – to Germany/GPL and less so from the Ukrainian route/Czech Rep.



2) NCG market is dominated by NL whereas GPL is by NO/RU gas

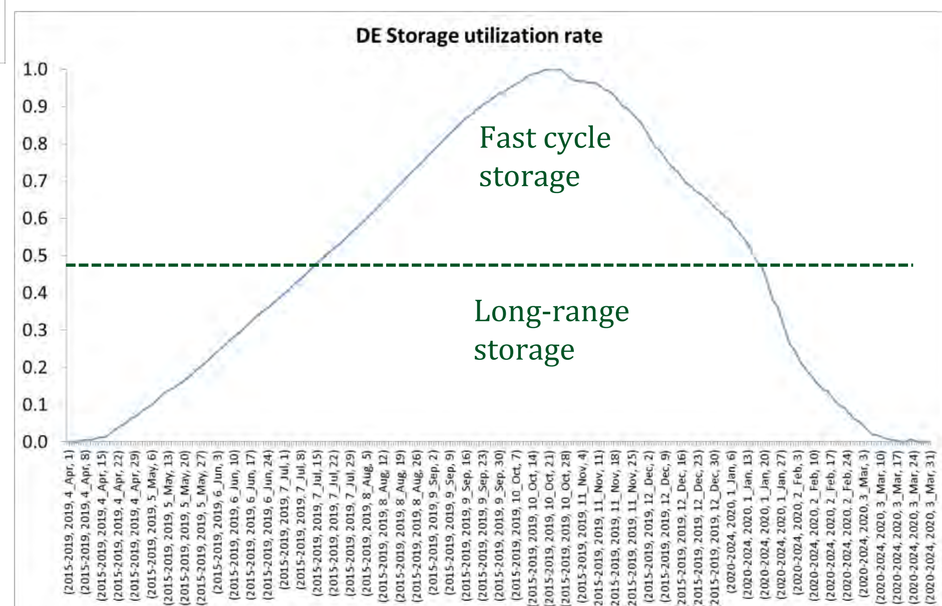
3) Russian gas seems to be less competitive vs. NO/NL gas in the NCG market area

Results from the model for 2019/20 storage year - DE



Max withdrawal rate for long-range storage + fast cycle storage

Max withdrawal rate for long-range storage



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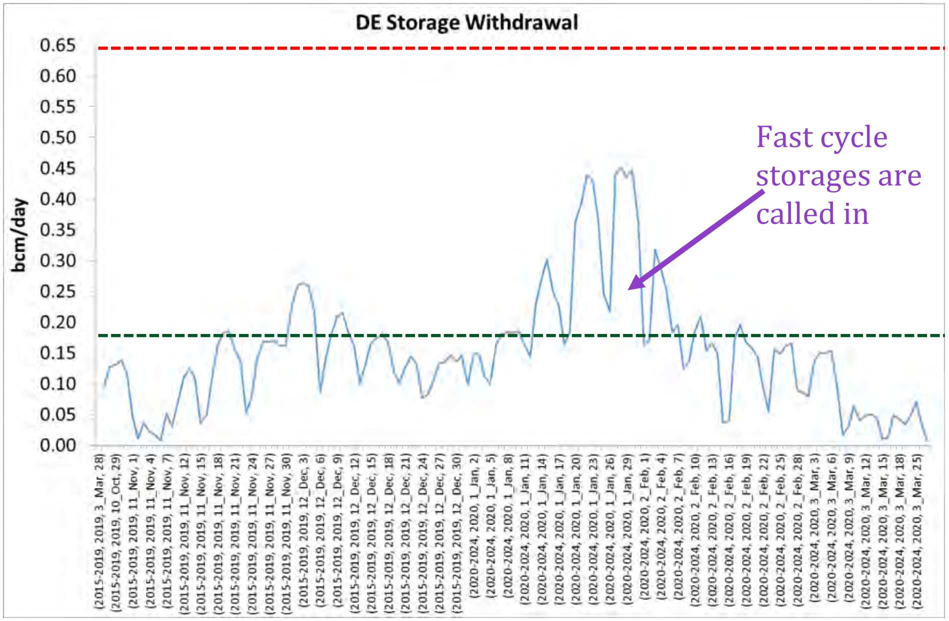
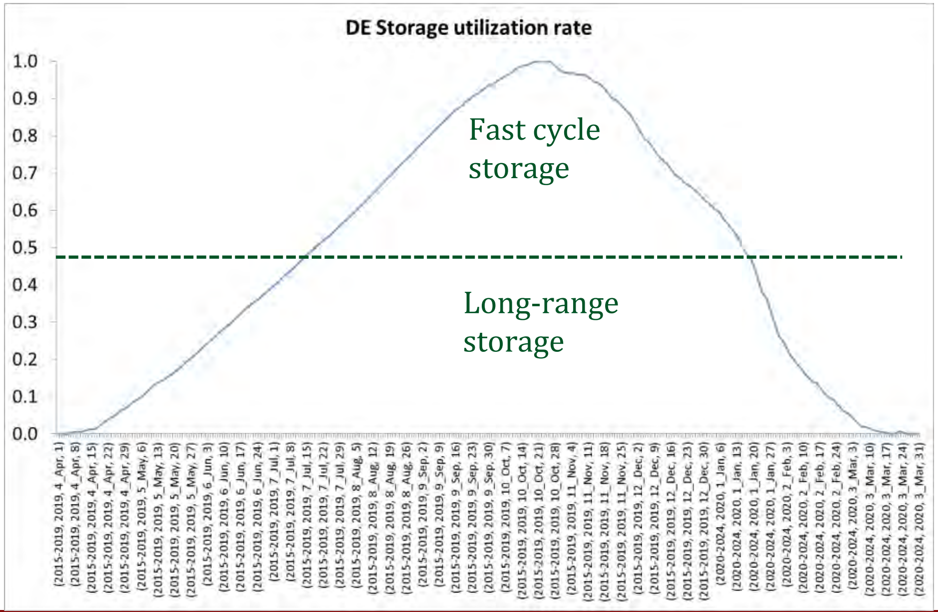


Max withdrawal rate for long-range storage + fast cycle storage

Max withdrawal rate for long-range storage

Summary:

- Setting the reservation price = *SRMC + existing entry/exit charges* encourages full utilization of storages in DE
- But there is only one day in the year when congestion rent is generated, ca. $7/tcm
- This is rather low and the overall picture is that of oversupply and that long-range storage in Germany is in competition with flexible supply from NO, NL & RU



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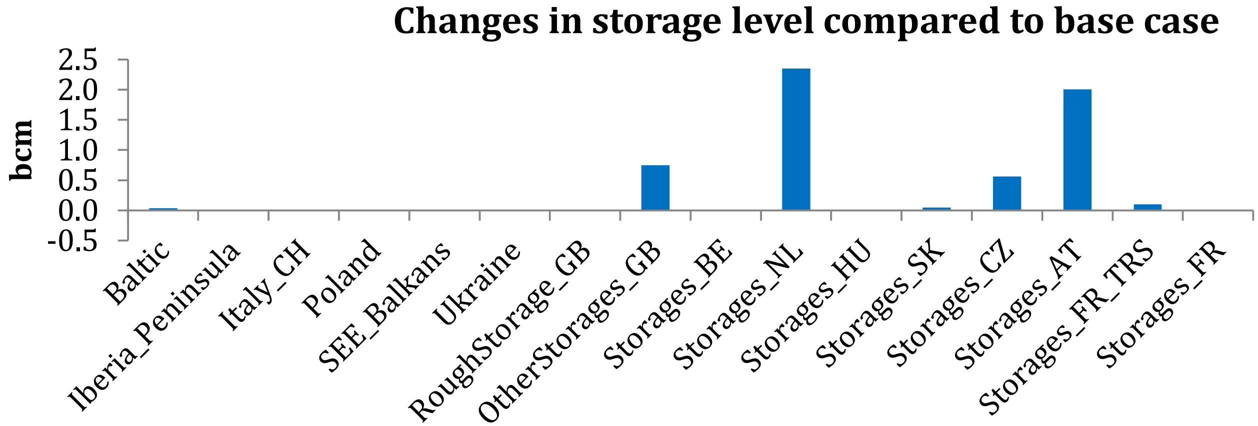
Competing sources of flexibility for DE gas market

- In order to understand sources of competition to seasonal gas storage located in Germany, we simulated 2019/20 gas year with all inputs as before BUT reducing Germany's total storage working volume by 50% of the original total capacity (base case)

- Results from these scenario, such as storage level, LNG send-out rate, Russian gas supplies through various export routes as well as total cleared gas demand, are then compared to the original results (base case)

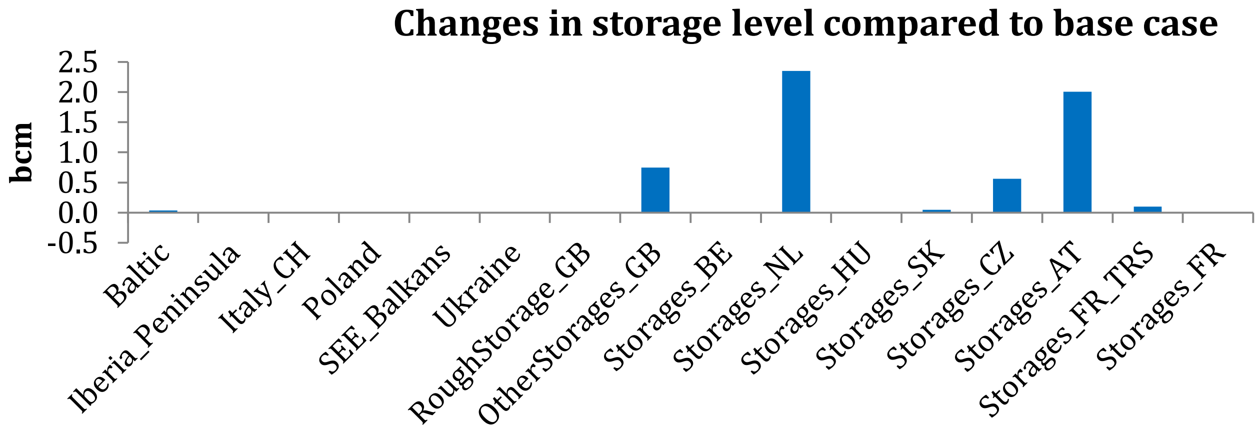
- These changes in supply mix are reported below

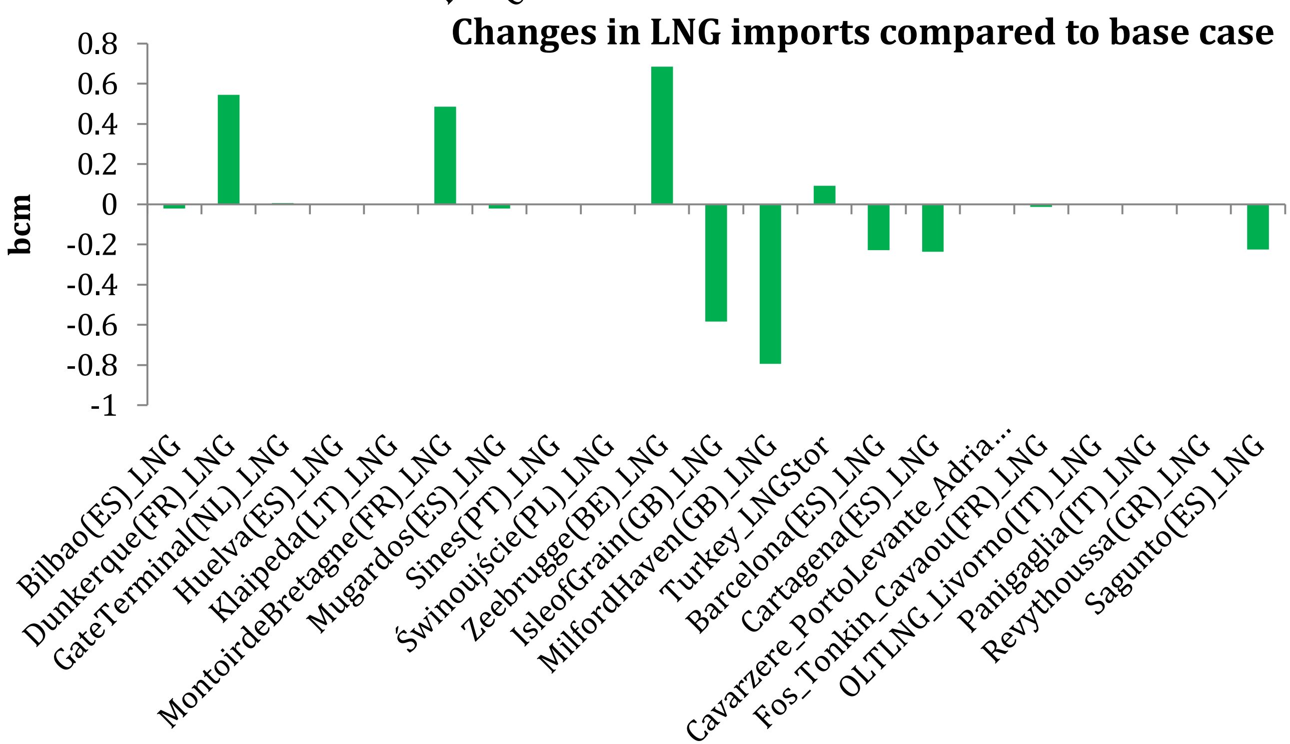
Competing sources of flexibility for DE gas market



Storage facilities in GB, NL, CZ & AT are in direct competition with storage in DE: when storage capacity in DE is reduced by 50%, more gas is stored in GB, NL, CZ and AT

Competing sources of flexibility for DE gas market





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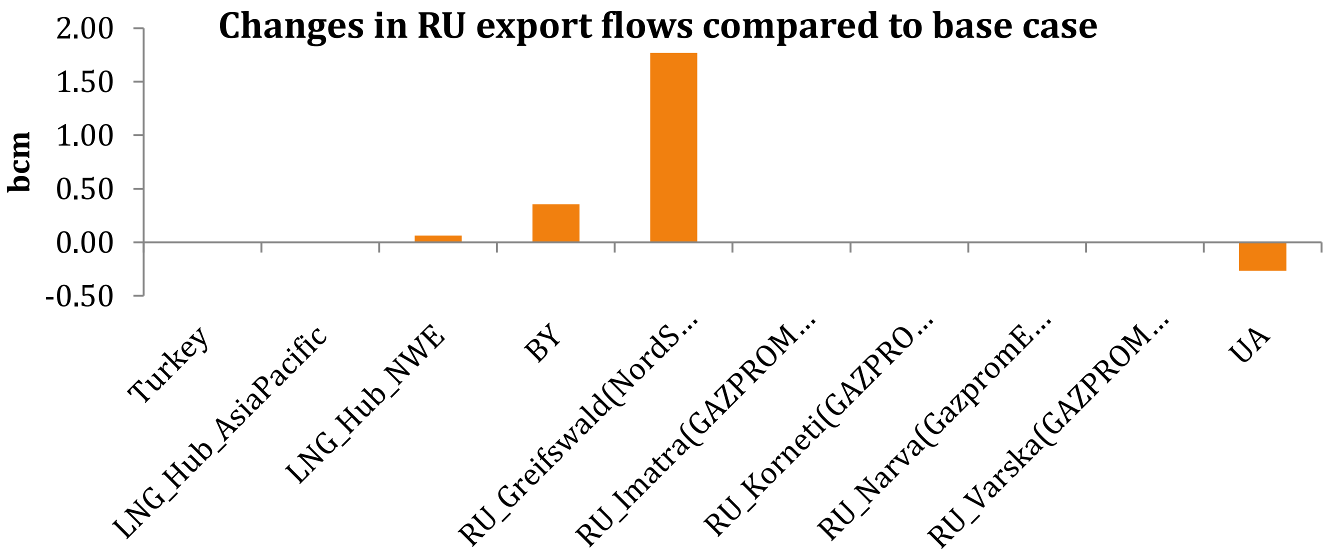
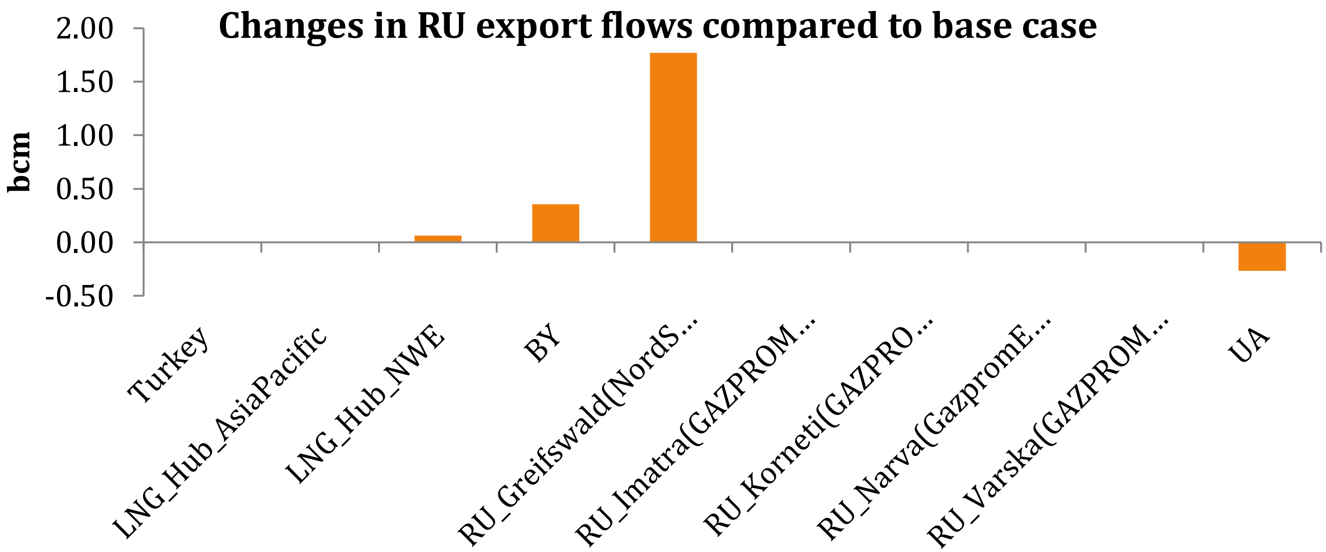
LNG to FR and BE directly competes with DE storage facilities: LNG market 're-dispatches' in response to a reduction in storage capacity in DE – less LNG is imported into GB, ES and more into FR and BE

Competing sources of flexibility for DE gas market



Russian flex gas comes mostly from Yamal & Nord Stream and less so from UA route

Competing sources of flexibility for DE gas market



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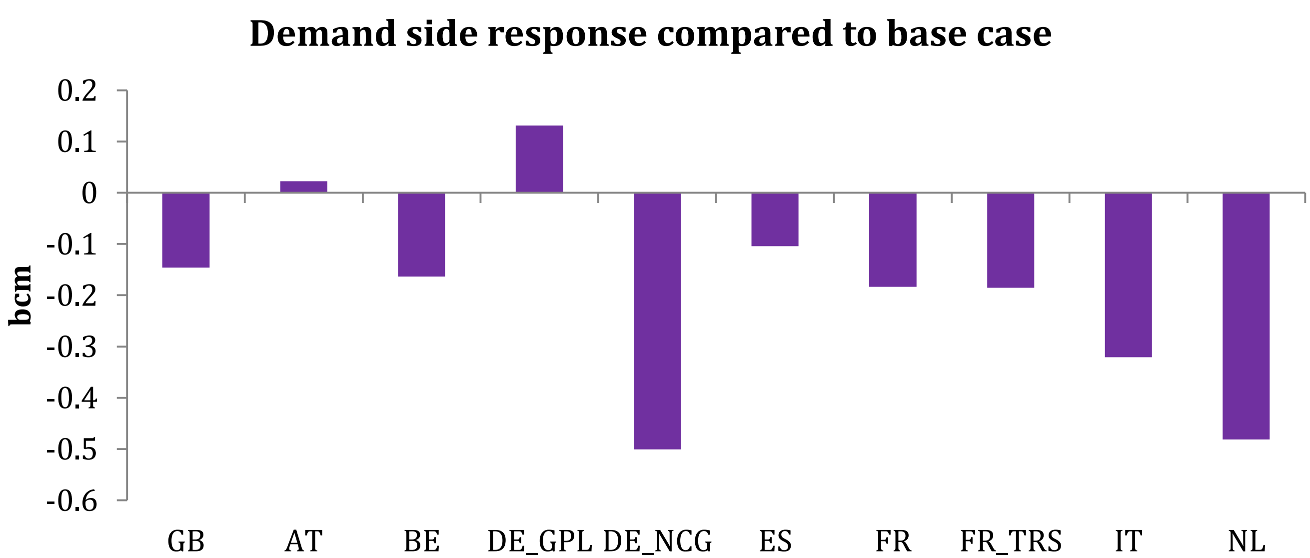

Rather strong demand response ca. 2bcm in total or 20% of entire DE depleted field capacity

Some preliminary conclusions

- Supply abundance & weak demand affect (negatively) storage markets in Europe up to 2020
- Storage markets are expected to improve once markets are becoming tight again (post 2025) (informed by our simulation results for 2025/26 gas year)
- SoS-related measures (strategic stock & supply obligations) & non-TPA (reserved for TSO operational reasons) capacities are not taken into account and once factored in could reduce storage capacities available to the market, improving S/W spreads
- A relevant policy question is: what is the optimal level of storage we should support between now and 2025 (when the situation is expected to improve for storage), given that
  - Once shut down, storage sites are gone (new investment could be more costly, perhaps due to geological limitations) and hence impacting security of supply provided by storage
  - However, since indigenous supply in Europe is declining, perhaps more storage sites may become available, should market conditions improve to support these investment opportunities?

Thank you for your attention

Questions & comments are welcomed

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