Groningen Production Cap and European gas (& electricity) markets

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EPRG Winter Seminar
Cambridge, 07/12/18

Agenda

I. Groningen Gas Field - overview

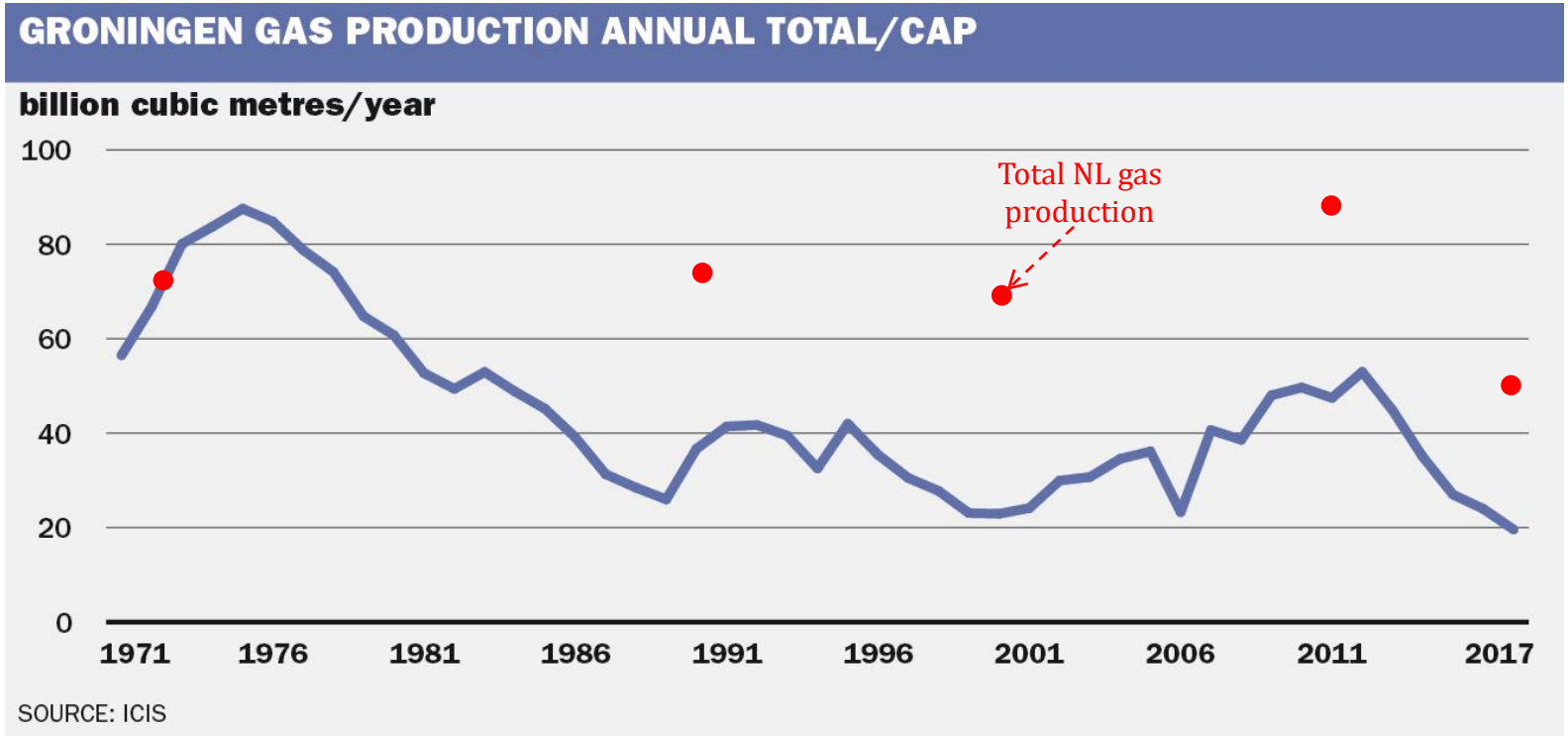
II. Potential Impact of the recently announced production cap for Groningen

III. Conclusions

Overview

The giant Groningen gas field

- NL's estimated gas reserves – 1,230 bcm (25 years worth of NL production)
- Groningen accounts for:
  - ca. 60% of NL remaining gas reserves (IEA, 2014)
  - about 43% of NL total production (2016)
  - 50% of NL consumption in 2016



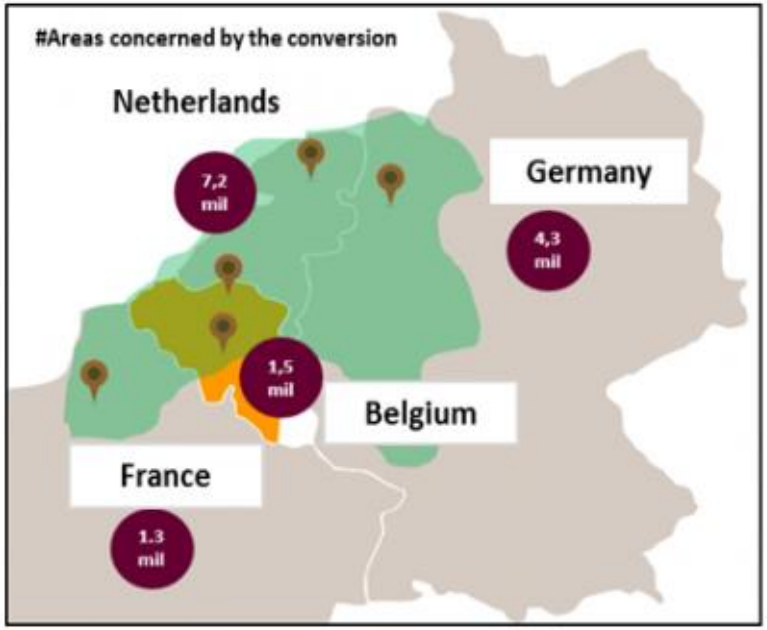
Overview

L-gas vs H-gas

- Groningen produces low calorific value gas (L-gas) which are consumed in NL, FR, BE and DE
- All residential and commercial customers in NL consume L-gas
- Gas with high calorific value (H-gas) and gas with low calorific value (L-gas) are transported on separate high-pressure networks.
- In order to interconnect these networks, the Dutch TSO operates so-called conversion facilities where H-gas can be converted into L-gas by adding nitrogen.
- GTS has the legal obligation to deliver gas in the required quality. Quality conversion is a so-called system service whose costs are socialised.

Overview

L-gas market size & conversion strategy



- Total L-gas market size is ca. 70 bcm/year (or 37% of total demand in NL, FR, BE and DE)
- In 2015, 42 bcm was sourced from Groningen; 10 bcm from small fields in NL; The rest was sourced from Russia & Norway (H-gas mixes with nitrogen = L-gas)
- Dutch, German, French and Belgian authorities have agreed to 'convert' various market areas in phases, to make them suitable for other gas qualities
- It has been agreed that this conversion will be implemented in Germany between 2020 and 2030.
- Belgium and France will also convert their systems in the period 2024-2030.
- Because of these agreements, the Netherlands can postpone conversion activities until 2030.

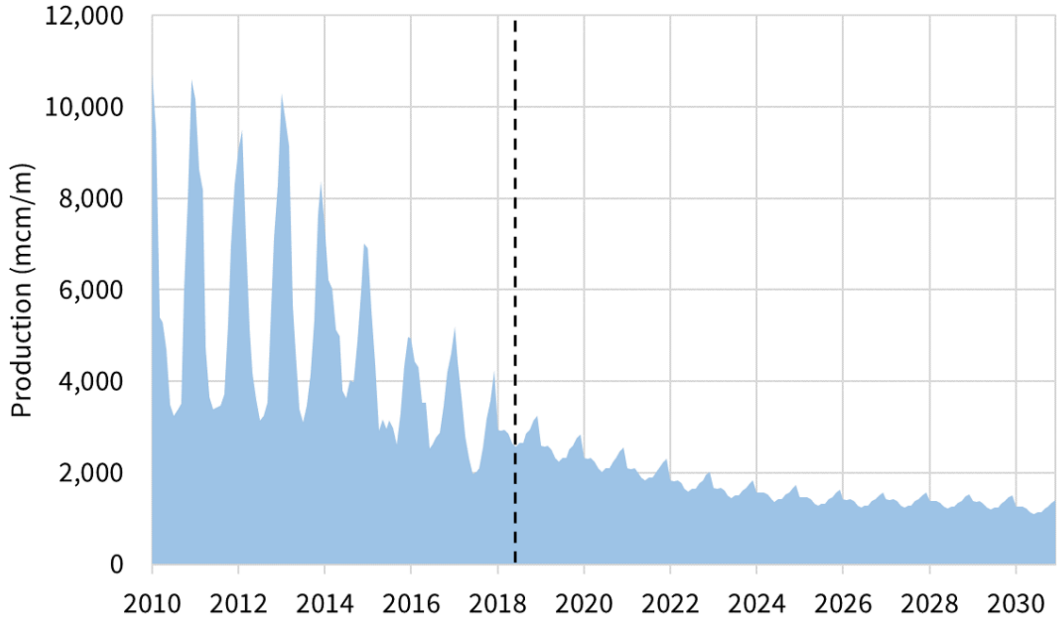
Overview

Groningen and system flexibility

- Relative to its market size, the Netherlands has a rather small working gas storage volume of 13.9 bcm from existing storages, mainly depleted gas fields

- The main system flexibility, however, is provided by the production swing from the Groningen field and some peak-shaving LNG capacity.

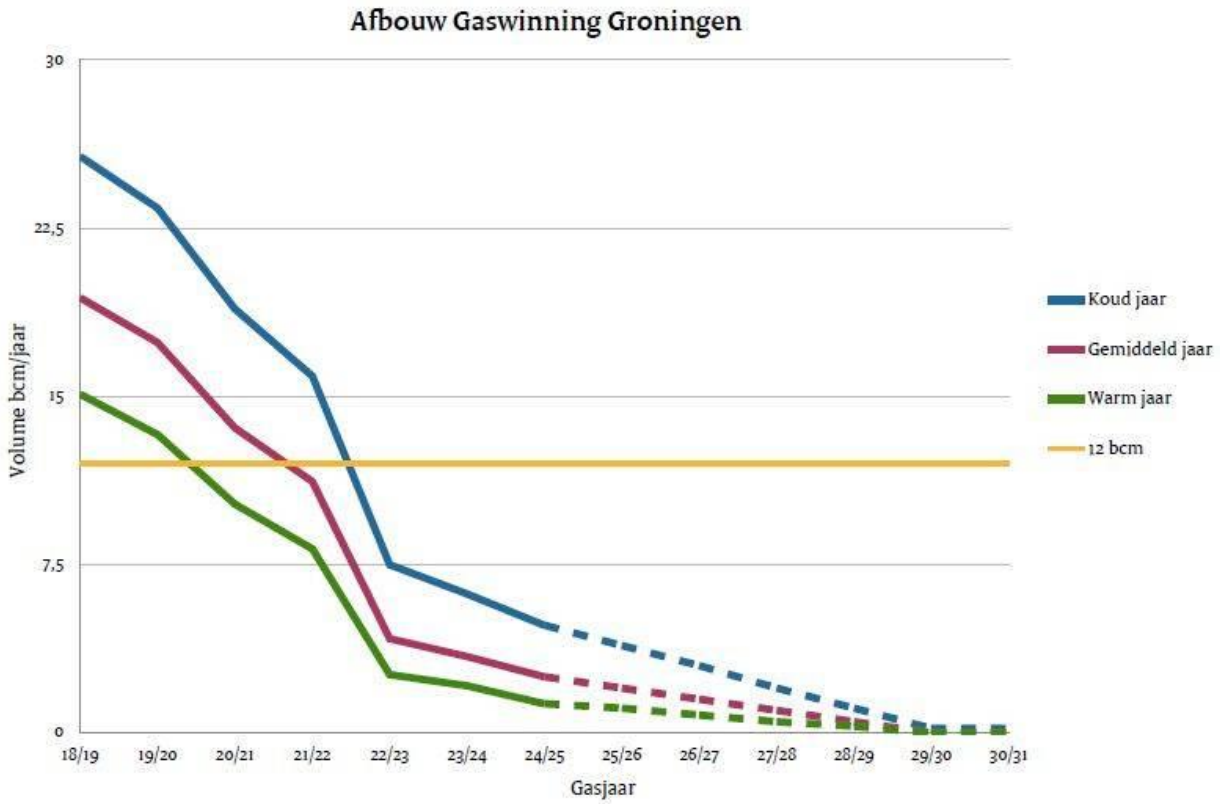
- With the production decline of Groningen, the country will need to increase its storage capacities to ensure flexibility and security of supply.



Source: Timera Energy

Overview
production cap

- The cap of 12 bcm/year by 2022 was approved in Mar-18 by the Dutch government following a series of increasingly significant earthquakes



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Modelling potential impacts of the Groningen production cap

- Several production scenarios were modelled for Groningen:
  1. **Baseline:** Annual production cap of **19.6-21.1 bcm/year** (2017/18 gas year);
  2. **Sensitivity A:** Annual production of **12 bcm/year** by 2022/23 (new cap);
  3. **Sensitivity B:** Annual production of **6 bcm/year** by 2022/23.
  4. **Sensitivity C: No** production from Groningen

- On 7 June the Dutch Economic Minister announced that the cap of 12 bcm/year could be achieved by 2020/21 gas year
- Further measures (conversion of L-gas demand to H-gas) mean that the cap could be reduced to 4 bcm/year by 2022 in an average year or 7.5 bcm/year in a cold year
- Potential closer of Groningen by 2030…

- The model simulates the gas year 2022/23; all inputs assumptions are informed by IEA WEO, NG FES scenarios, ENTSO-G TYNDP etc.

- Impact on prices and flows are measured against the Baseline (1): 19.6-21.1 bcm/year cap.

Gas Market Modelling Framework

- The gas market modelling framework, consisting of a number of models, has been developed at Cambridge since 2006
- Global & regional models with different time resolutions (annual, monthly and daily) and a detailed European/UK entry-exit system
- The modelling framework has been used in a number of research projects - recent study for the UK government department for Business, Energy and Industrial Strategy (BEIS) focusing on modelling GB's Gas Security of Supply to 2035

Department for
Business, Energy
& Industrial Strategy

GAS SECURITY OF SUPPLY

A strategic assessment of Great Britain's gas security of supply

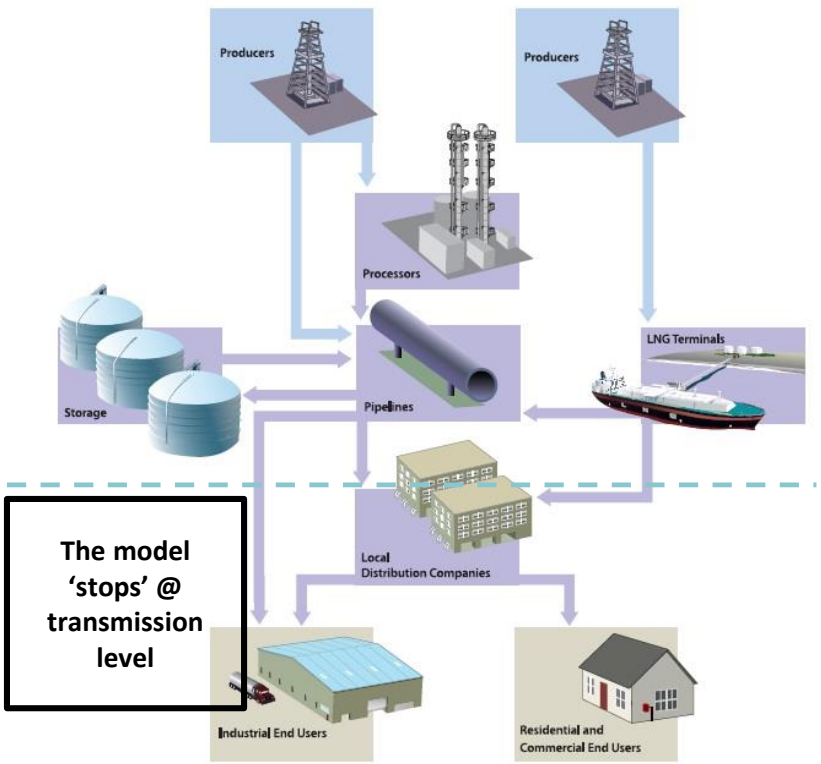
Global gas market simulation model

- **Geographic scope**
  - 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 includes the USA, Canada and Mexico)
  - Other demand centers are aggregated to the regional level, such as the Middle East or JKT (Japan, South Korea & Taiwan)

- **Time Resolution**
  - The model solves for **daily** flows and prices

- **Supply chain**
  - Covers the entire supply chain down to the transmission level (i.e., distribution level is not taken into account)
  - Represents production, demand, transit routes, LNG facilities, and gas storages

Model asset representation

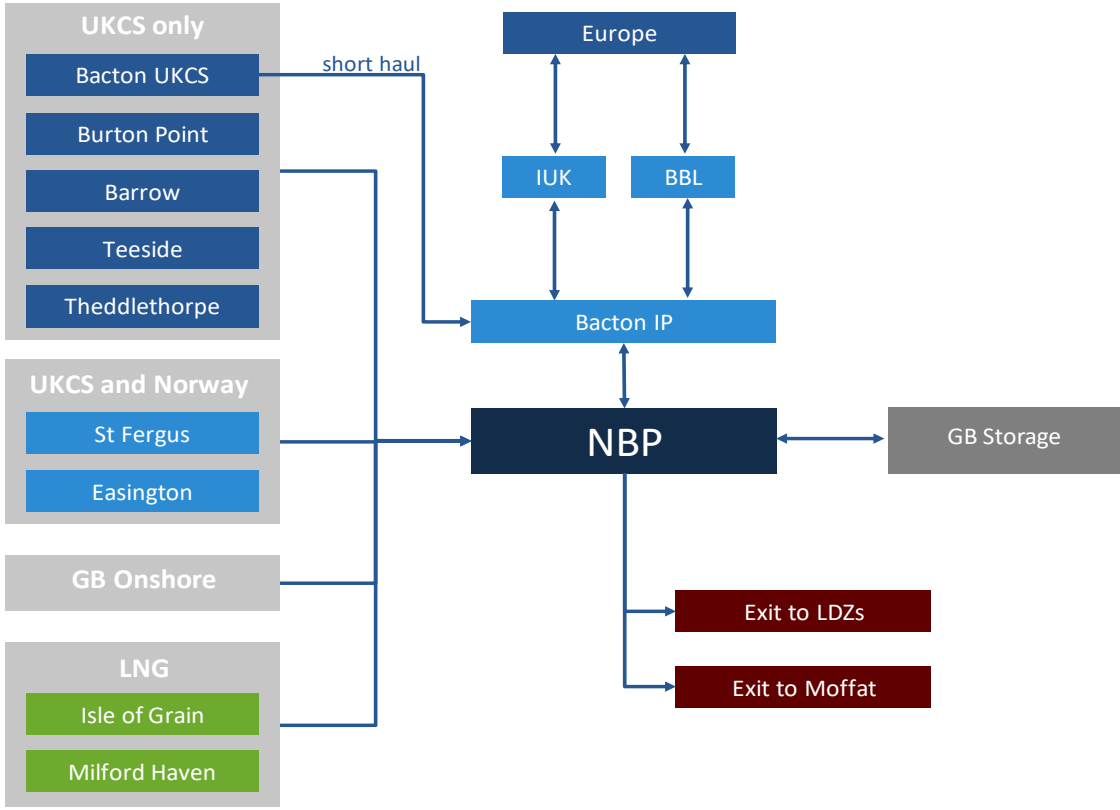


The model 'stops' @ transmission level

GB Gas network/E&E representation

model includes all main entry and exit points to the GB network:

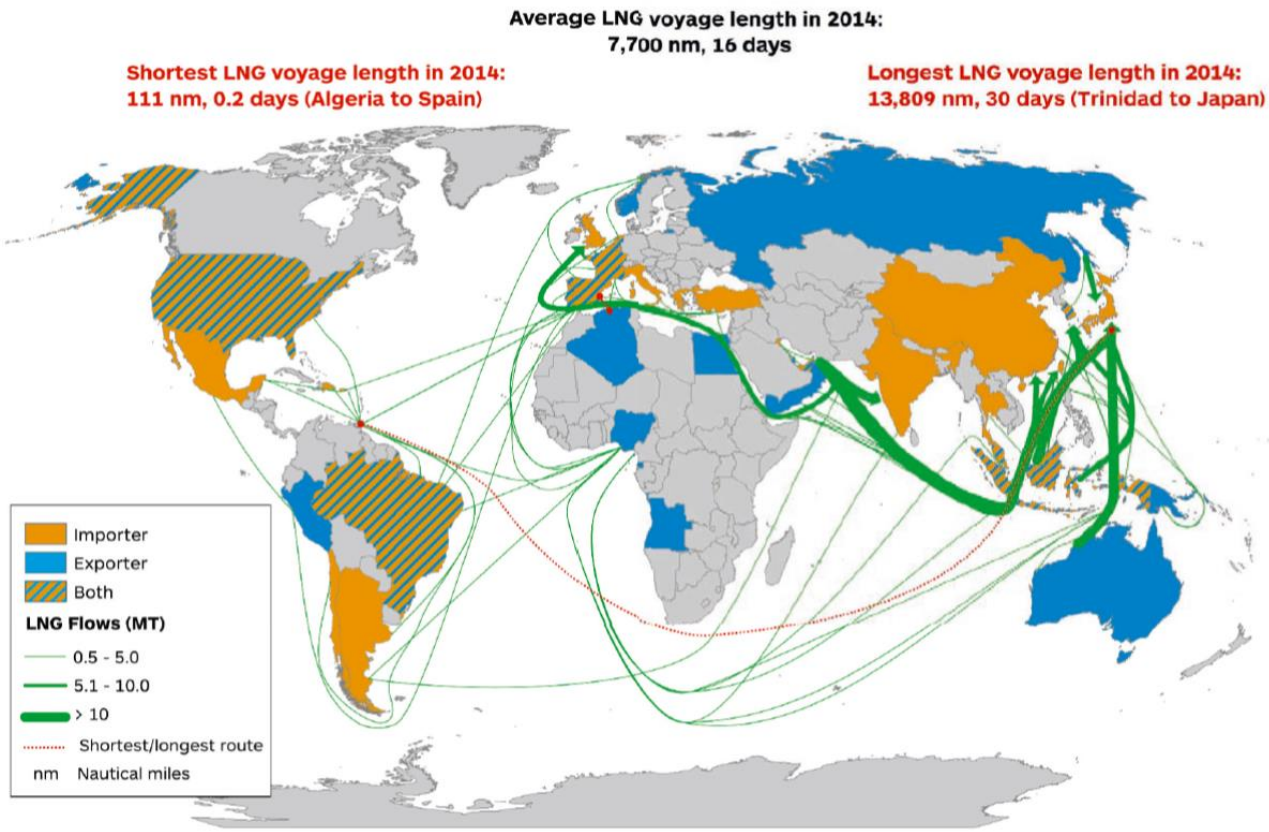
- UKCS only beach terminals;
- UKCS + Norway flows at Easington & St Fergus
- LNG terminals;
- GB storage facilities;
- bi-directional interconnection to Europe;
- potential to divert Bacton UKCS gas flows to Bacton IP through the shorthaul option;
- one-directional exit only interconnection to Ireland;
- domestic consumption.



European transmission network in the model

- **EU cross-border transmission capacities & tariffs**
  - The model incorporates ALL existing cross-border interconnector points (IP), as they are reported by ENTSO-G
  - Therefore, the daily model follows existing regulatory structure of European gas markets – entry/exit capacities are therefore **commercial products**, not actual physical pipeline capacities
  - For the transmission cost structure we assume existing tariffs (e.g., daily capacity products)
- **Storage capacities & costs**
  - All existing storage sites were aggregated to country level (i.e., each country/market area has one storage 'node' but marginal cost curves represent different withdrawal capabilities)

LNG Shipping



- LNG Shipping routes are 'pre-specified' in the model as network (nodes-arcs)
- We then apply average shipping rates
- We also take into account days it takes to sail from one point to another, assuming 19 knot/hour
- We take total stock of LNG as aggregate shipping capacity
- This aggregate shipping capacity is then applied to every route

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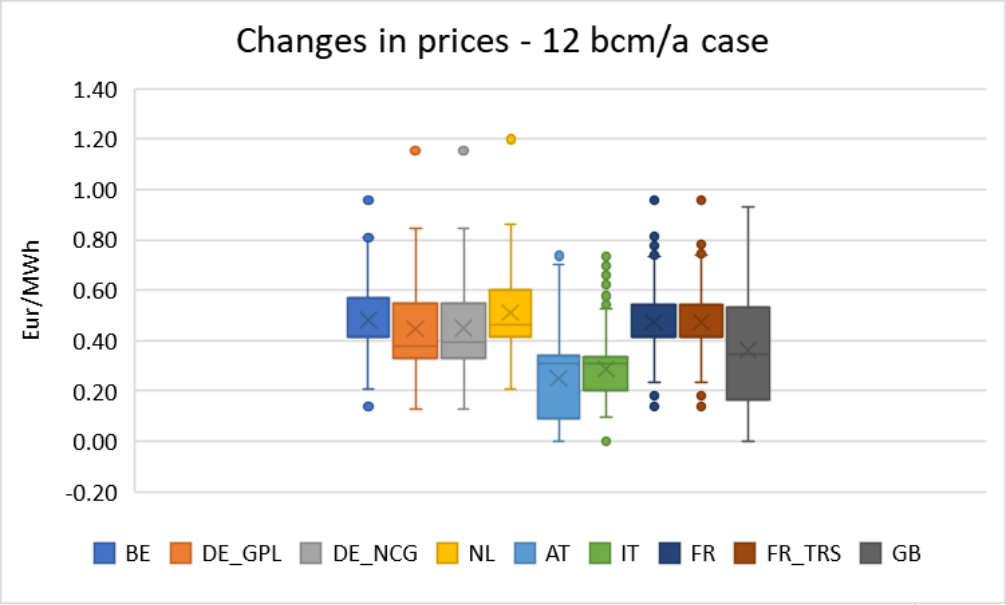
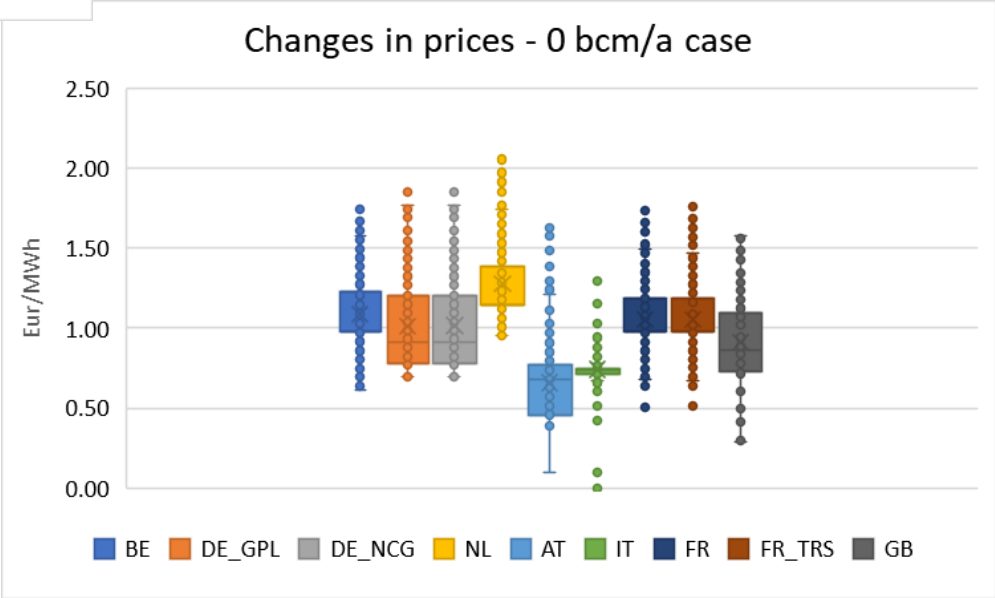
Impact on wholesale prices & costs in NWE

relative to the current production cap



- Impact on prices varies – up to 10% of the current traded level (Eur 20.2/MWh, TTF)
- With AT/IT seeing the least impact while NWE, as expected, would have higher impact
- Without Groningen prices could become more volatile



Impact on wholesale prices & costs in NWE

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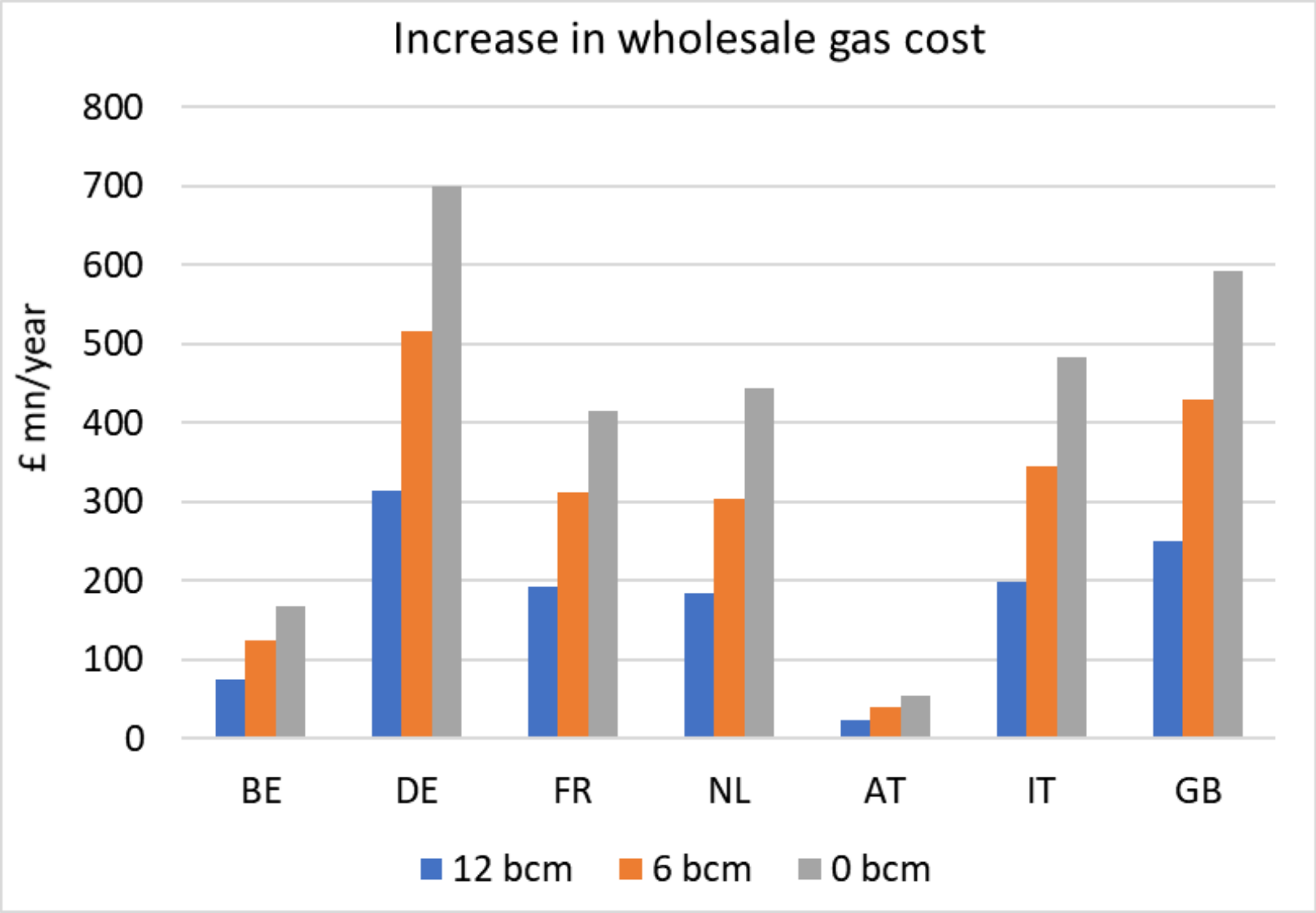
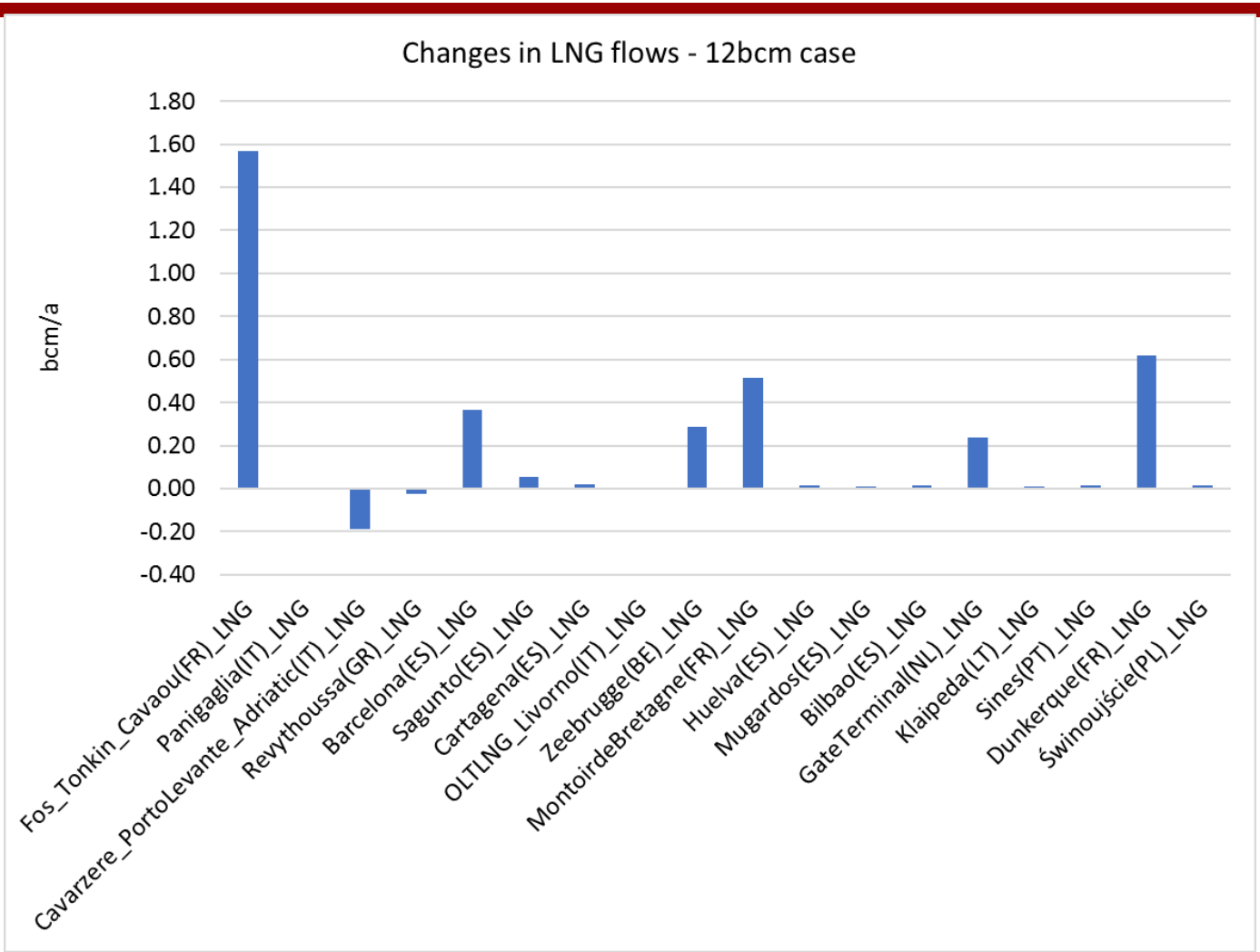


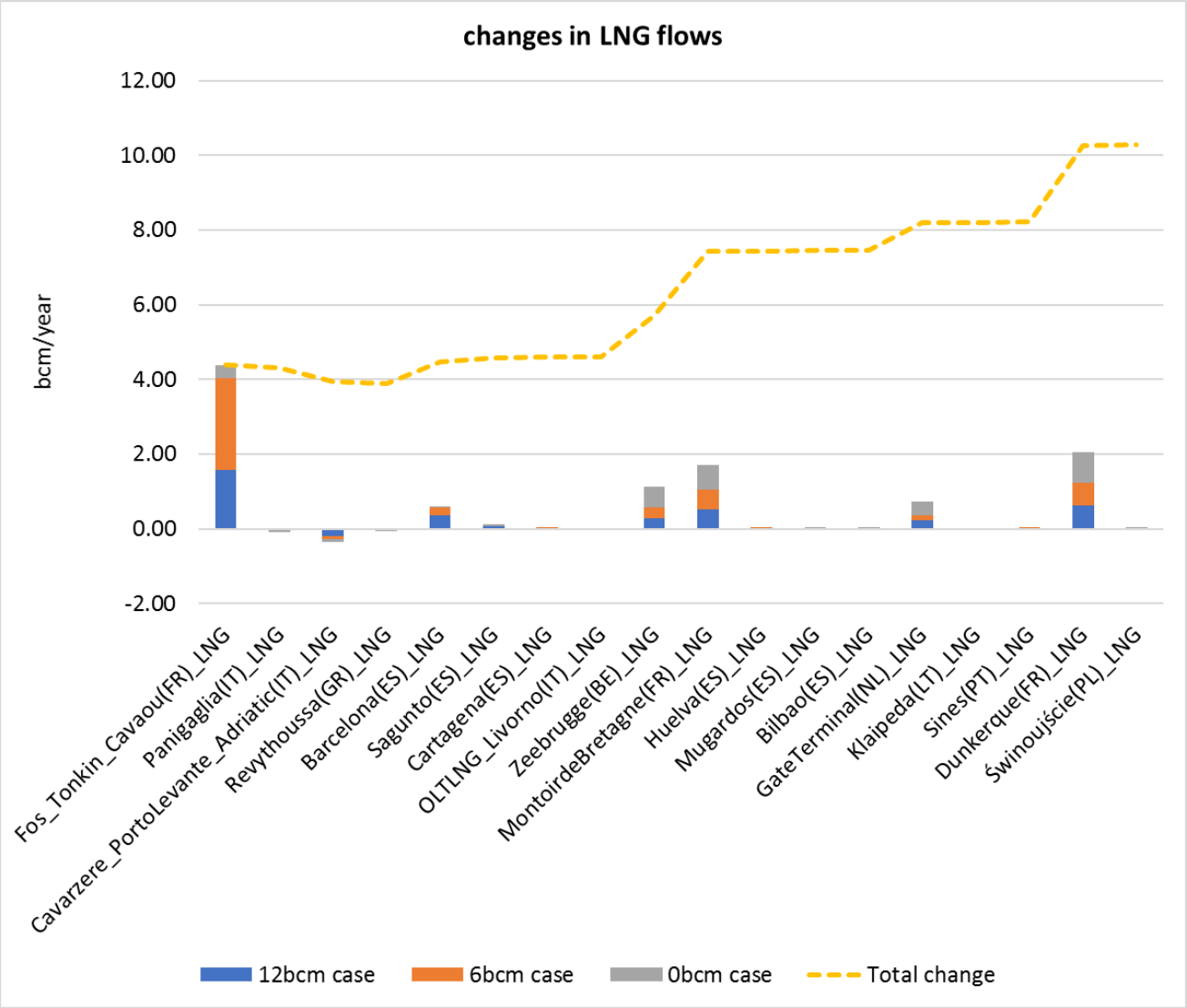
Impact on flows - - *LNG (1)*

Groningen production cap @ 12 bcm/year



- Marginal source of gas will increasingly be from LNG terminals in FR, ES & NL

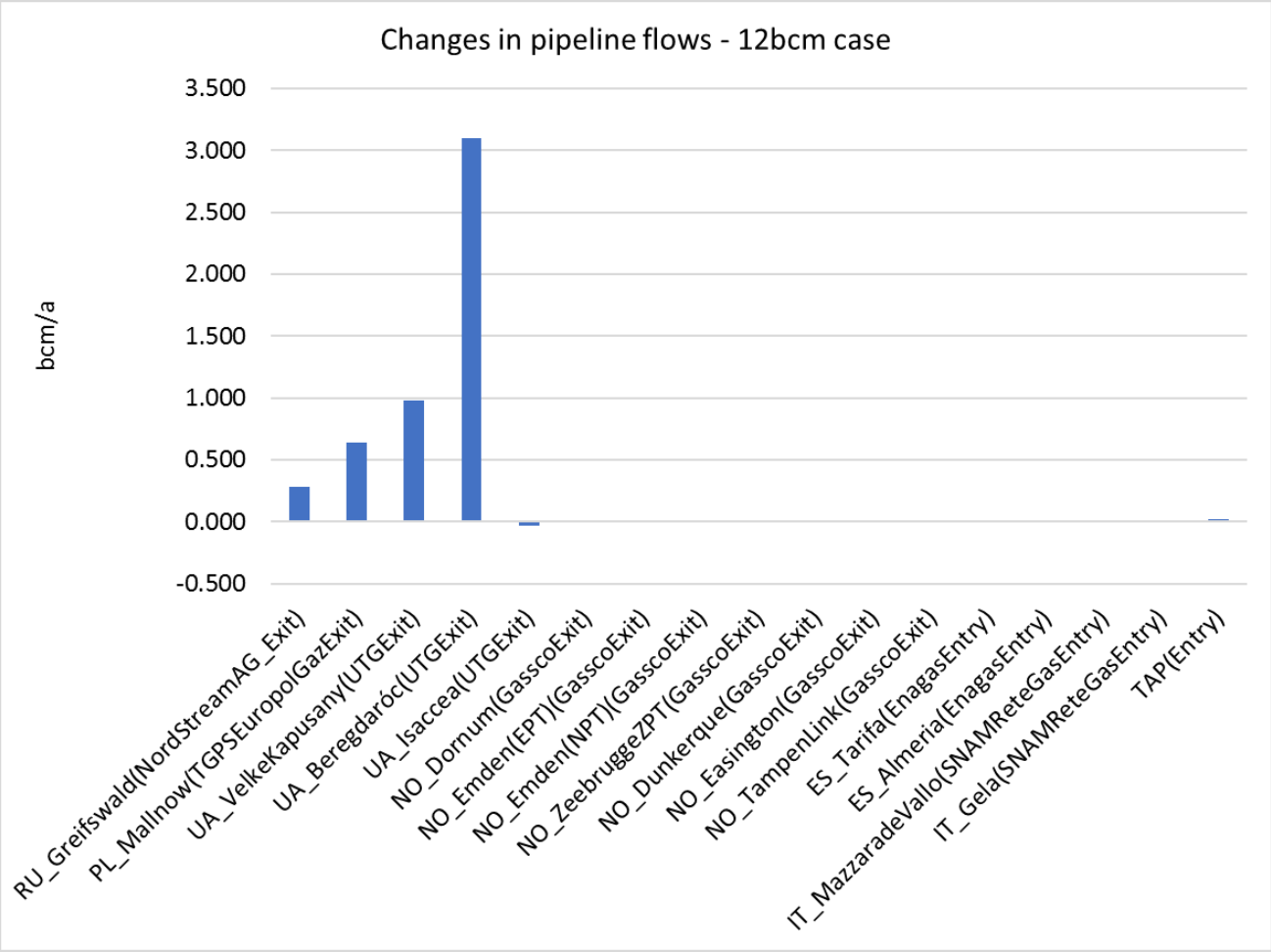
Impact on flows - - *LNG (2)*



- A complete shut down of Groningen (ca. 21 bcm/a) induces >10 bcm/a of additional LNG inflow

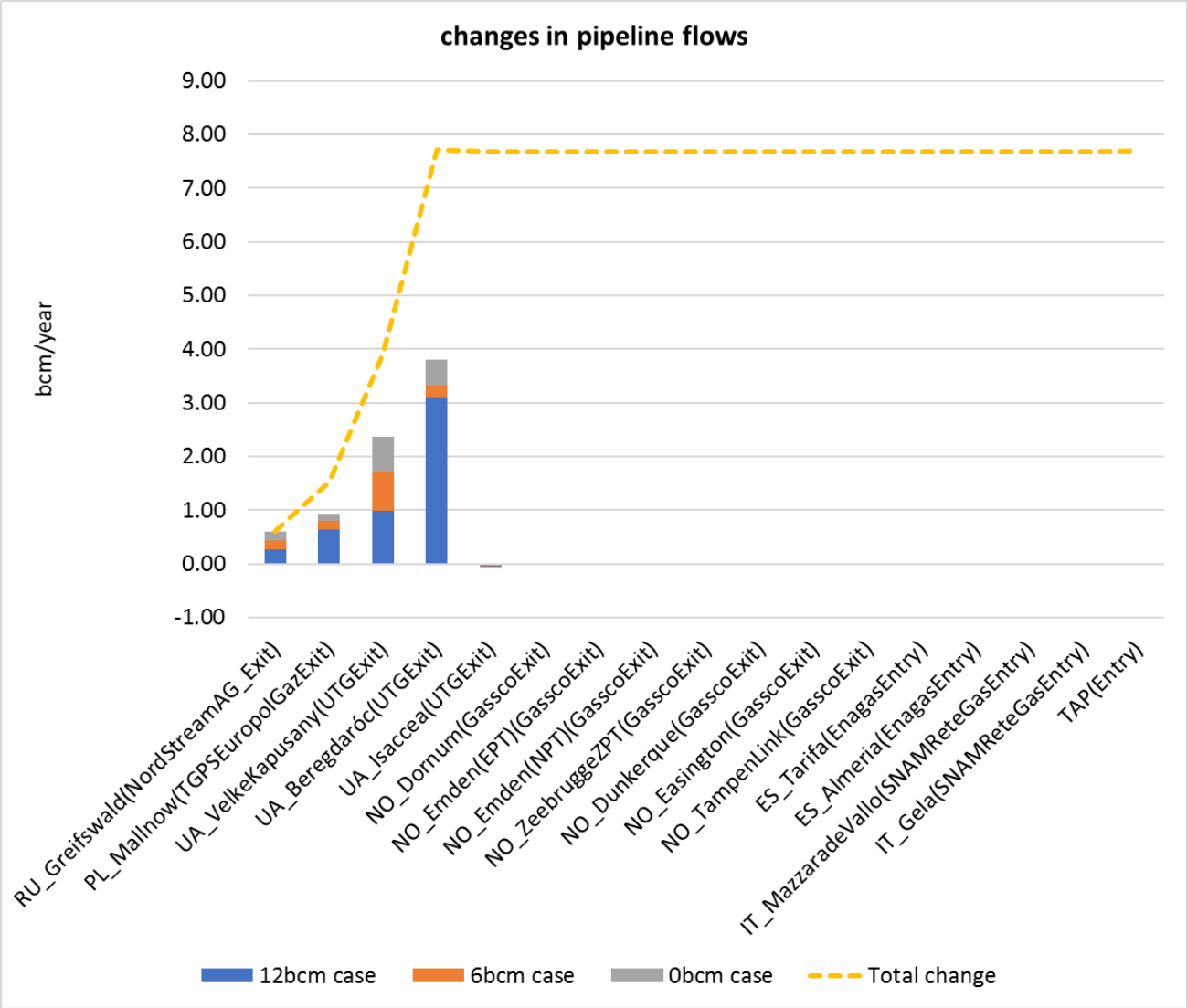
Impact on flows - - *pipeline gas (1)*

Groningen production cap @ 12 bcm/year



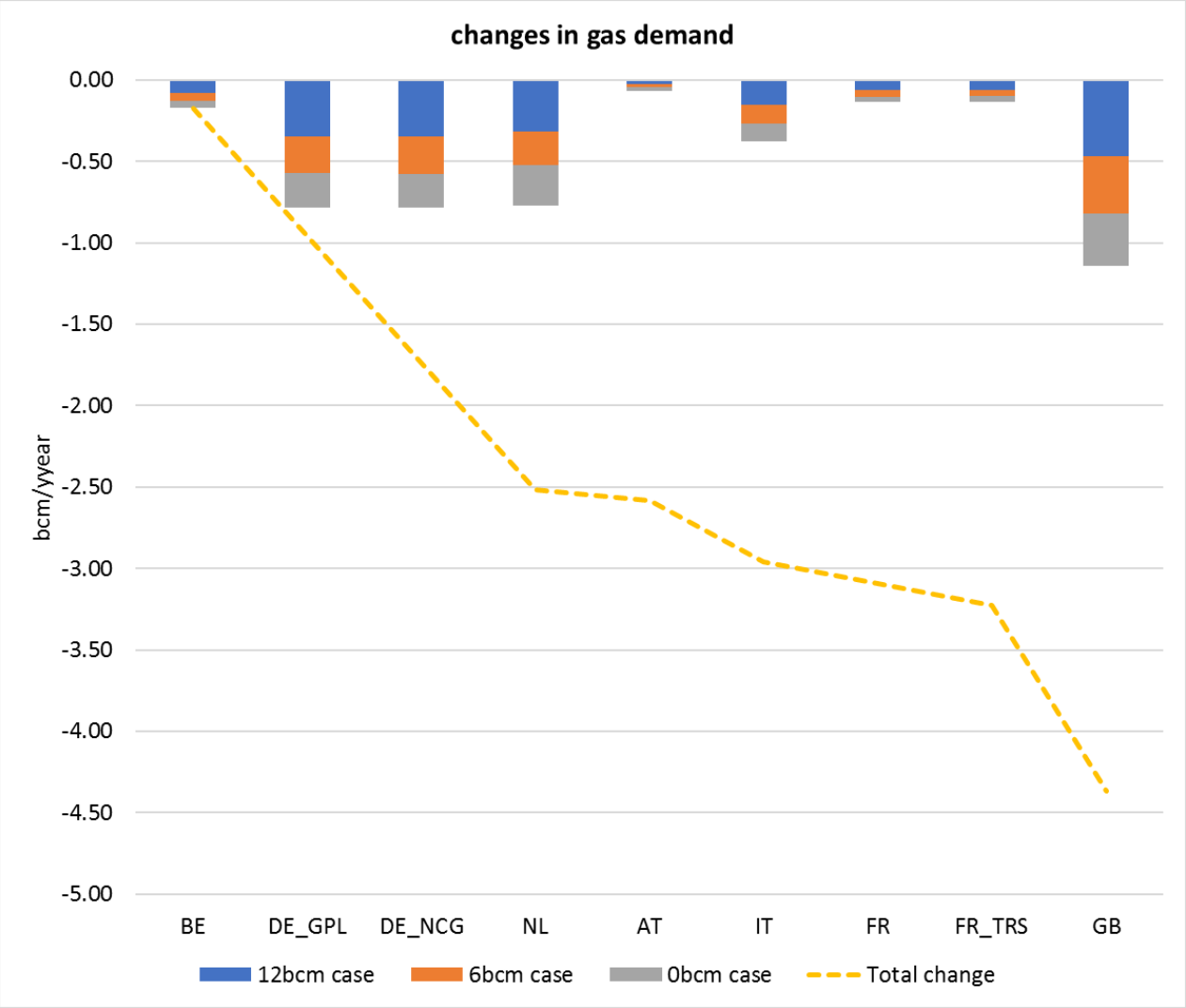
- Only RU gas responds to the production cut
- UA transit route is the marginal source of RU gas in Europe

Impact on flows - - *pipeline gas (2)*



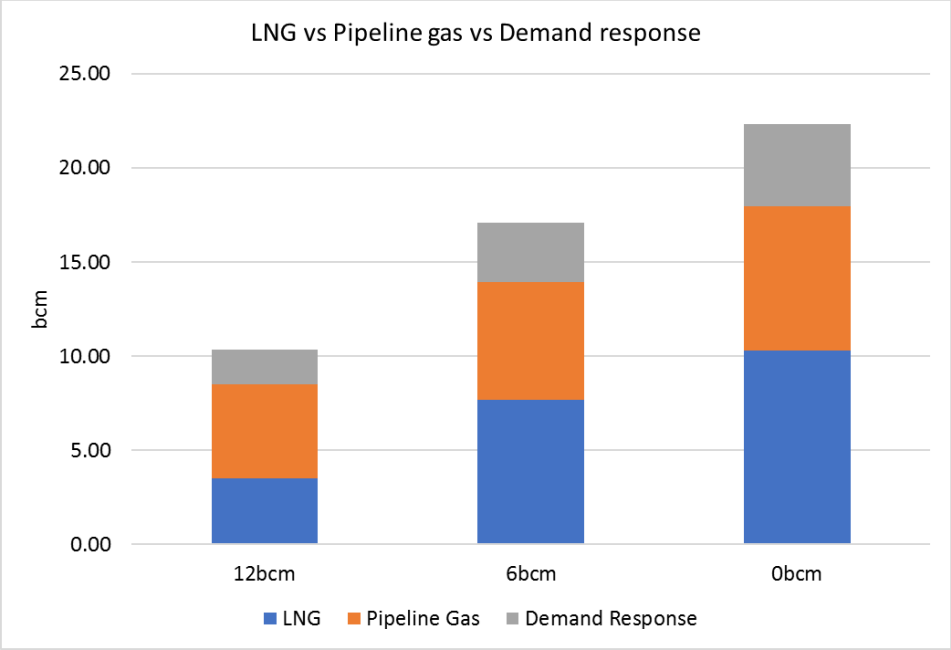
- A complete shut down of Groningen induces a reply of < 8bcm
- Predominantly from Russia <u>via UA route</u>
- LNG has greater capacity to respond

Impact on gas demand

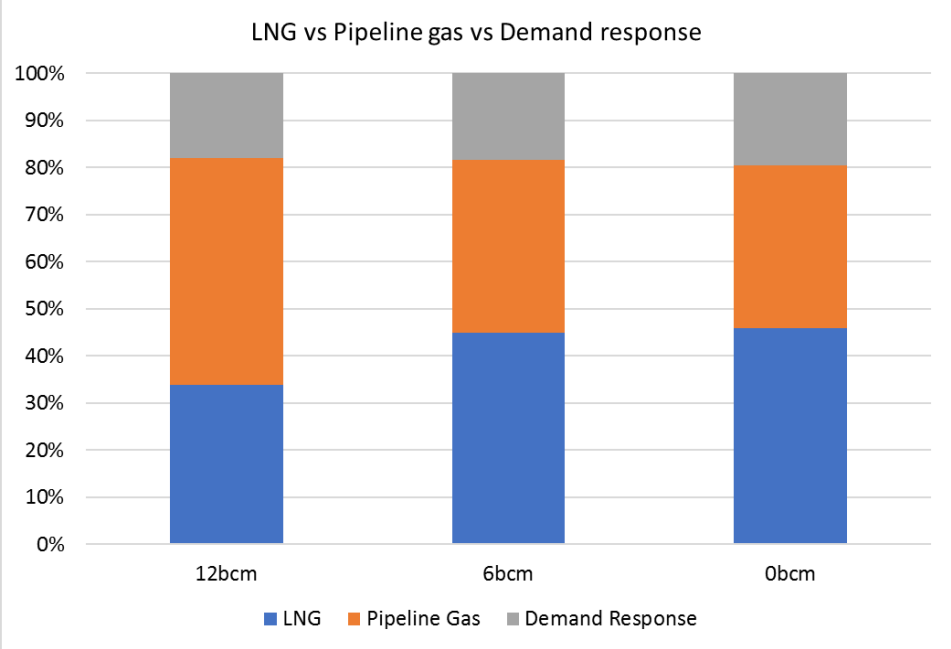


- Production cut at Groningen increases wholesale price
- Pushing marginal CCGTs out of the market (e.g., gas to coal switching) therefore destroying gas demand in powergen

Groningen production cap & competition between supply sources



- 9.6 bcm reduction in Groningen gas supply leads to >10bcm of supply response from alternative sources
- 15.6 bcm reduction leads to 17.1 bcm of response
- 21.6 bcm reduction leads to 22.34 bcm of response



Impact on GB gas and electricity markets

		21 bcm (baseline)	12 bcm	6 bcm	0 bcm
GAS	average price (£/MWh-th)	13.3	13.5	13.7	13.9
	volatility	27%	27%	27%	27%
	wholesale gas cost, £mn/a	17,719	18,038	18,269	18,479
	delta wholesale cost, £ mn/a	0	320	550	760
	% of baseline cost	na	1.80%	3.10%	4.29%
Electricity	average price (£/MWh-e)	41.4	42.0	42.4	42.8
	volatility	20%	21%	20%	20%
	wholesale electricity cost, £mn/a	13,492	13,678	13,820	13,951
	delta wholesale cost, £ mn/a	0	185	328	459
	% of baseline cost	na	1.37%	2.43%	3.40%
Total wholesale gas & electricity cost, £ mn/year			***505***	***878***	***1,219***

- Marginal impact on annual average prices while no impact on annual volatility for gas & electricity BUT
- maximum impact is ca. 4.3% of annual wholesale gas cost, £760mn/year
- Electricity: 3.4% of annual wholesale electricity cost, £459mn/year

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conclusions

I. production cuts will result in a reshuffle of supply in key European gas markets

II. LNG has greater capacity to respond than pipeline gas

III. Importance of transport tariffs
   I. Inside Europe – impacts locational spread
   II. Outside Europe (Ukraine) – impacts wholesale prices when Russian flex gas is called in

IV. Total cost of conversion of 70 bcm L-gas market to H-gas

V. Loss of welfare as demand is reduced and wholesale prices are higher

Dr. Chyong is a Research Associate at the Judge Business School and the Director of Energy Policy Forum, University of Cambridge. He is an expert in energy modelling with particular focus on natural gas & electricity market modelling and energy infrastructure and networks. His research interests include policy and economics of international gas and electricity markets, implications of decarbonisation agenda on gas and electricity, Russian natural gas export strategy, and Russo-Ukrainian energy relations. He has experience in advising corporations and governments on important energy issues primarily based on energy modelling and analytical tools that he has developed as well as deep knowledge of the energy industry and policy issues.

Kong holds a PhD in Energy Economics and Policy from Cambridge Judge Business School and an MPhil in Technology Policy from Cambridge.

Thank you for your attention

Questions & comments?

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Publications & presentations: http://www.eprg.group.cam.ac.uk/tag/ck-chyong/