

# Capacity value of gas storage infrastructure

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Executive Summary

May 2019

# Motivations for the study



Previous studies undertaken on behalf of Gas Infrastructure Europe (GIE) have focussed on:

1. **Gas storage market failures** - Identifying how gas storage capacities provide value to the energy system (seasonal storage, medium- and short-term flexibility, insurance value related to SoS, and system value), and which of these values are not currently remunerated by the markets.
2. **Pricing and regulatory measures** - Identifying market-based pricing and regulatory measures that could result in appropriate revenues for gas storage system operators (SSOs), in a context where seasonal gas storage supports the decarbonisation effort.
3. **Gas demand curtailment** - Assessing the risk of gas demand curtailment following a reduction of gas storage capacity, performed in collaboration with ENTSOG.

The objective of this study is to perform a **quantitative analysis** of the **cross-sectoral impacts** of a reduced gas storage capacity:

- Ability of the **electricity system** to meet the demand
- Evaluation of the **capacity value** of European gas storage capacities (by assessing the extra costs to meet the demand)

# Objective of the study

The key objective of the study is to understand the cross-sectoral implications of a lower gas storage capacity, and to assess the capacity value of gas storage for the electricity sector. To do so, we compare two situations:

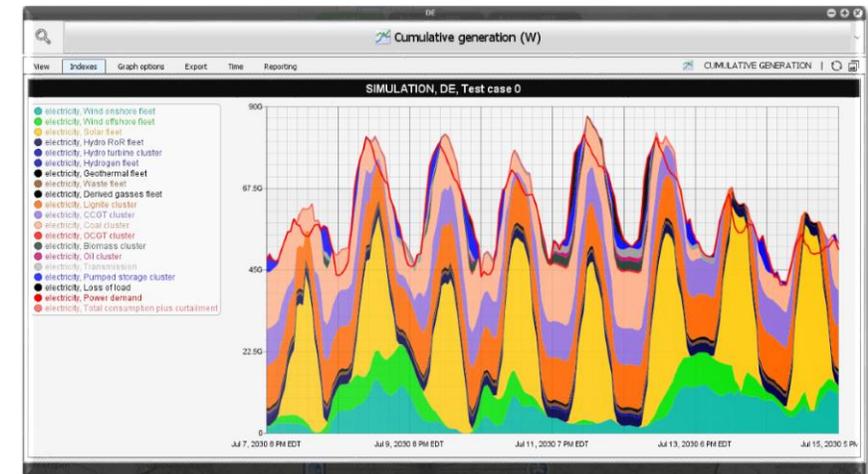
Gas storage capacities as foreseen in the TYNDP scenarios for 2030

Decrease of the gas storage capacity by 10%, 20% and 30%

The **key impacts** we are interested in are:

- > Electricity **dispatch** and its costs
- > Ability to meet electricity demand (loss of load)
- > **Investments** in additional technologies to ensure the electricity demand can be met at all times (as a proxy to calculate the capacity value)

When reducing the gas storage capacity, we assume an homogenous decrease of storage volume, withdrawal and injection rates, in all countries.

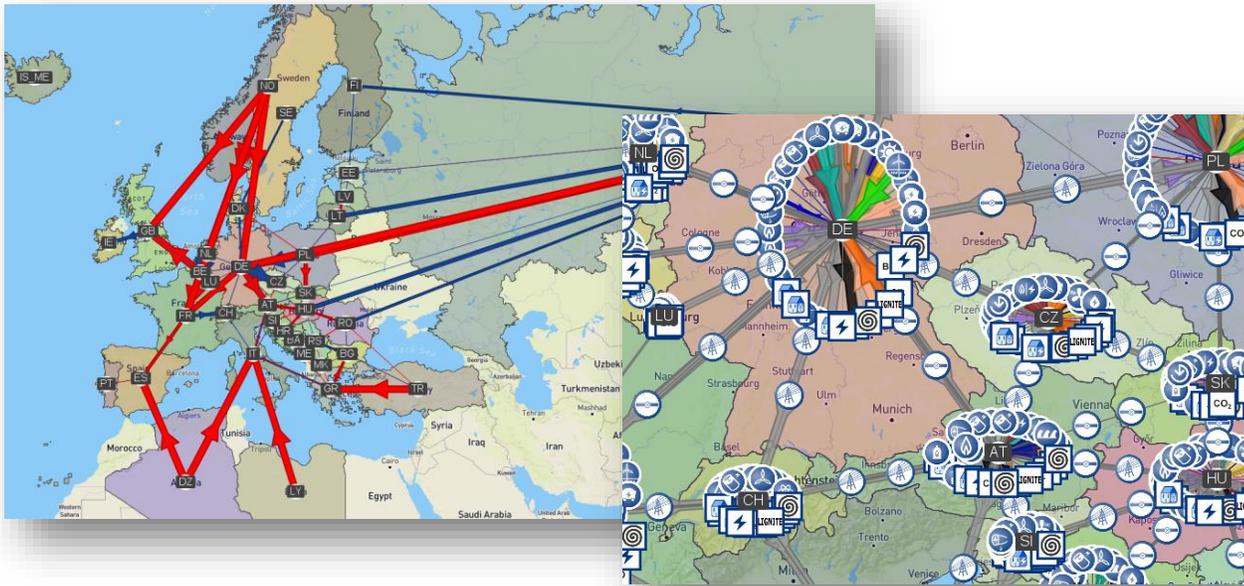


# Overview of the methodology

To perform this study, we use Artelys Crystal Super Grid, a tool allowing to jointly simulate the electricity and gas sectors with an hourly time-resolution, and to quantify investment needs in case adequacy criteria are not met.

The results presented today rely on the following assumptions:

- ✓ ENTSOG TYNDP 2018 Sustainable Transition (2030)
- ✓ ENTSO-E TYNDP 2018 Sustainable Transition (2030)
- ✓ METIS assumptions for techno-economic characteristics



## Joint modelling of the electricity and gas systems

Technologies are explicitly represented at the country-level, for both the electricity and gas systems:

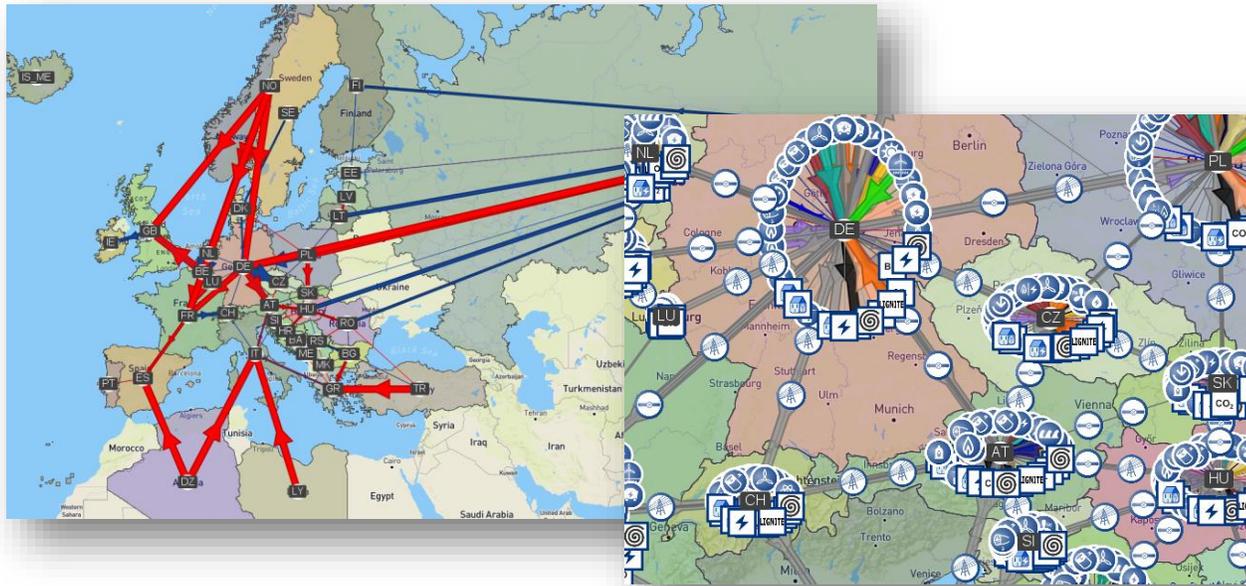
- ✓ Electricity generation technologies (CCGT, nuclear, hydro, RES, etc.), storage assets and interconnections
- ✓ Gas production, import sources, storage assets and interconnections

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Model **calibration** so as to reproduce **key results** of the ENTSOE-GIE analysis

	ENTSOE-GIE analysis	This study
Peak day (TWh/day)	~ 35	31.9
2-week demand (TWh/day)	~ 29	27.3

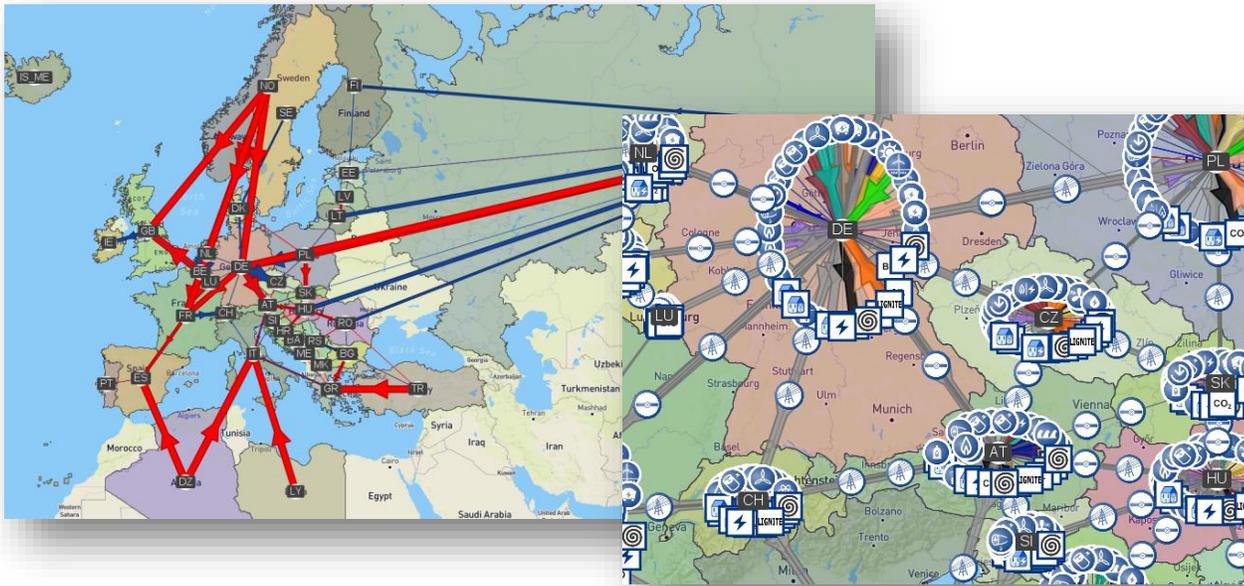
Gas-only simulations have been run to check consistency with ENTSOE-GIE analysis

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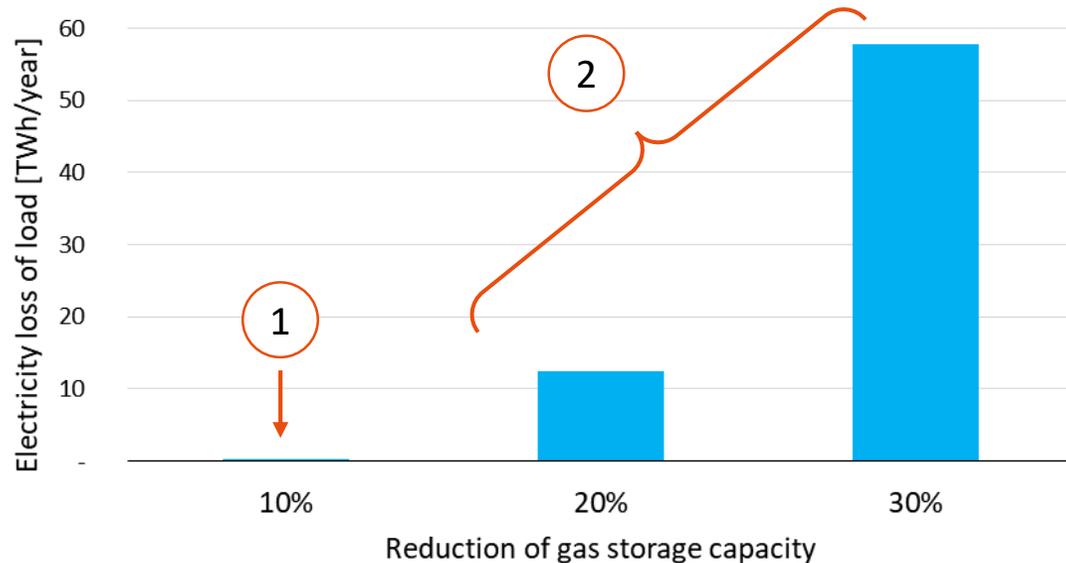
## Remarks

No sector coupling beyond what is considered in the *TYNDP 2018 Sustainable Transition 2030* scenario developed by the ENTSOs.

The results could differ for different assumptions on the decarbonisation level, RES portfolio, P2G deployment, climatic conditions, etc.

The model does not capture the impacts within countries (e.g. local network reinforcements)

# Gas storage flexibility is essential to ensure SoS/resilience



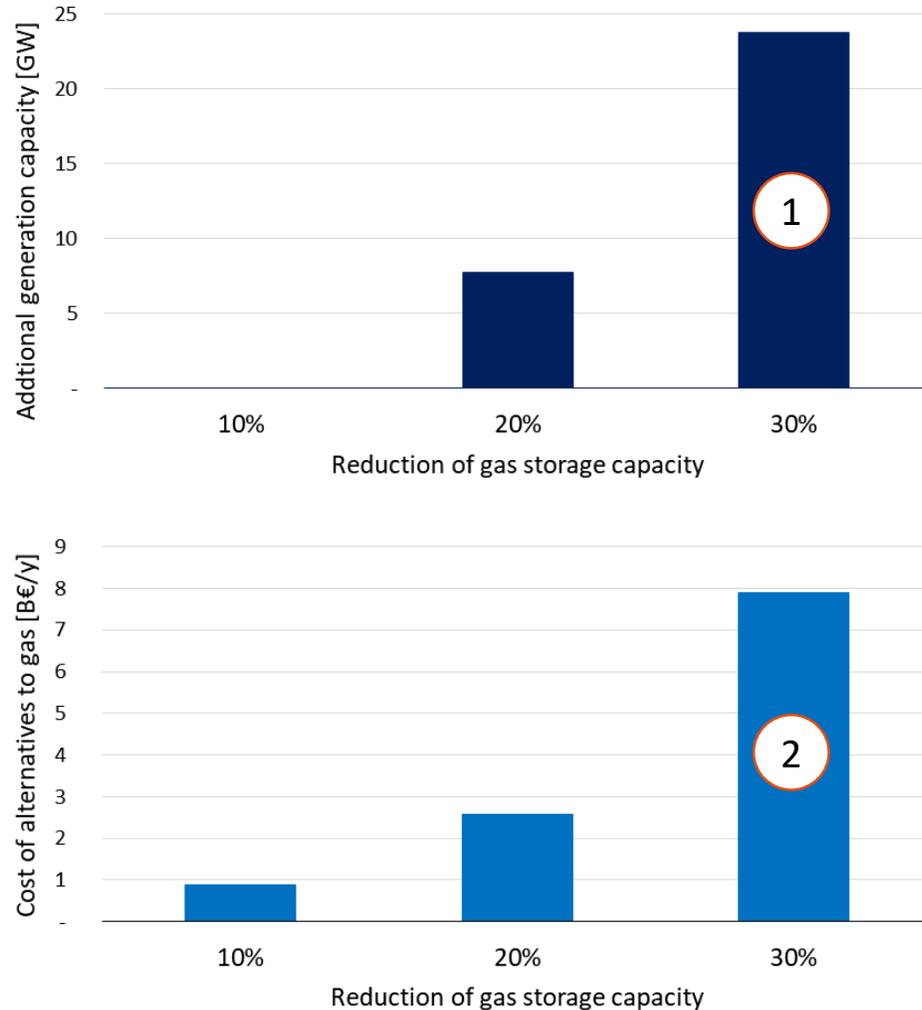
To evaluate the benefits of gas storage assets in ensuring electricity security of supply, we have **gradually removed gas storage capacity** in our simulations, without allowing for any investments.

In order to mitigate the impacts of the removal of gas storage assets, the electricity system can re-organise the dispatch and use expensive generation technologies during times of peak residual demand generating extra costs.

However, at some point, the flexibility of the power system is completely exploited and demand curtailment situations begin to appear.

- 1 The reduction of gas storage capacity prevents CCGTs and OCGTs to run during high electricity demand episodes in winter. The production costs of alternative generation units are found to increase by around **1 B€/y**.
- 2 A further reduction of gas storage capacity results in **electricity demand curtailment**. This signals a need for investments in electricity flexibility or generation technologies to allow the system to meet the demand.

# Gas storage assets prevent investments in e-gen



To evaluate the **capacity value** of gas storage assets, we estimate the cost that would be required to avoid the loss of load (taking into account the constraints from e.g. the electricity interconnectors). To do so we have let the model invest in a generic dispatchable electricity generation technology so as to ensure the electricity demand can be met at all times.

As an illustration, for a **30%** reduction of gas storage capacity:

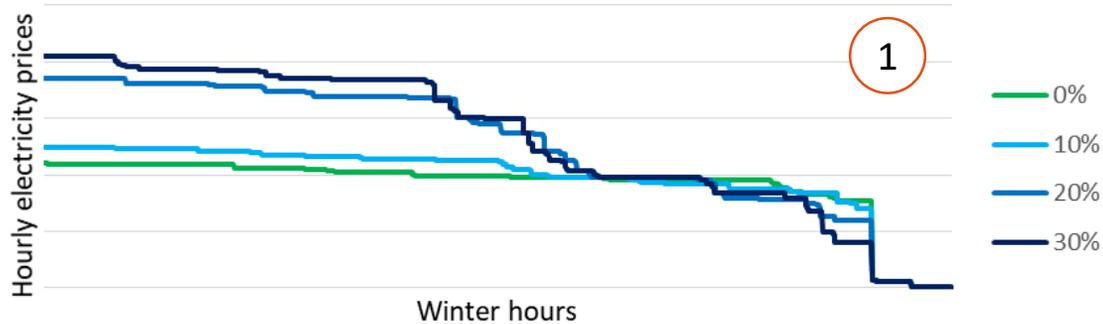
**1** [CAPEX] Investments in around **23 GW** of electricity generation technology is found to be necessary to ensure demand is met at all times. This extra-capacity can replace gas-fired power plants at times where gas cannot be delivered to these units due to the reduced level of gas storage. Under our assumptions, this would translate in additional investment costs of around **55 B€**.

**2** [OPEX] The operational cost of alternatives to gas-generation technologies is found to increase as (a) the system exploits the flexibility of the electricity sector and (b) the 23 GW of additional investments consume primary energy. Under our assumptions we find an increase of **8 B€/y**.

*Remark – The generation capacity could be provided by various portfolios of technologies (including RES + storage, hydro, etc.). The figures presented assume a single dispatchable technology. Other choices would result in different investment and fuel costs.*

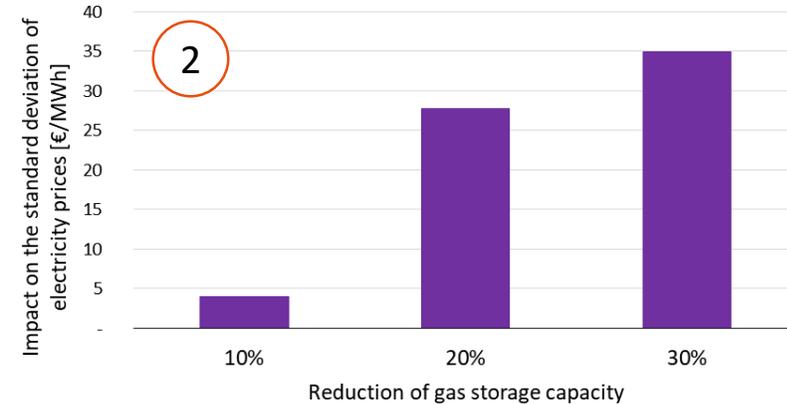
# Gas storage reduces the variability of power prices

The **variability** of electricity prices has been assessed for the different simulations by calculating the standard deviation of the distribution of hourly electricity prices.

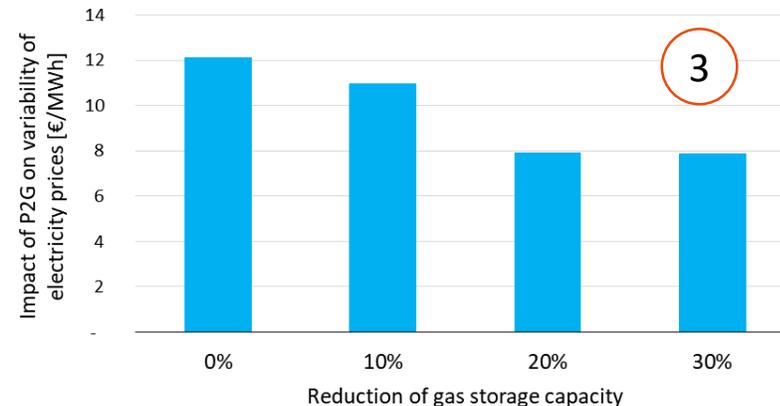


The electricity prices are calculated at the country-level, the example provided here illustrates the impacts on winter electricity prices for a given country. We can clearly see an **increase of electricity prices during the winter** as storage is gradually being removed from the simulations.

*Note: Periods with lower prices can also appear as the system can make immediate use of gas-fired generation instead of storing electricity for later use due to the unavailability of storage capacity.*



The **variability of electricity prices increases as storage is removed**. This figure presents the impacts in terms of electricity prices' standard deviation for a given country.



Finally, we have found that the ability of P2G to reduce the variability of electricity prices is less effective as the gas storage capacity decreases.

*Remark: the impact of P2G on electricity prices has been estimated by replacing the electricity price by the cost of electrolysis during hours where the marginal cost is set either by RES or nuclear.*

# Conclusions and outlook

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The preliminary **conclusions** of the study are:

- Through arbitrage, gas storage assets allow for the **best use of available resources**
- **Electricity demand curtailment** situations begin to appear when the gas storage capacity is reduced by 20%
- Avoiding electricity loss of load situations would require around 20 GW of additional electricity generation capacity in a situation where gas storage capacity is reduced by 30%; **gas storage assets therefore prevent the associated costs from materialising**
- The presence of gas storage assets allow to **decrease the variability of electricity prices**

# Thank you for your attention!

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