REVISITING POLICY CONCERNS IN DECARBONIZED ENERGY SYSTEMS: PRICE VOLATILITY, SEASONAL STORAGE, AND SHOCKS

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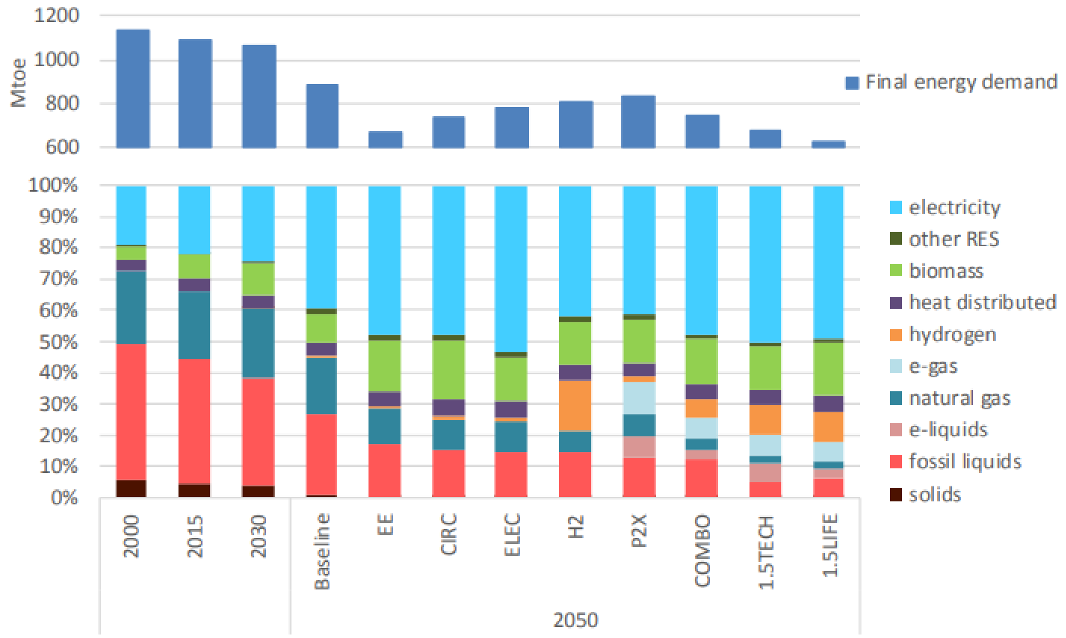
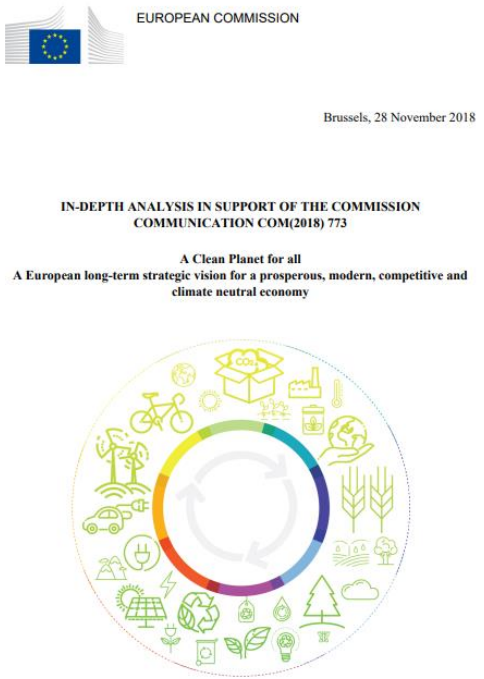
EUROPEAN COMMISSION
CLEAN PLANET FOR ALL IN-DEPTH ANALYSIS

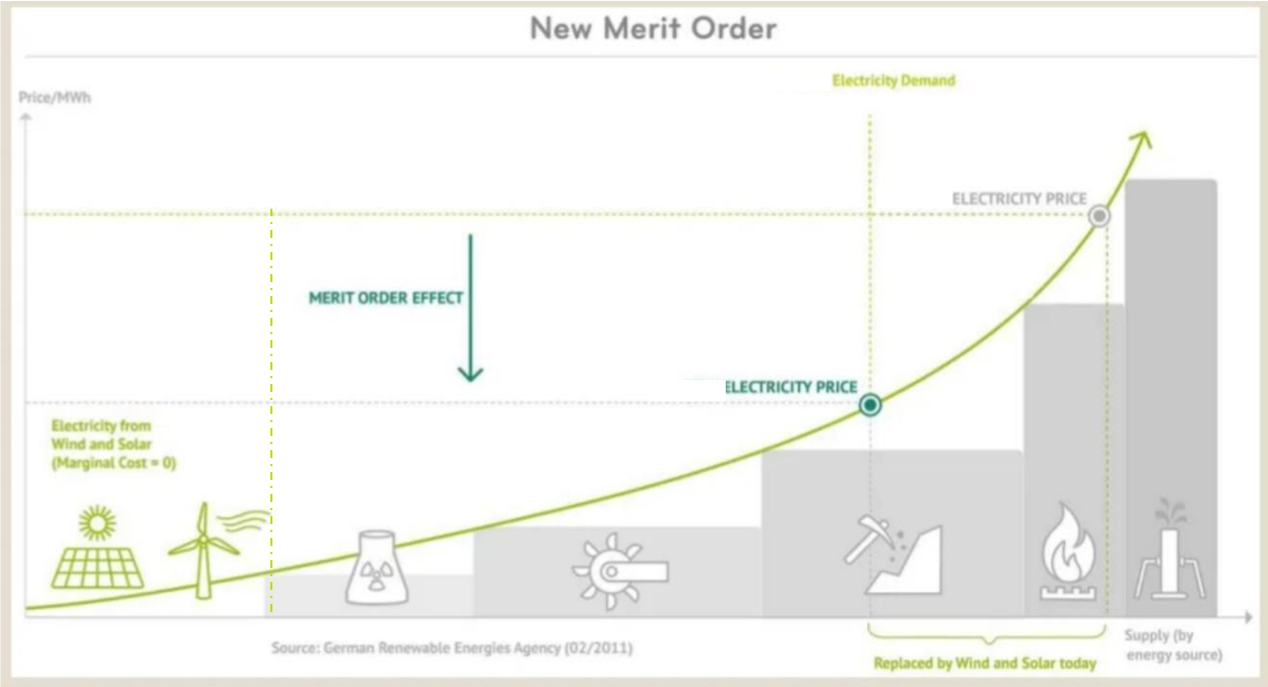
Figure 20: Share of energy carriers in final energy consumption



Source: Eurostat (2000, 2015), PRIMES.



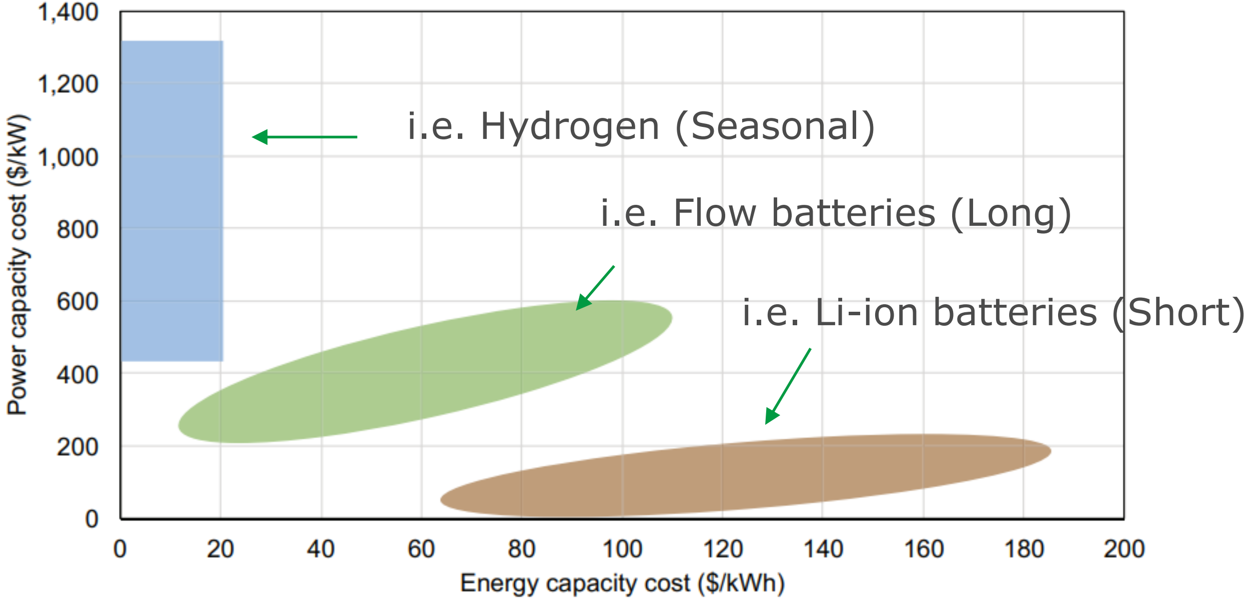
POLICY CONCERN 1: PRICE VOLATILITY

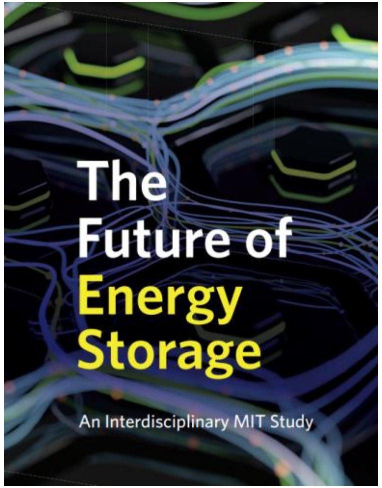


- Battery storage
- Demand side management
- Interconnections
- Curtailment bids
- Sector coupling
- Large energy storage capacities

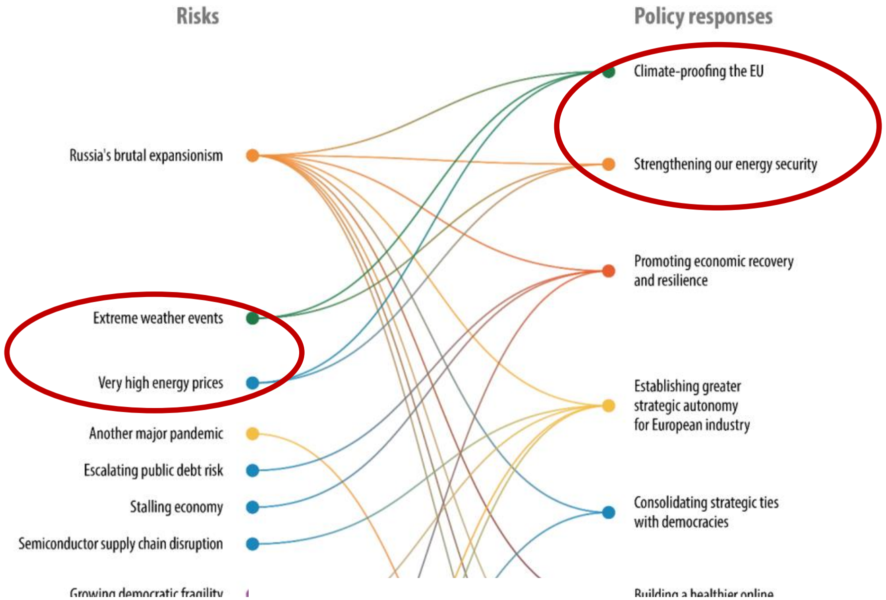
POLICY CONCERN 2: SEASONAL STORAGE

Figure ES.1: Three groups of storage technologies based on power- and energy-capacity costs





POLICY CONCERN 3: SHOCKS



European Parliament

Future Shocks 2022

Addressing risks and building capabilities for Europe in a contested world

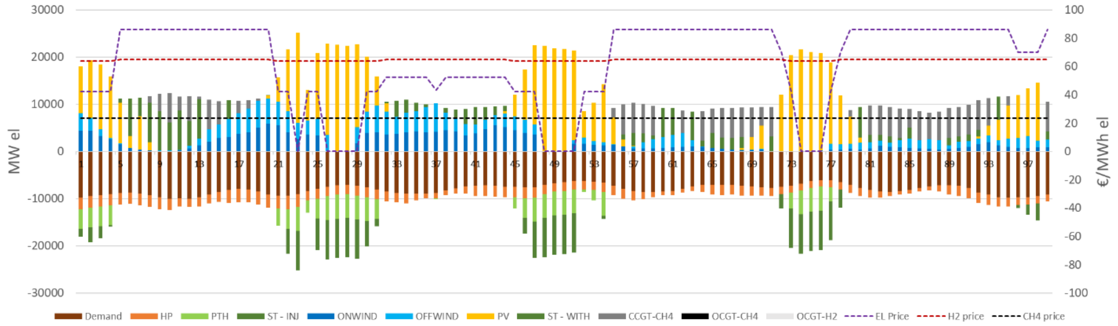
Table 1
Strategies.

Strategy	Description	Geographical scope*
Default	Pure cost-minimization	–
Diversity (generation-based)	Diversified generation mix	National/regional/Europe
Diversity (capacity-based)	Ability of diversified generation mix	National/regional/Europe
Self-sufficiency	Minimum constraint on domestic generation	National/regional
Redundancy	Excess generation capacities	National/regional/Europe
Interconnectivity	Expansion of transmission capacities	(National)
Flexibility	Expansion of storage capacities	National/regional/Europe

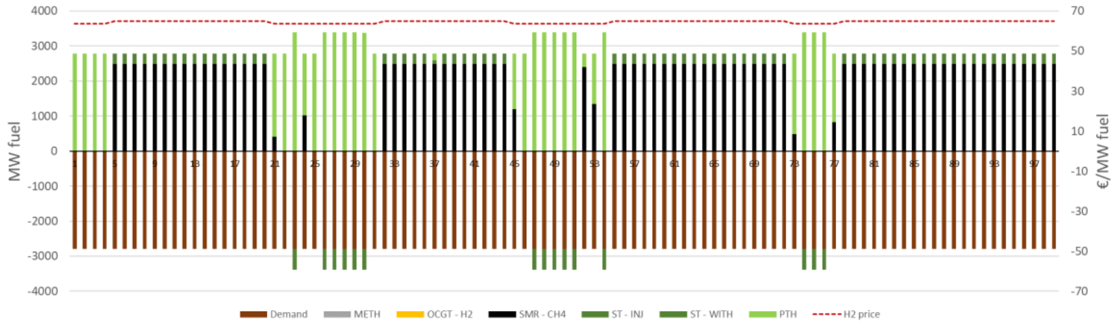
* National — strategy valid for each country separately; regional — strategy valid for each regional group of countries separately; and Europe — European-wide strategy.

Nahmmacher, P., Schmid, E., Pahle, M., Knopf, B., 2016. Strategies against shocks in power systems – An analysis for the case of Europe. Energy Economics 59, 455–465. https://doi.org/10.1016/j.eneco.2016.09.002

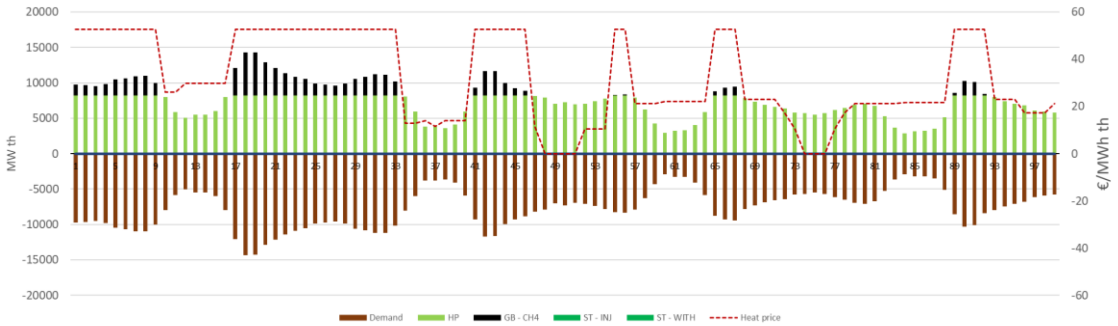
Electricity



Hydrogen

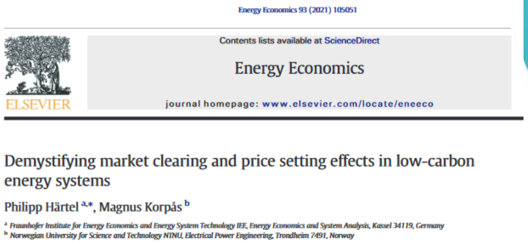


Heat



WILL PRICE VOLATILITY IN DECARBONIZED ENERGY SYSTEMS BE GREATER THAN TODAY DUE TO VARIABLE RENEWABLE ENERGY (VRE)?

- "…there will likely not be too many zero or even negative price situations due to excess renewable production in the system since the additional cross sectoral consumers will, depending on their actual flexibility potential, use it to supply final heat, industry, and transport demands" **(Härtel and Korpås, 2021).**


Energy Economics 93 (2021) 105051

Contents lists available at ScienceDirect

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ELSEVIER

Demystifying market clearing and price setting effects in low-carbon energy systems

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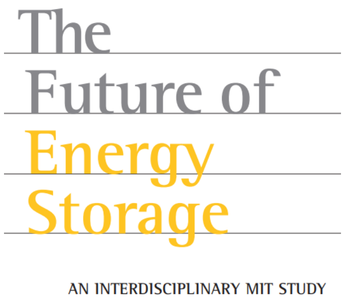
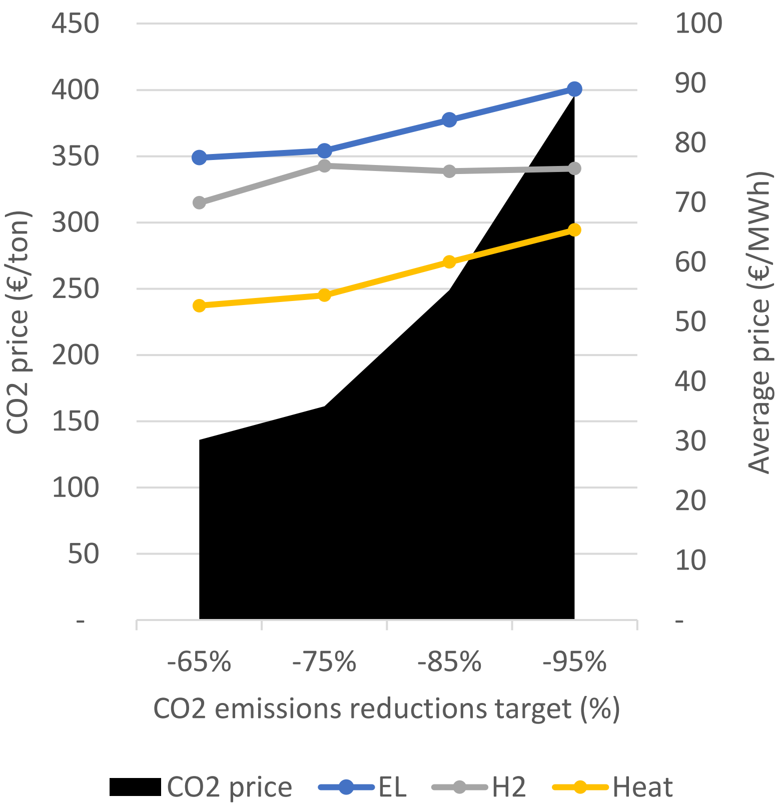
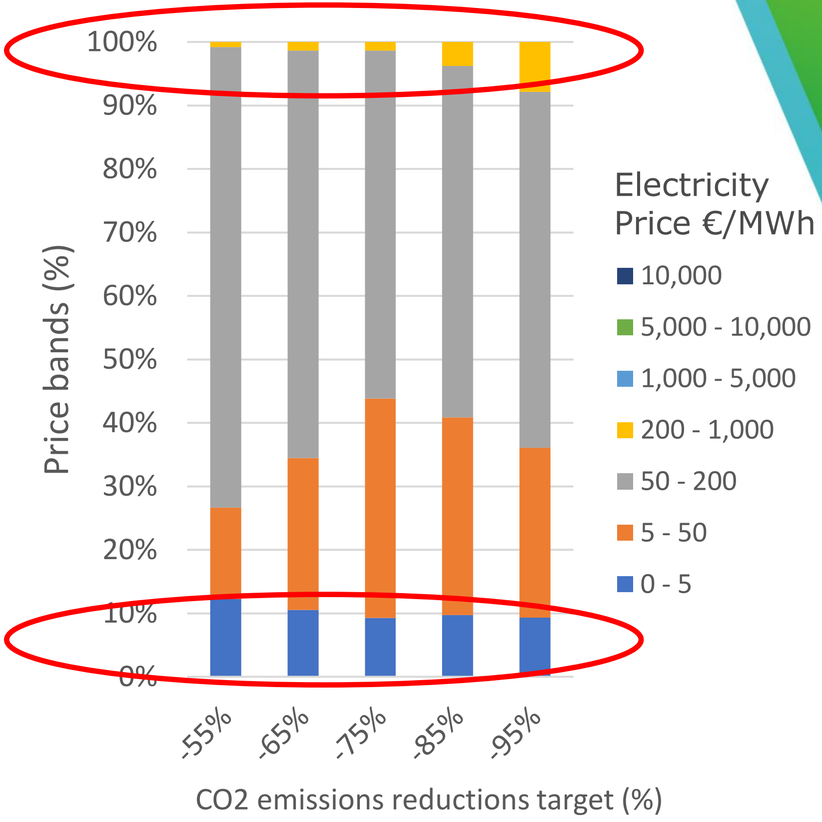
- "We find that increasing VRE penetration leads to many hours of very low prices interspersed with a few periods when prices are very high (approaching the value of lost load…) owing to scarcity events" **(MIT Energy Initiative, 2022).**



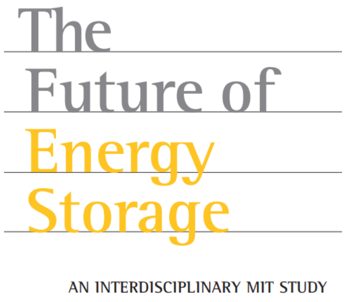
LONG-TERM EQUILIBRIUM WITH PERFECT FORESIGHT
ENERGY PRICES



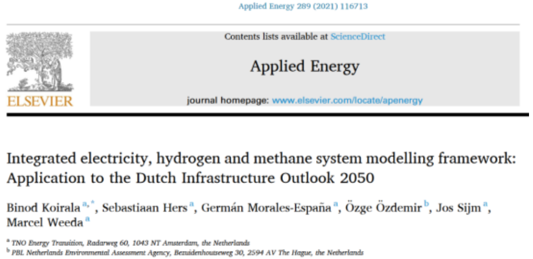


EVEN IF BATTERY STORAGE IS CHEAP, WILL WE STILL NEED OTHER TYPES OF ENERGY STORAGE TO MEET CLIMATE-NEUTRALITY OBJECTIVES?

- "Among Long Duration Energy Storage technology options, we find that hydrogen (and other forms of derived chemical energy storage) offers a unique value proposition if it is produced with electricity and used as a fuel to decarbonize other end uses, thereby creating a large flexible load that supports VRE integration in the power sector" **(MIT Energy Initiative, 2022).**



- "Flexibility from electric batteries balances daily variation of solar and wind whereas methane and hydrogen storage mostly balances seasonal variation of demand and supply" **(Koirala et al., 2021).**


Applied Energy 289 (2021) 116713

Contents lists available at ScienceDirect

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ELSEVIER

Integrated electricity, hydrogen and methane system modelling framework: Application to the Dutch Infrastructure Outlook 2050

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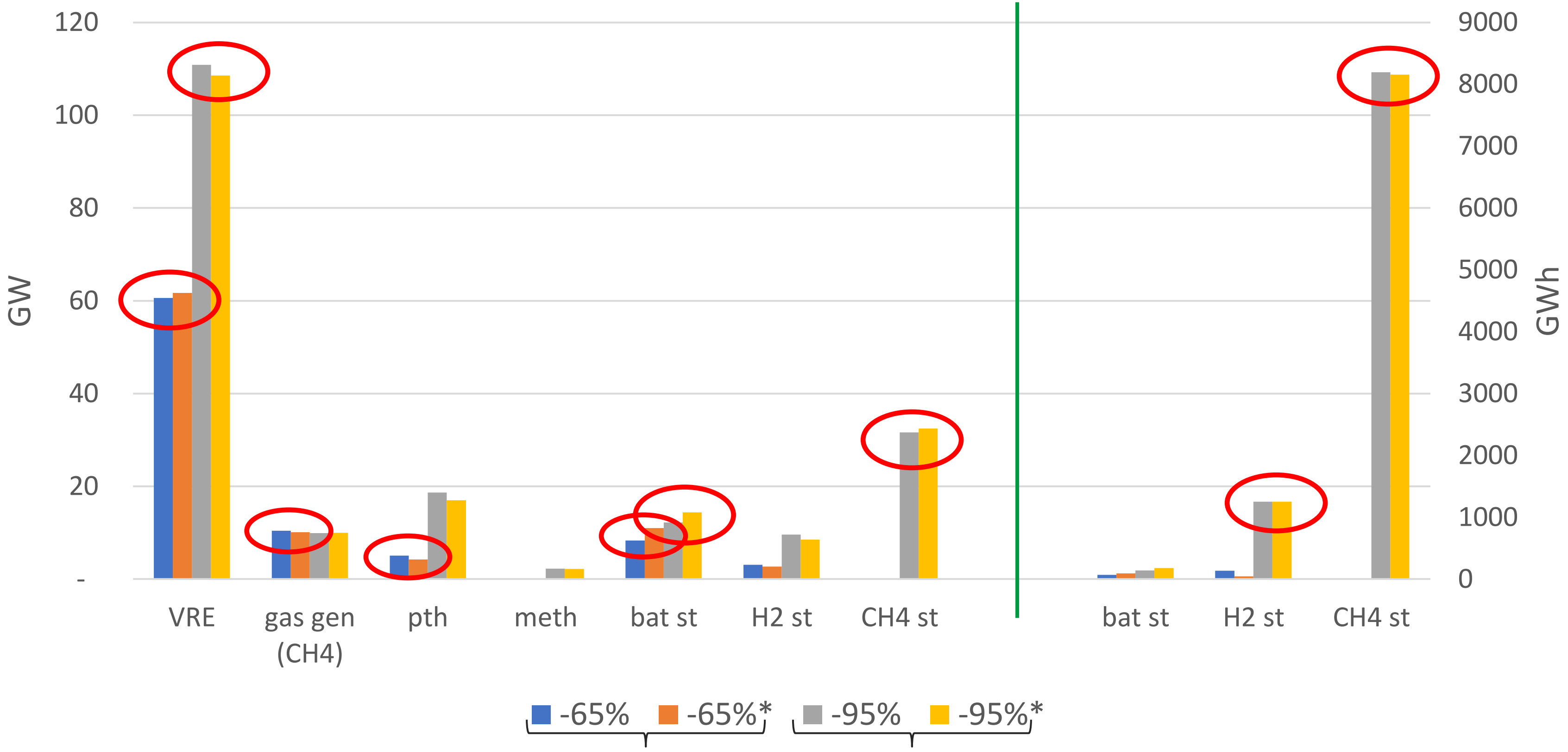
LONG-TERM EQUILIBRIUM WITH PERFECT FORESIGHT

ROLE OF (SEASONAL) ENERGY STORAGE



*** sensitivity: -25% battery capacity costs**

IF WE DO NOT HAVE PERFECT FORESIGHT, WHICH SITUATION IS PREFERRED TO DEAL WITH SHOCKS: UNDERPREPARED OR OVERPREPARED?

- "Will current electricity market designs give the right incentives for storage? The "European" paradigm of an energy-only market relies on the prospect of high peak prices … "precautionary" storage can be seen as arbitrage against the occasional risk of extreme prices when load might be lost" **(Geske and Green, 2020).**

- "for the example of Germany, storage requirements are defined by a 12-week or longer period of intermittent scarcity, and system planning based on average years significantly underestimates storage requirements" **(Ruhnau and Qvist, 2021).**

Optimal Storage, Investment and Management under Uncertainty: It is Costly to Avoid Outages!

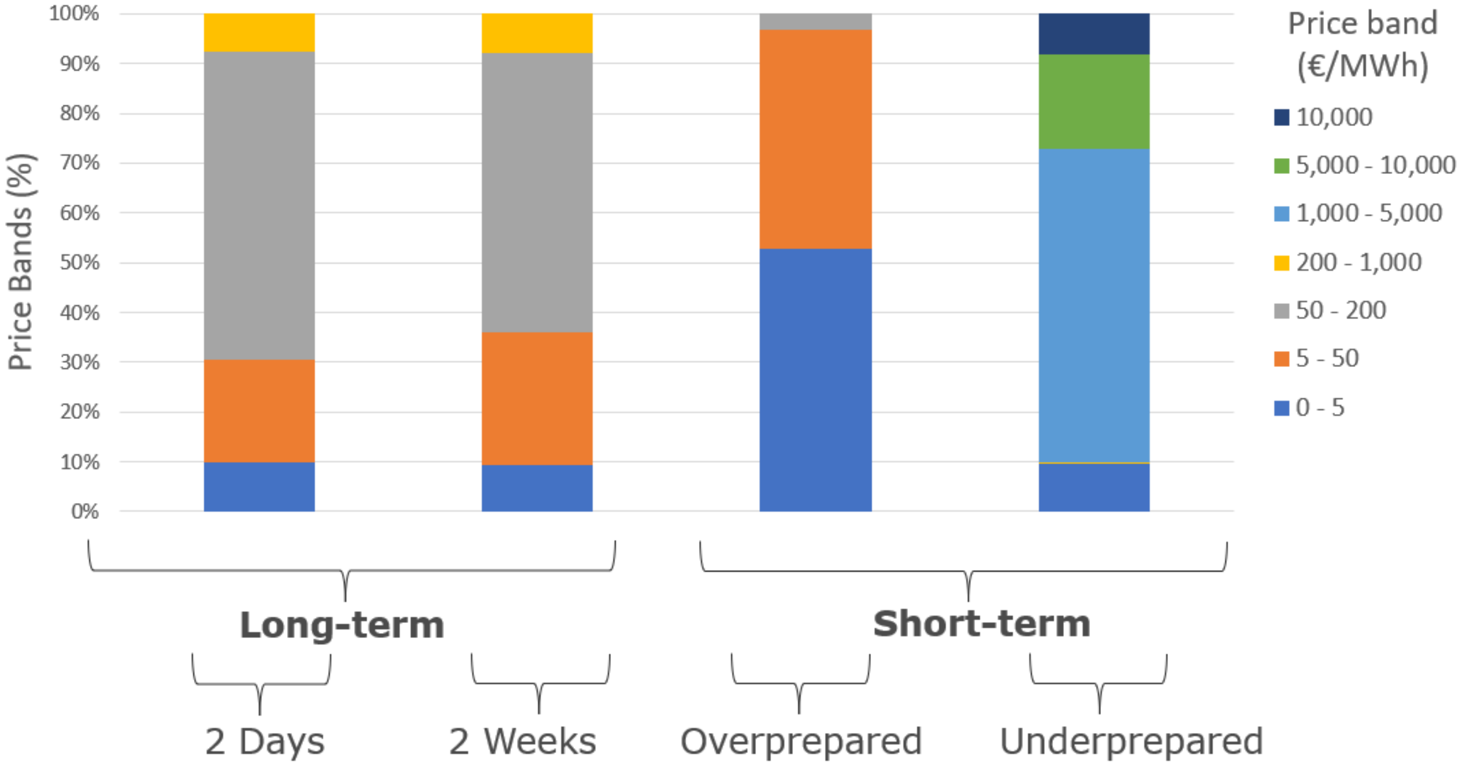
*Joachim Geske[a] and Richard Green[a]**

Ruhnau, Oliver; Qvist, Staffan

Working Paper

Storage requirements in a 100% renewable electricity system: Extreme events and inter-annual variability

SHORT-TERM EQUILIBRIUM WITH IMPERFECT FORESIGHT
-95% CO2 TARGET SCENARIO



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