Improving the Value of Energy Storage in Electricity Systems

Improving the Value of Energy Storage in Electricity Systems

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Self-introduction

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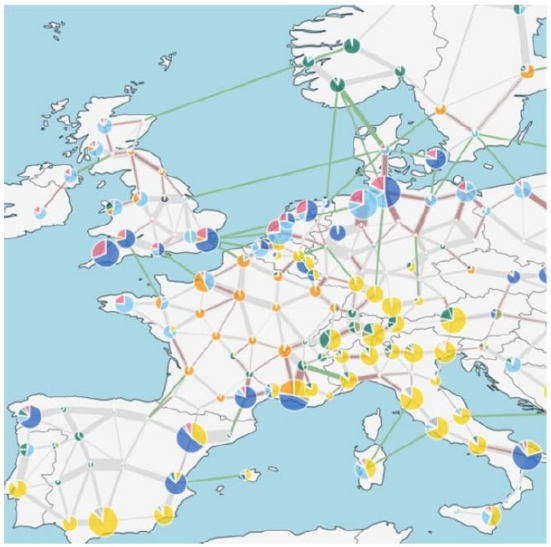
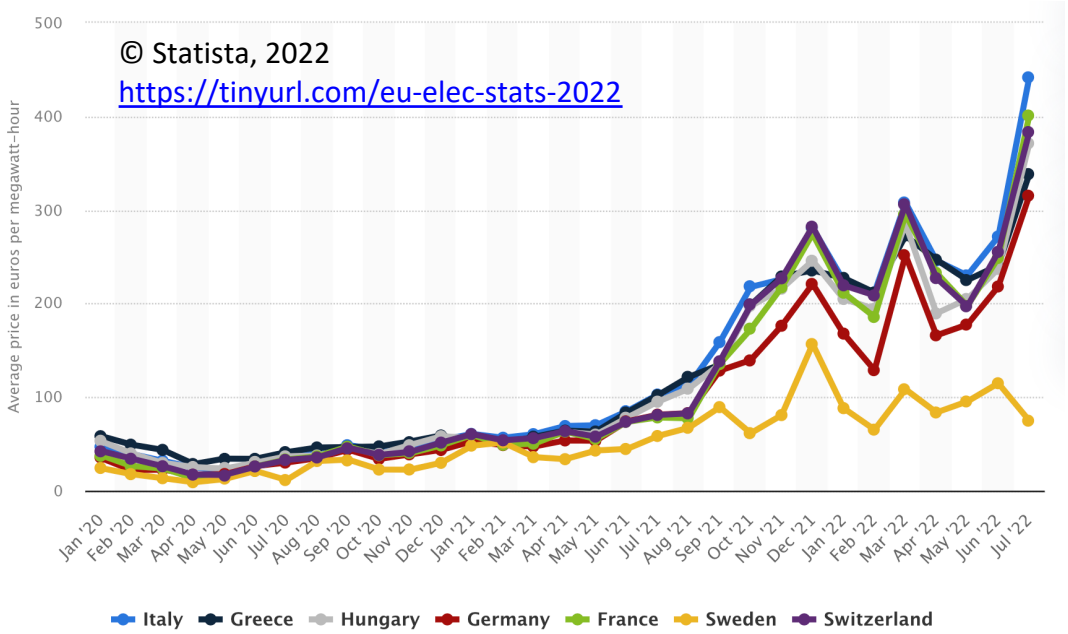
Overview of this Talk

- Energy balancing and the role of energy storage
- Energy storage valuation methods
- The Market Potential Valuation Method
- Performance & comparison

Energy System Model





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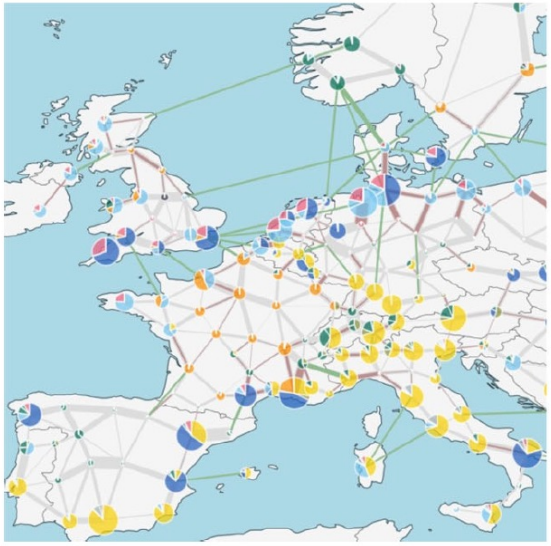

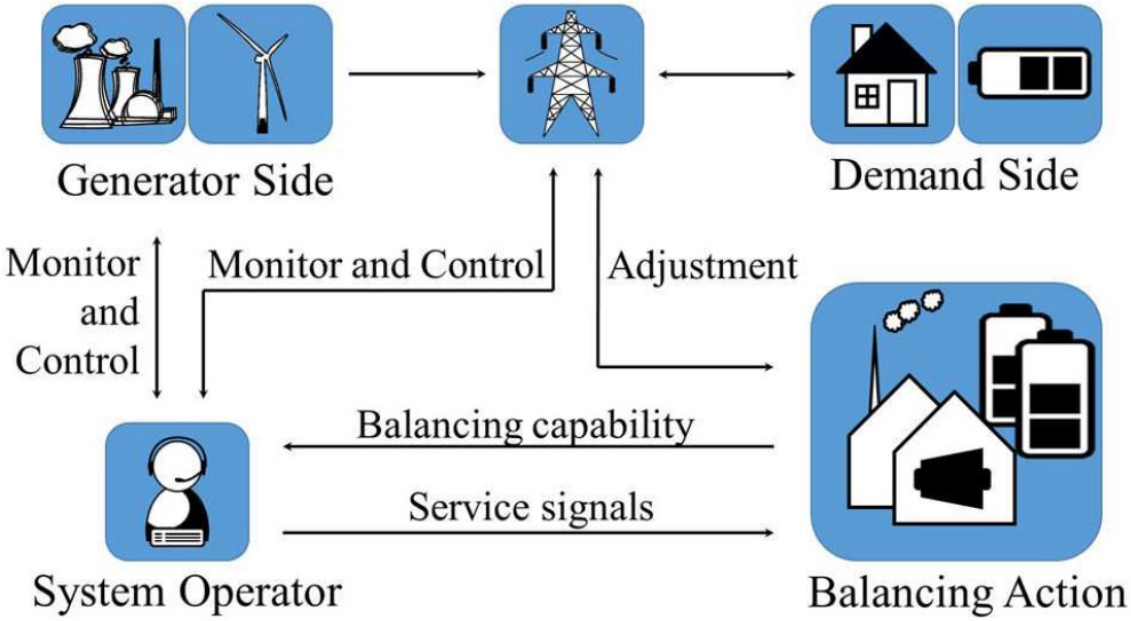

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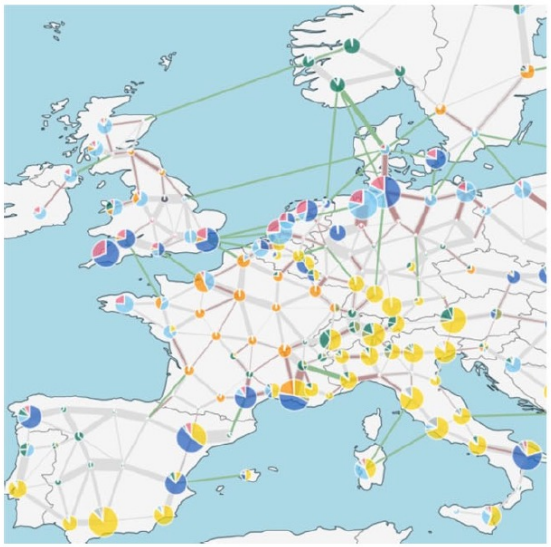
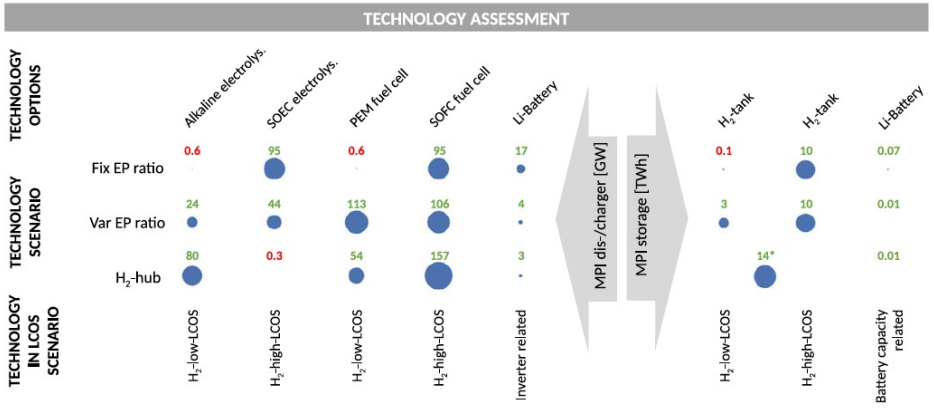
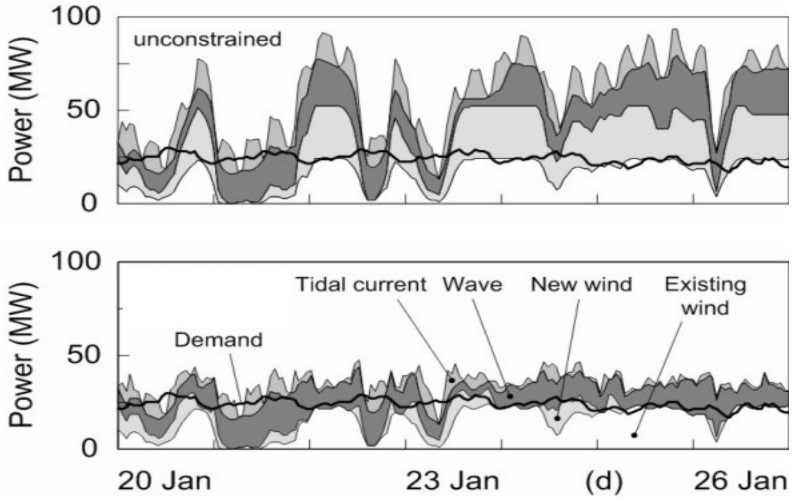


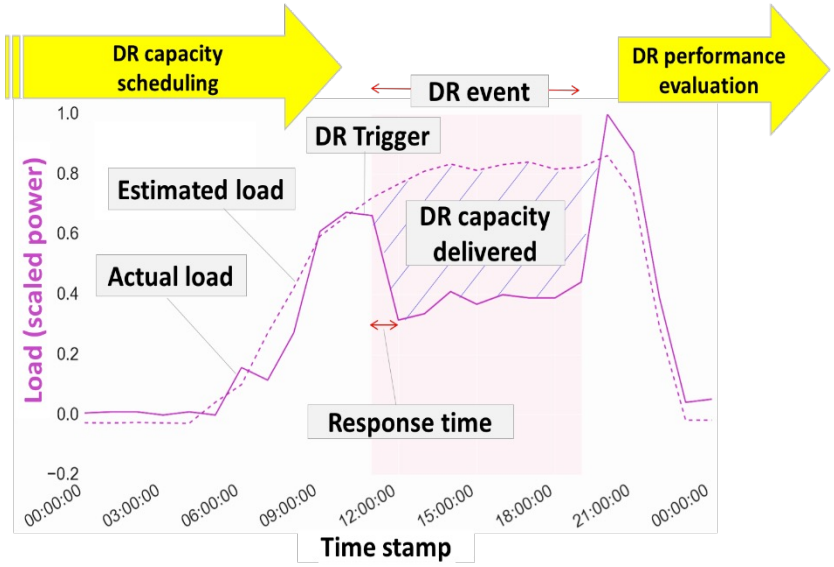
New value assessment method
"Market Potential Method"
to guide energy storage innovation

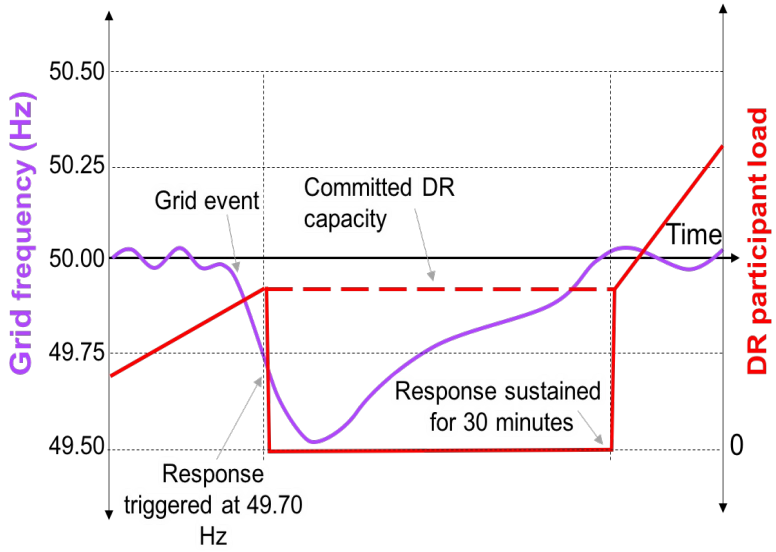


Energy Balancing: Demand Response

- How do we maximise low-carbon energy integration?
- Demand response can alleviate the impact of load/supply imbalance
- …but it is an invasive method!







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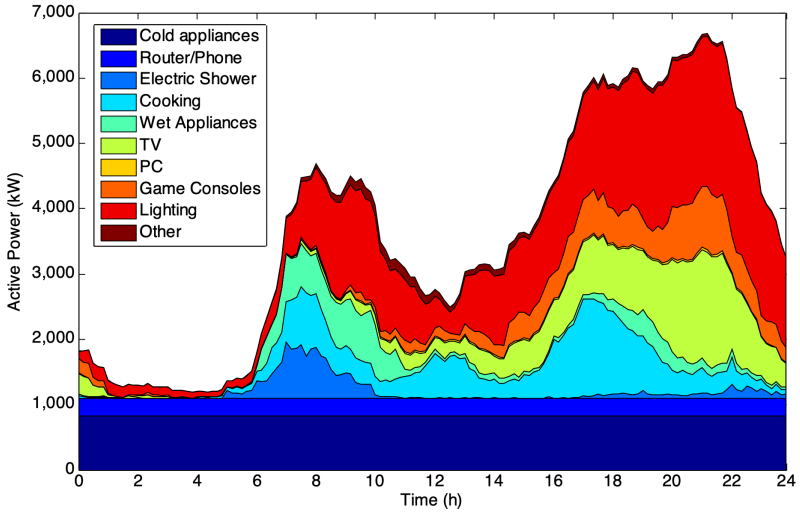
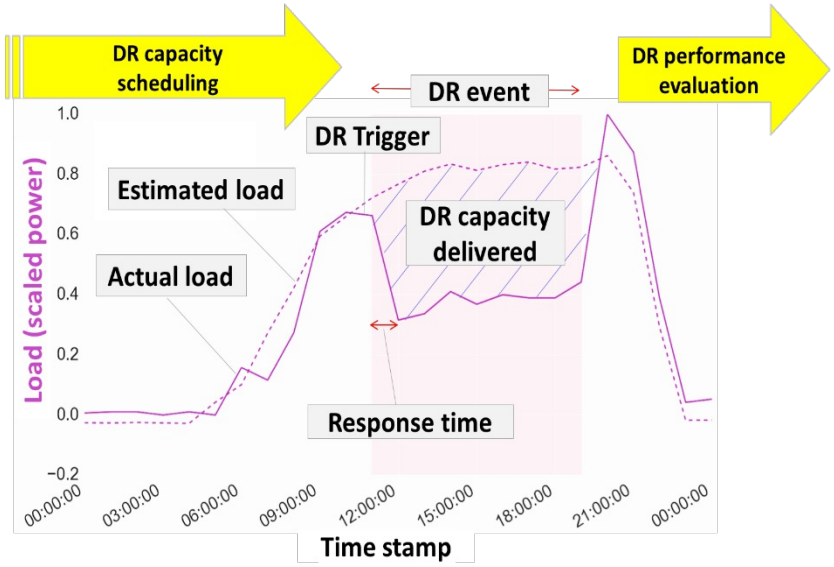
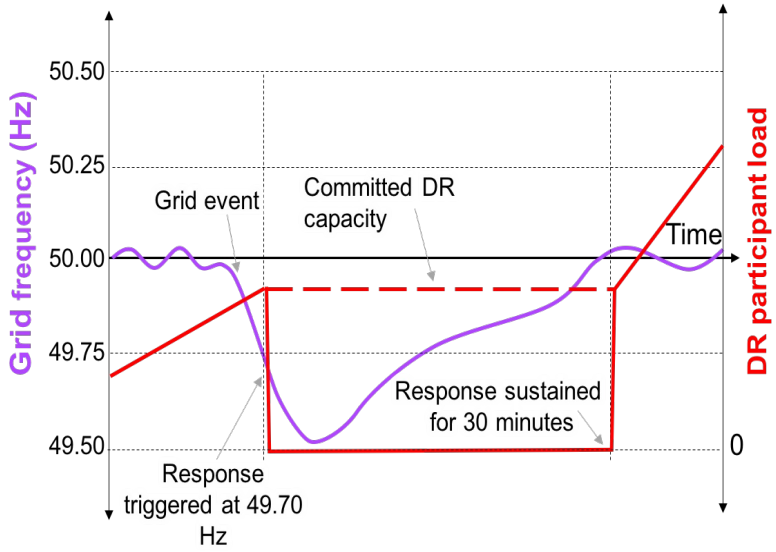
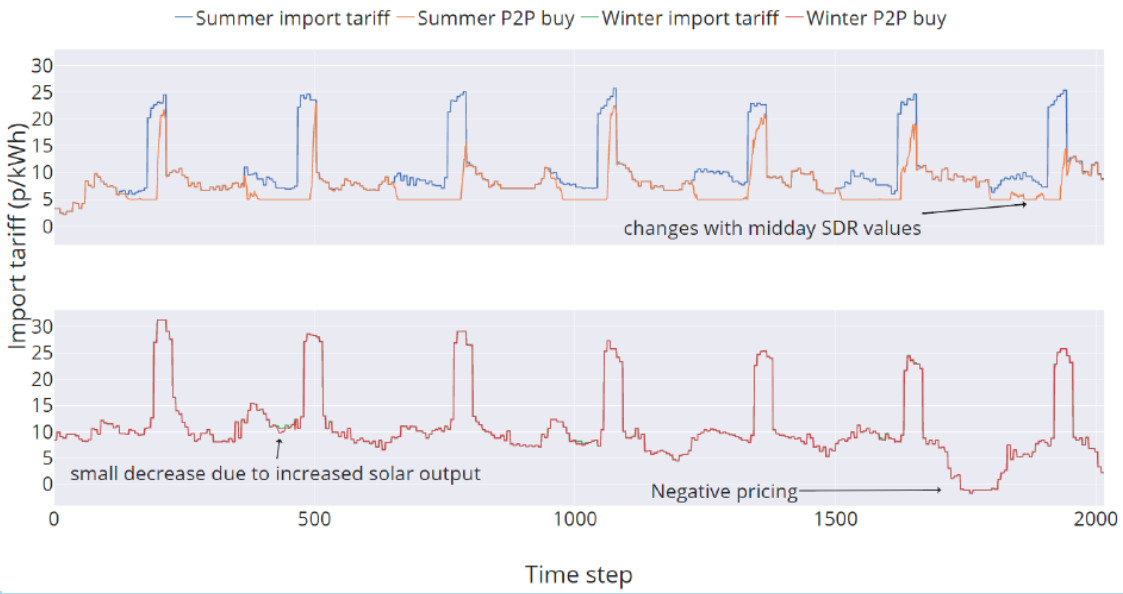


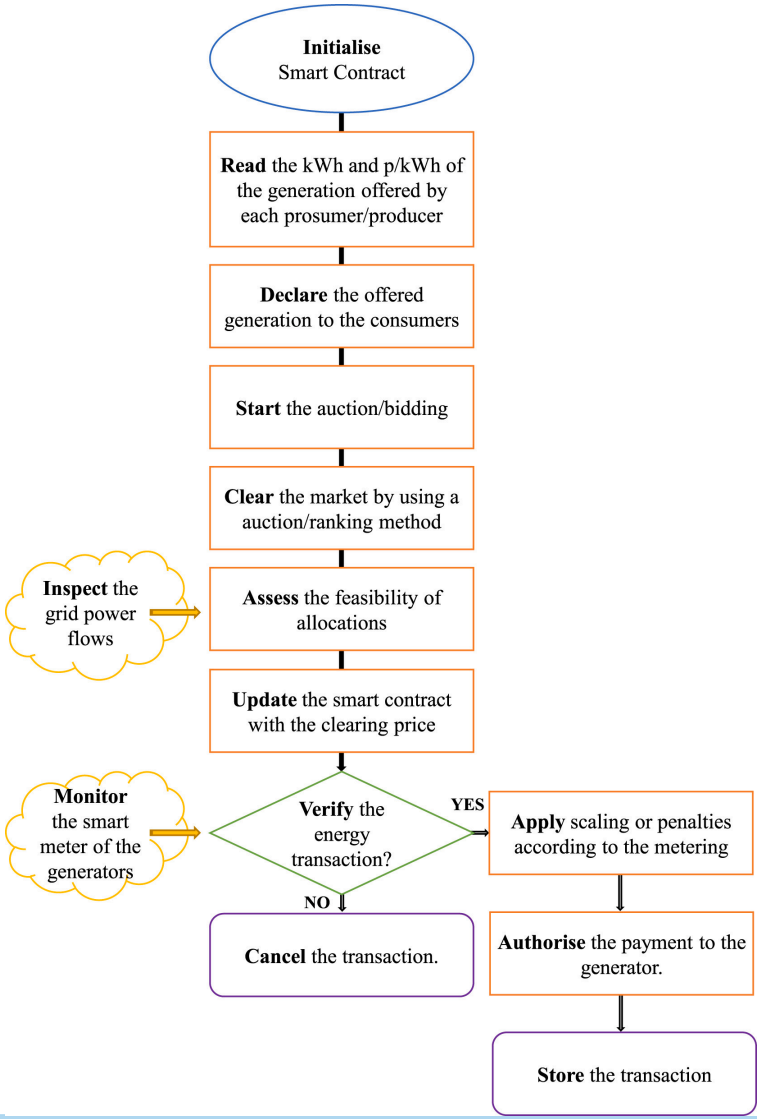




Energy Balancing: Smart Contracts & P2P trading

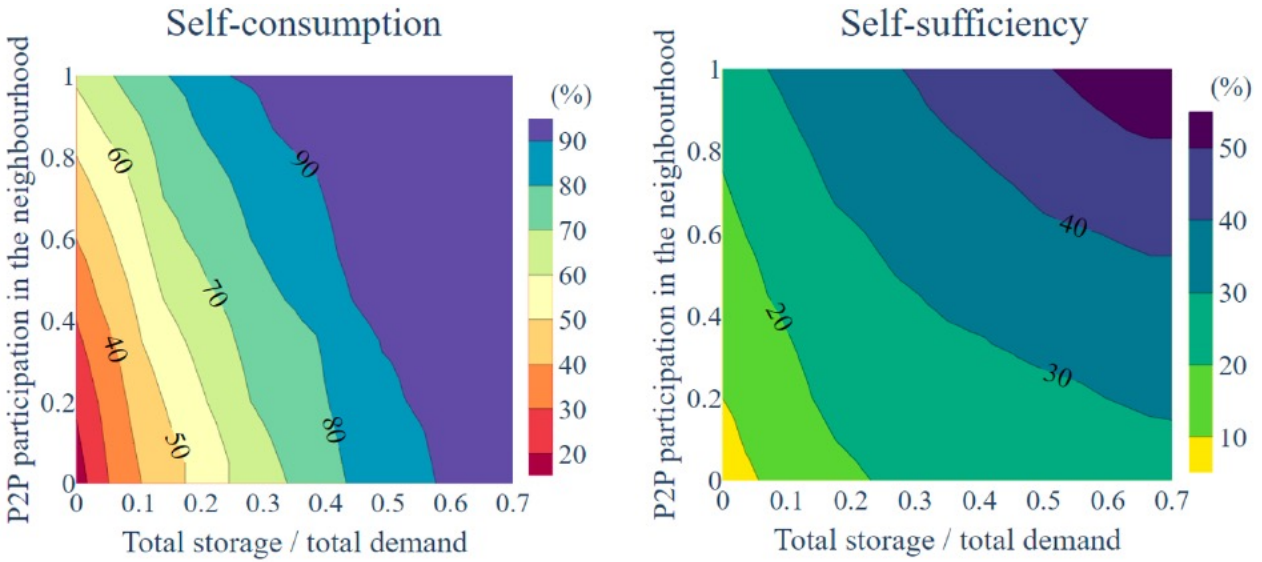
- How do we maximise low-carbon energy integration?
- Smart energy contracts & P2P trading can be tools for 'real-time' matching of supply & demand
- …but they require high level of user participation



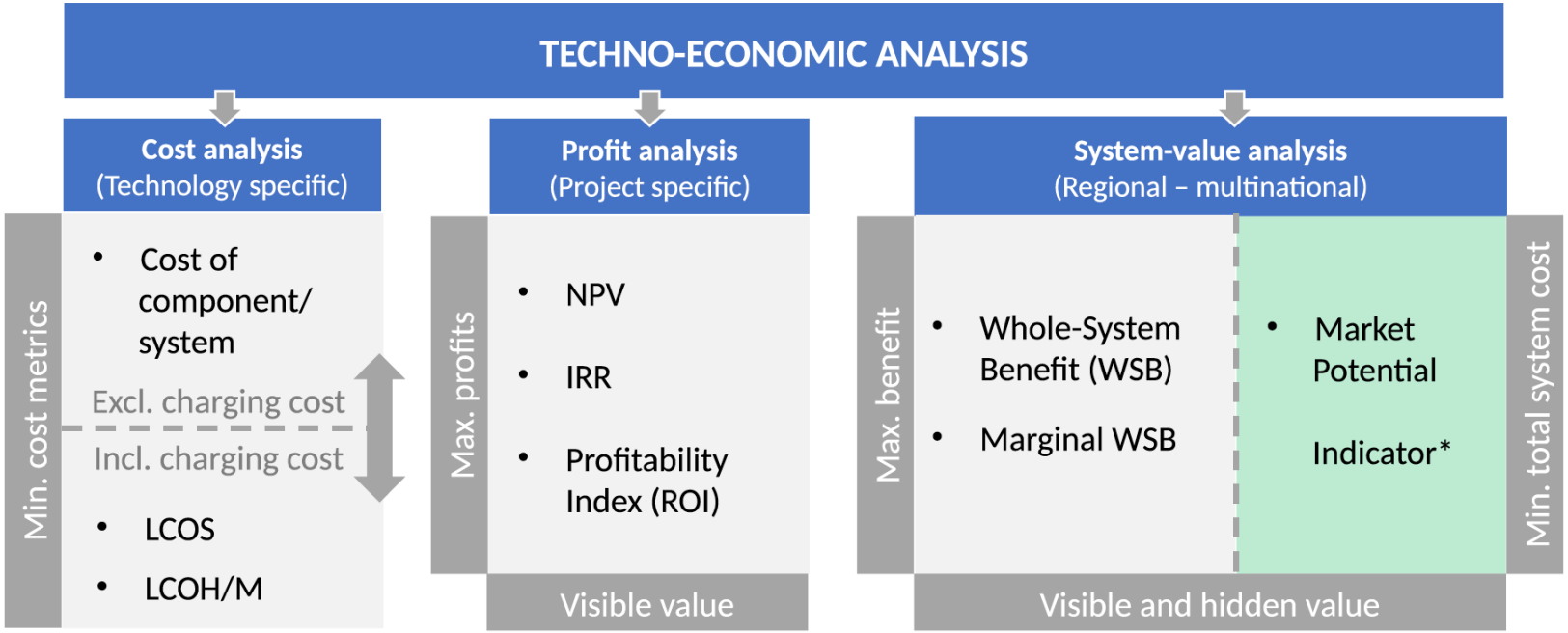


The Role of Energy Storage

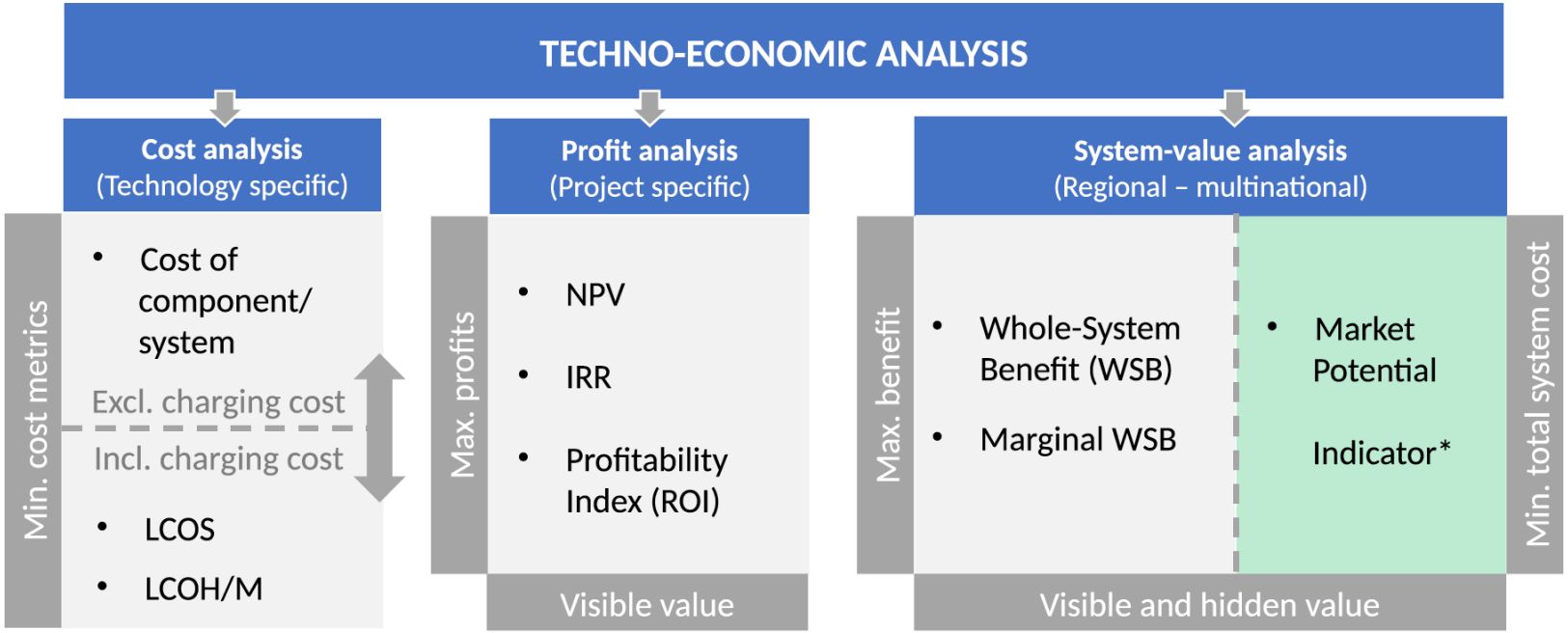
- Energy storage will defer need for network & generation expansion
- Can be combined with other flexibility mechanisms and will drastically improve their performance
- Used at all scales & energy system levels
- Comes at a cost!



Energy Storage Valuation: Methods

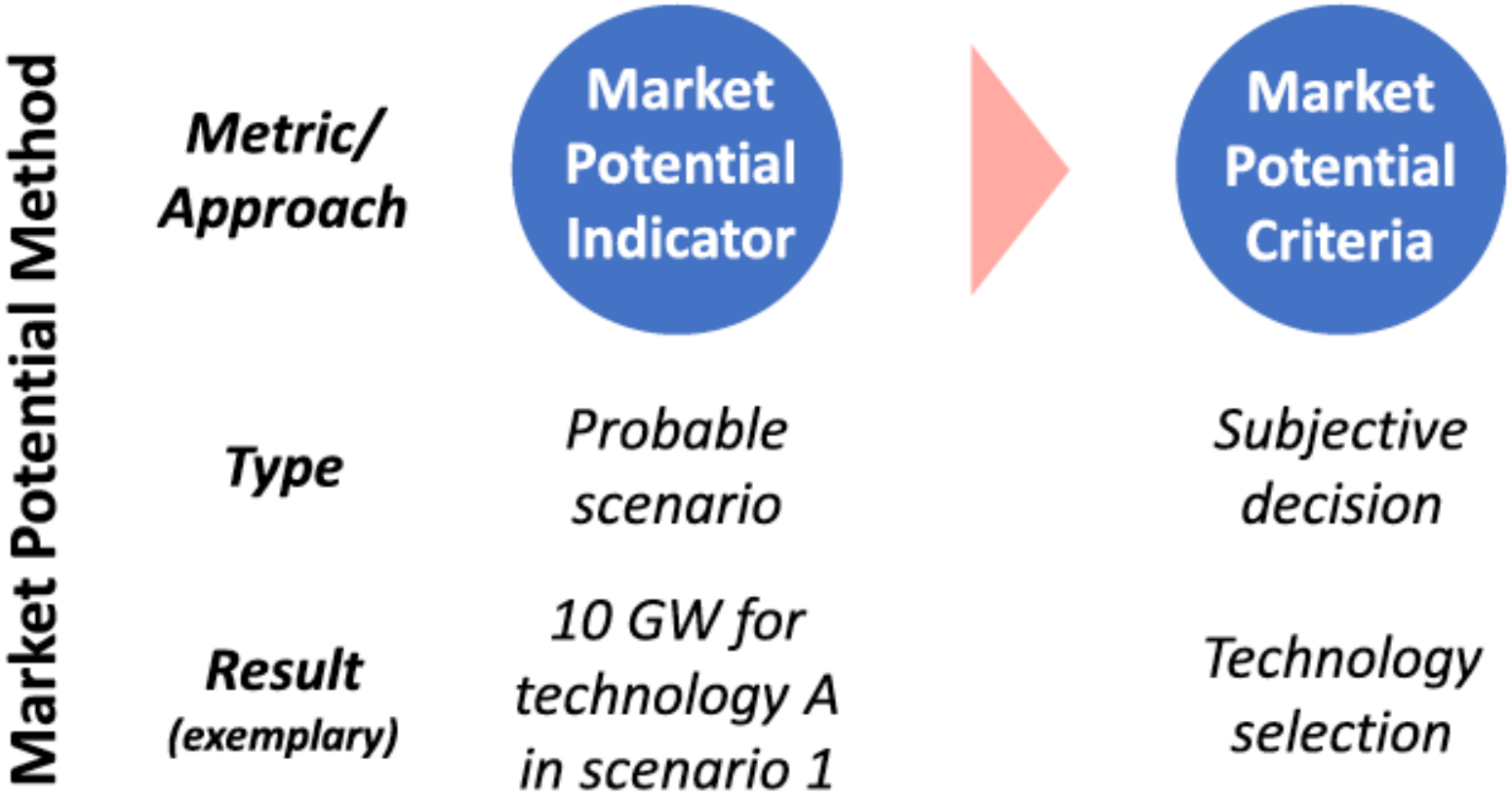


Energy Storage Valuation: Challenges



- Markets not temporally or spatially resolved
- Market power can be exploited
- Forecast information is imperfect
- Further negative and positive externalities exist

Market Potential Method



https://doi.org/10.1007/s43979-022-00027-3

Market Potential Method

- MPI=0 indicates no value for the selected scenario
- MPI>0 indicates likelihood for value
- Thresholds can be set (MPI>X) to account for uncertainty
- $MPI_A > MPI_B$ indicates scenario A more valuable than scenario B

Scenario	Tech. 1	Tech. 2	Tech. 3	Tech. 4
A	+++	++	+++	0
B	+++	++	0	0
C	+++	++	+	0

Certainty about positive value increases

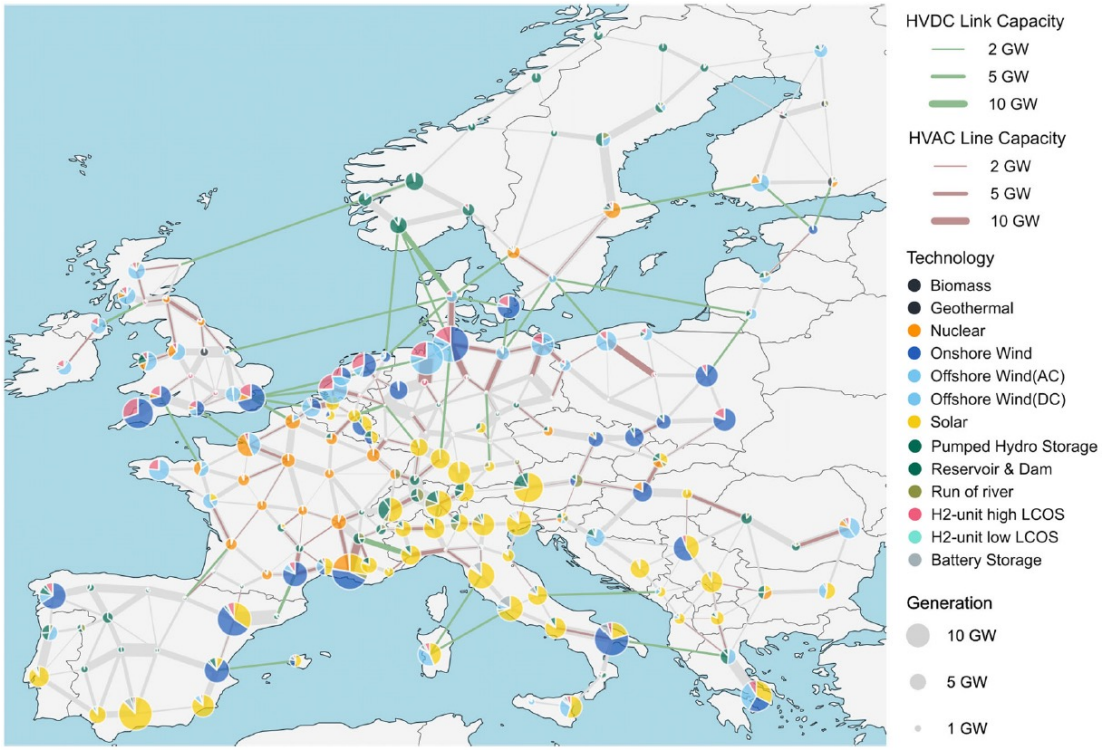
Likely to be valuable

Likely to be **not** valuable

'+' MPI magnitude

Case Study: Zero Carbon Europe by 2030

- Model of the ENSTOE-E area
- Transmission grid
- Database of power plants
- Time series of demand and RES generator availability



Energy related inputs

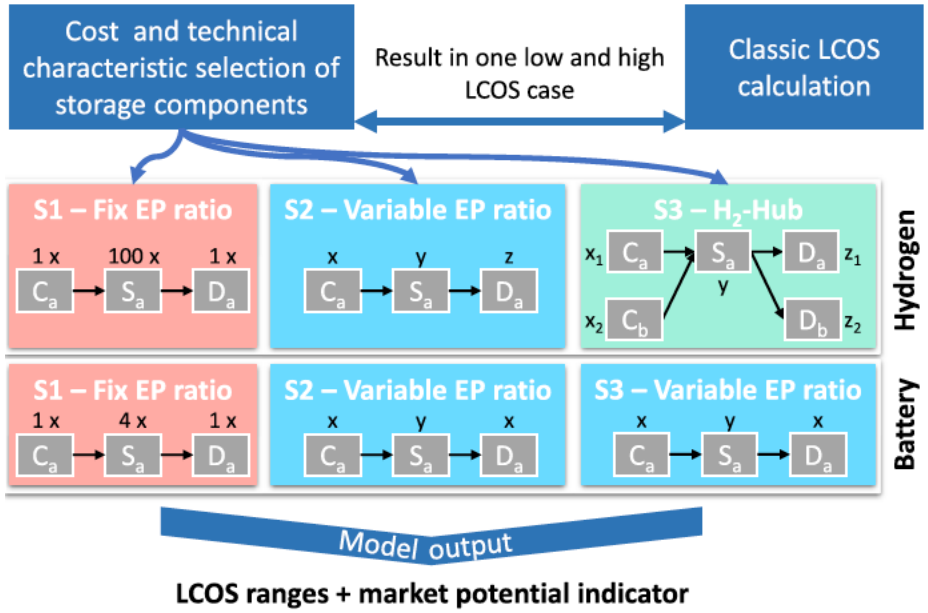
Energy storage components	H_2 storage		Battery storage
LCOS Scenario	[High]	[Low]	[-]
Investment [*EUR/kWh$_{el}$*]	8.4	8.4	188[b]
FOM[a] [%/*year*]	-	-	-
Lifetime [*a*]	20	20	10
Efficiency [%]	-	-	-

Power related inputs

Energy storage components	Electrolysor		Fuel cell		Battery Inverter
LCOS Scenario	[Low]	[High]	[Low]	[High]	[-]
Investment [*EUR/kW$_{el}$*]	339	677	339	423[b]	209[c]
FOM[a] [%/*year*]	2	3	2	3	3
Lifetime [*a*]	25	15	20	20	10
Efficiency [%]	68	79	47	58	90
Discount Rate [%]	7	7	7	7	7

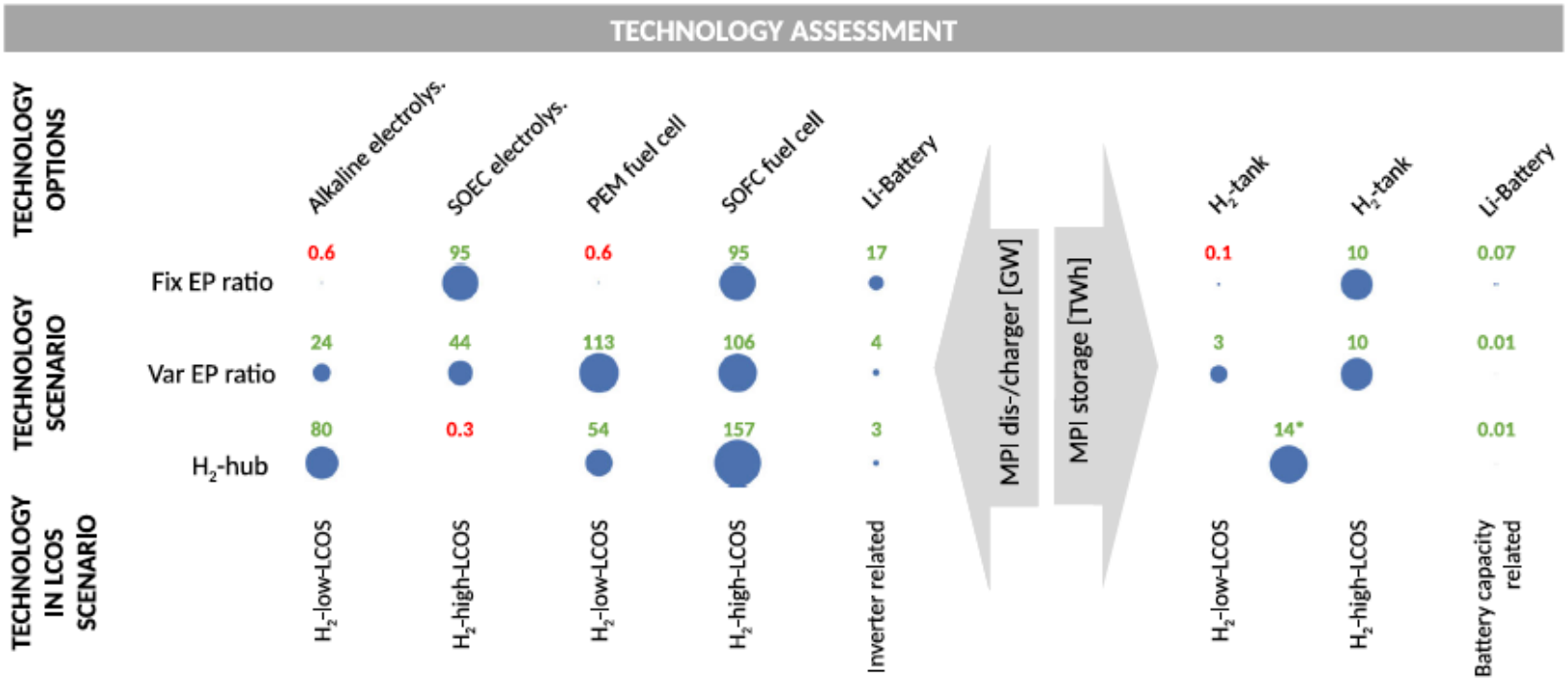
Considered Energy Storage Scenarios

- S1: Fixed energy/power ratio
- S2: Variable energy/power ratio
- S3: Variable EP, mixed technologies
- Hydrogen and battery storage considered in all scenarios



Optimisation Results

- Market Potential Indicator (MPI)



Conclusions

- Current cost metrics can be deceiving for technology design decisions
- The Market Potential Method extends current system-value approaches
- MPM systematically evaluates deployment estimations from energy models by looking at a set of probable scenarios in high spatial-temporal resolution over large regions
- This new approach could be more useful and overcomes many limitations
- Modifying the freedom of storage sizing and component interactions can lead to significant energy system benefits
- MPM enables a holistic approach in energy storage design & assessment from early stages in the design process

Further Reading

- Parzen, M., Neumann, F., Van Der Weijde, A.H., Friedrich, D., and Kiprakis, A., 'Beyond cost reduction: improving the value of energy storage in electricity systems', Carbon Neutrality 1, 26 (2022). https://doi.org/10.1007/s43979-022-00027-3
- Kirli, D. and Kiprakis, A., 'Techno-economic potential of battery energy storage systems in frequency response and balancing mechanism actions', J. Eng., 2020: 774-782. https://doi.org/10.1049/joe.2019.1053
- Kirli, D., 'Impact of Peer-to-Peer Trading and Flexibility on Local Energy Systems', PhD Thesis, (in press), University of Edinburgh, 2022.

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