PROFITABILITY OF BATTERY STORAGE

Techno-economic simulation of profit-maximising application for the example of Austria

Get Enspired

18-19 September 2023

T. Esterl, K. Maggauer, P. Ortmann, T. Forster (AIT)

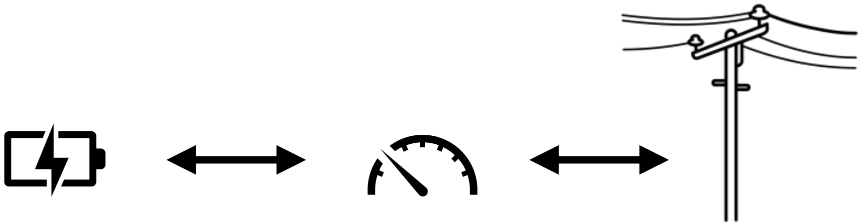
Study commissioned by

ASSESSMENT OF FOUR DIMENSIONS

Market & Use Case	**DA** Arbitrage against day-ahead price	**ID1** Arbitrage against ID full price (approximation of ID market)	**ID2** Arbitrage against maximum observable spread in every ID delivery interval	**FCR** Steadying the frequency on market for primary control reserve
Development PV & Wind	**Stand-alone** No co-production	**Coupled to generation (constant)** Currently installed wind & PV capacity	**Coupled to generation (increasing)** Future installed wind & PV capacity	
Grid Tariffs	**‚Unsupportive‘ for Storages** Austria	**‚Supportive‘ for Storages** Germany		
Price Development	**Historic** Price development for Austria (2022)	**Future** Price forecast for Austria (2023-40)		

STAND-ALONE

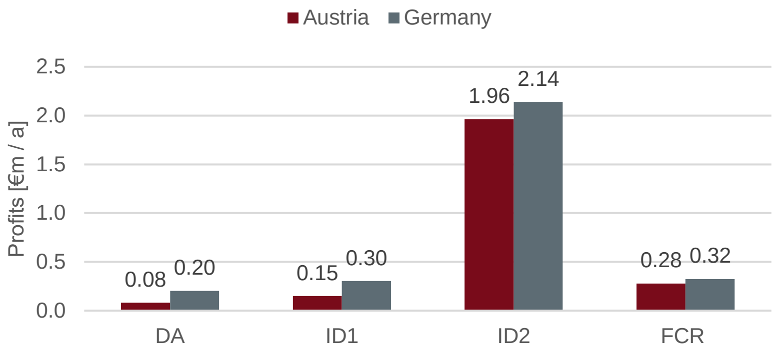
- Historical year 2022
- No coupling with generation
- Charging of storage via grid



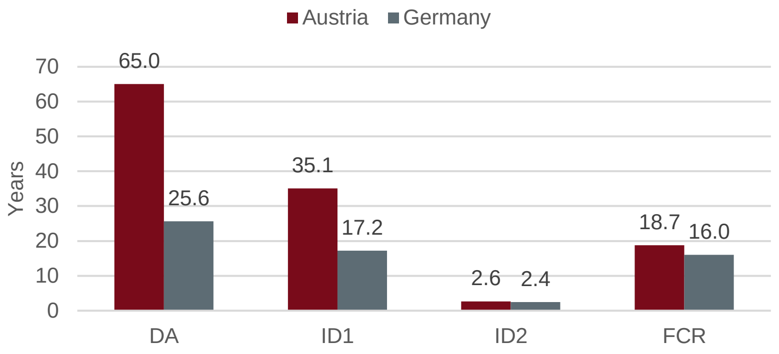
ANNUAL PROFITS & STATISTICAL AMORTISATION STAND-ALONE (2022)

AUSTRIAN INSTITUTE OF TECHNOLOGY

ANNUAL SURPLUS



STATISTICAL PAYBACK PERIOD



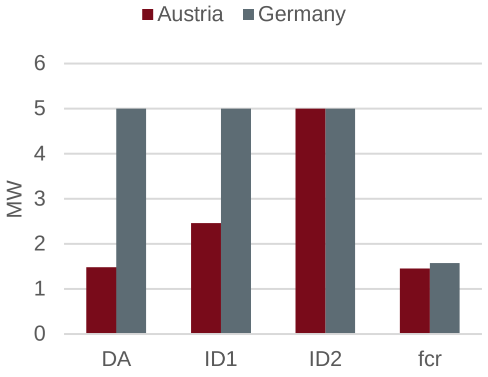
- Profits in all Austrian use cases trail behind profits in Germany, due to higher grid tariffs. This directly affects costs, as well as profits, since grid tariffs are taken into account for in the optimisation.
- ID market represents a more profitable earning possibility than DA market
- FCR lies in the same range as ID1

Chosen power/capacity: 5MW / 2h

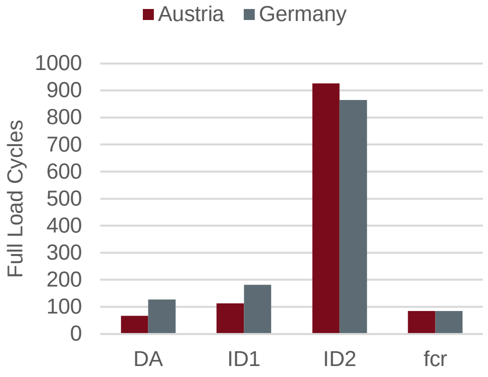
Neglected in Statistic Payback Period: Interest, OPEX, CAPEX inverter, over-dimensioning of storage, as useful capacity is 80%

DEMAND, CYCLES & LIFE SPAN STAND-ALONE (2022)

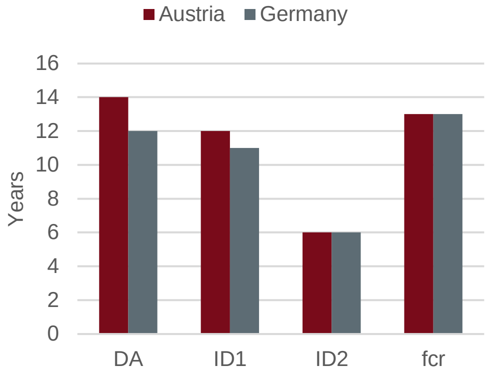
PEAK POWER (DEMAND, 15-MIN)



FULL-LOAD CYCLES



LIFE SPAN

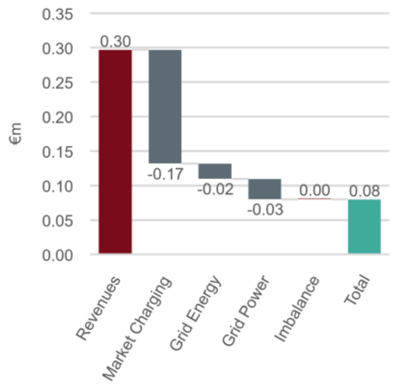


- Power demand is clearly reflected in the costs, and is taken into account in the optimisation. For this reason, only 2-5MW of a total of 10MW are consumed in Austria[1]
- Germany shows a larger demand for DA, whereas maximum power is demanded in the case of ID.
- Life span is calculated through a combination of calendric and cyclic ageing. High cycle counts reduce the life span in the ID2 case from 10-12 to 6 years.

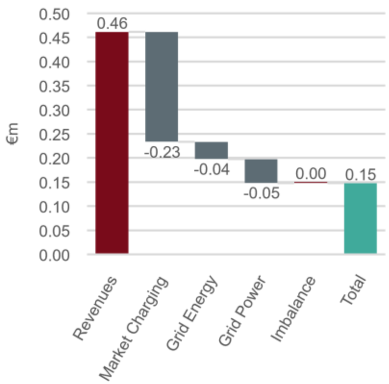
Chosen power/capacity: 5MW / 2h; Peak power demand is depicted as 15 minute average.

COMPOSITION OF COSTS/REVENUES AUSTRIA, STAND-ALONE (2022)

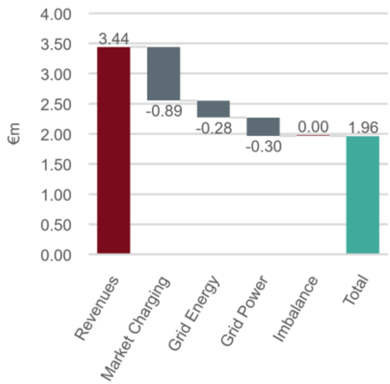
DAY-AHEAD



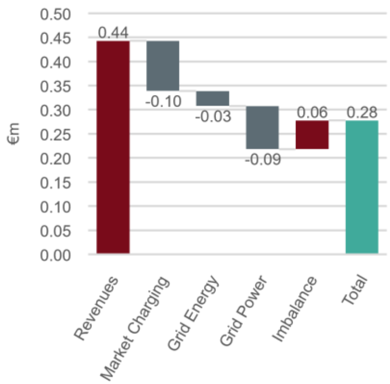
ID1



ID2



FCR



- Grid costs (power) for peak demand are minimised in Phase 1 of optimisation, using monthly (Austria) and annual (Germany) foresight. Optimisation in Phase 2 takes into account both, grid costs for energy, as well as market prices with three days foresight.
- Procuring energy on the wholesale market is the largest cost factor across all use cases.
- In the FCR case, revenues stem from balancing energy, as there is no scheduling.

Chosen power/capacity: 5MW / 2h

DIMENSIONING OF POWER & CAPACITY AUSTRIA, STAND-ALONE (2022)

AUSTRIAN INSTITUTE OF TECHNOLOGY

DA

		Capacity (h)		
		1	2	4
Power (MW)	5	0.08	0.11	0.11
	8	0.07	0.11	0.11
	10	0.08	0.11	0.11

ID1

		Capacity (h)		
		1	2	4
Power (MW)	5	0.15	0.18	0.17
	8	0.15	0.18	0.17
	10	0.15	0.18	0.17

ID2

		Capacity (h)		
		1	2	4
Power (MW)	5	1.18	1.33	1.05
	8	1.16	1.33	1.05
	10	1.17	1.33	1.04

FCR

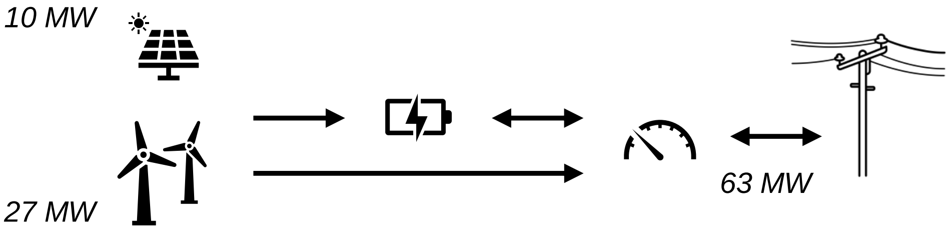
		Capacity (h)		
		1	2	4
Power (MW)	5	0.50	0.35	0.21
	8	0.52	0.37	0.22
	10	0.49	0.35	0.21

- A capacity of 1-2h appears to be optimal for all markets. In the case of FCR 1h is always dominant, as increasing capacities lead to overcapacities, and do not generate revenues.
- Revenues and costs scale near perfectly with power, therefore results are identical.
- FCR results differ for power, because power offered on the market is rounded.

Results show Return on Investment. Results for 2022 are updated over the simulated life span, discounted (discount rate 5%), and are put into proportion against CAPEX. A value of 1 means that discounted earnings exactly cover the investment.

COUPLED WITH GENERATION

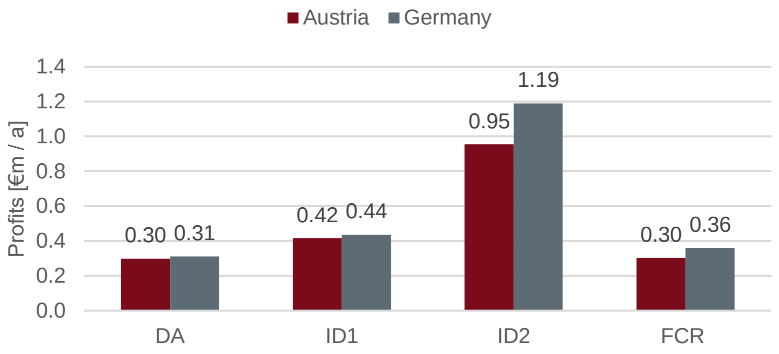
- Historical year 2022
- Coupled with generation
- Charging of storage with own generation
- Constant installed capacities due to historical year 2022



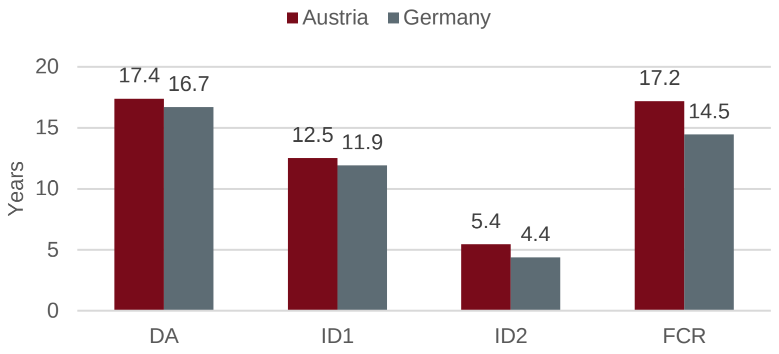
ANNUAL PROFITS & STATISTICAL AMORTISATION CONSTANT GENERATION (2022)

AUSTRIAN INSTITUTE OF TECHNOLOGY

ANNUAL SURPLUS



STATISTICAL PAYBACK PERIOD



- Rentability for DA & ID1 increases significantly, as arbitrage without grid purchases becomes possible.
- Surpluses for ID2 diminish due to a highly profitable base scenario, and furthermore because it may be assumed that the entire produced quantity can be sold at ID-max without storage (high baseline results compared to DA and ID1).
- Improvement of FCR, as self-generated quantities (when available) can be used to recharge. This reduces payable grid tariffs.

Chosen power/capacity: 5MW / 2h

Neglected in Statistic Payback Period: interest, OPEX, CAPEX inverter, over-dimensioning of storage, as useful capacity is 80%

MAIN RESULTS AND FINDINGS

Grid tariffs are a deciding factor	In Austria, there are no financial benefits for storage. Hence, grid tariffs are due for charging and discharging, which has a significant effect on profits.
Grid tariffs influence the optimal strategy	In Austria, grid tariffs for purchases lead to reduced power peak for consumption. Optimal behaviour is characterised by a charging capacity of 20% of peak capacity.
ID market shows high revenue potential	Under ideal circumstances, the ID market offers a tremendous revenue potential. Rentability on the DA market is difficult to show.
Ideal capacity 1-2h	In all markets, with exception of FCR, 1-2h capacities are optimal. For coupled generation of ~40 MW, 5MW is the optimal power.
Coupling with generation shows benefits	Coupling with RES generation (behind-the-meter) suggests realistic payback periods based on the year 2022. In this case, charging does not trigger grid charges, this improves the business case

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

PROFITABILITY OF BATTERY STORAGE

Techno-economic simulation of profit-maximising application for the example of Austria

Get Enspired
18-19 September 2023

T. Esterl, K. Maggauer, P. Ortmann, T. Forster (AIT)

Study commissioned by

ASCR
Aspern Smart City Research