

Requirements for battery systems providing primary and secondary control

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Research Topic

Grid stability

In the electricity grid generation and consumption need to be balanced. Control power is required to compensate occurring imbalances and keep the frequency at 50 Hz. Primary control is used immediately to stabilise the frequency. Secondary control is used to release primary control and to restore the frequency.

The situation in Germany

- TSOs are responsible for control power supply
 - different markets for primary and secondary control (cf. Tab. 1)
 - major part of primary control currently provided by fossil power plants
 - More and more fossil power plants will phase out.
- ➔ New options to meet control power demand will be required.

Batteries

- promising alternative for control power supply instead of fossil power plants
 - supply of both positive and negative control power
 - highly dynamic switchover between different loads or between charging and discharging operation
- ➔ Requirements for batteries providing control power are investigated.

Methodology

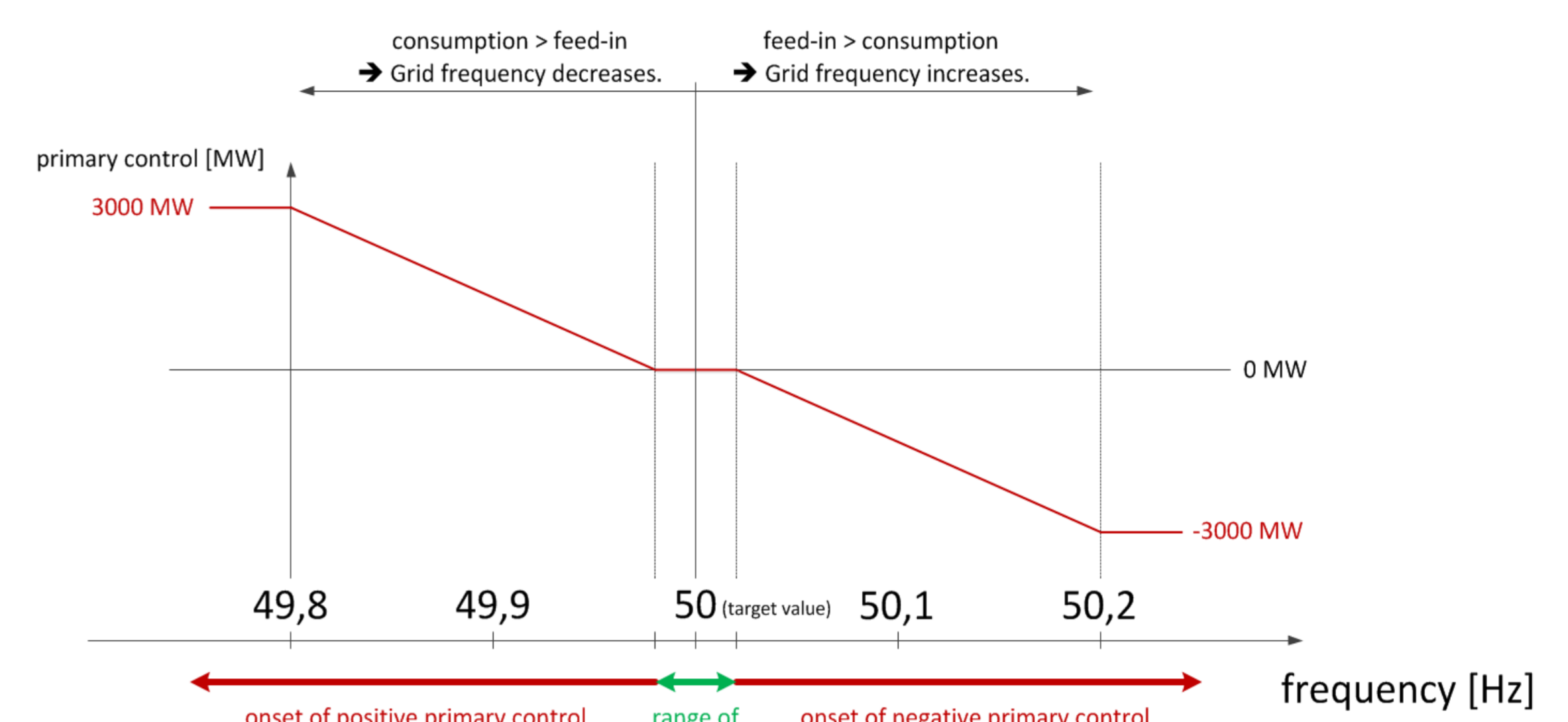
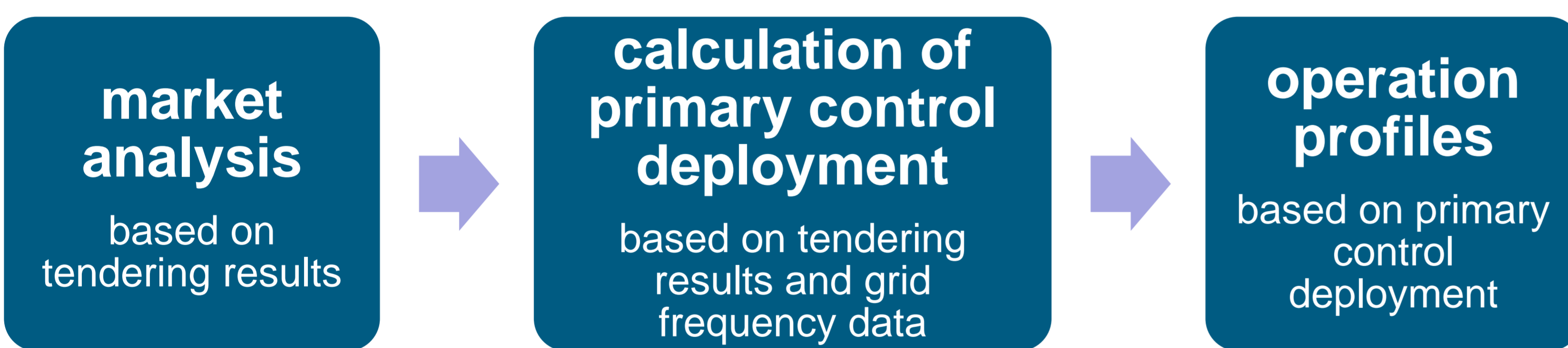


Fig. 1: ENTSO-E primary control deployment

Tab. 1: Market framework in Germany

	Primary control	Secondary control
tendering period	1 week	1 week
minimum tender size	±1 MW	+5 MW or -5 MW
pricing	demand rate	demand rate & energy rate
scheduling	"principle of joint action"	energy rate merit order
response	within 30 s	within 15 min
maximum deployment time	15 min	60 min

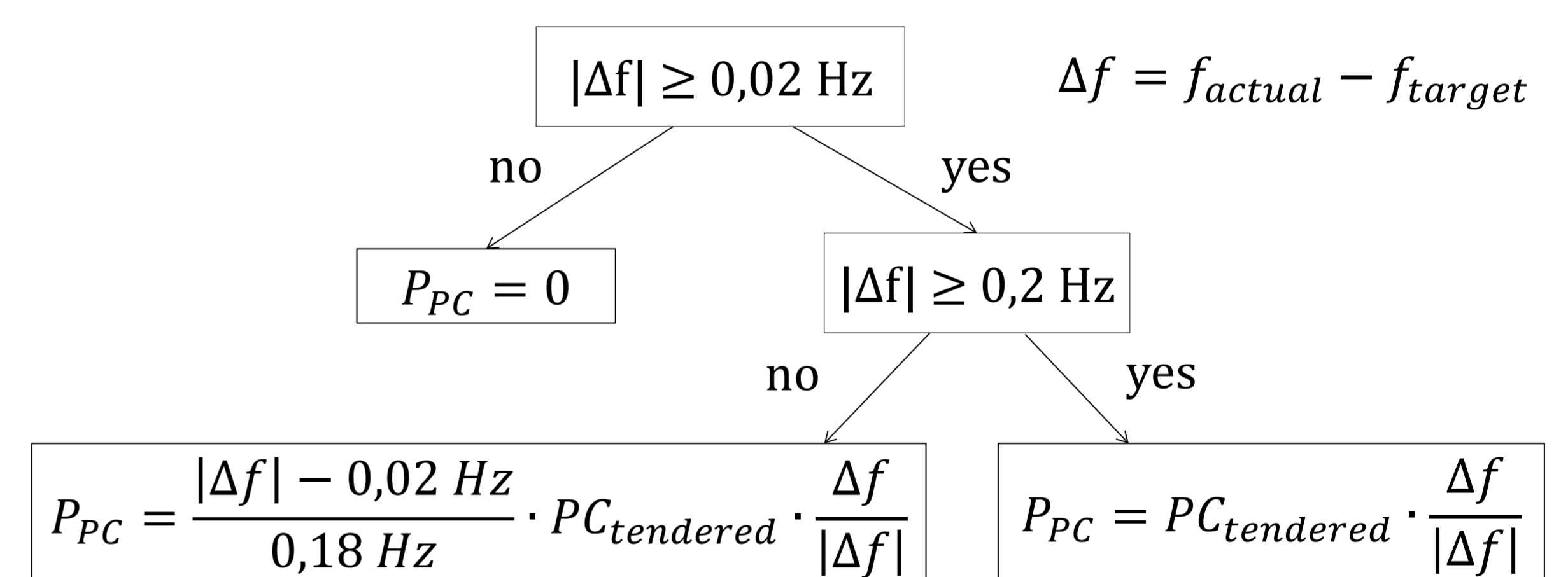


Fig. 2: Primary control deployment calculation

Results

Market analysis results (Fig. 3-5):

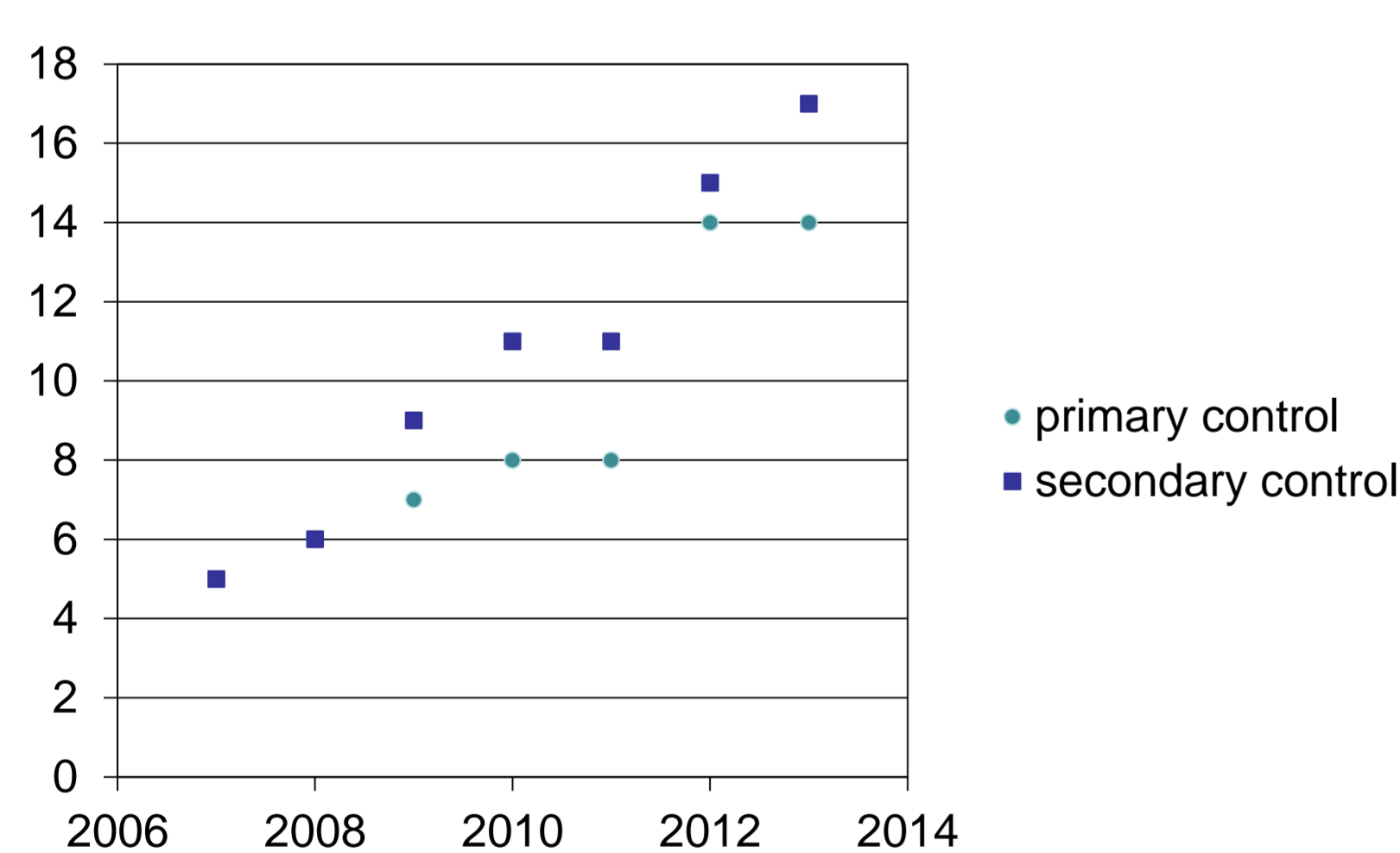


Fig. 3: Number of prequalified tenderers

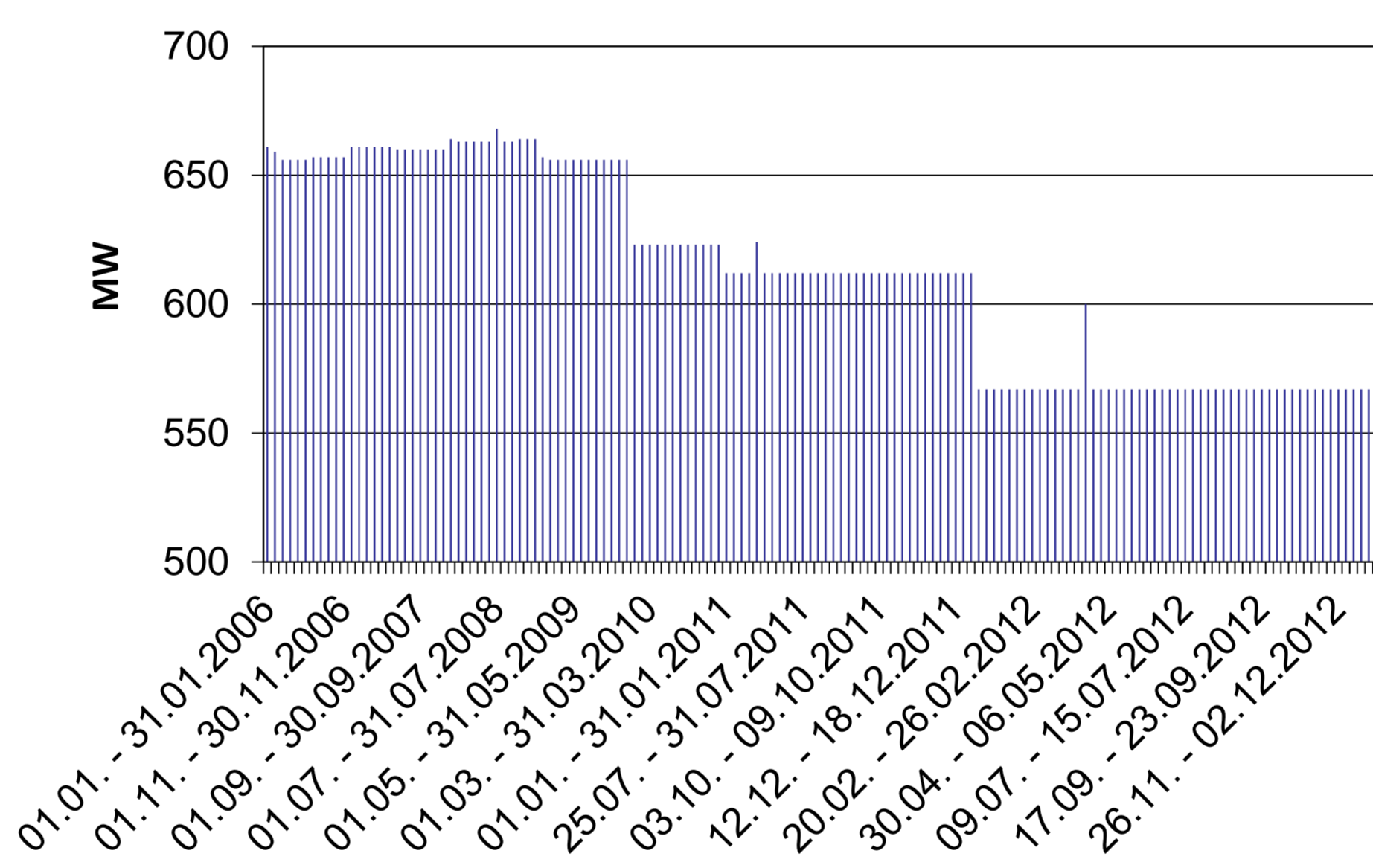


Fig. 4: Primary control tendered in Germany

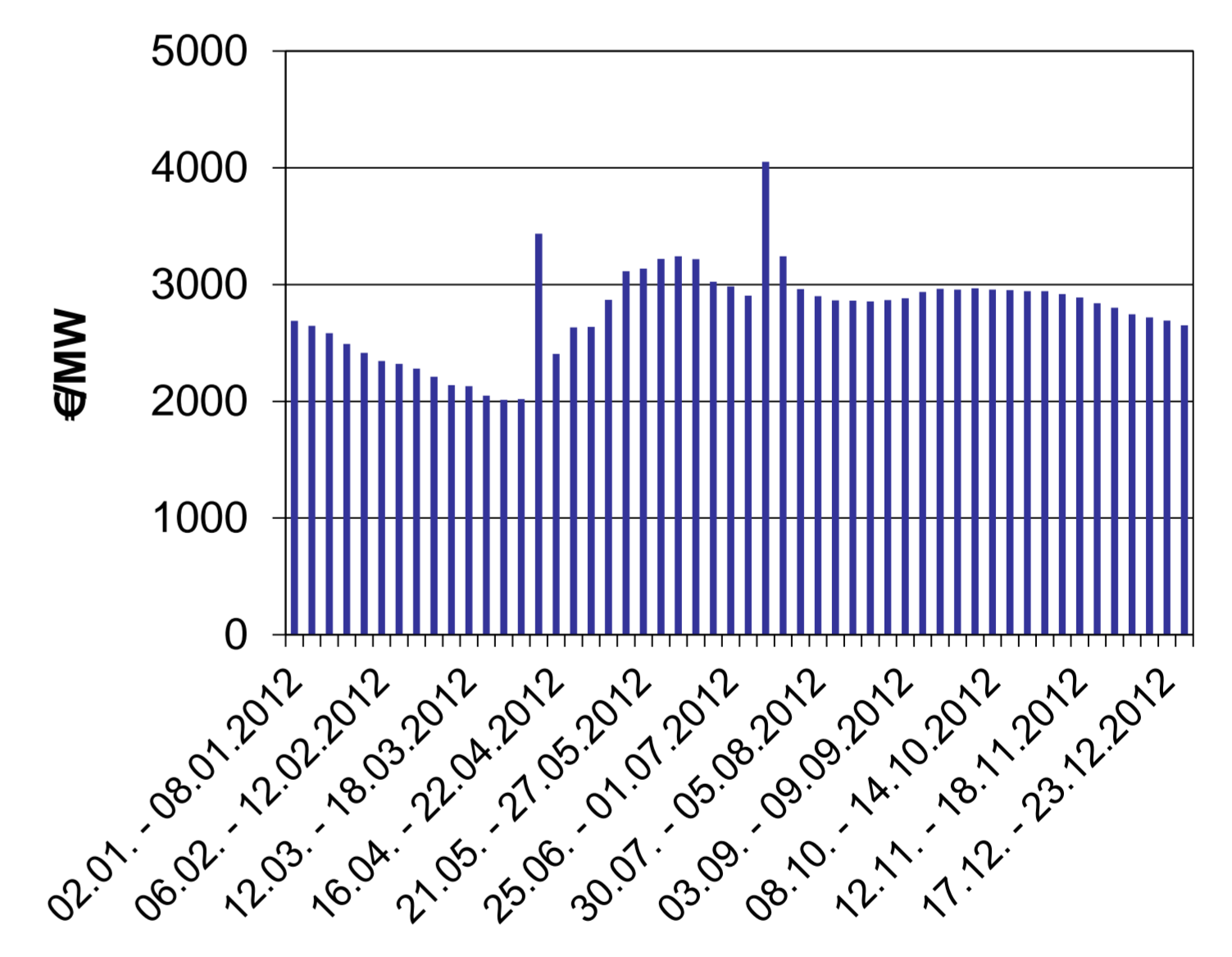


Fig. 5: Average price per MW

Exemplary operation profile of a 1 MW battery system providing primary control (Fig. 6):

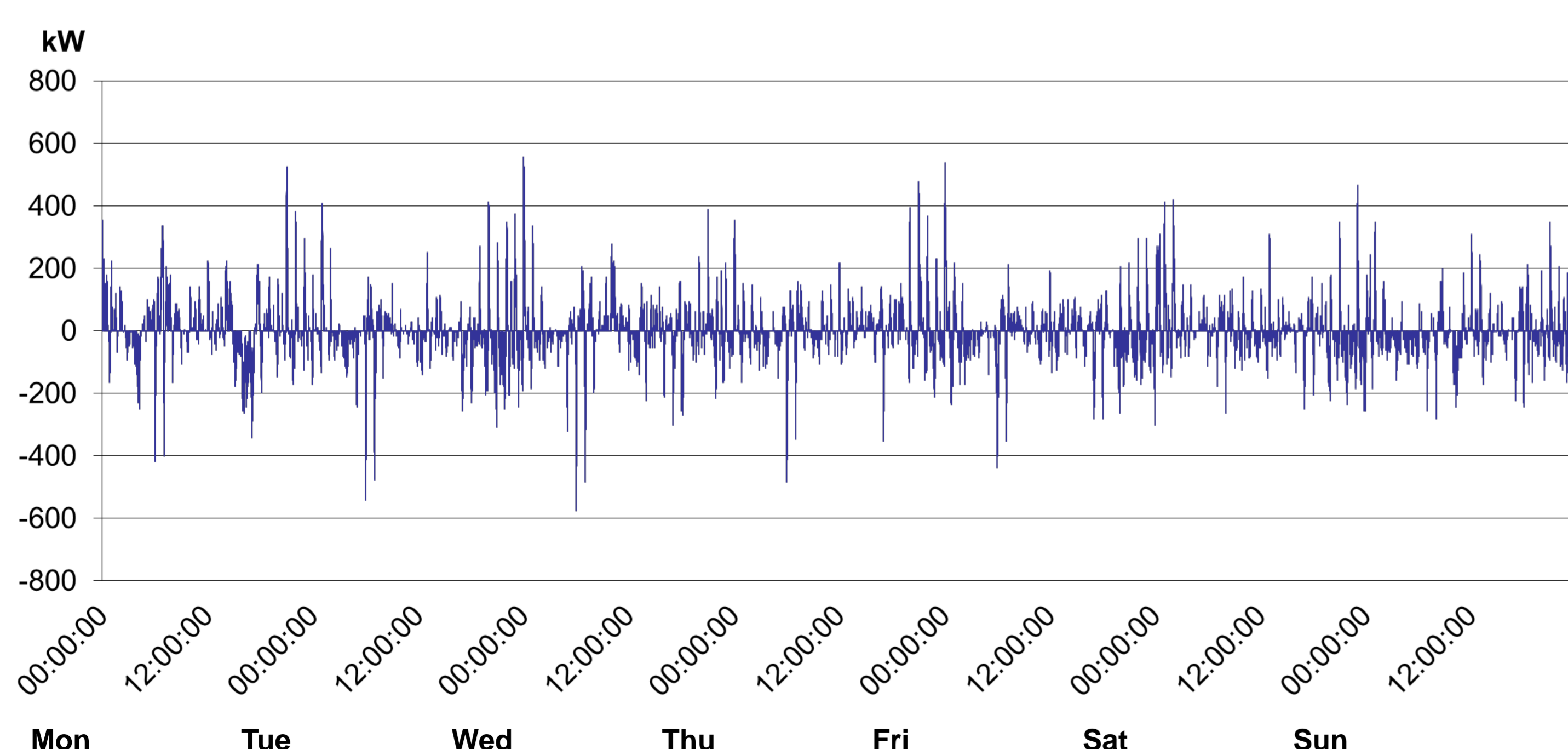


Fig. 6: 1 MW battery system operation profile

$$P_{Battery}(t) = \frac{P_{C_{offered}}}{P_{C_{tendered}}} \cdot P_{PC}(t)$$

This operation profile has been created based on grid frequency data of one week (Feb 13-19, 2012).

- Supply of positive primary control: 3564 discharging sequences, 2165 kWh (battery → grid)
- Supply of negative primary control: 4938 charging sequences, 2247 kWh (grid → battery)

Applications for primary control put higher requirements on battery dynamics than applications for secondary control. For primary control batteries with a balanced energy-to-power ratio (kWh/kW ≈ 1 h) are required, whereas for secondary control high energy batteries (kWh/kW > 2 h) are more suitable.