

Transformation from an energy producer to a grid stabilizer

HES-SO Valais-Wallis, Sion

Daniel Fischlin, CEO KWO

2nd October 2025



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What awaits you tonight



Some interesting facts about KWO



A large proportion of electricity production will become weather-dependent, placing new demands on the grid

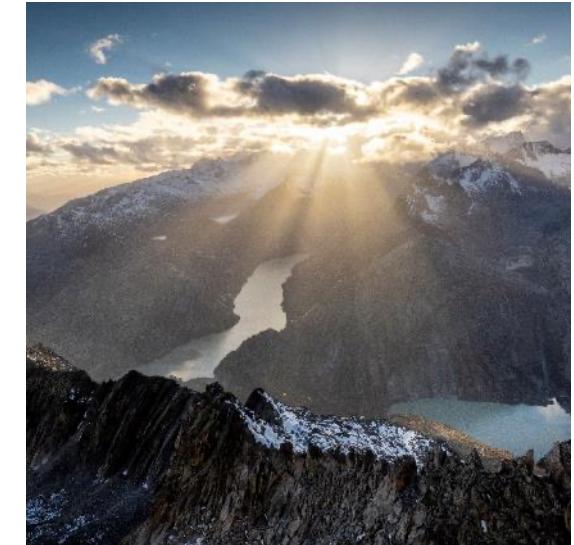
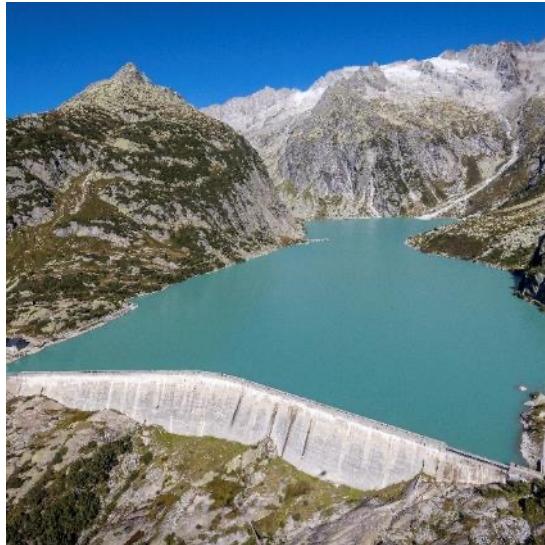


Grid services are becoming more important for storage power plant operators than electricity production

KWO in brief

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Second largest hydropower producer in Switzerland



195 Millions m³
Storage capacity

1'317 Megawatt
Installed capacity

2'300 GWh
Annually production

450 km²
Catchment area

8 Storage lakes
800 Mio. m³ inflow

13 Power Stations in the water tower of Switzerland

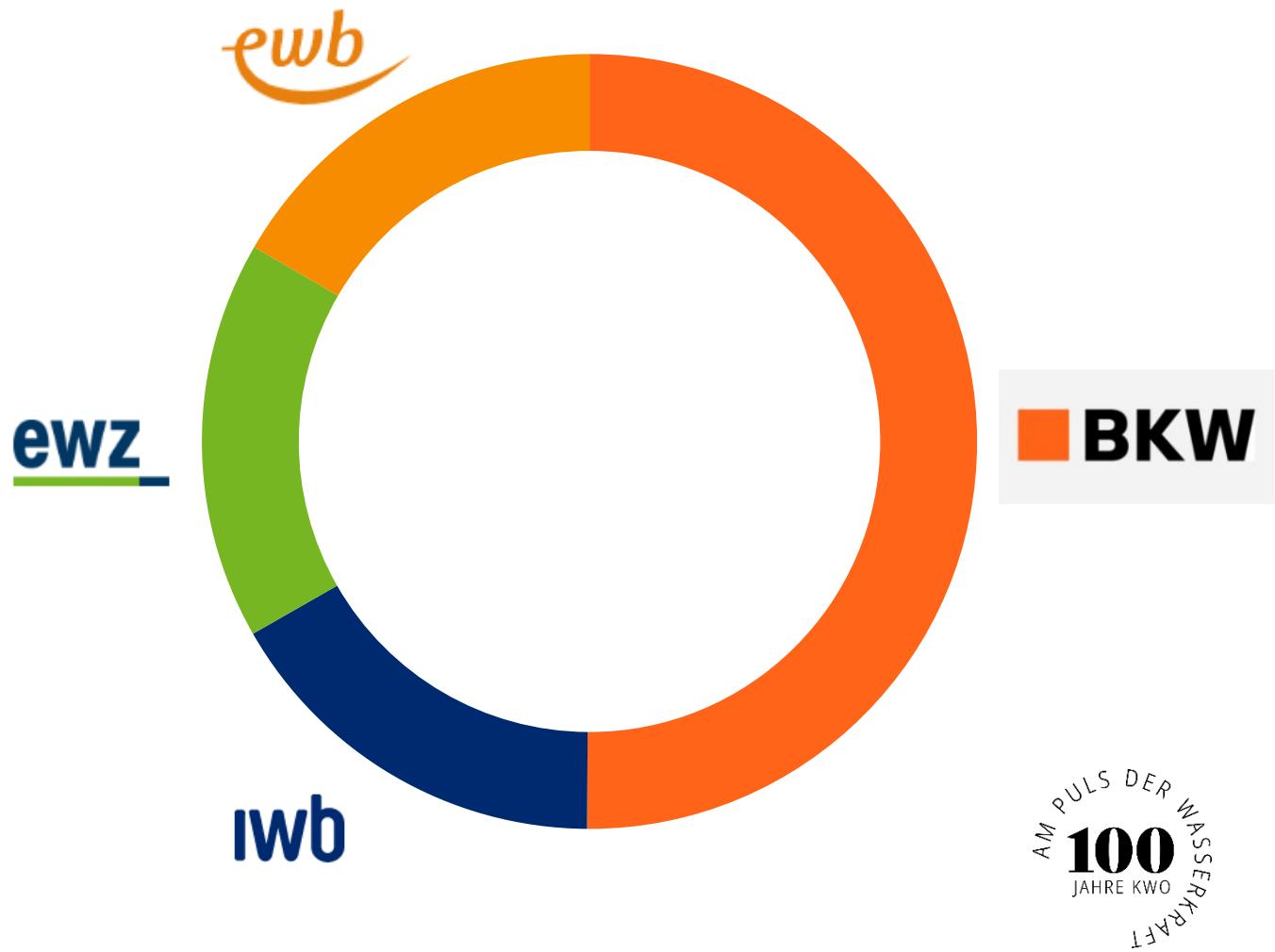
The shareholders of KWO

BKW Energie AG, 1/2

Energie Wasser Bern, 1/6

Industrielle Werke Basel, 1/6

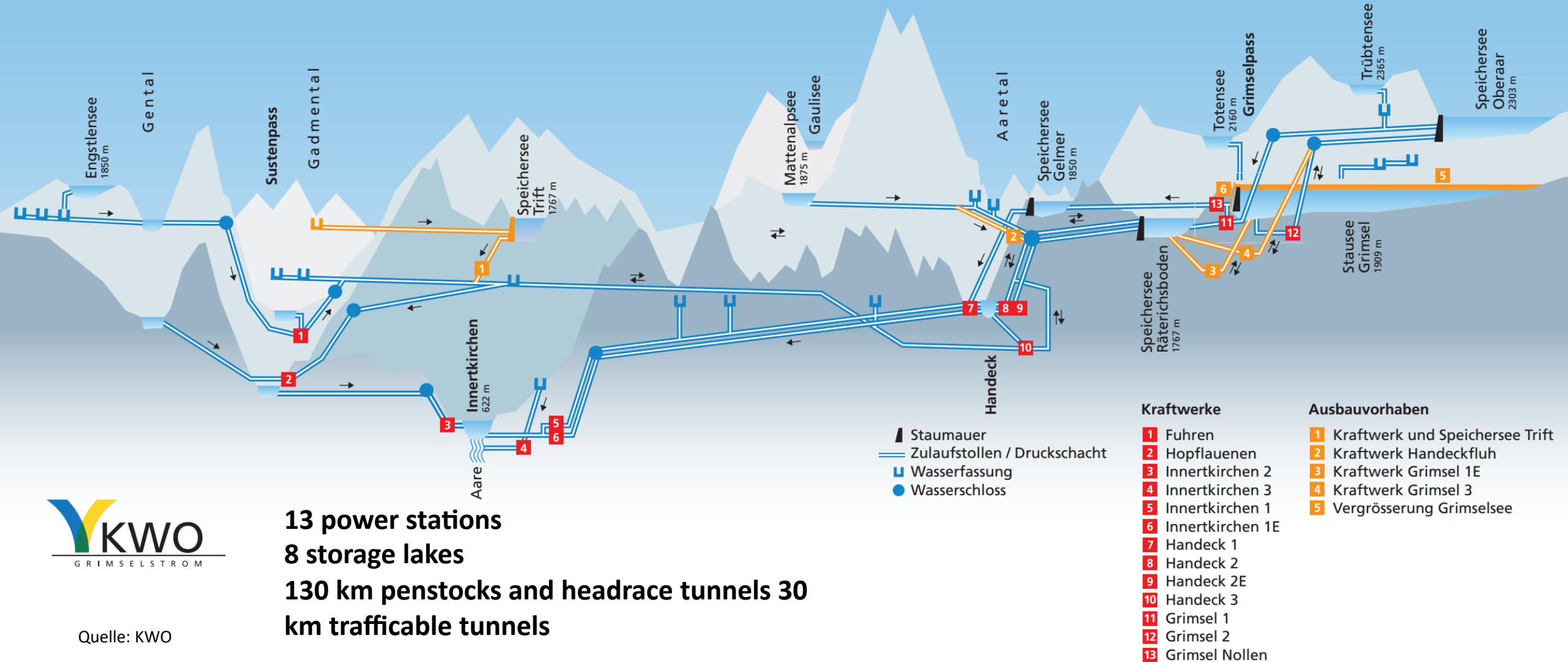
Elektrizitätswerk Zürich, 1/6





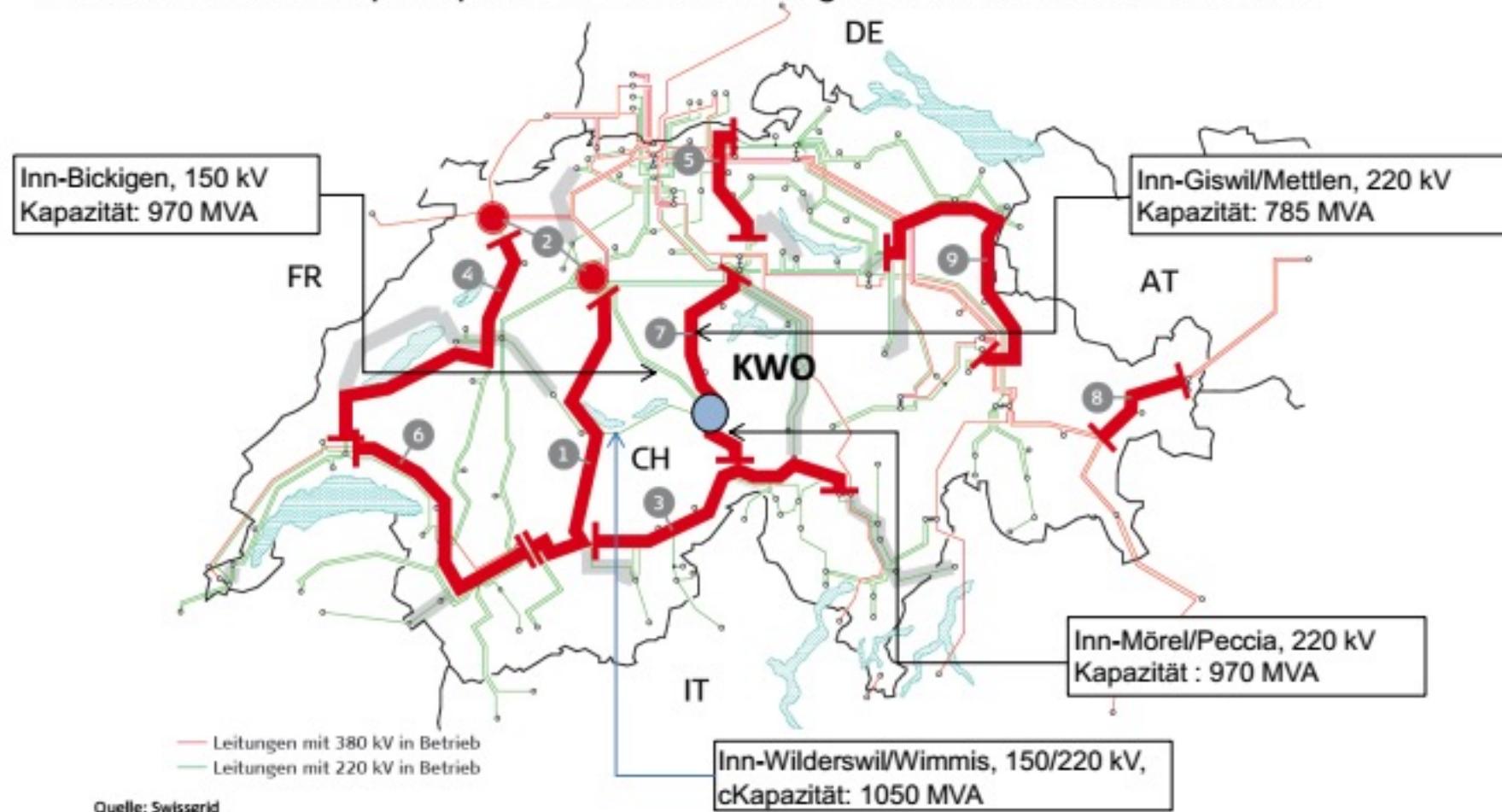
Quelle: KWO

Scheme of facilities



The geographical location of KWO in the high voltage grid Big Impact thanks to ideal location

- Die Anlagen Innertkirchen 1 and Handeck 2 sind **Schwarzstart-KW's (Zone CH-Mitte)**
- Die KWO hat 2 Einspeisepunkte: Die Schaltanlagen Innertkirchen und Handeck





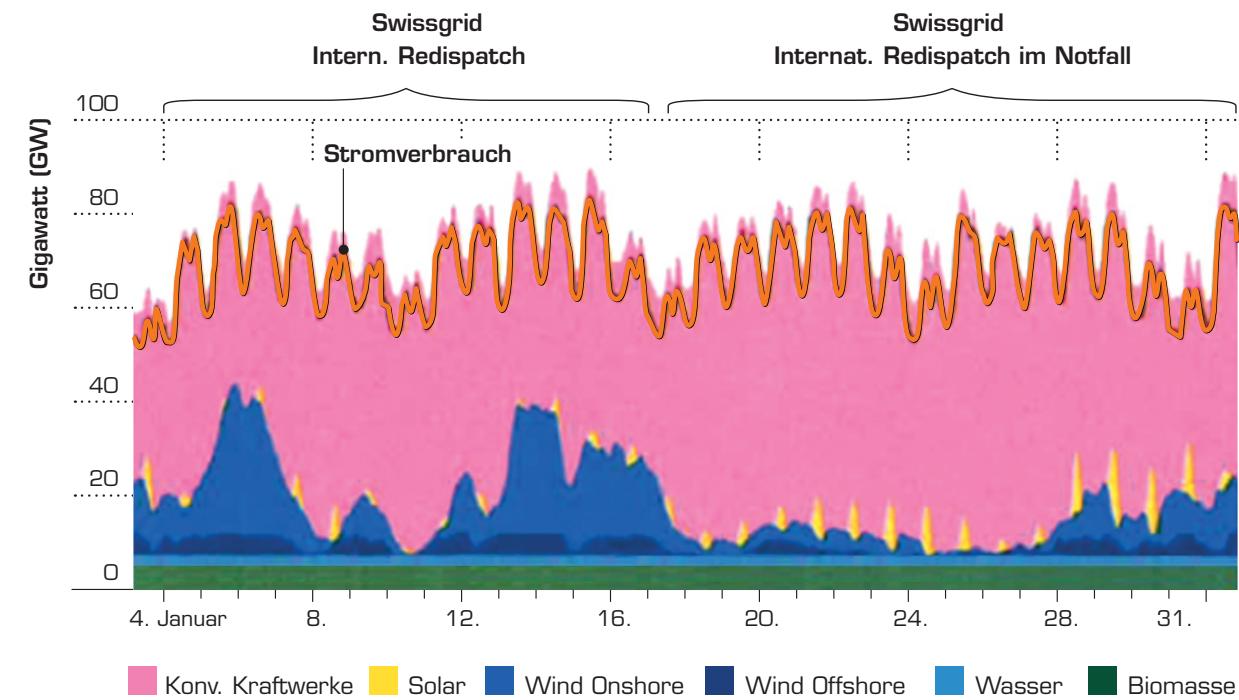
A large proportion of electricity production will become weather-dependent, placing new demands on the grid.

Quelle: KWO

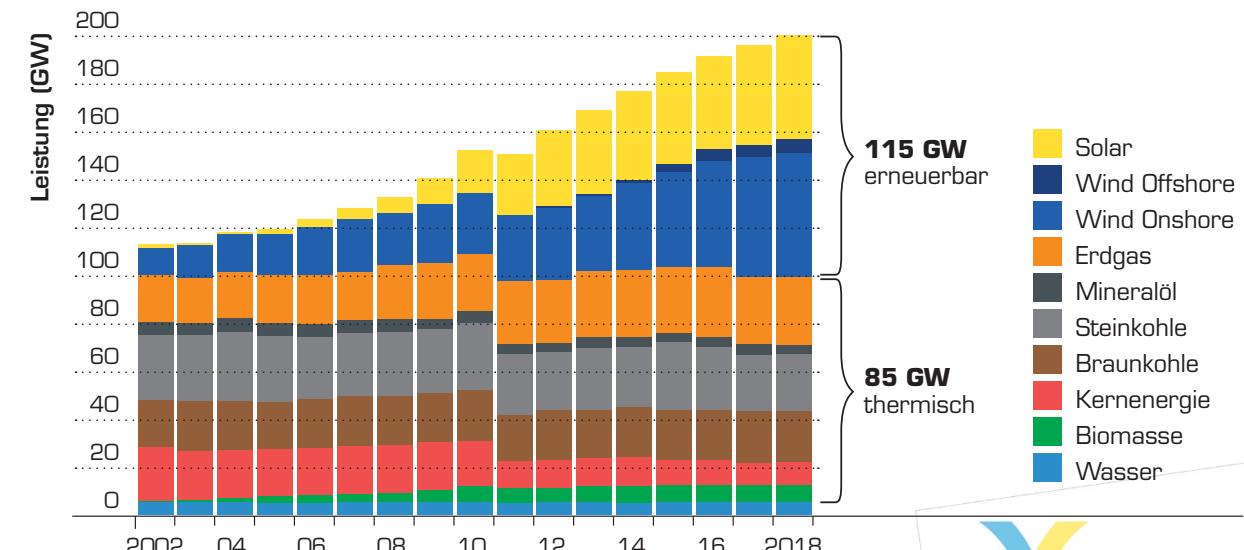


Renewable production is dependent on the weather

Power production in Germany January
2017



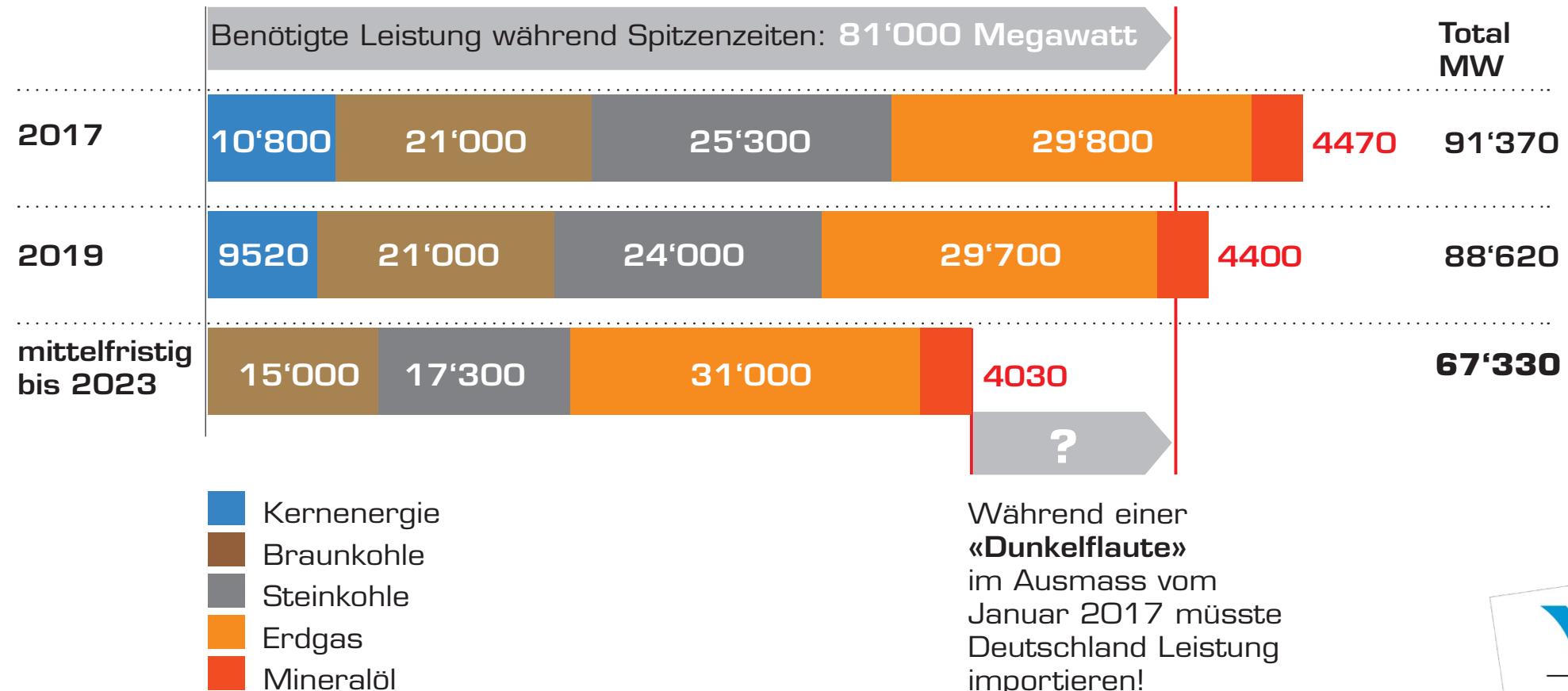
Installed capacity in Germany 2017



Quelle: Agora Energiewende

Quelle: Agora Energiewende

Decline in controllable production in Europe: Example Germany

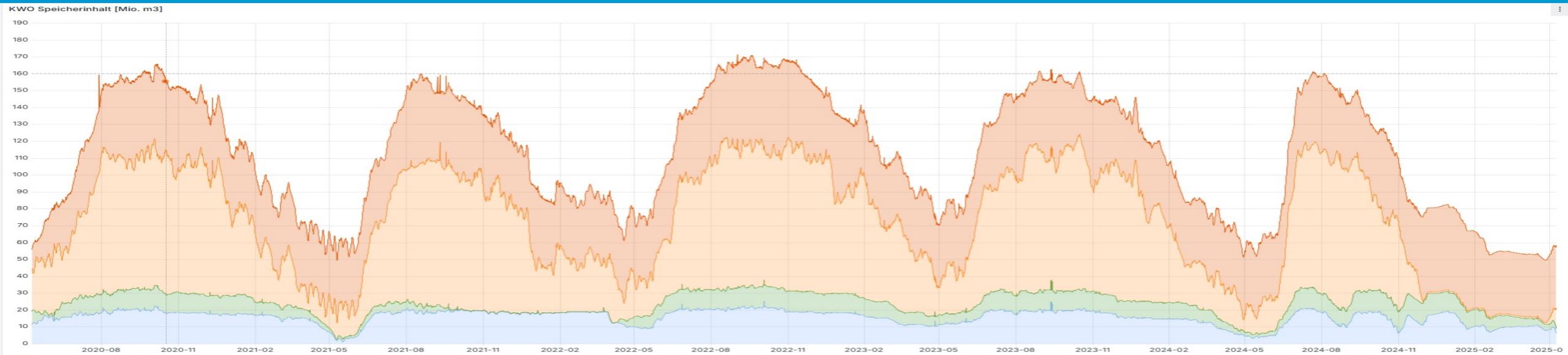


System services

Winter electricity

Flexibility

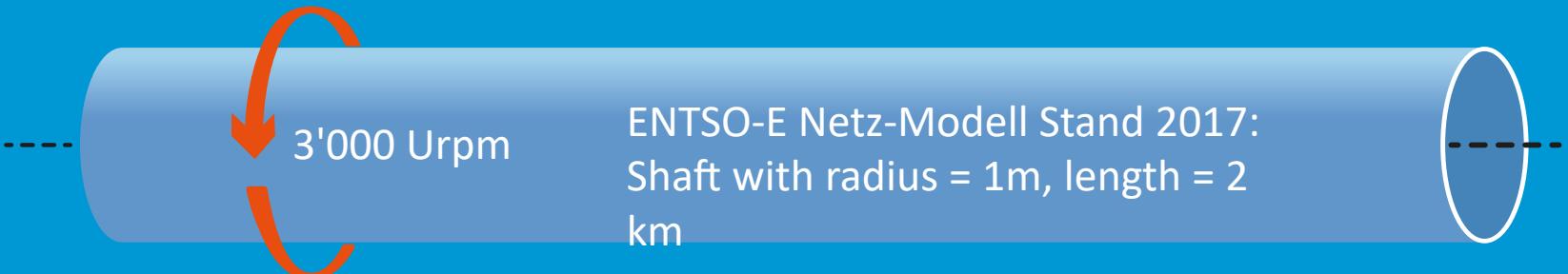
Network restoration



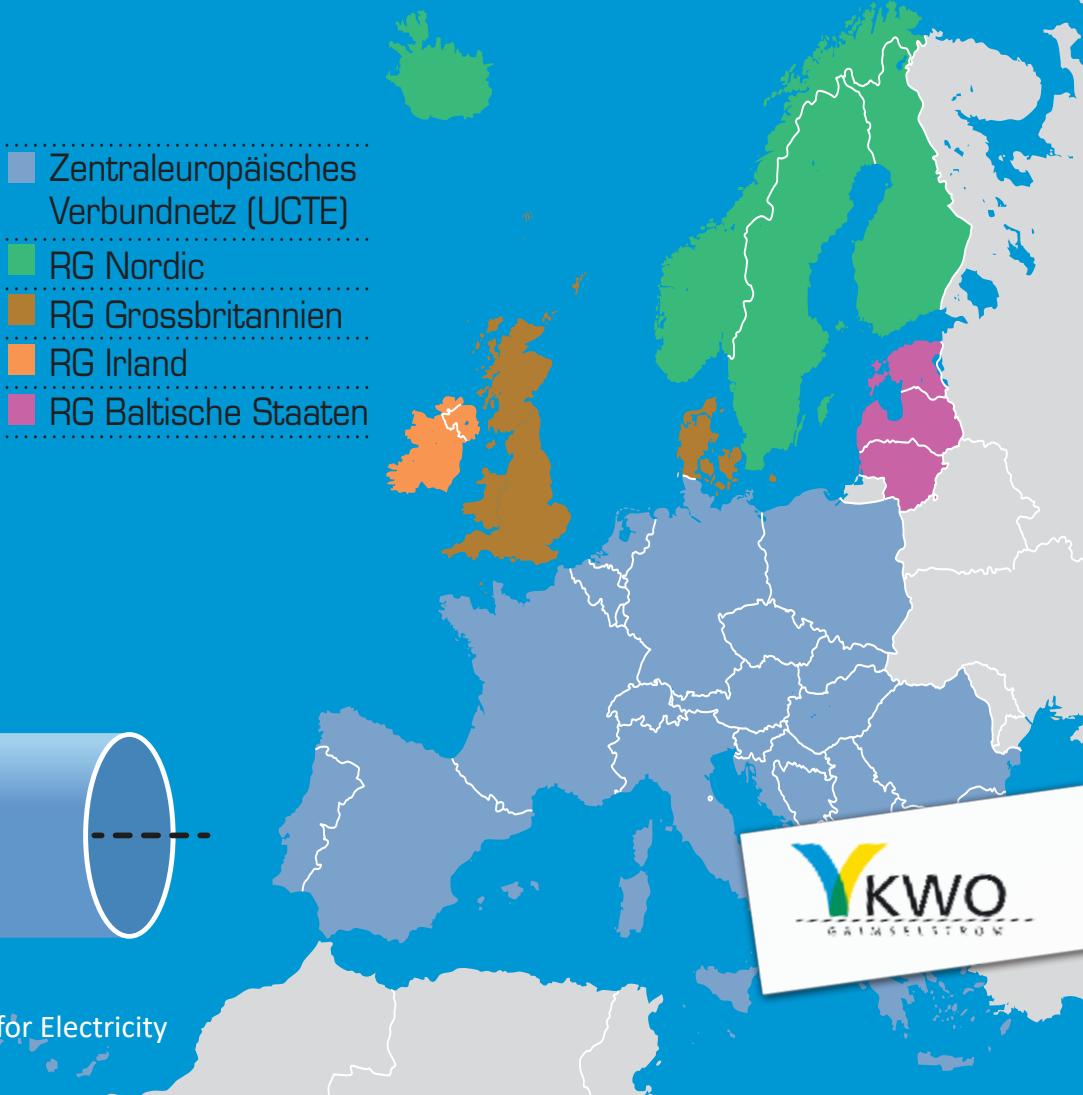
Grid stability

The role of rotating masses in the grid

- Grid as a model of a rotating shaft
- Shaft turns with 50 rps (50Hz)
- Producers and consumers are coupled via this shaft
- Producers accelerate, consumers slow down the shaft

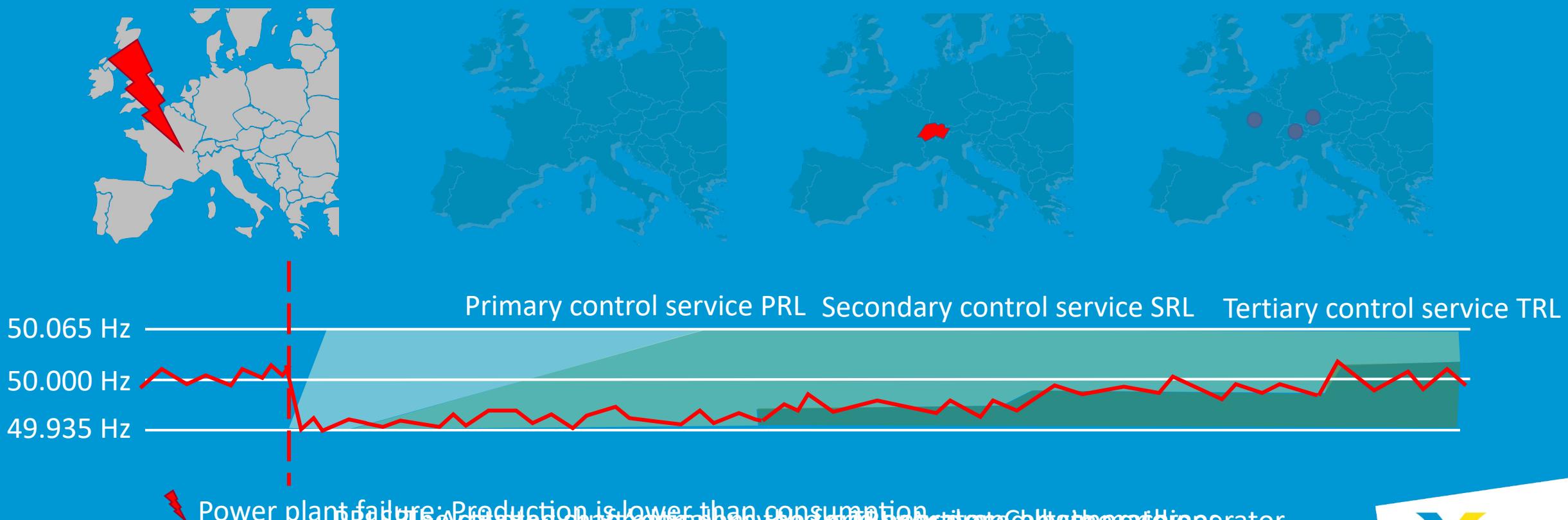


ENTSO-E Netz-Modell Stand 2017:
Shaft with radius = 1m, length = 2
km



Grid stability

When consumption and production are no longer in balance



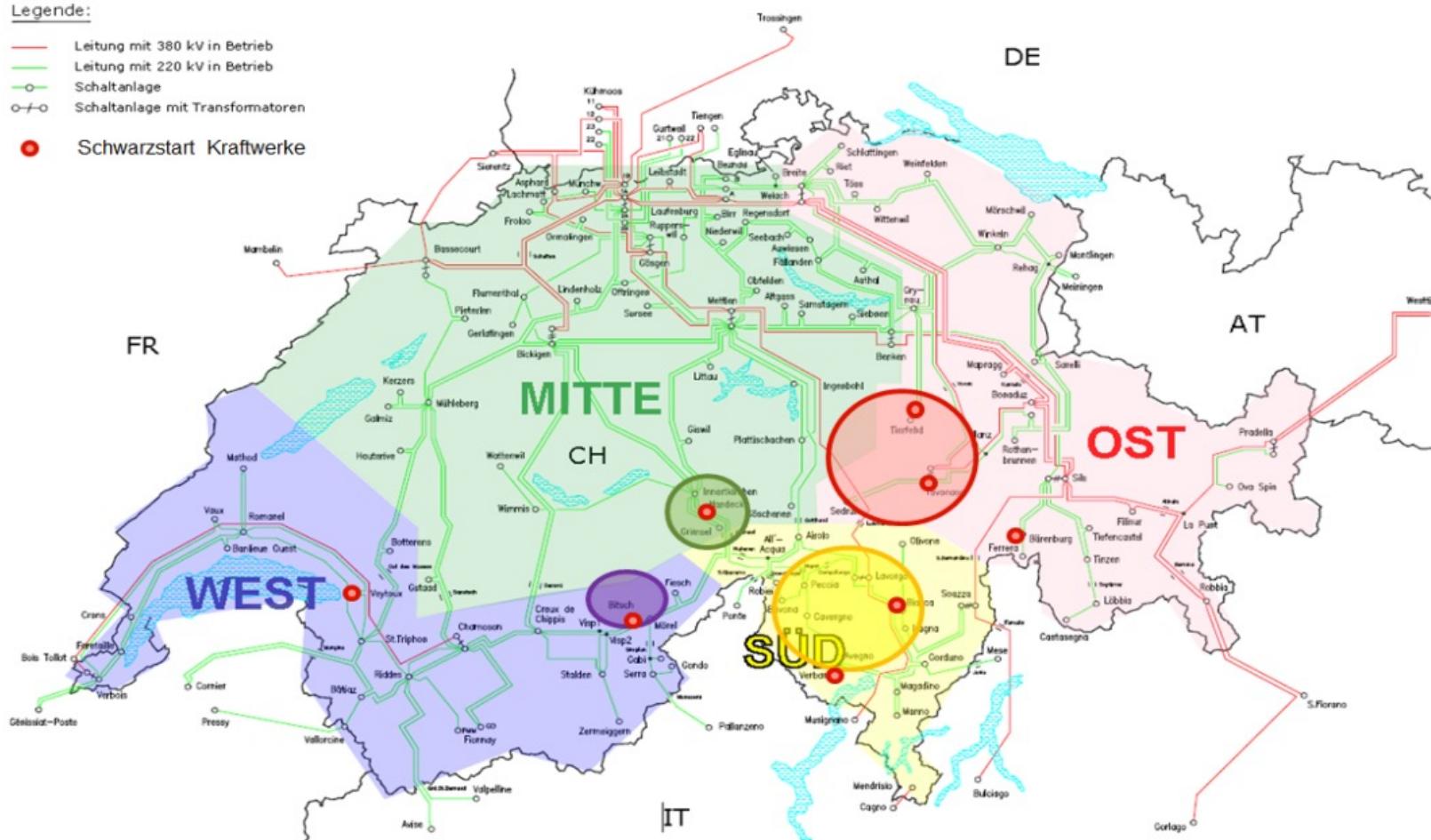
Restoration of transmission grids after a blackout

Storage power stations are responsible for rebuilding the grids in the four zones.

Netzwiederaufbauzellen

Legende:

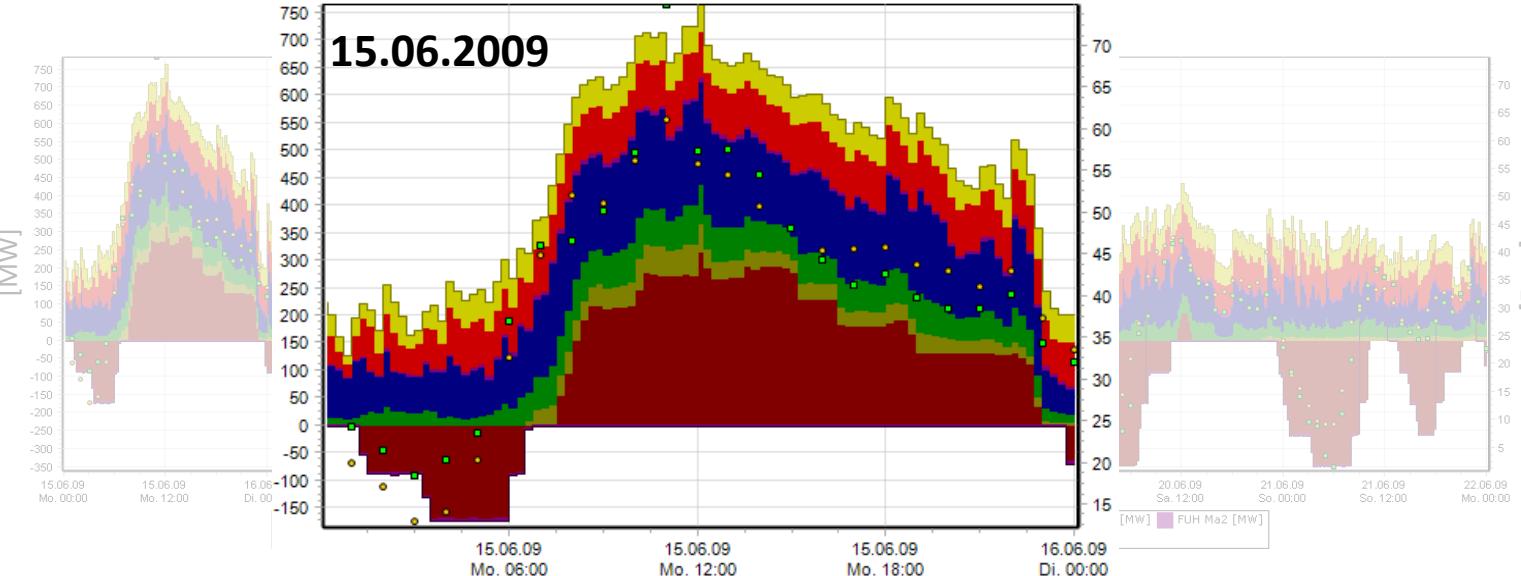
- Leitung mit 380 kV in Betrieb
- Leitung mit 220 kV in Betrieb
- Schaltanlage
- Schaltanlage mit Transformatoren
- Schwarzstart Kraftwerke



Netztrennungen

- Ausland
- 380 / 220 kV
- Anschlussnehmer
- Segmentierung

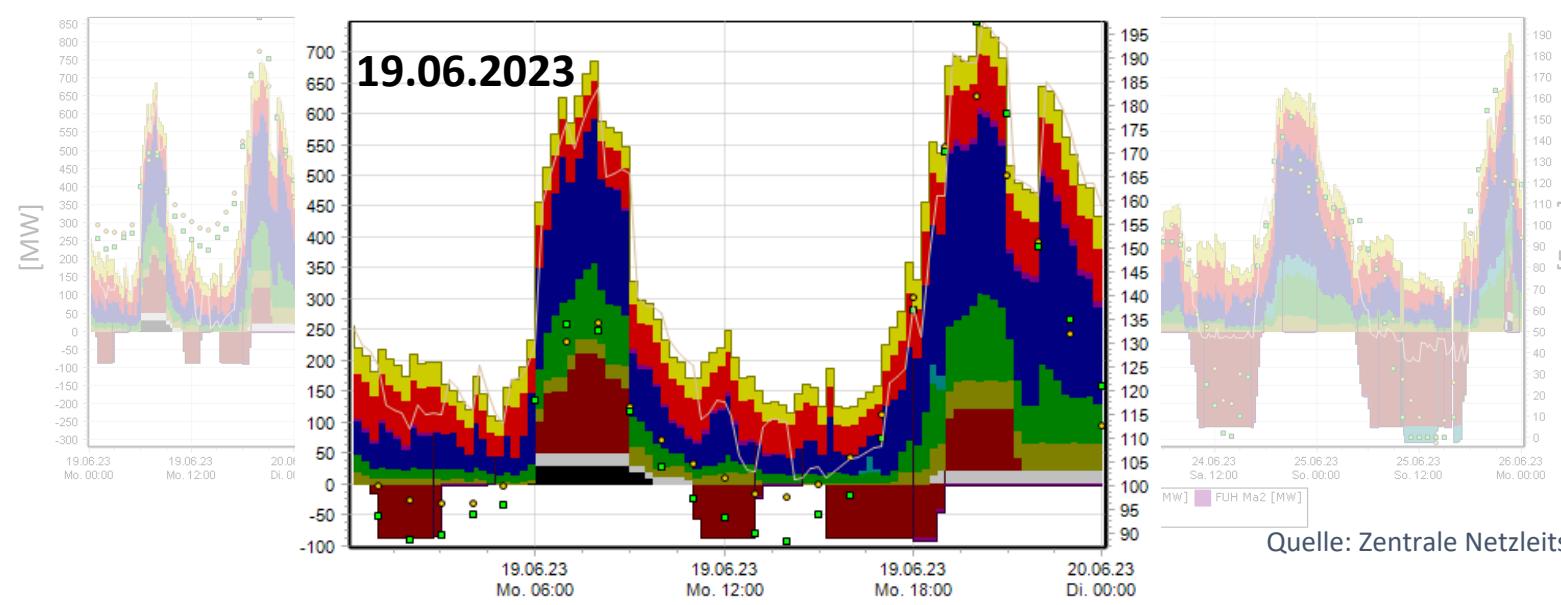
Impact of PV feed-in on KWO



Calendar week 25 2009

- High prices at midday -> high demand
- At nights & weekends low prices -> pumping

Spot market prices between 0 and 80 Euro/MWh



Calendar week 25 2023

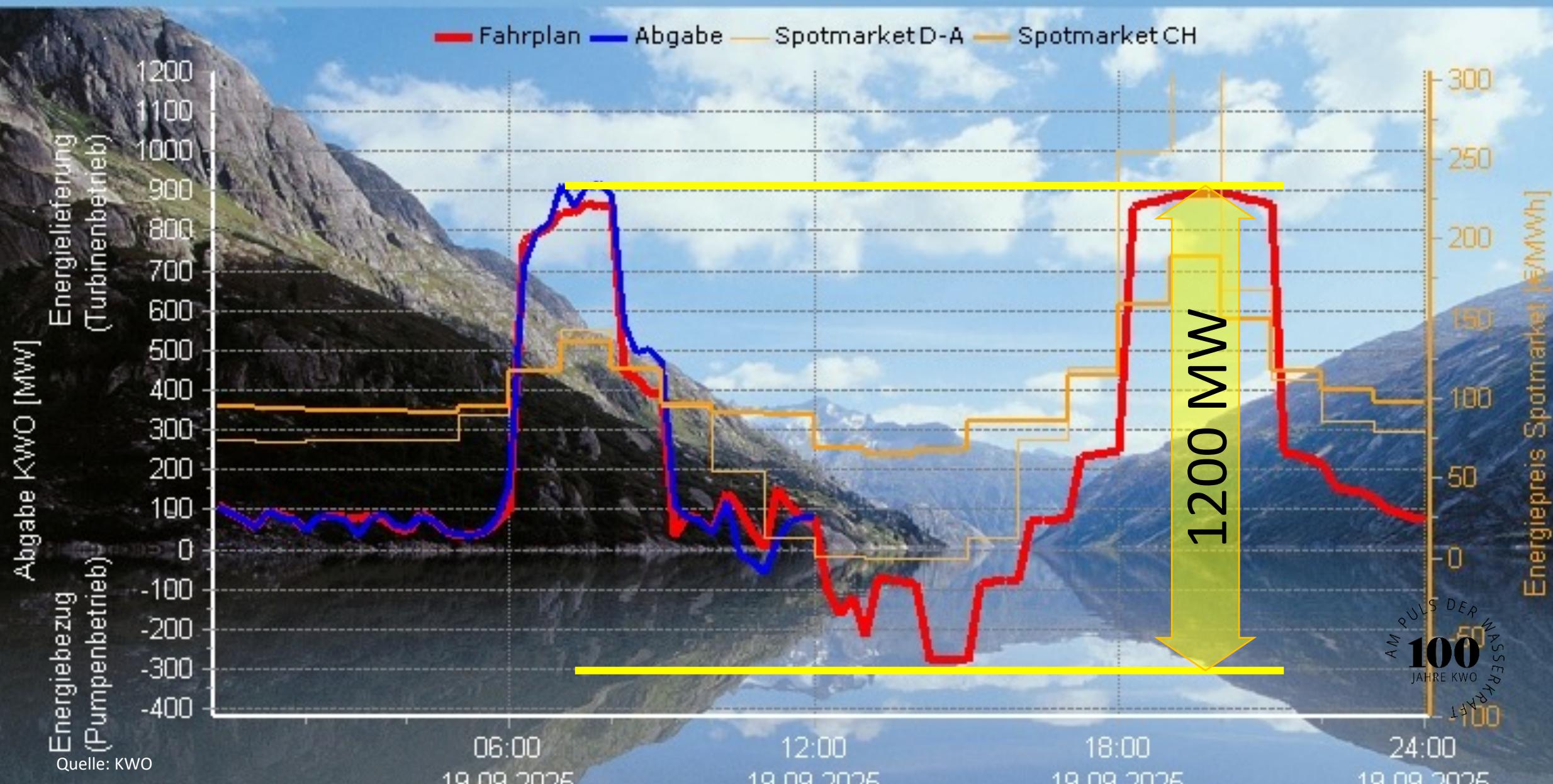
- Morning & evening high prices -> high demand
- During the day low prices (PV-production)
-> pumping

Spot market prices more volatile
between 0 und 200 Euro / MWh

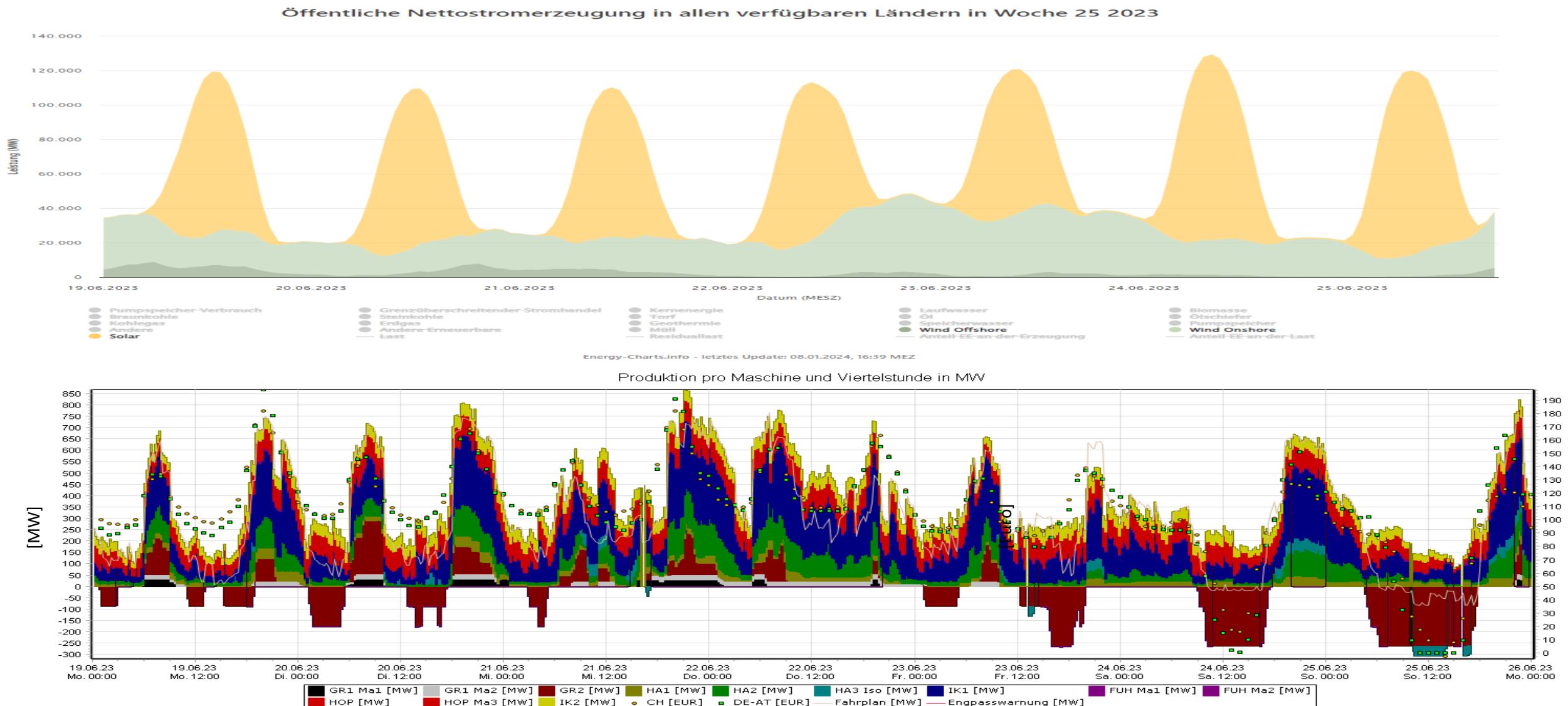
Quelle: Zentrale Netzleitstelle KWO



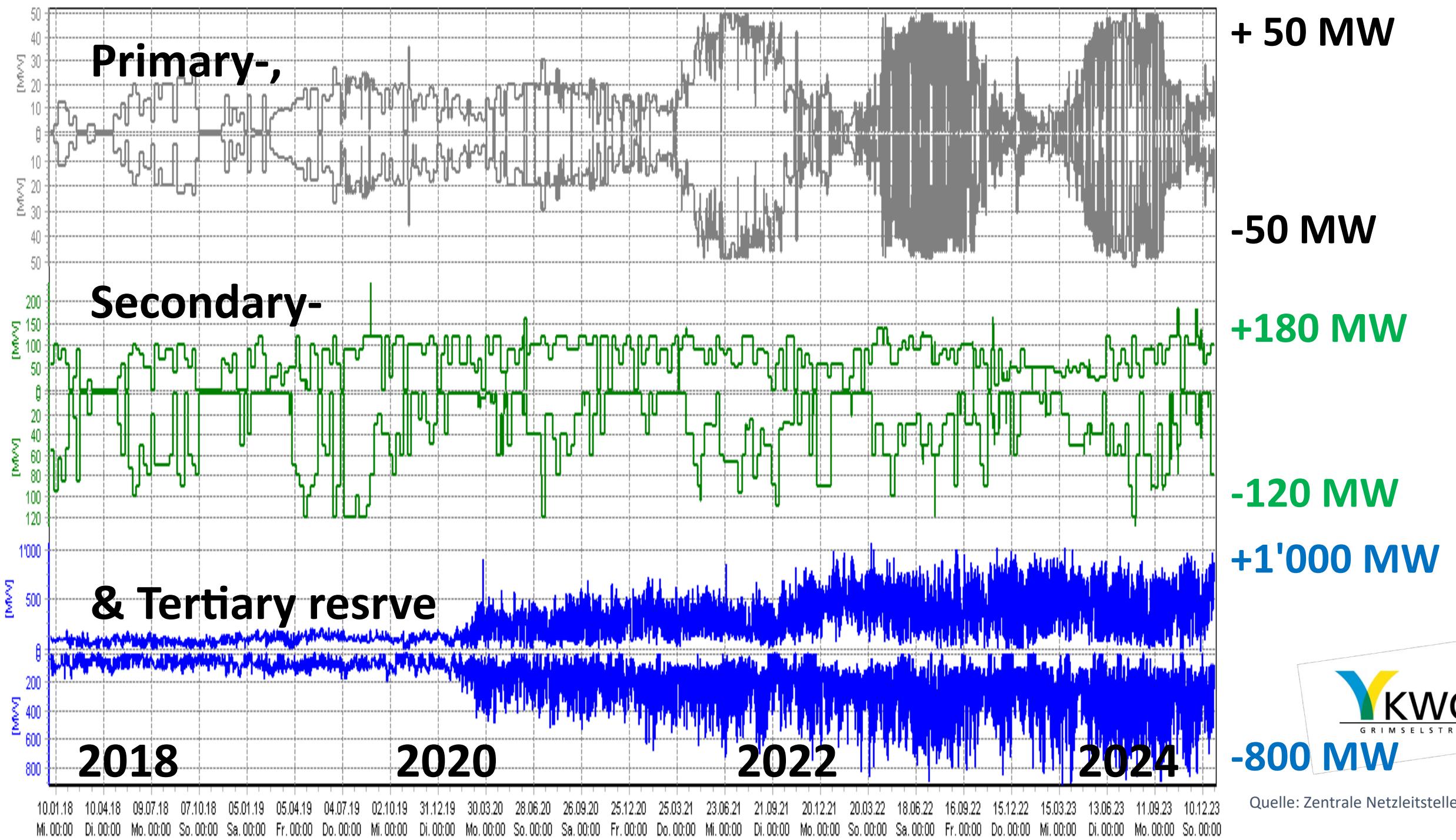
Produktion



Impact of new renewable energies on KWO production



Quelle: Zentrale Netzeitstelle KWO

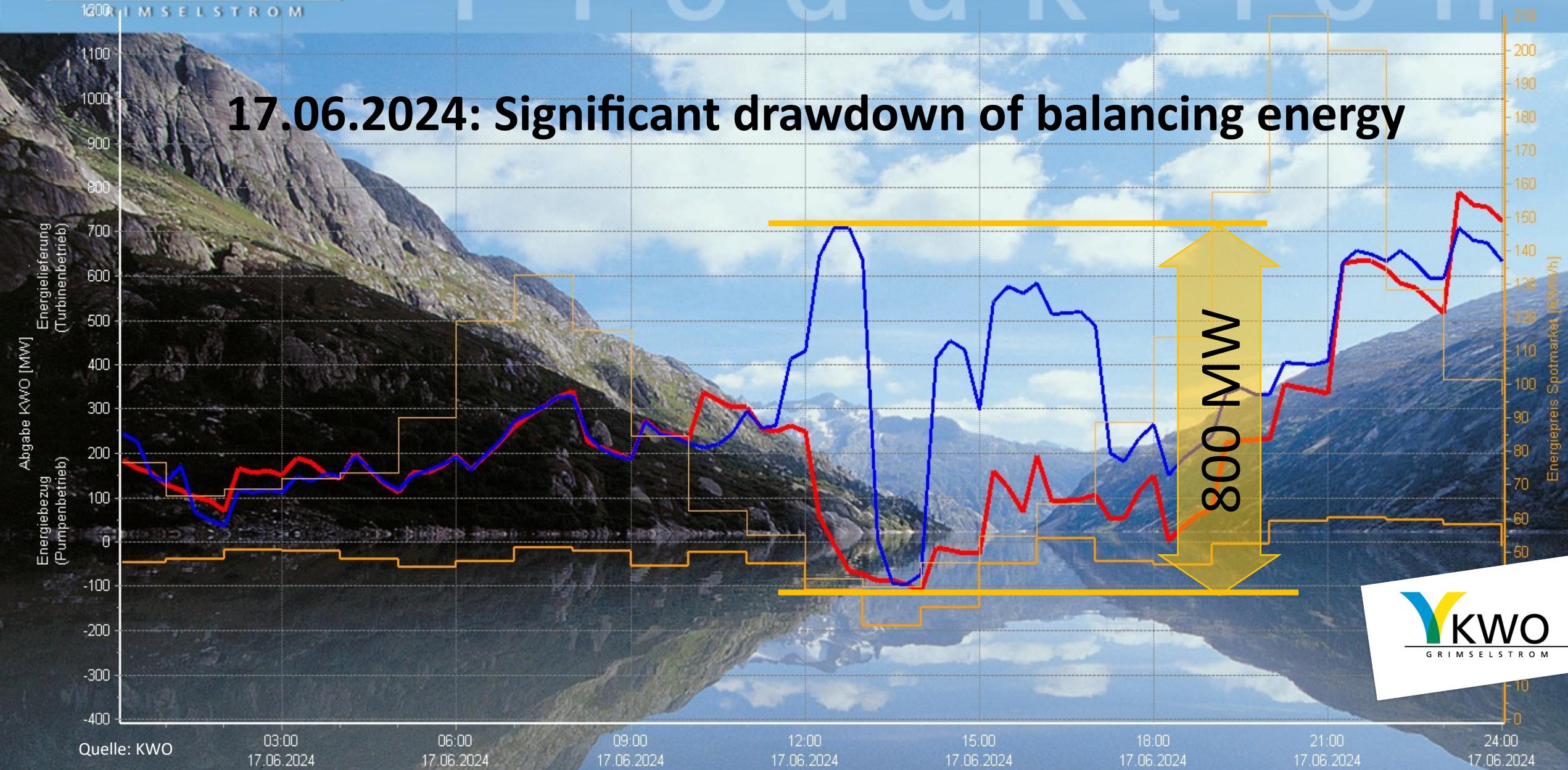




Fast start-up times, rapid load changes, and more starts/stops
are requirements for power plants to ensure a stable grid.

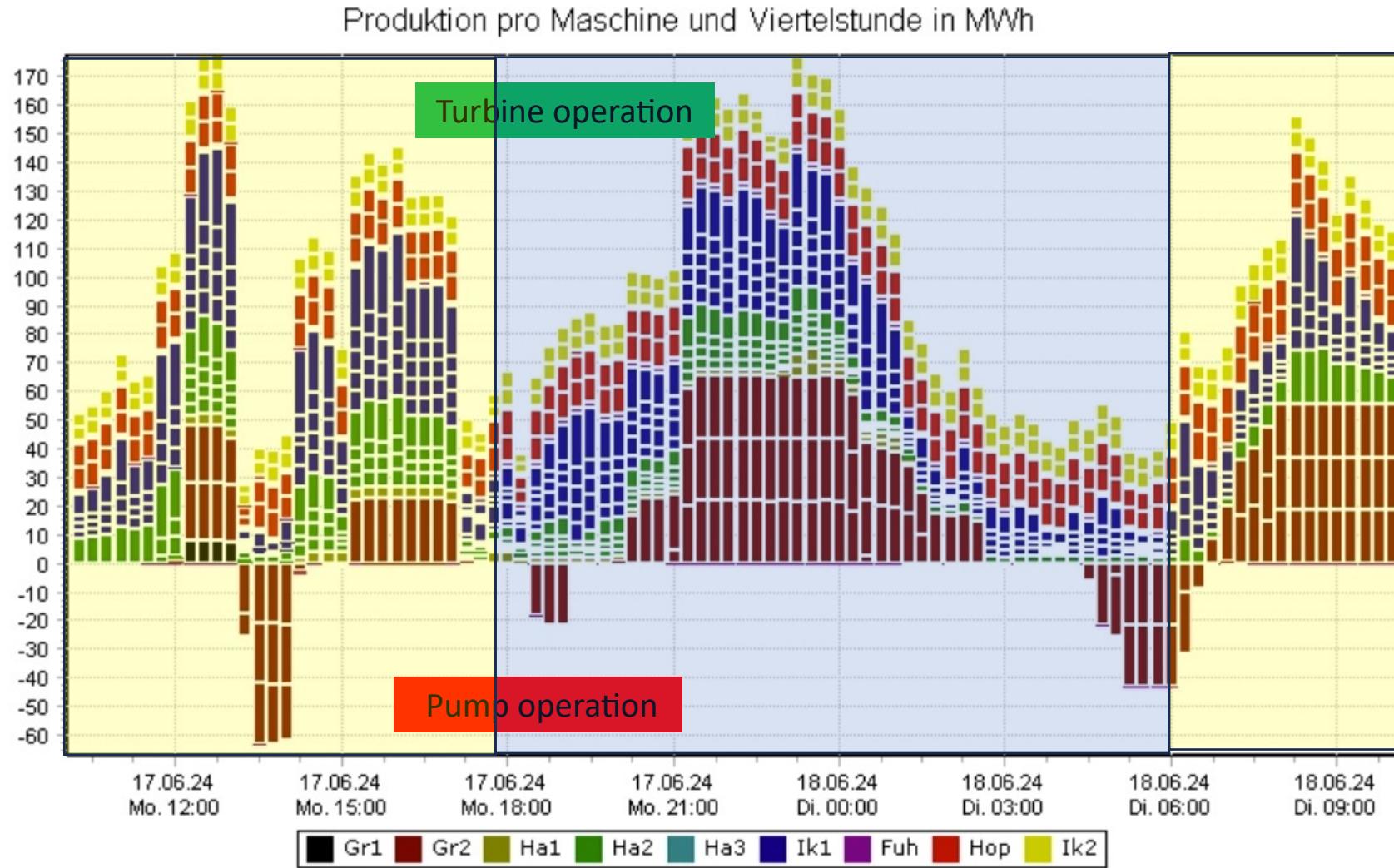
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17.06.2024: Significant drawdown of balancing energy



Use of machinery for grid stabilization

KWO – Turbine/pump operation for production and grid stabilization



Quelle: Zentrale Netzleitstelle KWO

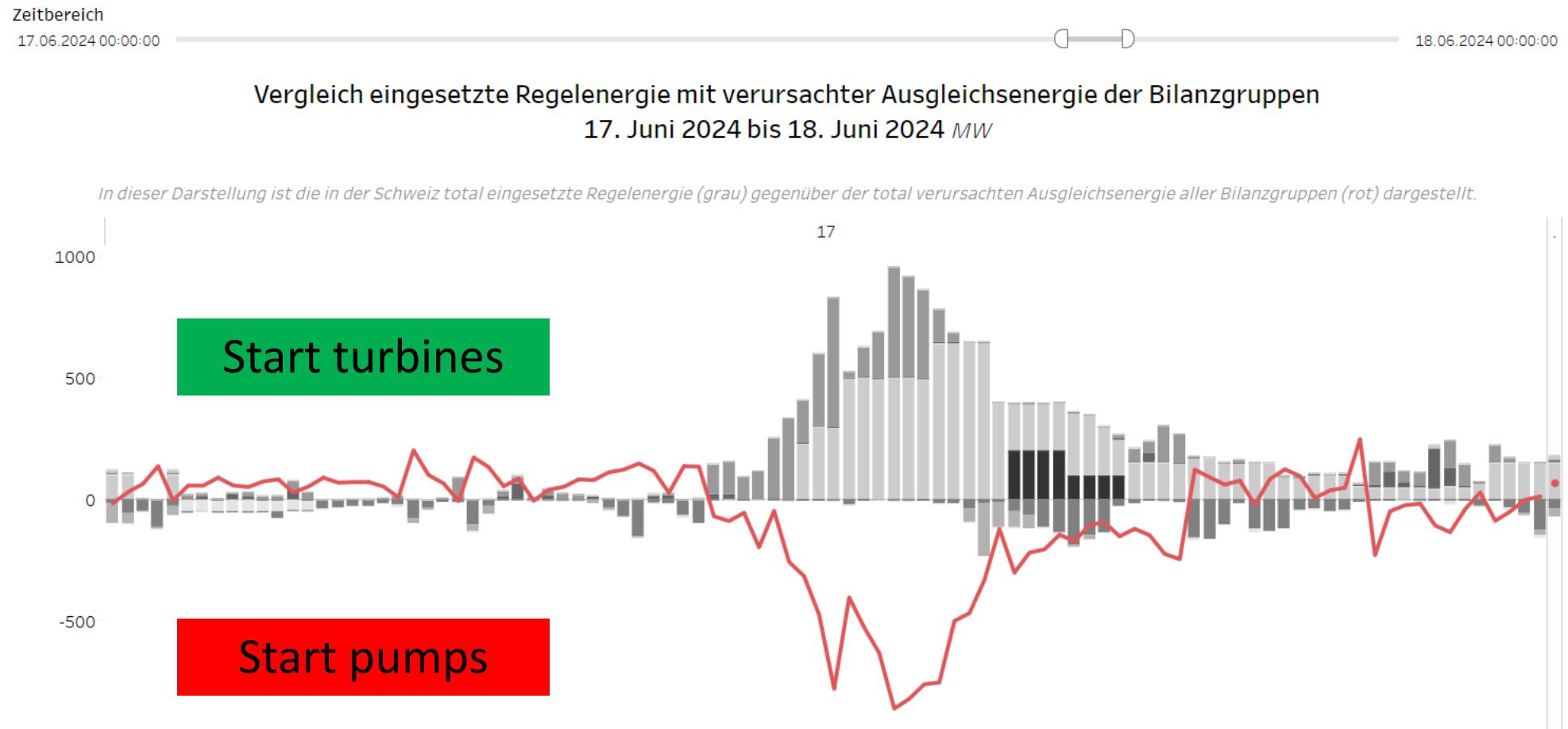
Events on 17. June

- At approximately 2 p.m., 18 machines are in operation.
- At approximately 2:15 p.m., 6 turbines and 2 additional pumps are connected to the grid.



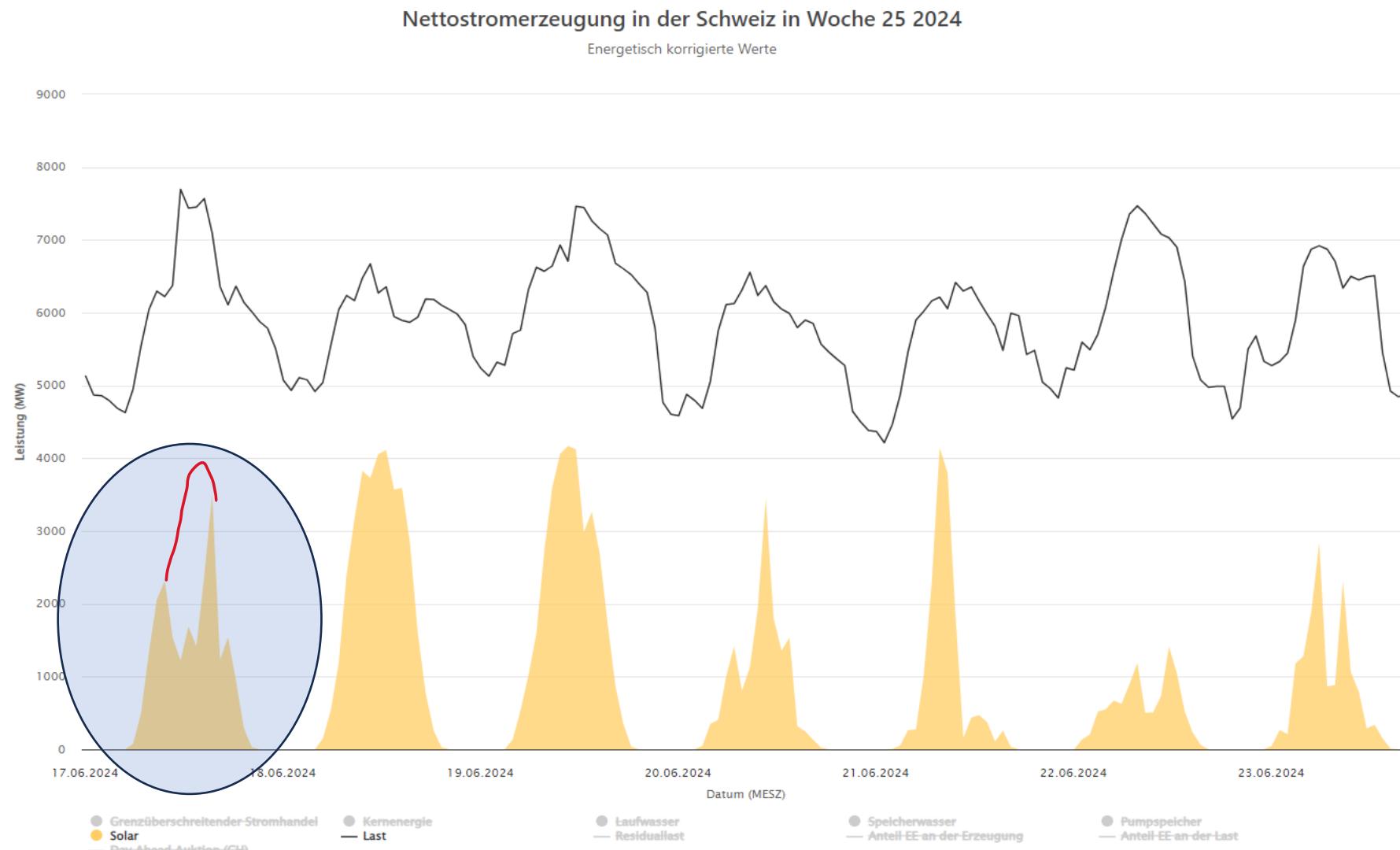
Grid stability

Large deviation in production/demand in the grid on 17. June



Grid stability

Cause on 17. June: A deviation from the forecast PV generation



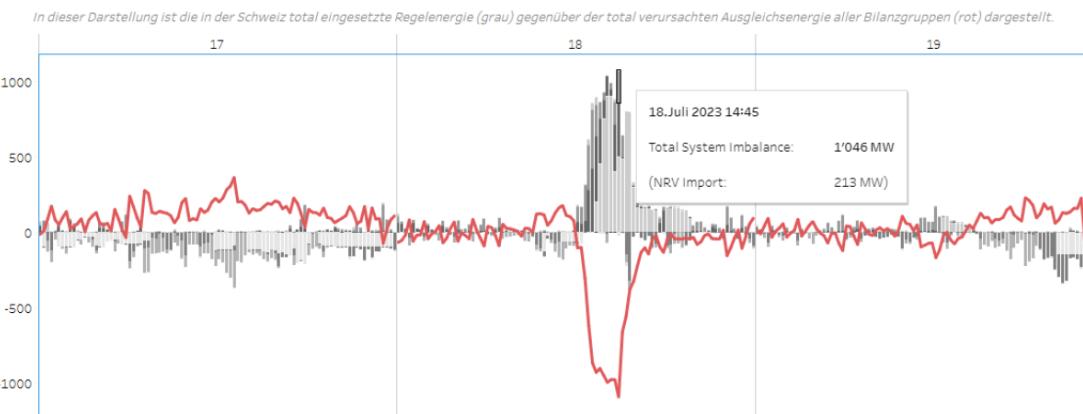
Quelle: Bearbeitung durch Zentrale Netzeleitstelle KMG

Energy-Charts.info - letztes Update: 03.07.2024, 08:43 MESZ

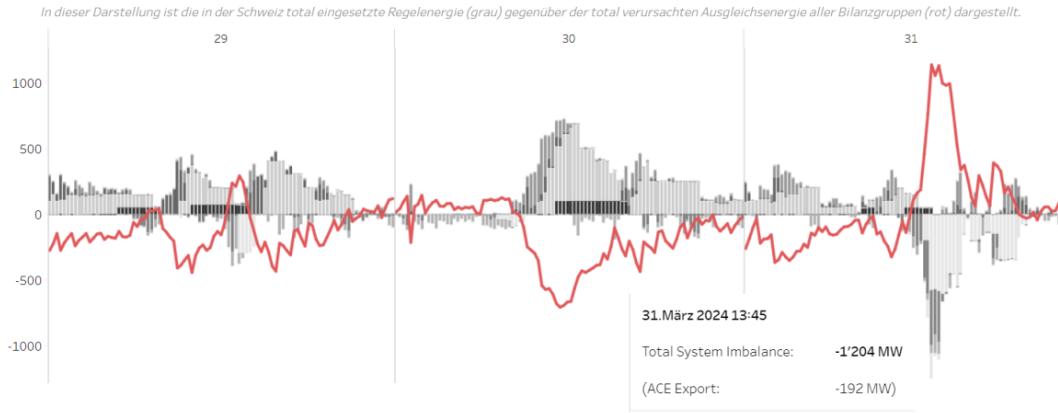
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Deviations between production and demand in the grid are increasing

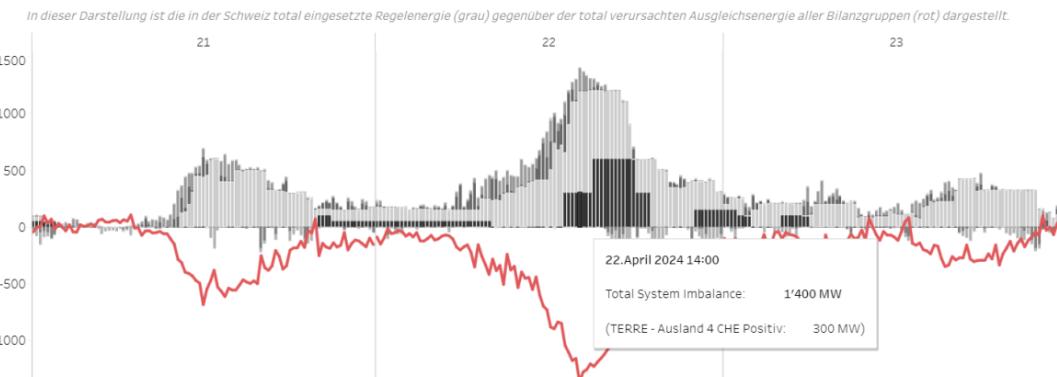
Vergleich eingesetzte Regelenergie mit verursachter Ausgleichsenergie der Bilanzgruppen
17. Juli 2023 bis 20. Juli 2023 MW



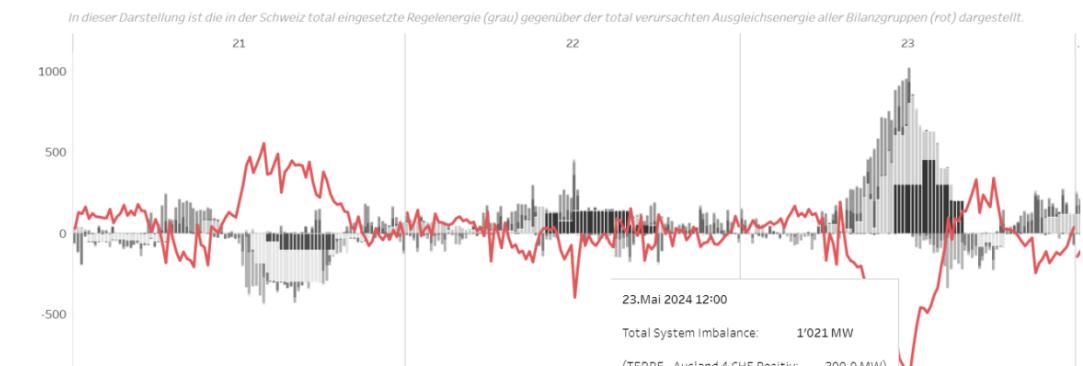
Vergleich eingesetzte Regelenergie mit verursachter Ausgleichsenergie der Bilanzgruppen
29. März 2024 bis 31. März 2024 MW



Vergleich eingesetzte Regelenergie mit verursachter Ausgleichsenergie der Bilanzgruppen
21. April 2024 bis 23. April 2024 MW



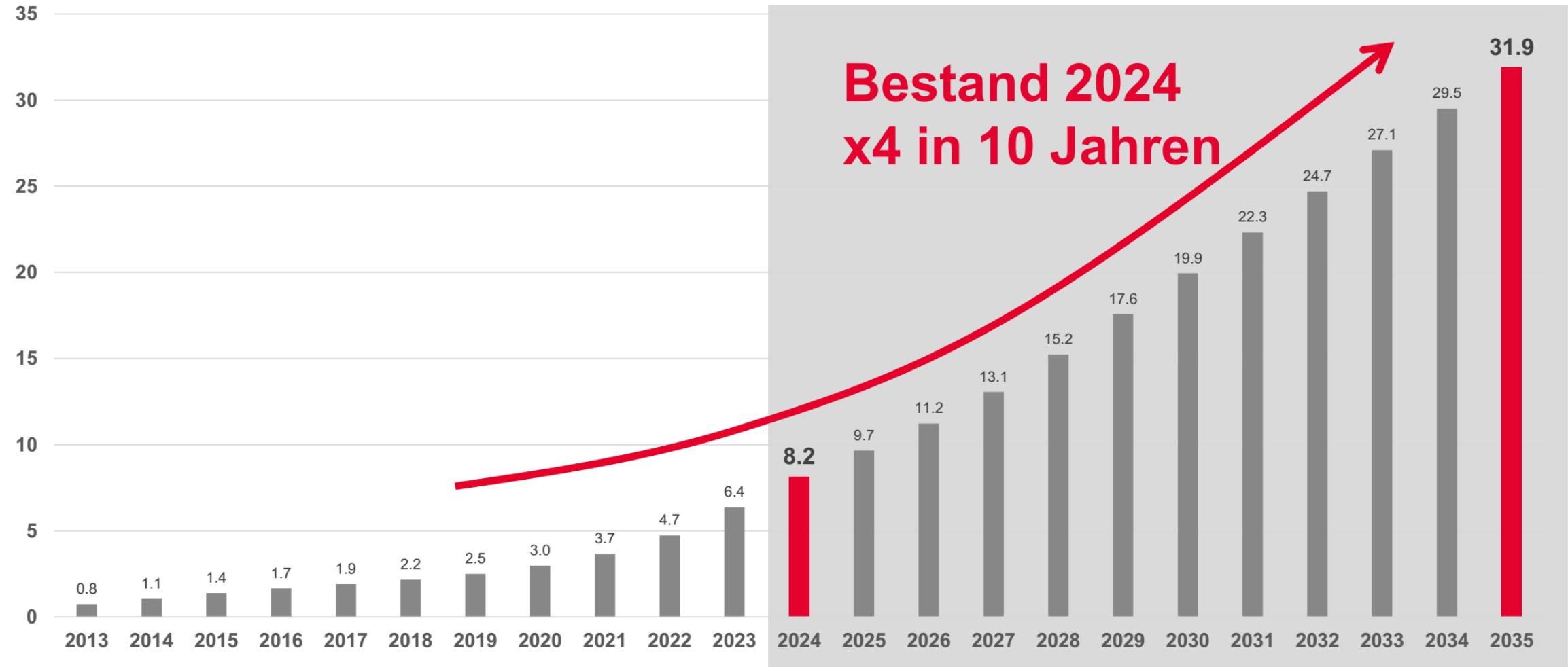
Vergleich eingesetzte Regelenergie mit verursachter Ausgleichsenergie der Bilanzgruppen
21. Mai 2024 bis 24. Mai 2024 MW



Quelle: Swissgrid

Key driver: expansion of photovoltaics

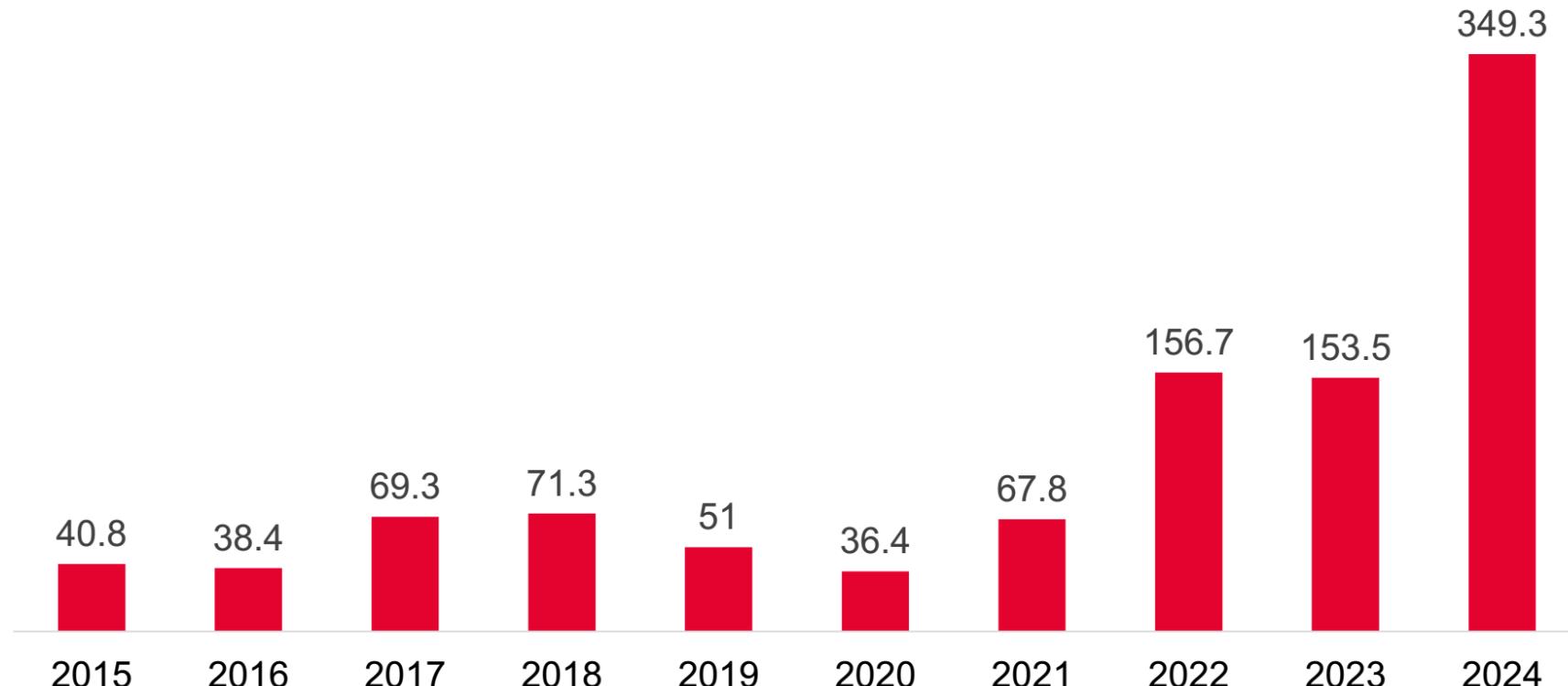
Cumulative installed PV capacity in Switzerland (in GW)



Quelle: Bestand bis 2023: Statistik Sonnenenergie BFE
Zubau ab 2024: Swissolar Solarmonitor Schweiz

Grid stability

Development of balancing energy costs (million euros)

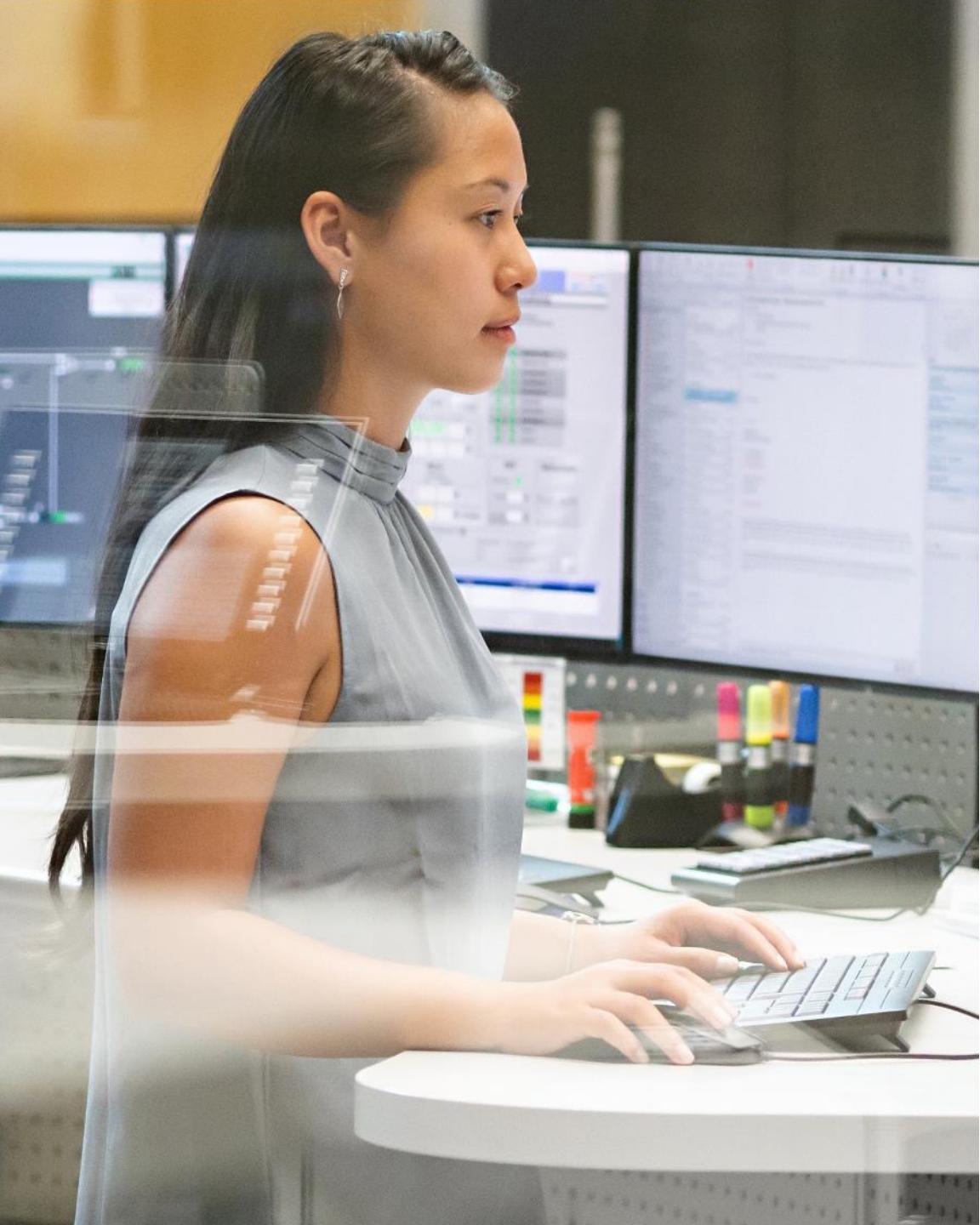
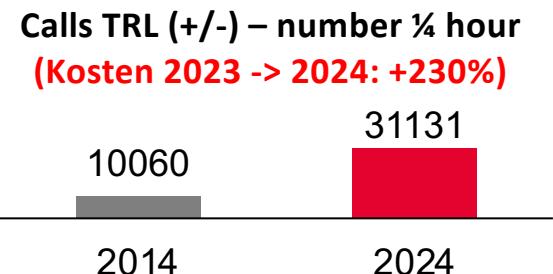
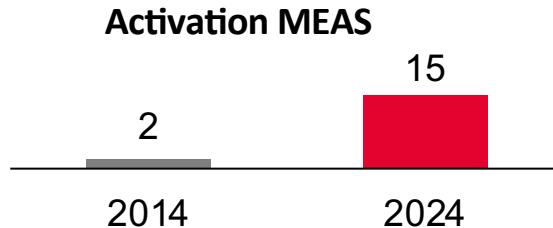
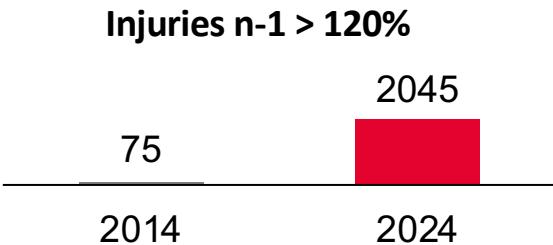
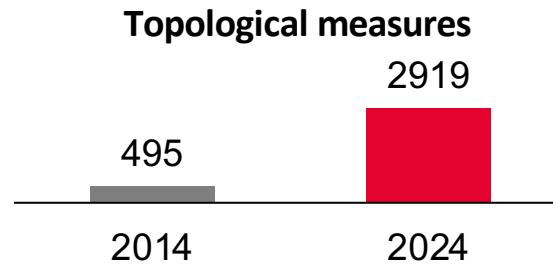
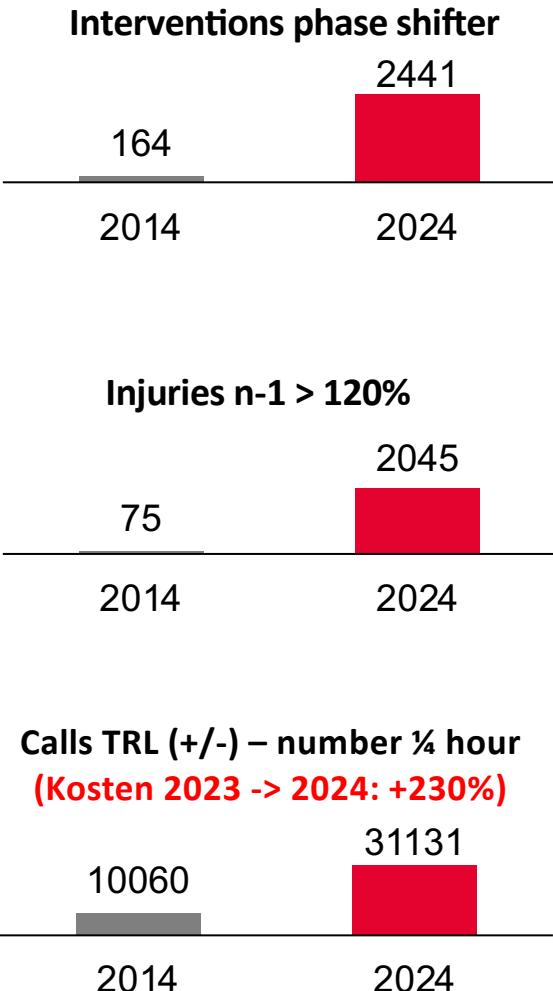
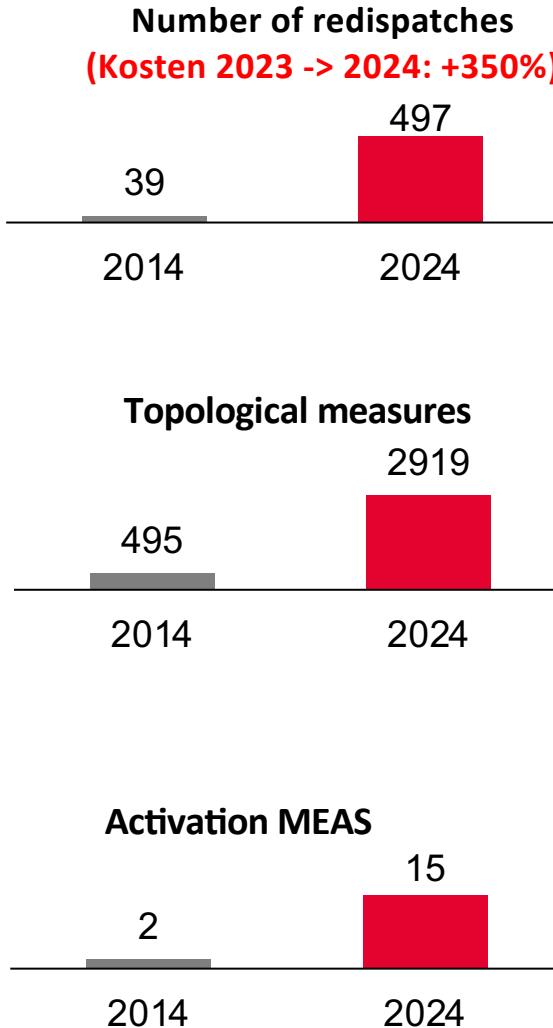


Quelle: Swissgrid-Reporting

Quelle: Swissgrid, 9. Januar 2025



The electricity system is increasingly reaching its limits: rising number of system disruptions, more frequent blackouts, rising costs.





Transition from energy producer to system service provider

 **KWO**
GRIMSELSTROM

Interval 1m

2023-01-01 00:00:00 to 2023-12-31 23:59:59 CET Refresh



Statistik im gewählten Zeitraum

Maschine	Turbinen.	Pumpen.	Blinden.	Stunden	Starts
Ma1	43.1 GWh	-152 GWh	26570 Mvarh	793	719
Ma2	109 GWh	-132 GWh	57785 Mvarh	3037	752
Ma3	125 GWh	-142 GWh	63929 Mvarh	3393	892
Ma4	143 GWh	-140 GWh	72075 Mvarh	3650	923
Gr2 Total	421 GWh	-566 GWh	220359 Mvarh	10872	3286

PSW Grimsel 2 (commissioned 1982):
700 Start/stop cycles in 1980s/1990s
3'286 Start/stop cycles in 2023



What now?



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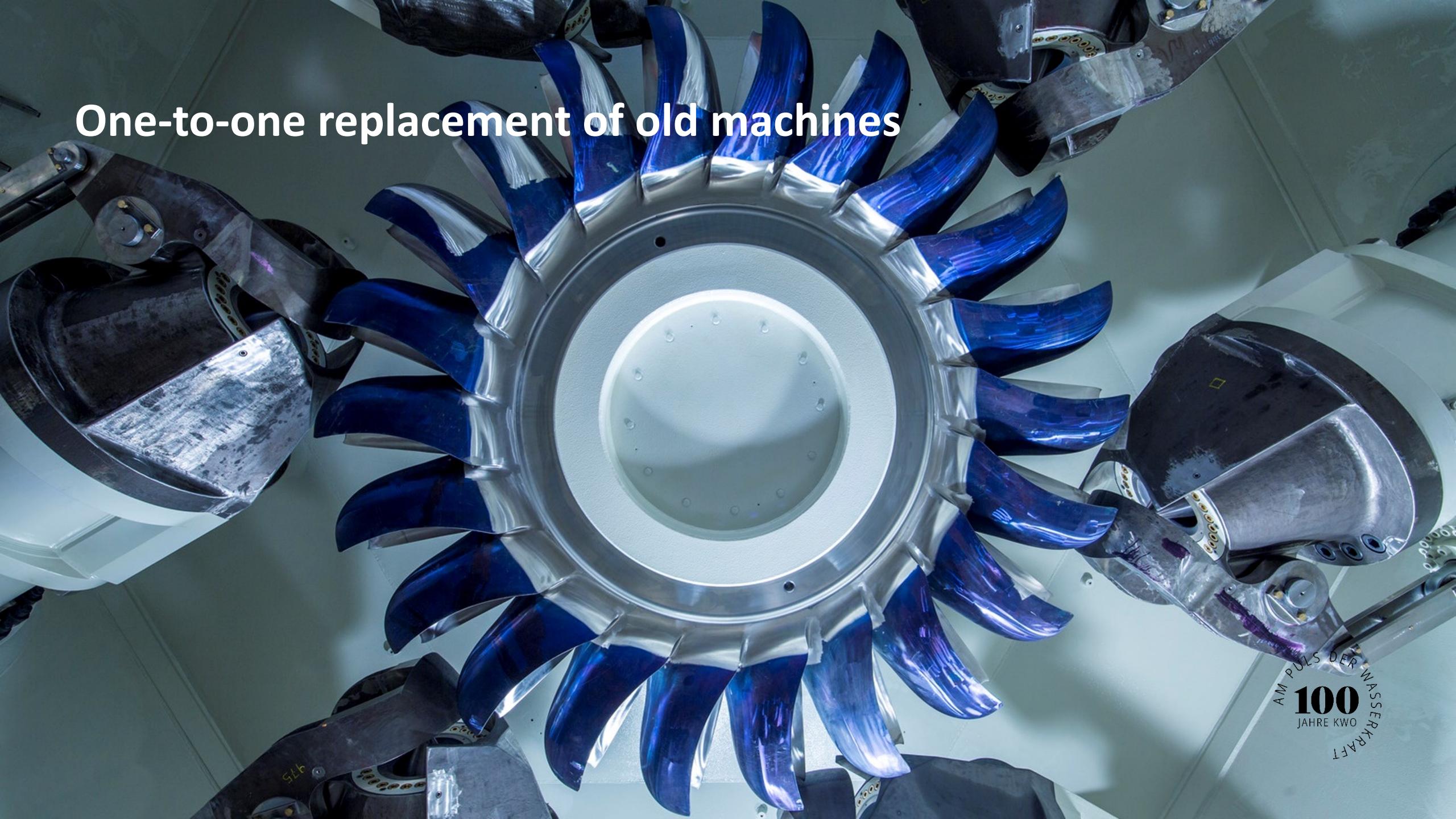
Refurbishment of machines and systems

MG1



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One-to-one replacement of old machines

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Conversion of a fixed-speed pump into a variable-speed pump

World record at Grimsel. The Grimsel 2 power station has commissioned the most powerful frequency converter for a hydraulic pump to date, with an output of 100 Mvar.

New construction of a highly flexible pumped storage power station

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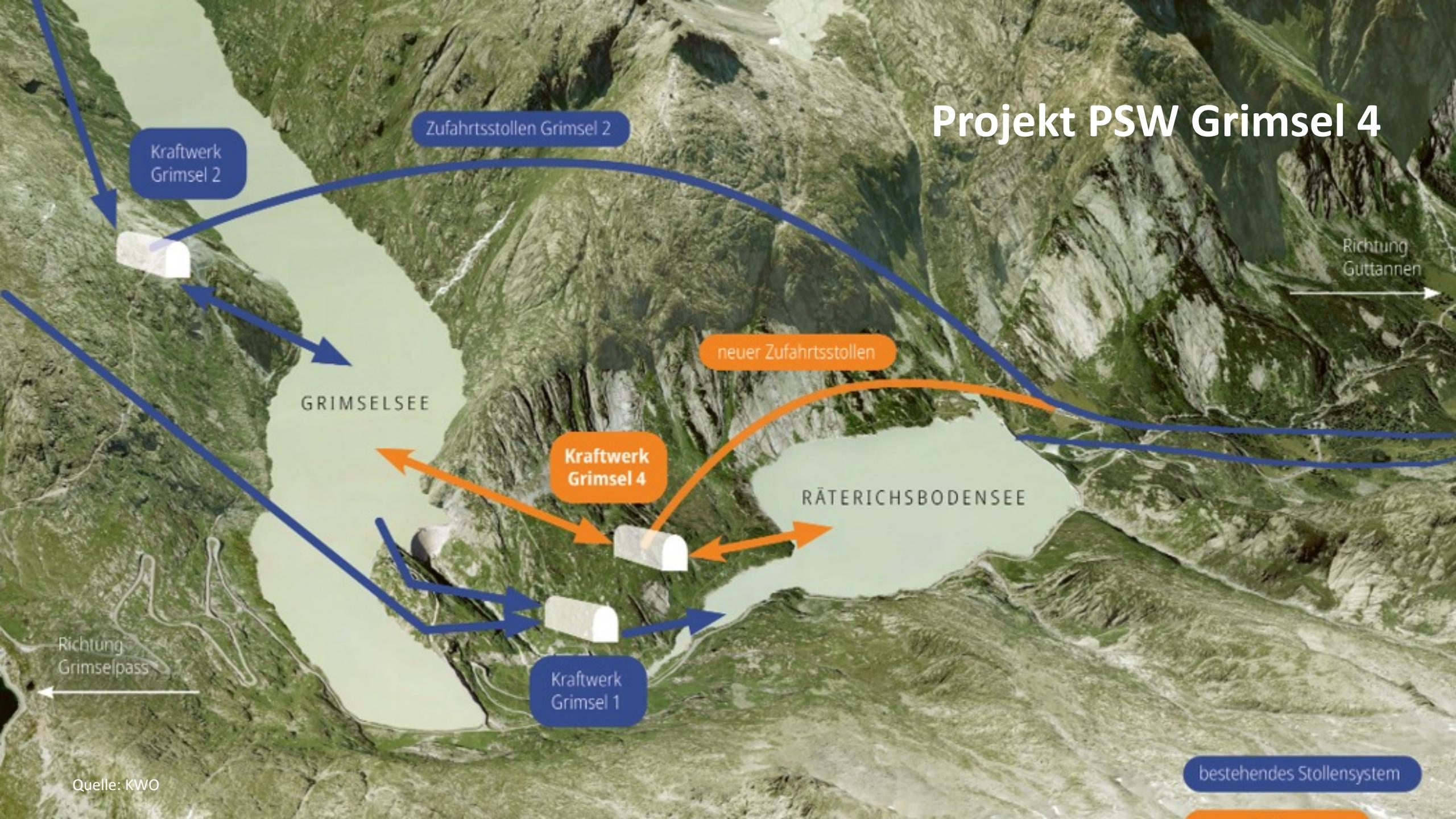
An aerial photograph of a hydroelectric power station under construction in a deep, rocky mountain valley. The reservoir is filled with water, and a large dam structure is visible. Several red construction cranes are positioned on the dam's face. In the background, a winding road follows the mountain's edge, and a small town or facility is nestled in a valley. The surrounding terrain is rugged and rocky.

Project PSW Grimsel 4

150 MW Capacity with fully converters

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Projekt PSW Grimsel 4



Project PSW Grimsel 4

Capacity Motor/Generator 2 x 75 MW

Power control range - 100 bis + 100 %

Switchover time Turbine/pump 60 s; Pump/turbine 60 s

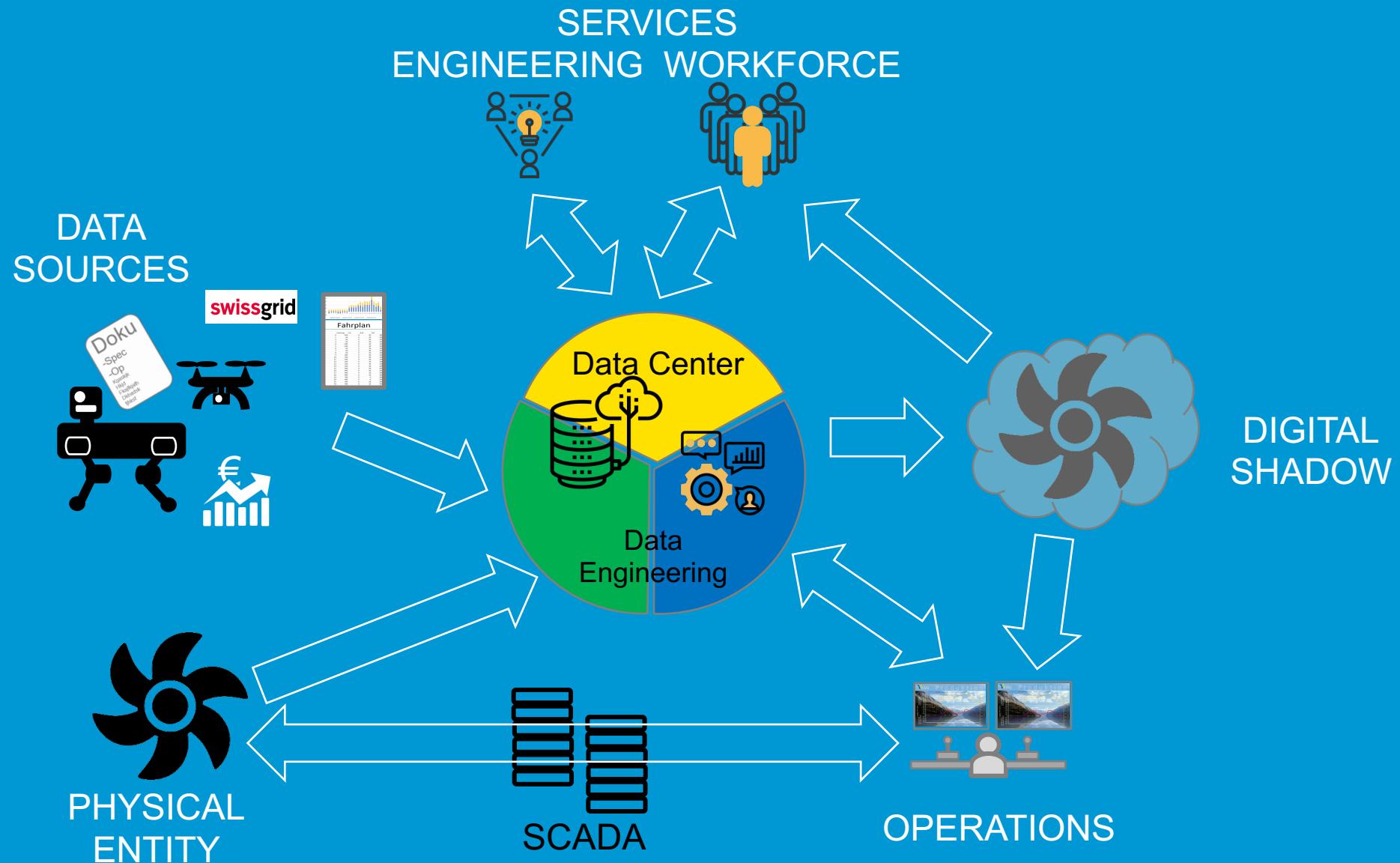
Construction time 4.5 Jahre

Start of construction At the earliest in the year of 2026

Investment costs approx. 250 Million Swiss Francs (Stand 2025)

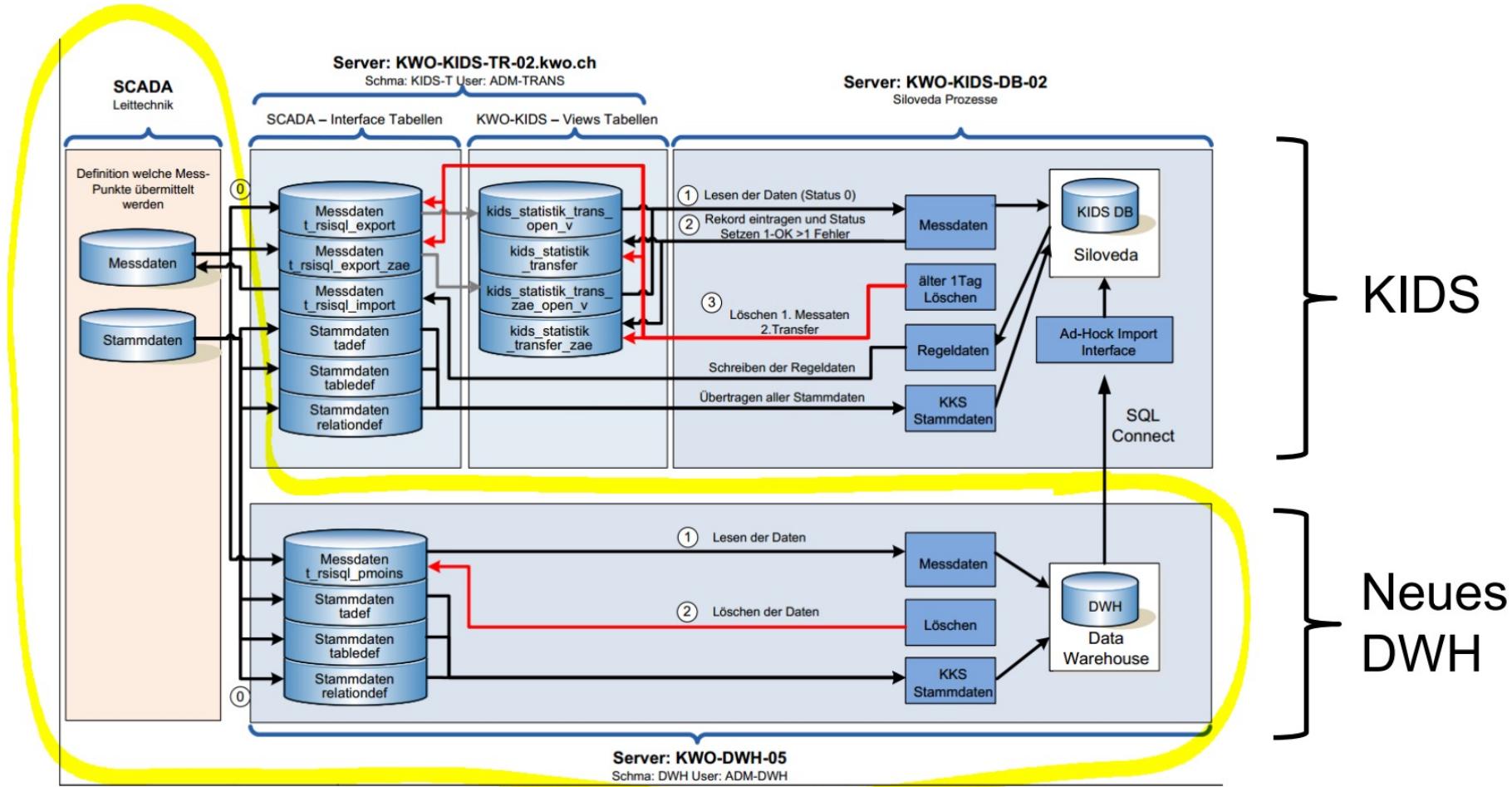
Data are essential for monitoring the service life of machines

Concept of data collection and handling



Provision of data for evaluation

Separate Data Warehouse for operational and engineering data

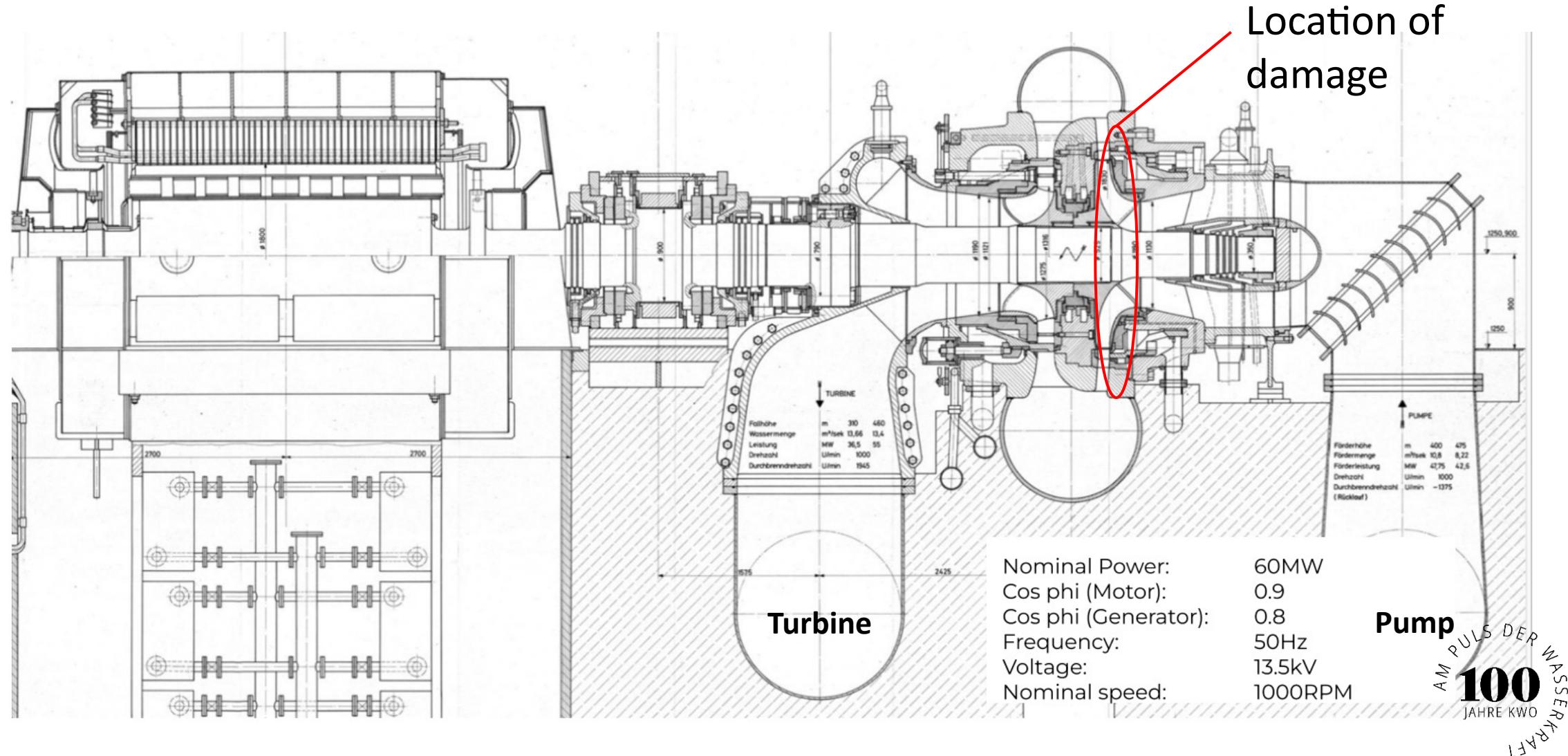


Every 10 seconds, 500-1000 pieces of data are transferred to the database.
→ Every Day 7 – 8 Mio. measured values

Quelle: KWO

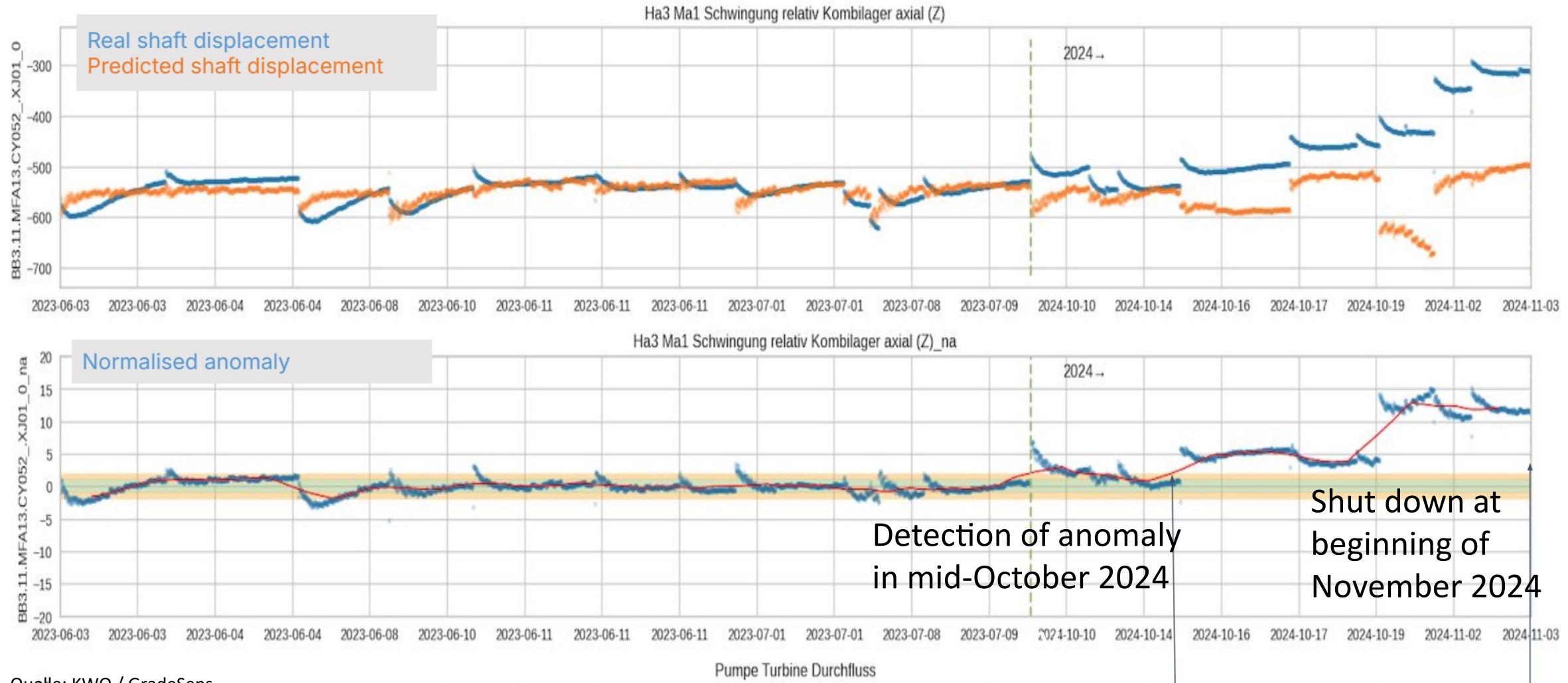
Example of data analysis

Investigation into whether a machine breakdown could have been detected at an early stage.



Example of data analysis

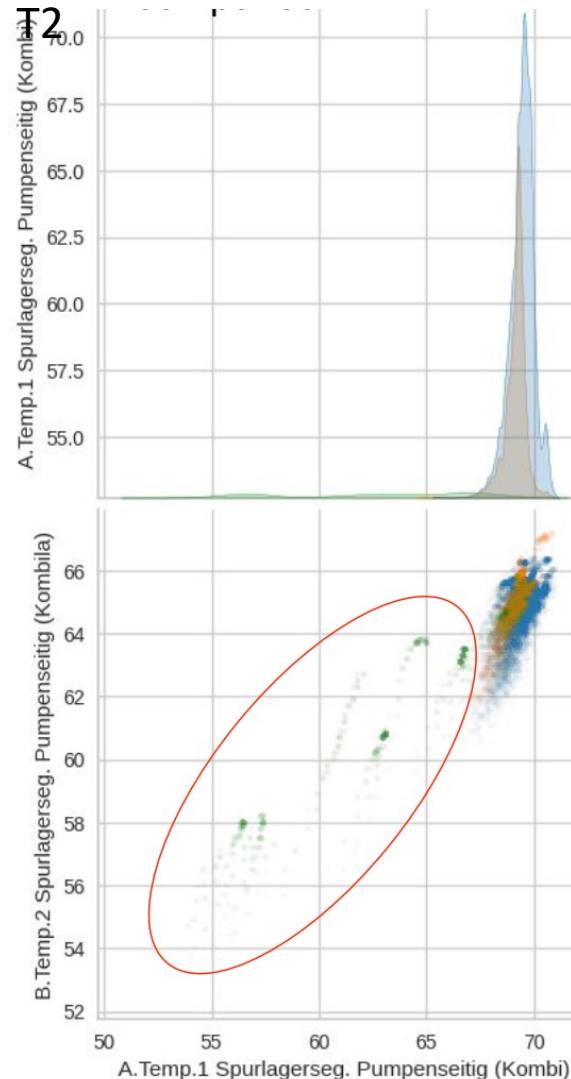
Example with measurement data evaluation of the axial shaft position of the machine



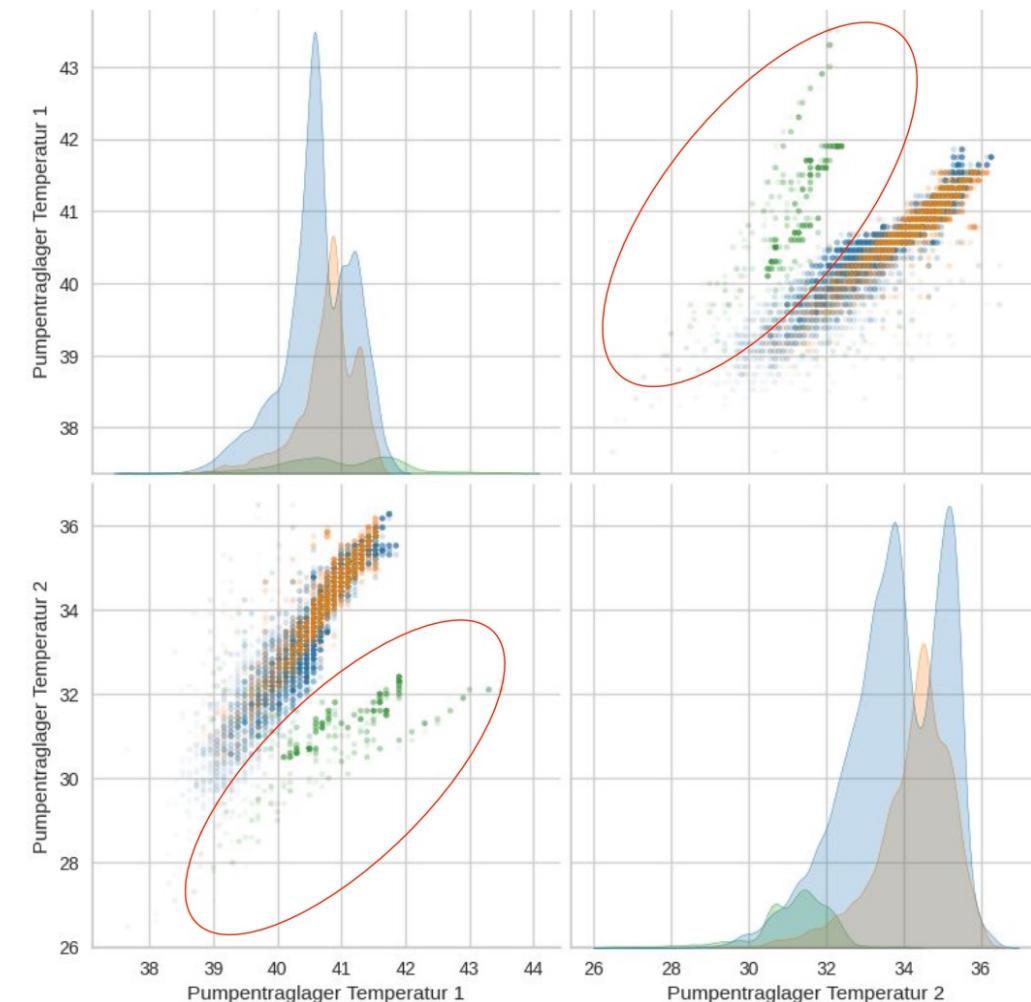
Example of data analysis

Analysis of pump-thrust and radial pump bearing temperatures

Comparison temp. thrust bearing in pump mode: T1 &



Comparison temp. pump bearing in pump mode: T1 & T2



Quelle: KWO / GradeSens

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