Extraordinary analyses winter 2022/2023

Findings and recommendations

5 Sept. 2022

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The brief

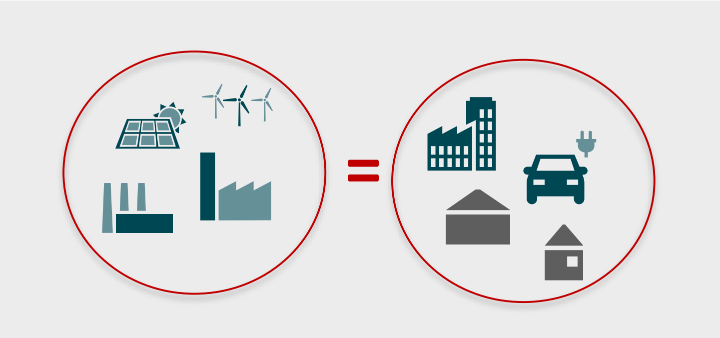
The Federal Ministry of Economics and Climate Protection (BMWK) asked the four transmission system operators responsible for the four control areas to carry out extraordinary analyses for winter 2022/23. They investigated three different scenarios for the power supply situation in winter 2022/23, each with increasingly critical assumptions (+, ++, +++), from two perspectives. First, whether the **demand for electricity will be met (demand balancing)** and second, whether **grid security (transmission adequacy)** will be achieved.

Compared to the first extraordinary analysis (March to May 2022), which focused primarily on saving gas, this second extraordinary analysis is based on significantly more onerous assumptions with regard to non-availability of power plant capacity in Germany and Europe and to identify different types of stress situations for electricity demand and grid security. The medium scenario (++) includes a sensitivity analysis of the effects of operating the Emsland, Isar and Neckarwestheim nuclear power plants in stretch-out mode until their existing fuel rods have been exhausted in the first quarter of 2023.

In addition, further basic recommendations for action were developed for the stress situations identified.

Examining electricity demand (load)

Demand balancing analysis



Objective:

- To determine the **capability to cover demand** in a market area
- Can the **demand** for electric power be **met at all times**?

Methodology for the extraordinary analysis for winter 2022/23:

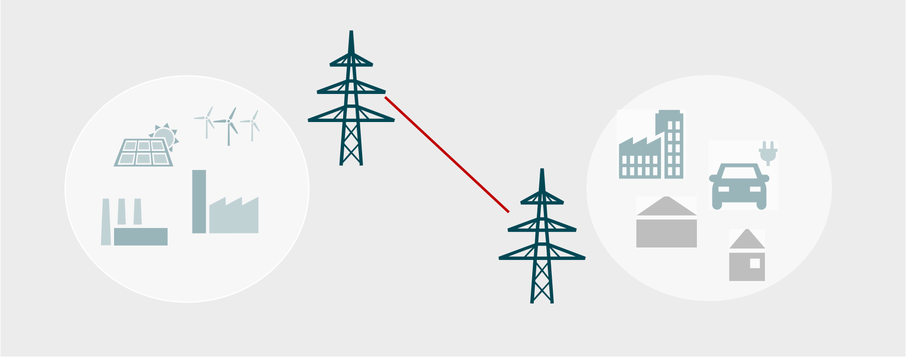
- **Demand balancing analysis** for a selected year, with load, renewable generation, availability of the conventional, dispatchable power generation examined in hourly resolution.
- Deployment of the conventional, dispatchable generation capacities in Europe by market simulation.
- **Dispatch of resource-dependent renewable generation** based on an hourly resolution of the relevant **weather data** (wind, solar) from **2012**.
- **Loss of load** occurs at times when it is not possible to meet demand by domestic generation and imports from abroad.
- Note: no considerations of **adjustments of demand due to scarcity warnings/high prices**.

The significance of the findings:

- **The calculated loss of load in one hour of the period under consideration is a deterministic value. It is determined in particular by the non-availability of generation plants and the weather conditions during 2012, which saw a severe cold spell in this hour in February, in this hour.**
- Note: Calculating resource adequacy on the basis of a single annual run is not particularly representative. It is normally determined by probabilistically examining the combination of a large number of weather years with many stochastic instances of non-availability of conventional generation plants in hourly resolution.

Examining the grid

Grid security analysis for Germany



Objective:

- **Identification** of a **congestion-free** and **secure grid status** in the German market area
- Can electrical energy be transported from power generation plants to centres of electricity consumption to meet demand at all times while maintaining grid security?

Methodology for the extraordinary analysis for winter 2022/23:

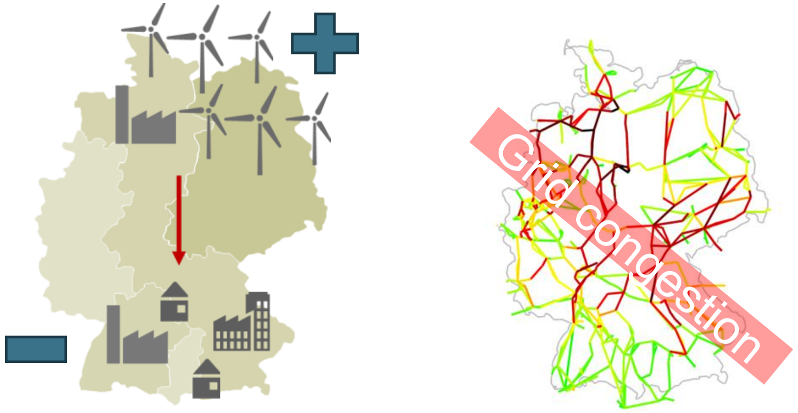
- Assessment of the interventions in the **market-based deployment of power plants** needed to establish power grid security.
- Identification of the **redispatch potential required** to maintain grid security in Germany and Europe.
- Dimensioning based on grid analyses (load flow calculation and optimisation) for **critical grid situations (CGS)**.

The significance of the findings:

- The grid security analysis identifies the redispatch potential required from domestic **reserve power plants** and from ones outside of Germany to manage the critical grid situations identified in Germany.
- Assumption: The dimensioning of the redispatch potential needed to establish grid security in a critical situation also applies to all other grid situations in the period considered by the analysis in which this potential is (partially) deployed.
- Note: This analysis is based on an established procedure that is routinely published annually in the spring as a "Demand Analysis for reserve capacities."

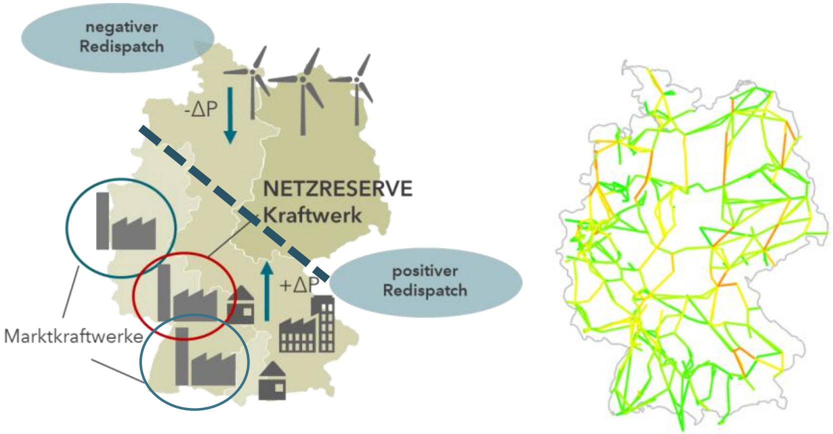
How redispatch is used to maintain grid security

Initial situation: congestion in the German grid



- **Northern Germany:** surplus electricity generation (wind/power plants), **Southern Germany**: high demand
  →too much in north east/too little in south west
- North east/south west transmission via power lines
- Congestion in the grid → grid stressed/power lines overloaded
- The transmission of energy exports aggravates domestic congestion

Mitigation of congestion through redispatch



- **Mitigating congestion** through:
  - **Negative redispatch**
    Reducing energy generation (wind/power plants) in north/east
  - **Positive redispatch**
    Increasing power generation in the south/west through market and reserve power plants + additional power plants abroad if ramp-up potential in Germany is insufficient
- Energy balancing ensures a congestion-free grid with no overloading

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Overview of the scope and input parameters of the analysis

All extraordinary analyses are based on the 2022 t+1 demand analysis in accordance with Section 3 (2) NetzResV.

Examining demand → Is there a risk that a lack of generation capacity will cause a loss of load?

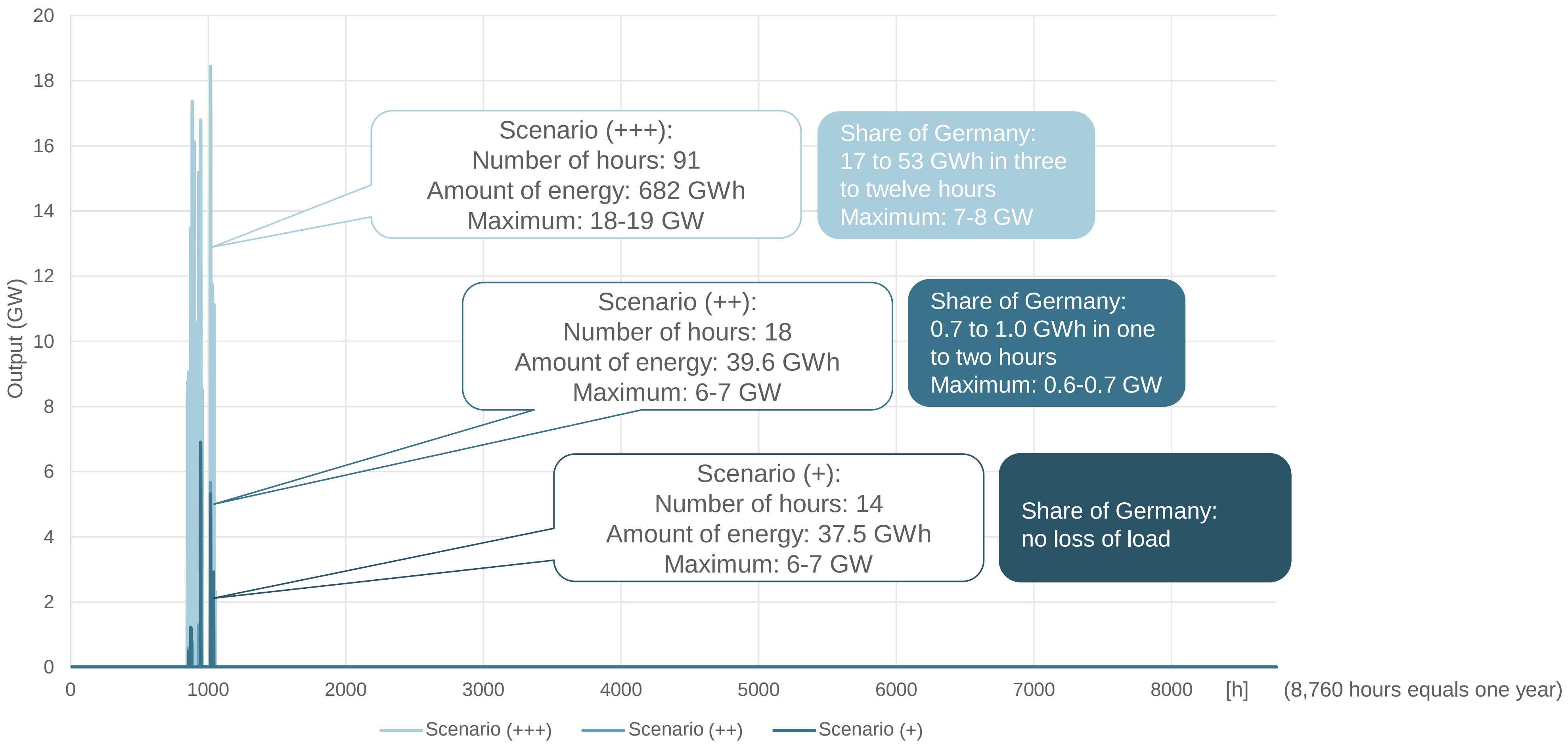
Examining the grid → Is grid security in place?

Examining the reduction of gas consumption in the electricity sector

Measure examined: Scenario (++) with NPPs in stretch-out operation

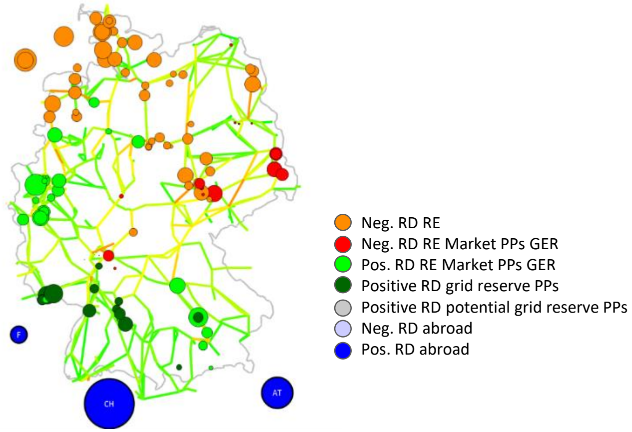
Assumptions	Demand analysis 2022	extraordinary analysis 1	extraordinary analysis 2 Scenario (+)	extraordinary analysis 2 Scenario (++)	extraordinary analysis 2 Scenario (+++)
Max. NPP availability in FR:	61 GW	51 GW	45 GW	45 GW	40 GW
Grid reserve and security reserve generators returning to market: availability	-	-	6.1 GW	5.0 GW	4.6 GW
Hard-coal-fired power plants: Reduced capacity due to low water situation	-	-	- 2 GW	- 3 GW	- 3.75 GW
Grid reserve availability:	6 GW (100%)	6 GW (100%)	4.5 GW (75%)	4 GW (67%)	3 GW (50%)
Gas availability in southern Germany and Austria:	100%	100%	100%	75%	50%
Load increase due to fan heaters:	-	-	1.5 GW/2.5 TWh	1.5 GW/2.5 TWh	2.5 GW/5.0 TWh
Gas price:	€68/MWh	€200/MWh	€300/MWh	€300/MWh	€300/MWh

Loss of load in Europe and Germany



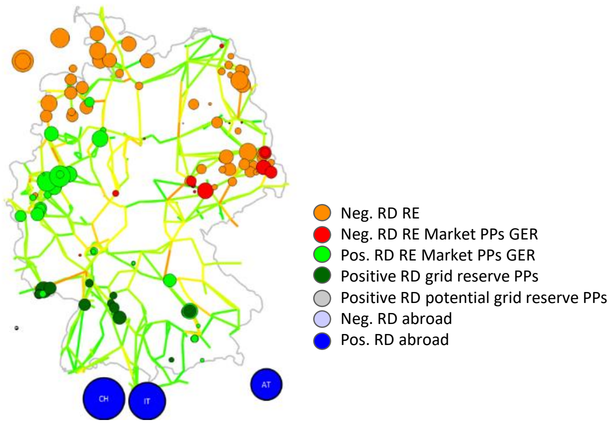
Grid situation during most critical hour (strong wind/strong load)

Scenario (+)



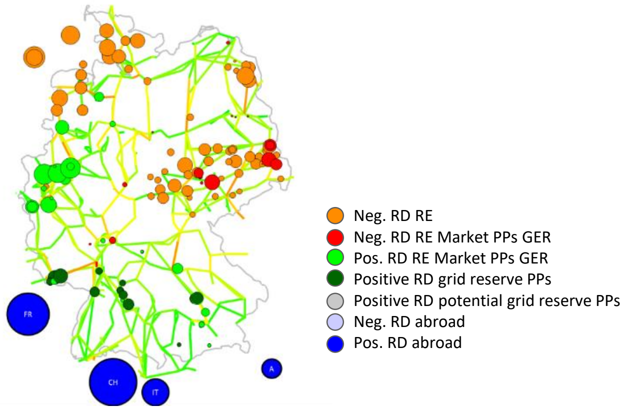
- **Total redispatch requirement:** 17.5 GW
- In Austria, a contractually guaranteed 1.5 GW is available for redispatch
- **Additional positive redispatch requirement of 4.3 GW abroad**

Scenario (++)



- **Total redispatch requirement:** 18.2 GW
- In Austria, a contractually guaranteed 1.5 GW is available for redispatch
- **Additional positive redispatch requirement of 5.1 GW abroad**

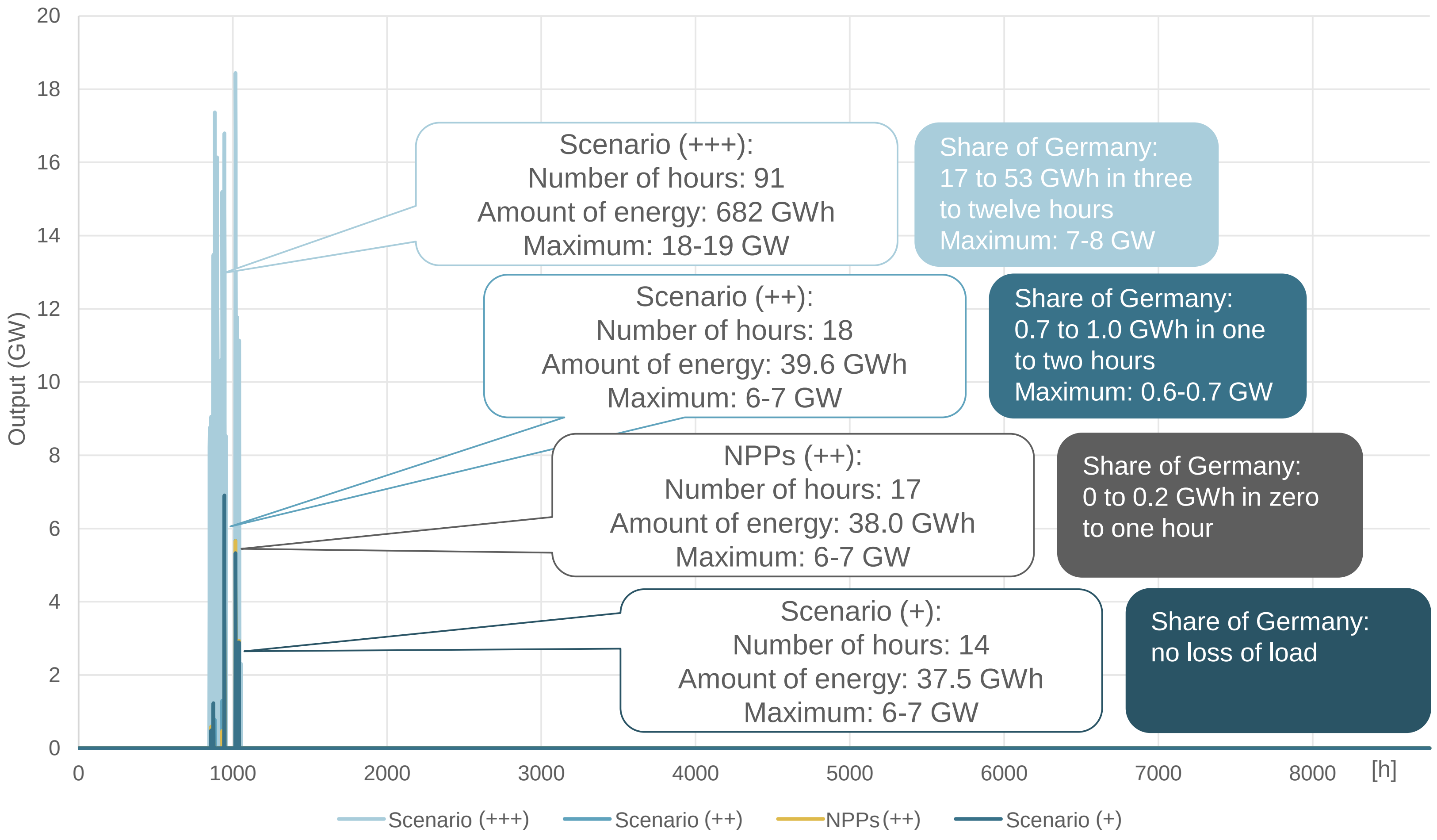
Scenario (+++)



- **Total redispatch requirement:** 18.8 GW
- In Austria, only 0.3 GW is available for redispatch in Germany once the domestic demand has been covered.
- **Additional positive redispatch requirement of 8.6 GW abroad**

To identify the most critical situation for the grid, a strong wind/strong load situation and a situation with low feed-in from renewables were investigated within a synthetic week in winter.
The **highest demand for additional redispatch abroad** was identified **in one hour of the strong wind/strong load situation**.
This is the **most critical situation for the grid**.

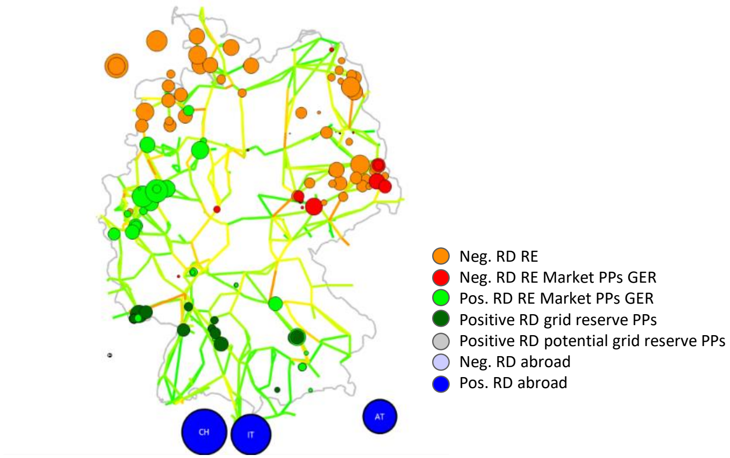
Loss of load in Europe and Germany with NPPs continuing to operate in stretch-out mode in scenario (++)



(8,760 hours equals one year)

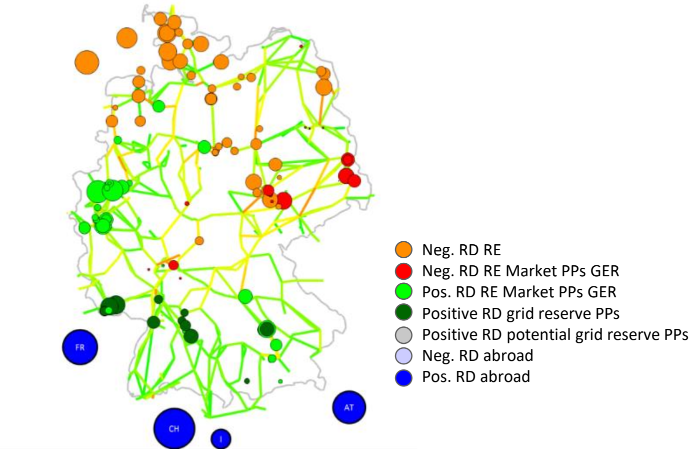
Grid situation in Germany with NPPs operating in stretch-out mode during the most critical hour

Scenario (++)



- **Total redispatch requirement:** 18.2 GW
- In Austria, a contractually guaranteed 1.5 GW is available for redispatch
- **Additional positive redispatch requirement of 5.1 GW abroad**

Scenario with NPPs (++)



- **Total redispatch requirement:** 16.8 GW
- In Austria, a contractually guaranteed 1.5 GW is available for redispatch
- **Additional positive redispatch requirement of 4.6 GW abroad**

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Key findings

- **Demand balancing:** **In each of the three scenarios examined, the supply situation** in the coming winter half-year appears **extremely tight** - In Europe, the electricity market is **unable to fully meet demand**.

  In the two more critical scenarios (++, +++), **loss of load** occurs at some times **in Germany as well**.

- **Grid security:** The domestic redispatch potential is not sufficient to manage grid congestion in any of the three scenarios. At least **5.8 GW of guaranteed potential** is needed from abroad, 1.5 GW of which is held in reserve via a redispatch agreement with Austria. A further approximately 1.6 GW is currently contracted (result of the 2022 demand analysis, call for expression of interest currently underway).

  However, the actual availability of these quantities is uncertain, due to the tight supply situation throughout Europe.

- **Effect of operating nuclear plants in stretch-out mode in scenario (++):**
  - **General effect in the market:**
    - The three nuclear power plants provide an additional approx. 5 TWh of electrical energy.
    - The electricity generation savings in gas-fired power plants is 0.9 TWh_{el} domestically and 1.5 TWh_{el} in other European countries.
  - **Demand balancing**: Loss of load in Germany can be largely avoided by operating the nuclear power plants in stretch-out mode in scenario (++).
  - **Grid security**: The demand for redispatch potential abroad to manage congestion decreases by 0.5 GW from 5.1 GW to 4.6 GW thanks to the continued operation of the nuclear power plants in stretch-out mode in scenario (++), but remains critical. **Additional measures are therefore needed in Germany for generation- and demand-side congestion management and to increase the transmission system's transport capacities.**

Recommendations of the transmission system operators (I)

It is strongly recommended that all available options for increasing power generation and transport capacities are exploited, specifically:

1. **Increase transport capacity:** The additional potential of weather-dependent overhead line operation should be exploited in the short term to increase north-south transport capacity.
2. **Focus on redispatch potential abroad:** This requires clear, binding arrangements with neighbouring countries.
3. **Contractual load management:** Short-term potential needs to be leveraged.
4. **Make reserves more widely available for stress situations.** All reserves (including grid reserves and special technical grid operating facilities) must be made available for demand balancing and redispatch.
5. **Secure the availability of additional power plant capacity in stress situations.**
   a. Make it easier for reserve coal-powered plants to return to the market (permits, cost recognition/cost coverage).
   b. The supply of gas for all gas-fired power plants required in a stress situation must be secured.
   c. The availability of nuclear power plants is another instrument for managing critical situations (see analysis findings).

All of these recommendations require timely legislative or government action.

If all of these measures prove to be insufficient, exports will have to be restricted and as a last resort, the supply to large consumers will have to be restricted or temporarily suspended in order to maintain grid security.

Recommendations of the transmission system operators (II)

Specific actions to be implemented

	Contribution to demand balancing	Contribution to grid security
Increase transport capacities (by 1 to 2 GW*)	./.	Contribution to reducing the redispatch requirement: depending on the grid topology
Increase the short-term potential of contractual load management	1.5 to 3 GW**	depending on location
Ensure the wider use and maximum availability of reserves	6 GW (grid reserve***)	./. already fully secured
	1.1 GW (capacity reserve) – already fully secured, earlier deployment a worthwhile option	depending on location
	0.6 GW (special technical grid operating facilities)	depending on the deployment model
Enable power plants to return to the market****	up to 6.7 GW	depending on location
Enable avability of nuclear power plants	3 GW (January) 2.75 GW (February) 2.5 GW (March)	Contribution to reducing redispatch requirements from abroad: 0.5 GW

* quantitative estimate
** data from external studies (Guidehouse/ffe, r2b).
*** grid reserve remaining after return to market
**** The extraordinary analysis assumed as a working hypothesis that 6.7 GW would return to market from the grid and security reserves.

Contact

50Hertz Transmission GmbH
Heidestraße 2
10557 Berlin
E-Mail: info@50hertz.com

Amprion GmbH
Robert-Schuman-Straße 7
44263 Dortmund
E-Mail: info@amprion.net

TenneT TSO GmbH
Bernecker Straße 70
95448 Bayreuth
E-Mail: info@tennet.eu

TransnetBW GmbH
Heilbronner Straße 51 – 55
70191 Stuttgart
E-Mail: info@transnetbw.de