» Grid Incident in Czech Republic on 4 July 2025

ICS Investigation Expert Panel
Factual Report

19 December 2025

Preamble

The following Technical Report, concerning the system event which occurred on 4 July 2025 in Czech Republic, has been prepared and issued by the Incident Classification Scale Investigation Expert Panel and is based on information as known on 8 December 2025.

The purpose of this report is to provide a technical and objective account of the incident, based on factual evidence. It aims to support transparency, learning, and continuous improvement in system operation across Europe. While this report is based on most reliable data made available to the Expert Panel by a range of data providers, no representation or warranty, express or implied, is made as to the fairness, completeness or correctness of information and opinions contained in this document. Importantly, the report is not intended to allocate liability or responsibility to any party and may, therefore, not be interpreted in such way.

It serves solely as a factual record to transparently inform stakeholders and governance bodies, and to facilitate further discussion and evaluation within the context of the final report referred to hereafter. This report has been agreed and prepared by the Expert Panel and is without prejudice to any investigation or enforcement action that may be taken by the competent authorities.

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1 MANAGEMENT SUMMARY

1.1 Introduction

On 4 July 2025, the power system in the Czech Republic experienced a sequence of events lasting about 8 minutes, starting with the tripping of the V411 Hradec–Výškov 400 kV line at 11:51:08 CEST and ending with a loss of about 28 % of consumption in the ČEPS control area. The operation of the interconnected European grid continued as usual, and no other country was affected by the incident. This factual report outlines the events of that day, including the operational planning, the conditions before the incident, the evolution of the incident and the subsequent restoration. It provides information on both the operational and market perspectives. Transmission system operators (TSOs), distribution system operators (DSOs), and significant grid users (SGUs) in the Czech Republic, as well as the relevant regional coordination centres (RCCs), provided the relevant information in this report. It will serve as a basis for the final report, which will analyse the information and draw recommendations.

1.2 System state and market conditions before the incident

With the ongoing energy transition, ČEPS faces significant investments to modernise and maintain the grid. On 4 July, ten 400 kV lines and one 220 kV line had scheduled outages due to modernisation and increase of parameters and two 400 kV lines were unavailable due to maintenance and repairs.

During weekly operational planning, the planners verified operational security limits, including transient stability, by assessing critical clearing times, and prepared remedial actions for three identified contingencies to keep the system N-1 secure. In the daily coordinated security analysis (the day-ahead congestion forecast (DACF) facilitated by TSCNET), preventive remedial actions were implemented in the model, including reconfigurations in 400 kV substation Hradec západ and 220 kV substation Čechy střed. Additional contingencies were identified, in which the transitory admissible overloads of the affected elements would allow the implementation of corrective measures.

The contingencies identified in intraday and real-time operations before the incident were consistent with the contingencies identified in the operational planning phase. At 11:01, the dispatchers applied the reconfiguration at the Čechy Střed 220 kV substation. At 11:17, the DSO operator requested permission to couple the 110 kV Řeporyje and Výškov areas to perform scheduled switching in the distribution network, thus creating a parallel connection to the transmission system. The ČEPS dispatcher authorised the coupling, and the two areas were coupled from 11:19 to 11:41.

The most critical element with a contingency identified before the incident was the 400/220 kV transformer at the Hradec substation in the event of the V411 line loss. The flow on the element would be 114.5 % (at 11:42). The contingency was solved by allowing a curative transitory admissible overloading of the transformer (120 % up to 3 h) and a curative reconfiguration at the Hradec Západ 400 kV and Čechy Střed 220 kV substations, had the contingency happened.

At 11:51, right before the incident, all other contingencies were modelled to result in a loading on monitored elements below 100 %, including the 220 kV V208 Čechy Střed–Milín line following the loss of line V411, which was at 98.2 %. The V411 line was transmitting about 1,200 MW, which corresponds to 76.8 % of capacity.

Production in the affected area comprised:

- 292 MW by transmission-connected Ledvice unit 6 (660 MW installed capacity, lignite)
- 282 MW by transmission-connected Počerady units 2 and 6 (205 MW installed capacity each, lignite)
- 141 MW by transmission-connected Chvaletice unit 4 (205 MW installed capacity, lignite)
- 74 MW by distribution-connected Ledvice unit 4 (110 MW installed capacity, lignite)
- 534 MW by distribution-connected power-generating modules.

1.3 Evolution of system conditions during the event

At 11:51:08, line V411 tripped (in all phases) following an unsuccessful autoreclosure in phase 2. The affected area remained connected to the rest of the system at three points: line V208, the busbar coupler at the Krasíkov 400 kV substation, and the 400/110 kV transformer at the Krasíkov substation. Within five seconds, the transmission-connected Ledvice (unit 6) and Počerady (units 2 and 6) power plants and the distribution-connected Ledvice power plant (unit 4) switched to droop speed control mode after detecting a frequency deviation above 200 mHz.

At 11:51:46, Ledvice unit 6 suffered a boiler outage due to a high steam temperature behind a high-pressure bypass station and began losing active power.

By 11:52, the ČEPS estimated system lost between 340 and 440 MW of active power, including:

- 110 MW decrease identified at Ledvice unit 6;
- 25 MW at Ledvice unit 4;
- 135 MW at distribution-connected renewables.

At 11:52, the situation in the transmission system worsened with some elements overloading:

- 220 kV line V208 at 126.1 % (912 A);
- 400/220 kV transformer at the Hradec substation at 119.3 %;
- busbar coupler at the Krasíkov 400 kV substation at 105.1 %.

At 11:52:45, the Ledvice unit 6 lost all remaining active power output. Subsequently, between 11:53 and 11:59, the situation further deteriorated with overloads increasing to:

- 220 kV line V208 at 142.9 % (1,035 A);
- 400/220 kV transformer at the Hradec substation at 121.6 %;
- Busbar coupler at the Krasíkov 400 kV substation at 115.5 %.

At 11:59:44, the ČEPS operator switched off the overloaded line V208. At this point, the affected area remained connected to the rest of the system through a busbar coupler and the 400/110 kV transformer at the Krasíkov substation.

At 11:59:47, the overcurrent relay opened the Krasíkov busbar coupler. The relay was set to 2,880 A (144 %) with a 3-second delay. 73 ms after the opening of the Krasíkov busbar coupler, the distance protection at the 110 kV side of the 400/110 kV transformer at the Krasíkov substation tripped. The transformer was the last connection between the affected area and the rest of the system, thus creating an island after it was tripped.

Within 780 ms, the island collapsed due to a significant power deficit of about 1,800 MW, which could not have been compensated by low-frequency demand disconnection (LFDD). The highest rate of change of frequency (RoCoF) recorded was 3.5 Hz/sec (over a 500-ms sliding interval). This resulted in the disconnection of Počerady units 2 and 6 and Chvaletice unit 4 to house load operation, tripping of pumped-storage Dlouhé Stráně unit 2 from pumping, and loss of the remaining distributed generation in the area. The total production loss in the affected area was between 1,200 and 1,400 MW. The total loss of load was about 2,300 MW, or 28 % of the ČEPS control area's consumption.

1.4 Preliminary causes of the initial faults

The unsuccessful autoreclosure of V411 in phase L2 was caused by a cable break. After further examination and analysis, it was found that the tensile coupling had an insufficiently tight connection at the aluminium part of the conductor. Ultimately, the rope at the coupling broke, and the conductor fell.

Unit 6 of the Ledvice power plant lost all active power output due to a boiler outage caused by high steam temperature behind the high-pressure bypass stations.

The high temperature was due to a stuck high-pressure turbine bypass valve, caused by a defective relay on the actuator motor for that valve.

The reason for the distributed generation disconnection will be investigated in more detail in the final report. The Expert Panel has issued additional data requests.

1.5 Restoration process

The restoration process began immediately after the event. At 12:09, the system state in the ENTSO-E Awareness System (EAS) was changed to emergency. Given that most of the grid was unaffected, the dispatchers decided to apply a top-down strategy and energise the affected area from two sides: the 400 kV grid from the Krasíkov 400 kV substation and the 220 kV grid from the Čechy Střed 220 kV substation. In both substations, one busbar remained energised from the unaffected grid. First, the dispatchers applied an open-all strategy in the affected transmission substations. At 12:19, dispatchers energised the first substation in the affected area – Týnec 400 kV substation. The dispatchers continued energising substations, with priority given to those supplying the capital Prague (the Chodov 400 kV substation and the Malešice 220 kV substation). At 12:30, both 220/110 kV transformers at the Malešice substation were energised, allowing load pickup in Prague. At 13:01, the Chodov 400 kV substation was energised, with two 400/110 kV transformers energised shortly after. At this point, all transformers supplying Prague before the incident were energised.

At substations where units operating in house-load operation were connected, the dispatchers synchronised them to the grid: at 12:46, Chvaletice unit 4 at the Týnec 400 kV substation; at 13:26, Počerady unit 2; and at 13:45, unit 6 at the Výškov 400 kV substation.

By 14:09, all 400- and 220-kV substations were energised. At 14:20, ČEPS dispatchers ordered a halt in load pickup due to significant contingencies on line V208 (up to 180 %) and ordered CCGT Počerady 2 to start. Load pickup resumed following the synchronisation of Počerady 2 at 15:18 (first gas turbine).

At 17:35, ČEPS dispatchers received information from DSOs that all the lost load was re-energised.

At 23:13, the V411 line was switched on following repairs.

During the incident, cross-border intraday trading was stopped at all Czech borders for the period from 13:30 to 00:00. Between 12:00 and 00:00, market activities were suspended, and special imbalance settlement rules were applied. Day-ahead trading for 5 July was unaffected. Intraday trading for 5 July was allowed at 22:28, thus affecting continuous trading up to that point and intraday auctions 1 and 2.

1.6 Regional coordination processes

All relevant operational planning processes coordinated by the RCCs were successfully executed on the business day of 4 July 2025. None of the RCC tasks identified a specific security risk for the Czech transmission system for the relevant hours on 4 July 2025, and the grid was considered N-1 secure. Short-term adequacy (STA) assessments showed no adequacy issues, outage planning was properly coordinated, and both day-ahead and intraday capacity calculation processes were completed without disruption. ČEPS provided all required input models on time, and regional security analyses (DACF and IDCF) confirmed that any detected congestion was within tolerable limits and resolvable through remedial actions. No unusual deviations between modelled and actual physical flows were observed, and despite the incident, all processes – including capacity calculations and contingency analyses – functioned as designed.

1.7 Incident classification based on ICS methodology

The highest-priority ICS criterion violated during this incident was a scale 2 incident on load (L2). This criterion is met if the load loss is between 10 % and 50 %.

In this incident, 2,300 MW of load was lost, which is 28 % of the demand before the incident (8,200 MW) in the ČEPS control area.

1.8 Next steps

Following the publication of the factual report, the Expert Panel will continue its investigation, including further clarification of the event. The Expert Panel has issued additional data requests. The final report, expected to be available by June 2026, will include recommendations to prevent such an event from happening in the future.

2 SYSTEM STATE AND MARKET CONDITIONS BEFORE THE INCIDENT

2.1 Information about topology

2.1.1 Planned outages

The transmission system operator has recently undertaken several investment initiatives that need to be included in the ČEPS outage plan to meet requirements for line modernization and proper maintenance. The grid configuration, including necessary planned outages to make these investments possible, was verified against the N-1 safety criterion in the framework of long-term (annual, monthly) operational preparation for various operational scenarios (high transit flow, high/low production of coal sources, etc.). These long-term requirements are supplemented by routine maintenance or line repairs during weekly operational preparation.

In addition to the contingency analysis, ČEPS performs a dynamic stability assessment (DSA) in all phases of operational planning – yearly, monthly, weekly and daily – and in real time. The DSA tool assesses transient stability by calculating the critical clearing time (CCT) for a zero-impedance three-phase fault on lines directly[1] connected to a substation where a synchronous power-generating module is connected, representing the worst possible fault in terms of potential loss of synchronism. The offline version of the DSA tool, designed for operational planning, allows selecting critical scenarios to reduce the computational time of dynamic simulations. The ability to preselect critical scenarios based on the criteria listed below is implemented in the offline version of the DSA tool. Once the user selects the critical scenarios option, the algorithm first generates only those scenarios that meet the specified criteria for criticality before the CCT calculations take place.

The calculation is performed if:

- the short-circuit power of the node is considered low;
- the loading of the power-generating module (ratio of scheduled active power to apparent power) is considered high;
- a pump storage power-generating module is in pumping mode.

The CCT threshold for preparing remedial actions is set at 100 ms, which is about 120 % of the fault-clearing time.

A scenario like that of 4 July was calculated across all phases of operational planning for July. Based on the indicators described above, the calculation was performed for faults on lines V473, V474 and V475 (all connected to the Kočín 400 kV substation in the southern part of the Czech Republic), considering the impact on power-generating modules at the Temelín NPP (also connected to the Kočín 400 kV substation). No indicators were fulfilled and therefore no calculation was performed for a fault on line V411 or V480, which is the closest to unit 6 of TPP Ledvice.

The online version of the DSA tool, used for real-time operation, calculates all scenarios[2] without applying the critical scenario selection, every minute based on the real-time model in the control system. Before the V411 outage, the online DSA tool did not detect any violation in dynamic stability (CCT less than 100 ms) for TPP Ledvice unit 6.

1 This implies that for the Ledvice power plant, connected to the Chotějovice substation, only a fault on the Chtějovice–Výškov double-circuit line V479/V480 is calculated. This is the worst-case scenario. A fault elsewhere in the grid (in this case on V411 Hradec–Výškov) has a lesser impact on the power-generating module due to the extra impedance of the lines between the power-generating module and the fault.

2 See chapter 2.1.5 (paragraph 11:50 DSA).

The dispatchers can also display the following trends in the online version of the DSA tool:

» simulated time profile of accelerating power of the generator (kinetic energy);

» simulated time profile of active power output;

» simulated time profile of terminal voltage.

These simulation results can be displayed for each scenario. Figure 2.1 provides an example of how simulated trends from the dispatcher control system can be displayed.

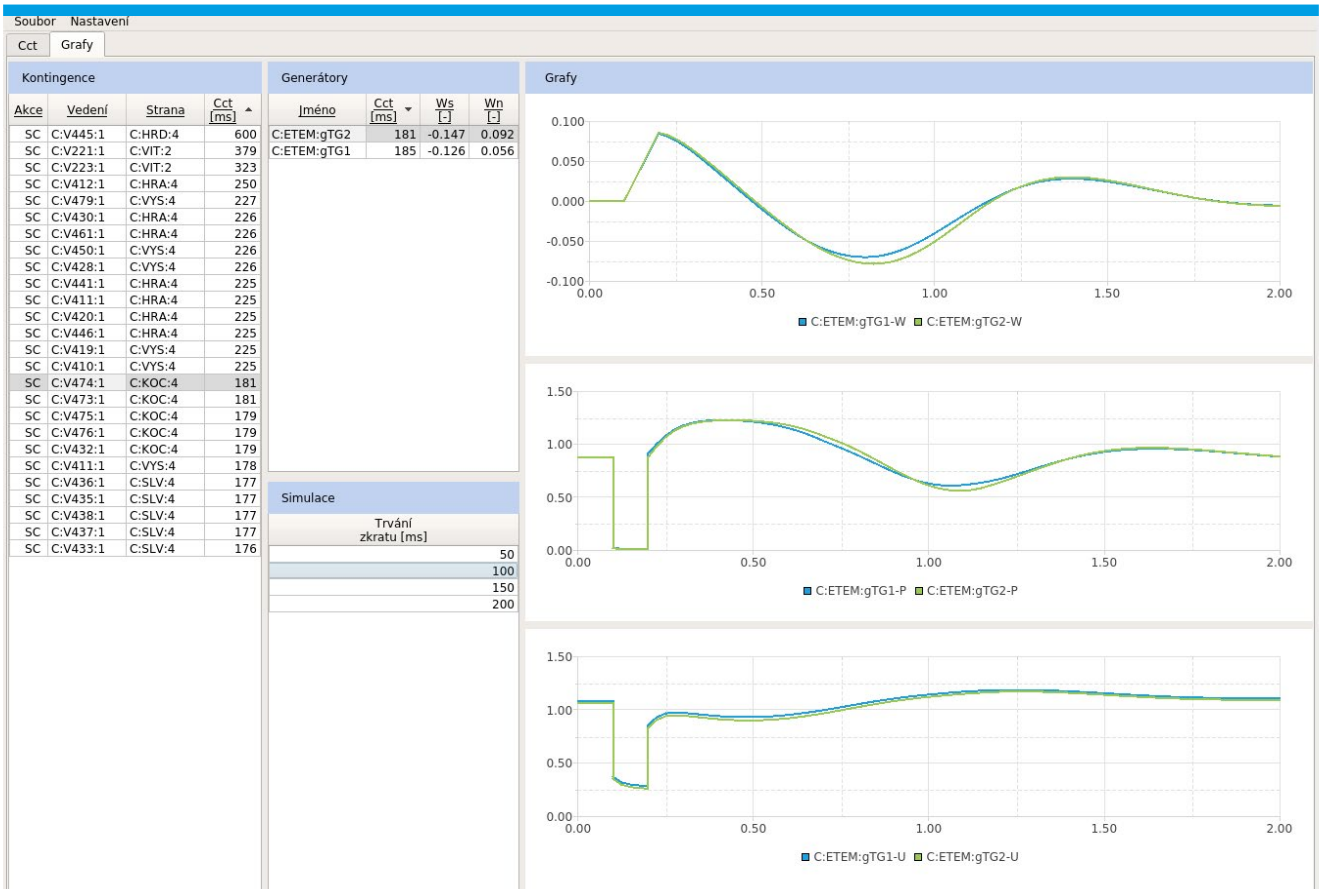


Figure 2.1: Example of visualisation in the online version of the DSA tool

2.1.2 Weekly operational planning for 4 July 2025

Figure 2.2 presents the 400 kV and 220 kV overhead lines that were switched off in the Czech power system on 4 July 2025.

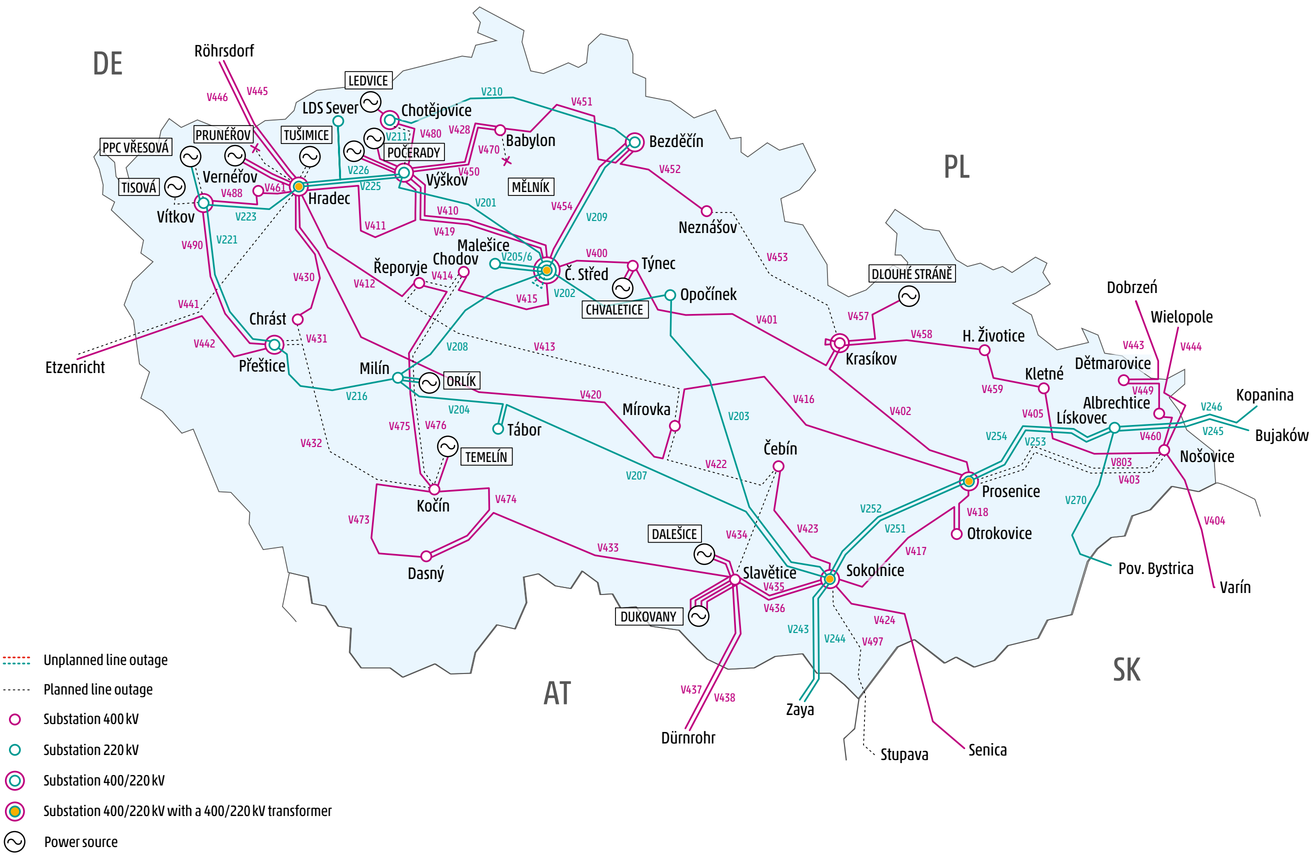


Figure 2.2: Situation of the Czech Republic transmission system on 4 July 2025, before the incident

400 kV lines

- » V431 Chrást–Přeštice without return-to-service time, 25.11.2024–3.10.2025 due to doubling of the line (V431/V831).
- » V453 Krasíkov–Neznášov without return-to-service time, 03.03.2025–29.8.2025 due to line modernisation.
- » V413 Mírovka–Řeporyje without return-to-service time, 03.03.2025–27.11.2025, due to modernisation to higher transmission parameters.
- » V403 and V803 Nošovice–Prosenice, with a return-to-service time of 2 days, 02.06.2025–15.8.2025, due to the finishing of the line doubling.
- » V497 Sokolnice–Stupava without return-to-service time, 16.06.2025–04.07.2025 due to SEPS works in Slovakia.
- » V434 Čebín–Slavětice without return-to-service time, 17.06.2025–31.7.2025 due to modernisation to higher transmission parameters.
- » V432 Kočín–Přeštice without return-to-service time, 25.06.2025–29.08.2025 due to doubling of lines (V432/V429).
- » V422 Čebín–Mírovka without return-to-service time, 01.07.2025–14.11.2025 due to modernisation to higher transmission parameters.

» V414 Chodov–Řeporyje and V476 Chodov–Kočín, both without return-to-service time, 27.06.2025–21.7.2025, for replacement of the V414/476 pylons and protections in the Chodov substation.

› The Chodov substation was in radial operation on line V415 (Chodov–Čechy Střed) due to the replacement of the V414+V476 pylons. The disconnection of V414+V476 was planned at the time of the shutdown of the Temelín NPP (B1), which was planned until 01.08.2025, so that the remaining outgoing lines from the Kočín substation would be able to transfer energy from the ETEM B2 to the transmission grid even in the event of a failure of one of them. Therefore, the work could not be postponed until the V453 line was put into operation on 29.08.2025.

» V441 Etzenricht–Hradec without return-to-service time, 02.06.2025–15.09.2025 due to the repair of a damaged cable bushing on the ČEPS side.

220 kV lines

V211 Chotějovice–Výškov without return-to-service time, 01.07.2025–24.07.2025 for switching of the conductors from the 220 kV to 400 kV substation and the redesignation to the new line V479.

Lines disconnected for voltage control

At 11:50, there were no lines disconnected for voltage control in Czech Republic, just the connection of the 400 kV Krasíkov substation was prepared for a possible reconfiguration of the substation in order to reduce the voltage. The substation was prepared to switch off the line V402 or V458 to lower voltage in the event that the EDST was not in operation. Given the ongoing investment project and the direction of flow from west to east, the substation was optimally connected. The current through the KSP in KRA4 at 11:51 was 307 A (16 % of load capacity).

Transformers

» T401PRN (until 05.12.2025, without return-to-service time), reconstruction of the 220 kV substation.

» T402CST (until 14.08.2025, without return-to-service time), consumption switched to T201CST.

» T201VYS, termination of operation.

Hradec substation

» Operation of both HRA (Hradec west) and HRD (Hradec east) in basic connection.[3]

» Phase-shifting transformer T454HRD (on line V446) switched off due to the defect.

» Phase-shifting transformer T453HRD (on line V446) switched off due to maintenance until 11.07.2025.

» Flow on line V446 controlled by the phase-shifting transformer T442ROH (confirmed by 50Hertz).

» HRA4:KSP1 (busbar coupler) switched off due to maintenance until 25.07.2025.

Weekly operational planning

As the basic calculation model, the control system model (including the observability area) from 9:35 on 25 June 2025 was used. This model was updated in line with the expected parameters for 4 July 2025.

Parameters of the model used for 4 July 2025

Balance [MW]	Transit [MW]	PSE [MW]	SEPS [MW]	50Hertz [MW]	APG [MW]	TenneT [MW]
−588.5	2,983.1	−2,066.3	1,005.5	−1,505.3	1,788.7	188.9

Table 2.1: Cross-border flows in the week-ahead operational planning model for the ČEPS transmission grid for 4 July 2025

Balance: '+' = export / '-' = import
Profile flows: '+' = from ČEPS / '-' = to ČEPS
Dynamic thermal rating considered for temperature 33 °C

3 The internal regulation of ČEPS specifies the basic connection of elements in all substations of the transmission system. The actual connection may vary depending on the current network situation.

Flows through the lines:

- V411: 842 MW (HRA → VYS)
- V208: 22 MW (MIL → CST)

Power plant	Power [MW]	Power plant	Power [MW]	Power plant	Power [MW]
EDUK (Dukovany)	1,980	ETU2 (Tušimice)	0	ETI2 (Tisová)	0
ETEM (Temelín)	1,075	ECHV (Chvaletice)	0	EPVR (Vřesová)	0
ELED (B6) (Ledvice)	616	EPC2 (Počerady)	0	EORK (Orlík)	0
EPR2 (Prunéřov)	410	EDST (Dlouhé Stráně)	0		
EPOC (Počerady)	205	EDAL (Dalešice)	0		

Table 2.2: Active power output of the power plants in the week-ahead model of the ČEPS transmission grid for 4 July 2025 (gross)

Tables 2.3 to 2.5 present the predicted breaching of N-1 for 4 July 2025 and the appropriate measures to handle it.

Overloaded element	Contingency	Measures
T402HRA (109 %)	V411	» Use the transformer overloadability. » Change connection in the Hradec west and Hradec east substations. » Transfer of consumption supplied from the 220 kV to the 400 kV grid. » Switch off the overloaded transformer (last resort).

Table 2.3: Predicted breaching in case of transit flow from Germany and low generation in the Czech Republic

Overloaded element	Contingency	Measures
V444 (99 %)	V443	» Preventive reconfiguration in the Nošovice substation. » Discuss the possibility of PST regulation on the 50Hertz-PSE profile.

Table 2.4: Predicted breaching of N-1 in case of high transit from Poland

Overloaded element	Contingency	Measures
T401VER (97 %) **Lines 110 kV (108 %)** **VER-VYS**	V411	» Preventively ask distribution company to separate the Vernéřov-Výškov area. » Separation of the Vernéřov-Výškov area can cause N-1 breaching on the T202CHT transformer after the T401VYS switch-off. In this case, ask distribution to reduce consumption in the Výškov area and switch off the T202CHT transformer.

Table 2.5: Predicting breaching of N-1 in the VER-VYS interconnected area

When operating Hradec west and Hradec east in the basic connection, the recommended limit flow from 50Hertz is 1,500 MW (considering the nominal transmission limit of PST Rohrsdorf at 1,200 MVA, with an overloadability of 120 %).

Dynamic stability

Individual operating modes were checked for compliance with angular stability using the DSA application, which calculated the CCT for these network states on the outgoing lines from the transmission substations, where the power plants are connected. In all cases, the CCT results were well above the limit of 100 ms (the lowest CCT was 176 ms at the Temelín NPP).

Results of weekly operational planning

All proposed measures from the weekly operational planning led to resolving potential non-fulfilment of the N-1 criterion in the model, and there was no possible propagation of the fault to other elements, even with a transit flow of 1,500 MW in the direction from 50Hertz to ČEPS.

2.1.3 DACF

The DACF process for 4 July 2025 was completed on 3 July at 23:48, with the N-1 operational safety criteria being met. At the 11:30 time stamp (relevant to the time of the initial cause, outage V411), the following preventive measures were implemented in the prediction model:

- » Reconfiguration in the Čechy Střed 220 kV substation due to breaching of N-1 on V201.
  - › Busbar W2: T201, V205, V206, V208, V202.
  - › Busbar W3: T401, V209, V201, busbar coupler open.
- » Reconfiguration in the Hradec Západ 400 kV substation due to breaching of N-1 on V411/VER:T401 125 %.
  - › Busbar W1: T402, V461 W2: V411, V412 and all from HRD4.

Table 2.6 presents the results of the DACF report.

DACF results

N-1 for 4 July is met. The highest N-1 value is for the time stamp at 11:30, with V203/V208 at 94.64 %. Additional information are provided for each relevant set of Contingency/Affected branches.

Contingency/Affected branches

- » HRA: T402/CST:T401
- » CST: T401/HRA:T402
- » V411/HRA:T402
  - › No measures are implemented in advance, because time-limited overload capacity 120 %/3 h and 130 %/1 h can be used, and corrective measures after the outage can be applied during this time. This is verified by the relevant calculations (reconfiguration in HRD4 and CST2).
- » V435/V436
- » V436/V435
  - › No measures are implemented in advance, because time-limited overload capacity of 120 %/1 h can be used and corrective measures after the outage can be applied during this time. This was verified in advance by the relevant calculations (reconfiguration in the Sokolnice 400 kV substation, SOK4).

Contingency cases				Affected Branches				Hour																							
ename	sub1	sub2	type	ename	sub1	sub2	type	0:30	1:30	2:30	3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30	18:30	19:30	20:30	21:30	22:30	23:30
C:HRA:T402	CHRA__11	CHRA__22	transformer	C:CST:T401	CCST__11	CCST__22	transformer	98,11	91,21	92,03	93,99	93,76	93,99	102,77	102,59	100,86	86,17	86,1										99,15	105,06	105,36	129,25
C:HRA:T402	CHRA__11	CHRA__22	transformer	C:CST:T401	CCST__11	CCST__23	transformer																		77,59	76,88	73,55				
C:CST:T401	CCST__11	CCST__22	transformer	C:HRA:T402	CHRA__11	CHRA__22	transformer	88,86	80,54	81,37	81,96	81,77	82,39	92,79	91,22	90,63	82,45						74,66	87,57	98,07	97,56	93,03	88,76	94,91	94,17	120,37
V436:1	CSLV__1A	CSOK__12	line	V435:1	CSLV__1I	CSOK__11	line							73,58										73,8	72,53	100,72	106,89	107,14	110,94	99,09	93,54
V435:1	CSLV__1I	CSOK__11	line	V436:1	CSLV__1A	CSOK__12	line							73,32										73,54	72,28	100,36	106,5	106,76	110,54	98,73	93,19
V411:1	CVYSH_14	CHRA__14	line	C:HRA:T402	CHRA__11	CHRA__22	transformer										73,09						97,33	103,02	91,55	85,28	79,91				78,47
V461:1	CVER__11	CHRA__13	line	C:VYS:T401	CVYSH_1B	CVYS__53	transformer	94,71	100,03	91,95	88,22	88,17	87,37	86,35	93,54	88,48															76,85
C:CST:T401	CCST__11	CCST__22	transformer	V201:1	CVYS__21	CCST__23	line																					93,4	97,1	95,27	89,86
V411:1	CVYSH_14	CHRA__14	line	C:VER:T401	CVER__11	CVER__57	transformer												70,09	74,71	73,42		86,48	96,27							
V208:1	CMIL__22	CCST__22	line	V203:1	COPO__21	CSOK__21	line												96,08	85,64	83,98	85,56	81,13	70,95	73,7	72,75					
V203:1	COPO__21	CSOK__21	line	V208:1	CMIL__22	CCST__22	line												94,64	84,46	82,32	84,09	79,53	70,13	74,21	73,74	71,32				
V223:1	CHRA__21	CVIT__22	line	V203:1	COPO__21	CSOK__21	line												89,62	84,41	79,68	81,3	79,26	72,95	77,06						
V420:1	CHRD__11	CHBM__14	line	KRA:4:nKSP	CKRA__11	CKRA__12	line																				89,51	79,01	88,17	84,2	
V433:1	CDAS__13	CSLV__1B	line	V216:1	CPRE__21	CMIL__21	line																			78,94	89,06				
V411:1	CVYSH_14	CHRA__14	line	V201:1	CVYS__21	CCST__23	line																78,34	88,21							
V401:1	CTYN__11	CKRA__11	line	V202:1	COPO__22	CCST__22	line																					77,54	87,6	85,2	71,02

Table 2.6: Day-ahead contingency report for the ČEPS transmission grid from AMICA generated on 3 July 2025 at 23:20, after final run of the DACF process

2.1.4 IDCF

The description of the IDCF process for 4 July 2025 is based on the shift handover at approximately 6:45 and on the IDCF calculation at 11:15.

Based on the results presented in Table 2.7, corrective measures were implemented in the model for the time stamp at 11:30:

» The same reconfiguration in the Čechy Střed 220 kV substation as in the DACF process was implemented:

› Busbar W2: T201, V205, V206, V208, V202.

› Busbar W3: T401, V209, V201 SP OFF.

The implementation of real-time reconfiguration at the Čechy Střed substation has been postponed until real-time calculations confirm the N-1 non-compliance. This type of decision is used as standard to avoid unnecessarily weakening the ČEPS transmission network.

Contingency cases				Affected Branches				Hour																							
ename	sub1	sub2	type	ename	sub1	sub2	type	0:30	1:30	2:30	3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30	18:30	19:30	20:30	21:30	22:30	23:30
C:HRA:T402	CHRA_11	CHRA_22	trafo	C:CST:T401	CCST_11	CCST_22	transformer	105,39	95,75	98,28	97,54	96,65	96,63	103,18	99,77	101,97	87,23	80,37							114,97	122,44		102,58	107,29	107,33	131,12
C:CST:T401	CCST_11	CCST_22	trafo	C:HRA:T402	CHRA_11	CHRA_22	transformer	96,22	85,22	87,48	86,88	85,81	86,00	93,50	89,83	93,64	84,15	80,90	74,86	73,09	70,3	76,5	77,29	82,78	111,08	114,28	86,21	91,93	97,14	96,04	121,69
C:CST:T401	CCST_11	CCST_23	trafo	C:HRA:T402	CHRA_11	CHRA_22	transformer	96,22	85,22	87,48	86,88	85,81	86,00	93,50	89,83	93,64	84,15	80,90	74,86	73,09	70,3	76,5	77,29	82,78	111,08	114,28	86,21	91,93	97,14	96,04	121,69
V411:1	CVYSH_14	CHRA_14	line	C:VER:T401	CVER_11	CVER_57	transformer											95,53	116,99	116,24	114,17	111,92	97,81	98,66	77,44						
V436:1	CSLV_1A	CSOK_12	line	V435:1	CSLV_1I	CSOK_11	line							75,01										76,3	76,29	100,35	109,49	107,41	113,14	101,24	94,03
V435:1	CSLV_1I	CSOK_11	line	V436:1	CSLV_1A	CSOK_12	line							74,74										76,04	76,03	99,99	109,10	107,03	112,73	100,88	93,69
V411:1	CVYSH_14	CHRA_14	line	C:HRA:T402	CHRA_11	CHRA_22	transformer										77,85	95,62	111,15	108,66	106,07	110,20	105,09	107,21	98,94	87,44	81,60				76,86
V401:1	CTYN_11	CKRA_11	line	VIT:2:nSP:1	CVIT_21	CVIT_22	line																				110,87				
V203:1	COPO_21	CSOK_21	line	VIT:2:nSP:1	CVIT_21	CVIT_22	line												71,92					75,59			110,12				
C:CST:T401	CCST_11	CCST_22	trafo	V201:1	CVYS_21	CCST_23	line									70,57									96,90	109,15		95,52	98,24	95,99	90,34
V461:1	CVER_11	CHRA_13	line	C:VYS:T401	CVYSH_1B	CVYS_53	transformer	93,56	102,56	92,96	82,84	82,54	85,59	91,78	96,49	83,52														71,2	79,25
V208:1	CMIL_22	CCST_22	line	V203:1	COPO_21	CSOK_21	line												93,63	82,72	82,86	86,64	85,17	95,39			101,04				
V203:1	COPO_21	CSOK_21	line	V208:1	CMIL_22	CCST_22	line												91,71	81,02	80,71	84,55	83,67	93,86			100,96				
V411:1	CVYSH_14	CHRA_14	line	V201:1	CVYS_21	CCST_23	line											83,82	99,31	99,07	99,43	100,50	88,69	84,52	81,38	77,57					
V401:1	CTYN_11	CKRA_11	line	V216:1	CPRE_21	CMIL_21	line																				99,11				
V420:1	CHRD_11	CHBM_14	line	KRA:4:nKSP	CKRA_11	CKRA_12	line																				92,60	83,47	88,69	84,38	
V251:1	CXPRN_21	CSOK_21	line	V254:1	CLIS_22	CPRN_25	line																					82,84	91,57	73,54	
V252:1	CPRN_25	CSOK_22	line	V253:1	CLIS_21	CXPRN_21	line																					82,84	91,57	73,54	

Table 2.7: Intraday contingency report for the ČEPS transmission grid from AMICA for IDCF process generated on 4 July 2025 at 6:24 (shift change)

IDCF results

The indicated N-1 non-fulfilment can be easily addressed as presented hereafter, for each relevant set of Contingency/ Affected branches.

Contingency/Affected branches

» V411/VER:T401

› Reconfiguration in the Hradec Západ 400kV substation was not implemented by changing the connection of the 110kV grid at the moment of the indicated non-fulfilment of N-1 in the real-time calculation. This type of decision is used as standard to avoid unnecessarily weakening the ČEPS transmission network or distribution network.

» T402HRA/T401CST

» T401 CST /T402 HRA

» V411/T402 HRA

› No measures were implemented in advance, because time-limited overload capacity of 120%/3h and 130%/1h can be used and corrective measures after the outage could be applied during this time (verified in advance by the relevant calculations, reconfiguration in the Hradec east 400kV and Čechy Střed 220kV substations).

» V435/V436

» V436/V435

› No measures were implemented in advance, because time-limited overload capacity of 120%/1h can be used and corrective measures after the outage can be applied during this time (reconfiguration in SOK4).

Contingency cases				Affected Branches				Hour																							
ename	sub1	sub2	type	ename	sub1	sub2	type	0:30	1:30	2:30	3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30	18:30	19:30	20:30	21:30	22:30	23:30
C:HRA:T402	CHRA_11	CHRA_22	trafo	C:CST:T401	CCST_11	CCST_22	transformer	105,39	95,75	98,28	97,54	96,65	96,63	103,18	101,88	104,99	91,86	90,77							112,11	120,52		101,3	105,47	104,61	129,11
C:CST:T401	CCST_11	CCST_23	trafo	C:HRA:T402	CHRA_11	CHRA_22	transformer	96,22	85,22	87,48	86,88	85,81	86	93,5	91,89	97,86	88,85	91	82,56	81,08	77,37	79,62	83,47	83,3	108,17	112,39	84,66	91,19	95,8	93,7	120,33
C:CST:T401	CCST_11	CCST_22	trafo	C:HRA:T402	CHRA_11	CHRA_22	transformer	96,22	85,22	87,48	86,88	85,81	86	93,5	91,89	97,86	88,85	91	82,56	81,08	77,37	79,62	83,47	83,3	108,17	112,39	84,66	91,19	95,8	93,7	120,33
V411:1	CVYSH_14	CHRA_14	line	C:VER:T401	CVER_11	CVER_57	transformer										72,97	99,08	118,61	119,5	118,26	110,85	102,25	101,27	74,95						
V411:1	CVYSH_14	CHRA_14	line	C:HRA:T402	CHRA_11	CHRA_22	transformer										82,29	102,25	115,13	113,47	111,08	109,68	110,2	108,16	96,17	85,91	82,92				79,25
V436:1	CSLV_1A	CSOK_12	line	V435:1	CSLV_1I	CSOK_11	line							75,01										76,39	75,54	100,84	108,79	106,81	112,05	100,33	92,44
V435:1	CSLV_1I	CSOK_11	line	V436:1	CSLV_1A	CSOK_12	line							74,74										76,12	75,28	100,47	108,4	106,43	111,65	99,97	92,1
V208:1	CMIL_22	CCST_22	line	V203:1	COPO_21	CSOK_21	line												110,63	102,01	98,22	91,95	91,56	95,64			98,13				
V203:1	COPO_21	CSOK_21	line	V208:1	CMIL_22	CCST_22	line												109,34	101,46	98,01	91,85	91,16	94,97			98,58				
V401:1	CTYN_11	CKRA_11	line	VIT:2:nSP:1	CVIT_21	CVIT_22	line																				109,03				
V203:1	COPO_21	CSOK_21	line	VIT:2:nSP:1	CVIT_21	CVIT_22	line												83,42	80,04	74,97	73,59	76,68	77,09			108,73				
V223:1	CHRA_21	CVIT_22	line	V203:1	COPO_21	CSOK_21	line												107,38	102,83	95,26	89,68	91,46	89,68							
C:CST:T401	CCST_11	CCST_22	trafo	V201:1	CVYS_21	CCST_23	line									71,44		74,38							91,43	104,71		93,07	96,93	94,25	89,43
V461:1	CVER_11	CHRA_13	line	C:VYS:T401	CVYSH_1B	CVYS_53	transformer	93,56	102,56	92,96	82,84	82,54	85,59	91,78	94,73	82,43															77,15
V411:1	CVYSH_14	CHRA_14	line	V201:1	CVYS_21	CCST_23	line											85,92	96,55	97,68	99,25	95,37	88,08	83,57	76,46	74,28					
V401:1	CTYN_11	CKRA_11	line	V216:1	CPRE_21	CMIL_21	line																				97,02				
V221:1	CPRE_21	CVIT_21	line	C:SOK:T401	CSOK_12	CSOK_21	transformer																				90,66				
V420:1	CHRD_11	CHBM_14	line	KRA:4:nKSP	CKRA_11	CKRA_12	line																				90,48	83,23	87,98	82,87	

Table 2.8: Last relevant intraday contingency report for the ČEPS transmission grid from AMICA before the outage of V411, generated on 4 July 2025 at 10:24

As presented in Table 2.8, a deterioration of the N-1 V203/V208 at 109.34 % was indicated for time 11:30.

This non-fulfilment can be solved by the reconfiguration of the Čechy Střed 220 kV substation:

» Busbar W2: T401, V205, V206, V208, V202.

» Busbar W3: T201, V209, V201 SP OFF).

This reconfiguration was recalculated by the study in AMICA (as shown in Table 2.9) and led to a significant reduction in the non-fulfilment of V203/V208. N-1 on V411/208 was 92 %, which meets the N-1 criterion.

Contingency V411/T401VER will be solved by disconnection of the 110 kV Vernéřov–Výškov area.

Contingency cases						Affected Branches					Hour
name	ename	sub1	sub2	type	category	name	ename	sub1	sub2	type	11:30
CVYSH_1_CHRA__1_1:line	V411:1	CVYSH_11	CHRA__11	line	Single	CVER__1_CVER__5_2:trf	C:VER:T401	CVER__11	CVER__57	trafo	136,00
CVYSH_1_CHRA__1_1:line	V411:1	CVYSH_11	CHRA__11	line	Single	CHRA__1_CHRA__2_1:trf	C:HRA:T402	CHRA__11	CHRA__22	trafo	92,12
CCST__1_CCST__2_1:trf	C:CST:T401	CCST__11	CCST__22	trafo	Single	CMIL__2_CCST__2_1:line	V208:1	CMIL__22	CCST__22	line	91,73
BASECASE					Single	CBEZ__2_CBEZ__5_3:trf	C:BEZ:T201	CBEZ__21	CBEZ__51	trafo	78,88
XHR_RO1_D8ROE_1_445:line	445	XHR_RO11	D8ROE_11	line	Single	CHRD_21_XHR_RO1_2:line	V446:1	CHRD_212	XHR_RO12	line	78,6
CCST__1_CCST__2_1:trf	C:CST:T401	CCST__11	CCST__22	trafo	Single	CHRA__2_CVIT__2_1:line	V223:1	CHRA__21	CVIT__22	line	77,08
CCST__1_CCST__2_1:trf	C:CST:T401	CCST__11	CCST__22	trafo	Single	CVIT__2_CVIT__2_2:line	VIT:2:nSP:1	CVIT__21	CVIT__22	line	76,9
CKOC__1_CETEM_1_2:line	V052:1	CKOC__11	CETEM_12	line	Single	CHRD__1_CHRA__1_I:line	HRD:4:nSRW2	CHRD__12	CHRA__14	line	76,49
D8ROE_1_D8ROE_1_442:trf	442	D8ROE_11	D8ROE_18	trafo	Single	CHRD_21_XHR_RO1_1:line	V445:1	CHRD_211	XHR_RO11	line	76,46
CKLT__1_CNOS__1_1:line	V405:1	CKLT__11	CNOS__11	line	Single	CVYSH_1_CHRA__1_1:line	V411:1	CVYSH_14	CHRA__14	line	76,42
CHRA__2_CVIT__2_1:line	V223:1	CHRA__21	CVIT__21	line	Single	CCST__1_CCST__2_1:trf	C:CST:T401	CCST__11	CCST__23	trafo	75,89
D8ROE_1_D8ROE_1_442:trf	442	D8ROE_11	D8ROE_18	trafo	Single	CHRD_21_CHRD_21_2:trf	C:HRD:T452	CHRD_213	CHRD_215	trafo	75,83
D8ROE_1_D8ROE_1_442:trf	442	D8ROE_11	D8ROE_18	trafo	Single	CHRD_21_CHRD_21_1:trf	C:HRD:T451	CHRD_213	CHRD_215	trafo	75,83

Table 2.9: Study report for the ČEPS transmission grid from AMICA – proposal of the measure for N-1 V203 on V208

2.1.5 Situation in real time before the incident

Tables 2.10 and 2.11 present the 10:30 N-1 reports from the ČEPS control system.

Kontingence	N-1%	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Zařízení
C:V411:1	114.8	574.2	74.2	355.2	0.0	71.0	+219.0	+43.8	C:HRA:T402
C:CST:T401	97.5	487.4	0.0	355.2	0.0	71.0	+132.3	+26.5	C:HRA:T402
C:HRA:T402	96.8	484.2	0.0	220.5	0.0	44.1	+263.7	+52.7	C:CST:T401
C:V445:1	94.4	1359.1	0.0	833.9	0.0	57.9	+525.2	+36.5	D8:ROH:T442
C:CHD:T401	91.0	318.4	0.0	169.1	0.0	48.3	+149.3	+42.7	C:CHD:T403
C:CHD:T403	90.9	318.2	0.0	149.0	0.0	42.6	+169.2	+48.3	C:CHD:T401
C:V446:1	85.9	1954.5	0.0	1252.2	0.0	55.0	+702.3	+30.9	C:V445:1
C:V433:1	79.1	395.6	0.0	355.2	0.0	71.0	+40.4	+8.1	C:HRA:T402

Table 2.10: N-1 report from the ČEPS control system[4] at 10:30 – per relevant contingency

Zařízení	N-1%	Uzel1	Uzel2	Limit	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Kontingence
C:HRA:T402	114.8	C:HRA:4:...	C:HRA:2:...	500.0	574.2	74.2	355.2	0.0	71.0	+219.0	+43.8	C:V411:1
C:VER:T401	111.8	C:VER:4:...	C:VER:1:...	350.0	391.4	41.4	161.0	0.0	46.0	+230.5	+65.8	C:V411:1
C:CST:T401	96.8	C:CST:4:...	C:CST:2:...	500.0	484.2	0.0	220.5	0.0	44.1	+263.7	+52.7	C:HRA:T402
C:V201:1	96.3	C:VYS:2:W1	C:CST:2:...	796.0	766.4	0.0	363.7	0.0	45.7	+402.7	+50.6	C:V411:1
D8:ROH:T442	94.4	D8:ROH:4...	D8:ROH:4...	1440.0	1359.1	0.0	833.9	0.0	57.9	+525.2	+36.5	C:V445:1
C:CHD:T403	91.0	C:CHD:4:...	C:CHD:1:...	350.0	318.4	0.0	169.1	0.0	48.3	+149.3	+42.7	C:CHD:T401
C:CHD:T401	90.9	C:CHD:4:...	C:CHD:1:...	350.0	318.2	0.0	149.0	0.0	42.6	+169.2	+48.3	C:CHD:T403
C:V445:1	85.9	C:HRD:4:...	D8:ROH:4...	2276.0	1954.5	0.0	1252.2	0.0	55.0	+702.3	+30.9	C:V446:1
C:V446:1	84.6	C:HRA:4:...	D8:ROH:4...	2276.0	1926.5	0.0	1180.4	0.0	51.9	+746.1	+32.8	C:V445:1
C:HRD:T451	80.2	C:HRA:4:...	C:HRD:4:...	850.0	681.3	0.0	438.7	0.0	51.6	+242.6	+28.5	C:V446:1
C:HRD:T452	80.2	C:HRA:4:...	C:HRD:4:...	850.0	681.3	0.0	438.7	0.0	51.6	+242.6	+28.5	C:V446:1
C:HRD:4:Y1_465_K...	77.3	C:HRA:4:...	C:HRA:4:...	2882.0	2227.5	0.0	1530.6	0.0	53.1	+696.9	+24.2	C:V446:1

Table 2.11: N-1 report from the ČEPS control system[5] at 10:30 – per relevant monitored element

Results of N-1 at 10:30:

Both the C:HRA:T402 and C:VER:T401 transformers are overloadable.

- The solution for the case of N-1 non-fulfilment on the C:VER:T401 transformer was, in cooperation with the distribution company, the splitting of the interconnected 110 kV Vernéřov–Výškov area.
- The solution for the case of N-1 non-fulfilment on the C:HRA:T402 transformer is to coordinate with the distribution company to relieve consumption at the 220 kV level (e.g. in the area of c:VIT:T402) and switch off the C:CHT:T202 transformer.
- It is not necessary yet to proceed with the application of reconfiguration in Čechy Střed substation. The highest relevant N-1 value for V411/V201 is 96.3 %.

4 Kontingence – contingency, element whose shutdown is simulated.
N-1 – flow through the monitored element (lines in A, transformers in MVA) in case of contingency, <80, ≥80 and <100, ≥100 %.
N-1 % – flow through the monitored element as % of limit in case of contingency.
Přes N-1 – flow through the monitored element above the nominal power (lines in A, transformers in MVA).
Limit – nominal limit of the monitored element (lines in A, transformers in MVA).
N-0 – flow through the monitored element without contingency (lines in A, transformers in MVA).
Přes N-0 – flow through the monitored element without contingency above nominal power (lines in A, transformers in MVA).
N-0 % – flow in normal case without contingency, as % of limit.
Rozdíl – difference of the flow on the monitored element in N-0 and N-1 (lines in A, transformers in MVA).
Rozdíl% – difference of the flow on the monitored element in N-0 and N-1 in %.

5 Zařízení – monitored element, element through which the flow is detected.
Uzel 1, Uzel 2 – nodes through which the device is connected to the network.
Limit – Nominal power (lines in A, transformers in MVA)

Tables 2.12 and 2.13 present the 11:01 N-1 report from the ČEPS control system before the decision to implement the reconfiguration at the Čechy Střed 220 kV substation and the disconnection of the 110 kV Výškov–Vernéřov area.

Kontingence	N-1%	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Zařízení
C:V411:1	121.3	606.5	106.5	372.9	0.0	74.6	+233.6	+46.7	C:HRA:T402
C:CST:T401	103.0	515.0	15.0	372.9	0.0	74.6	+142.1	+28.4	C:HRA:T402
C:HRA:T402	102.9	514.3	14.3	238.0	0.0	47.6	+276.3	+55.3	C:CST:T401
C:V445:1	96.3	1386.6	0.0	849.8	0.0	59.0	+536.8	+37.3	D8:ROH:T442
C:CHD:T401	89.2	312.1	0.0	165.6	0.0	47.3	+146.5	+41.8	C:CHD:T403
C:CHD:T403	89.1	311.9	0.0	146.2	0.0	41.8	+165.7	+47.3	C:CHD:T401
C:V446:1	87.3	1987.8	0.0	1271.5	0.0	55.9	+716.3	+31.5	C:V445:1
C:V433:1	82.6	412.8	0.0	372.9	0.0	74.6	+39.9	+8.0	C:HRA:T402
D8:V572:1	82.4	1187.2	0.0	866.2	0.0	60.2	+321.0	+22.3	D8:ROH:T441
C:V420:1	80.4	402.0	0.0	372.9	0.0	74.6	+29.1	+5.8	C:HRA:T402
C:V410:1	80.0	400.0	0.0	372.9	0.0	74.6	+27.1	+5.4	C:HRA:T402
C:V419:1	80.0	400.0	0.0	372.9	0.0	74.6	+27.1	+5.4	C:HRA:T402

Table 2.12: N-1 report from ČEPS control system at 11:01 – per relevant contingency

Zařízení	N-1%	Uzel1	Uzel2	Limit	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Kontingence
C:HRA:T402	121.3	C:HRA:4:...	C:HRA:2:...	500.0	606.5	106.5	372.9	0.0	74.6	+233.6	+46.7	C:V411:1
C:VER:T401	121.2	C:VER:4:...	C:VER:1:...	350.0	424.2	74.2	178.1	0.0	50.9	+246.1	+70.3	C:V411:1
C:CST:T401	102.9	C:CST:4:...	C:CST:2:...	500.0	514.3	14.3	238.0	0.0	47.6	+276.3	+55.3	C:HRA:T402
C:V201:1	100.6	C:VYS:2:W1	C:CST:2:...	796.0	800.7	4.7	370.0	0.0	46.5	+430.7	+54.1	C:V411:1
D8:ROH:T442	96.3	D8:ROH:4...	D8:ROH:4...	1440.0	1386.6	0.0	849.8	0.0	59.0	+536.8	+37.3	C:V445:1
C:CHD:T403	89.2	C:CHD:4:...	C:CHD:1:...	350.0	312.1	0.0	165.6	0.0	47.3	+146.5	+41.8	C:CHD:T401
C:CHD:T401	89.1	C:CHD:4:...	C:CHD:1:...	350.0	311.9	0.0	146.2	0.0	41.8	+165.7	+47.3	C:CHD:T403
C:V445:1	87.3	C:HRD:4:...	D8:ROH:4...	2276.0	1987.8	0.0	1271.5	0.0	55.9	+716.3	+31.5	C:V446:1
C:V446:1	86.1	C:HRA:4:...	D8:ROH:4...	2276.0	1960.1	0.0	1199.9	0.0	52.7	+760.2	+33.4	C:V445:1
D8:ROH:T441	82.4	D8:ROH:4...	D8:ROH:4...	1440.0	1187.2	0.0	866.2	0.0	60.2	+321.0	+22.3	D8:V572:1
C:HRD:T451	81.6	C:HRA:4:...	C:HRD:4:...	850.0	693.5	0.0	446.1	0.0	52.5	+247.4	+29.1	C:V446:1
C:HRD:T452	81.6	C:HRA:4:...	C:HRD:4:...	850.0	693.5	0.0	446.1	0.0	52.5	+247.4	+29.1	C:V446:1
C:HRD:4:ACT84:1	78.4	C:HRD:4:...	C:HRD:4:...	2530.0	1983.8	0.0	1264.9	0.0	50.0	+718.9	+28.4	C:V446:1

Table 2.13: N-1 report from ČEPS control system at 11:01 – per relevant monitored element

Results of N-1 at 11:01:

- The C:HRA:T402 transformer is overloadable. The solution for the case of N-1 non-fulfilment is to coordinate with the distribution company to reduce consumption at the 220 kV level (e.g., in the area of c:VIT:T402) and switch off the C:CHT:T202 transformer.
- Based on the non-fulfilment of N-1 on the VER:T401 transformer, it was decided to disconnect the Výškov–Vernéřov 110 kV area.
- Based on the non-fulfilment of N-1 on line V201, it was decided to execute the reconfiguration in the Čechy Střed 220 kV substation.
- Several options were considered and finally it was decided to implement the following reconfiguration (different to reconfigurations modelled in DACF and IDCF):
  - Busbar W2 – V201, V202.
  - Busbar W3 – V205, V206, V208, V209, T401, SP OFF.

At 11:04, the ČEPS operator issued the order to ČEZd to disconnect the Vernéřov–Výškov interconnected area.

At 11:12, disconnection of the Výškov–Vernéřov 110 kV area was executed, and reconfiguration at the Čechy Střed 220 kV substation was implemented.

Tables 2.14 and 2.15 present the 11:13 N-1 report from the ČEPS control system, after the reconfiguration at the Čechy Střed 220 kV substation.

Kontingence	N-1%	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Zařízení
C:V411:1	112.1	560.3	60.3	339.8	0.0	68.0	+220.6	+44.1	C:HRA:T402
C:V445:1	98.4	1416.3	0.0	867.5	0.0	60.2	+548.8	+38.1	D8:ROH:T442
C:CST:T401	96.1	480.4	0.0	339.8	0.0	68.0	+140.6	+28.1	C:HRA:T402
C:CHD:T401	89.9	314.5	0.0	167.0	0.0	47.7	+147.5	+42.1	C:CHD:T403
C:CHD:T403	89.8	314.3	0.0	147.2	0.0	42.1	+167.1	+47.7	C:CHD:T401
C:V446:1	88.9	2022.7	0.0	1292.1	0.0	56.8	+730.6	+32.1	C:V445:1
C:V052:1	87.6	2523.8	0.0	1993.4	0.0	69.2	+530.4	+18.4	C:HRD:4:nSR...
C:V405:1	85.8	1935.2	0.0	1684.4	0.0	74.7	+250.9	+11.1	C:V411:1
C:V420:1	84.8	1912.7	0.0	1684.4	0.0	74.7	+228.3	+10.1	C:V411:1
C:HRA:T402	84.8	1912.4	0.0	1684.4	0.0	74.7	+228.1	+10.1	C:V411:1
C:V433:1	83.7	1888.3	0.0	1684.4	0.0	74.7	+203.9	+9.0	C:V411:1
C:V223:1	83.5	1883.2	0.0	1684.4	0.0	74.7	+198.8	+8.8	C:V411:1
C:V480:1	83.1	1873.8	0.0	1684.4	0.0	74.7	+189.5	+8.4	C:V411:1
C:V459:1	81.0	1827.1	0.0	1684.4	0.0	74.7	+142.7	+6.3	C:V411:1
D8:V572:1	80.9	1164.3	0.0	852.0	0.0	59.2	+312.3	+21.7	D8:ROH:T441
C:REP:T404	79.4	277.7	0.0	175.8	0.0	50.2	+101.9	+29.1	C:REP:T403

Table 2.14: N-1 report from ČEPS control system at 11:13 – per relevant contingency

Zařízení	N-1%	Uzel1	Uzel2	Limit	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Kontingence
C:HRA:T402	112.1	C:HRA:4:...	C:HRA:2:...	500.0	560.3	60.3	339.8	0.0	68.0	+220.6	+44.1	C:V411:1
D8:ROH:T442	98.4	D8:ROH:4...	D8:ROH:4...	1440.0	1416.3	0.0	867.5	0.0	60.2	+548.8	+38.1	C:V445:1
C:V208:1	94.1	C:MIL:2:W...	C:CST:2:W3	749.0	704.5	0.0	87.7	0.0	11.7	+616.8	+82.4	C:V411:1
C:CHD:T403	89.9	C:CHD:4:...	C:CHD:1:...	350.0	314.5	0.0	167.0	0.0	47.7	+147.5	+42.1	C:CHD:T401
C:CHD:T401	89.8	C:CHD:4:...	C:CHD:1:...	350.0	314.3	0.0	147.2	0.0	42.1	+167.1	+47.7	C:CHD:T403
C:V223:1	89.7	C:HRA:2:...	C:VIT:2:W...	1165.0	1044.9	0.0	569.6	0.0	48.9	+475.3	+40.8	C:V411:1
C:VIT:2:nSP:1	89.6	C:VIT:2:W...	C:VIT:2:W...	1165.0	1044.0	0.0	565.5	0.0	48.5	+478.5	+41.1	C:V411:1
C:V445:1	88.9	C:HRD:4:...	D8:ROH:4...	2276.0	2022.7	0.0	1292.1	0.0	56.8	+730.6	+32.1	C:V446:1
C:V446:1	87.7	C:HRA:4:...	D8:ROH:4...	2276.0	1995.3	0.0	1221.0	0.0	53.6	+774.3	+34.0	C:V445:1
C:HRD:4:nSRW2:1	87.6	C:HRA:4:...	C:HRA:4:...	2882.0	2523.8	0.0	1993.4	0.0	69.2	+530.4	+18.4	C:V052:1
C:V411:1	85.8	C:VYS:4:...	C:HRA:4:...	2256.0	1935.2	0.0	1684.4	0.0	74.7	+250.9	+11.1	C:V405:1
C:HRD:T452	83.2	C:HRA:4:...	C:HRD:4:...	850.0	707.0	0.0	454.6	0.0	53.5	+252.4	+29.7	C:V446:1
C:HRD:T451	83.2	C:HRA:4:...	C:HRD:4:...	850.0	707.0	0.0	454.6	0.0	53.5	+252.4	+29.7	C:V446:1
C:CST:T401	82.5	C:CST:4:...	C:CST:2:W3	500.0	412.3	0.0	259.0	0.0	51.8	+153.3	+30.7	C:V223:1
C:KRA:4:nKSP:1	81.8	C:KRA:4:...	C:KRA:4:...	2000.0	1637.0	0.0	298.1	0.0	14.9	+1338.9	+66.9	C:V411:1
D8:ROH:T441	80.9	D8:ROH:4...	D8:ROH:4...	1440.0	1164.3	0.0	852.0	0.0	59.2	+312.3	+21.7	D8:V572:1
C:HRD:4:ACT84:1	79.8	C:HRD:4:...	C:HRD:4:...	2530.0	2019.5	0.0	1286.7	0.0	50.9	+732.8	+29.0	C:V446:1

Table 2.15: N-1 report from ČEPS control system at 11:13 – per relevant monitored element

Results of N-1 at 11:13:

- The C:HRA:T402 transformer is overloadable. The solution for the case of N-1 non-fulfilment is to coordinate with the distribution company to reduce consumption at the 220 kV level (e.g., in the area of c:VIT:T402) and switch off the C:CHT:T202 transformer.
- After the aforementioned reconfigurations were executed, the ČEPS grid was N-1 secure.

At 11:14, the ČEZd operator requested permission from the ČEPS operator to perform coupling of the Řeporyje and Týnec 110 kV areas. The ČEPS dispatcher authorised the coupling.

At 11:17, the ČEZd operator asked the ČEPS operator for permission to couple the Řeporyje and Výškov 110 kV areas to change the configuration of the MV and HV networks at several locations. The ČEPS operator authorised coupling. The Řeporyje and Výškov areas were coupled from 11:19 to 11:41.

Tables 2.16 and 2.17 present the N-1 report from the ČEPS control system at 11:20, after the connection of the Řeporyje and Výškov 110 kV areas.

Kontingence	N-1%	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Zařízení
C:V411:1	103.0	514.8	14.8	339.9	0.0	68.0	+175.0	+35.0	C:HRA:T402
C:V445:1	99.7	1435.1	0.0	878.9	0.0	61.0	+556.2	+38.6	D8:ROH:T442
C:CST:T401	96.3	481.5	0.0	339.9	0.0	68.0	+141.6	+28.3	C:HRA:T402
C:V446:1	90.0	2049.4	0.0	1308.2	0.0	57.5	+741.1	+32.6	C:V445:1
C:CHD:T401	89.7	313.8	0.0	166.5	0.0	47.6	+147.2	+42.1	C:CHD:T403
C:CHD:T403	89.6	313.6	0.0	146.9	0.0	42.0	+166.6	+47.6	C:CHD:T401
C:V052:1	86.6	2494.9	0.0	1959.5	0.0	68.0	+535.4	+18.6	C:HRD:4:nSR...
D8:V572:1	83.8	1207.3	0.0	879.4	0.0	61.1	+327.9	+22.8	D8:ROH:T441
C:REP:T404	83.1	290.8	0.0	192.7	0.0	55.1	+98.1	+28.0	C:REP:T403
C:V223:1	83.0	414.9	0.0	260.8	0.0	52.2	+154.1	+30.8	C:CST:T401
C:V405:1	82.6	1862.8	0.0	1620.1	0.0	71.8	+242.7	+10.8	C:V411:1
C:HRA:T402	81.8	1846.2	0.0	1620.1	0.0	71.8	+226.1	+10.0	C:V411:1
C:V420:1	81.8	1845.9	0.0	1620.1	0.0	71.8	+225.8	+10.0	C:V411:1
C:REP:T403	80.1	280.4	0.0	178.3	0.0	50.9	+102.1	+29.2	C:REP:T404
C:V480:1	78.6	1772.8	0.0	1620.1	0.0	71.8	+152.7	+6.8	C:V411:1

Table 2.16: N-1 report from the ČEPS control system at 11:20 – per relevant contingency

Zařízení	N-1%	Uzel1	Uzel2	Limit	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Kontingence
C:HRA:T402	103.0	C:HRA:4:...	C:HRA:2:...	500.0	514.8	14.8	339.9	0.0	68.0	+175.0	+35.0	C:V411:1
D8:ROH:T442	99.7	D8:ROH:4...	D8:ROH:4...	1440.0	1435.1	0.0	878.9	0.0	61.0	+556.2	+38.6	C:V445:1
C:V445:1	90.0	C:HRD:4:...	D8:ROH:4...	2276.0	2049.4	0.0	1308.2	0.0	57.5	+741.1	+32.6	C:V446:1
C:V208:1	89.9	C:MIL:2:W...	C:CST:2:W3	749.0	673.6	0.0	89.4	0.0	11.9	+584.1	+78.0	C:CST:T401
C:CHD:T403	89.7	C:CHD:4:...	C:CHD:1:...	350.0	313.8	0.0	166.5	0.0	47.6	+147.2	+42.1	C:CHD:T401
C:CHD:T401	89.6	C:CHD:4:...	C:CHD:1:...	350.0	313.6	0.0	146.9	0.0	42.0	+166.6	+47.6	C:CHD:T403
C:V446:1	88.8	C:HRA:4:...	D8:ROH:4...	2276.0	2022.1	0.0	1237.2	0.0	54.4	+784.8	+34.5	C:V445:1
C:HRD:4:nSRW2:1	86.6	C:HRA:4:...	C:HRA:4:...	2882.0	2494.9	0.0	1959.5	0.0	68.0	+535.4	+18.6	C:V052:1
C:REP:T403	84.2	C:REP:4:...	C:REP:1:...	350.0	294.8	0.0	192.7	0.0	55.1	+102.1	+29.2	C:V411:1
C:HRD:T452	84.2	C:HRA:4:...	C:HRD:4:...	850.0	715.9	0.0	460.1	0.0	54.1	+255.8	+30.1	C:V446:1
C:HRD:T451	84.2	C:HRA:4:...	C:HRD:4:...	850.0	715.9	0.0	460.1	0.0	54.1	+255.8	+30.1	C:V446:1
D8:ROH:T441	83.8	D8:ROH:4...	D8:ROH:4...	1440.0	1207.3	0.0	879.4	0.0	61.1	+327.9	+22.8	D8:V572:1
C:CST:T401	83.0	C:CST:4:...	C:CST:2:W3	500.0	414.9	0.0	260.8	0.0	52.2	+154.1	+30.8	C:V223:1
C:V411:1	82.6	C:VYS:4:...	C:HRA:4:...	2256.0	1862.8	0.0	1620.1	0.0	71.8	+242.7	+10.8	C:V405:1
C:V223:1	81.1	C:HRA:2:...	C:VIT:2:W...	1165.0	944.8	0.0	571.3	0.0	49.0	+373.5	+32.1	C:CST:T401
C:VIT:2:nSP:1	81.0	C:VIT:2:W...	C:VIT:2:W...	1165.0	943.1	0.0	566.9	0.0	48.7	+376.2	+32.3	C:CST:T401
C:HRD:4:ACT84:1	80.9	C:HRD:4:...	C:HRD:4:...	2530.0	2046.4	0.0	1303.0	0.0	51.5	+743.4	+29.4	C:V446:1
C:HRD:4:ACT94:1	80.9	C:HRA:4:...	C:HRA:4:...	2530.0	2046.0	0.0	1302.6	0.0	51.5	+743.4	+29.4	C:V446:1
C:REP:T404	80.1	C:REP:4:...	C:REP:1:...	350.0	280.4	0.0	178.3	0.0	50.9	+102.1	+29.2	C:REP:T403
C:HRD:4:Y1_465_K...	79.8	C:HRA:4:...	C:HRA:4:...	2882.0	2300.6	0.0	1568.8	0.0	54.4	+731.8	+25.4	C:V446:1

Table 2.17: N-1 report from the ČEPS control system at 11:20 – per relevant monitored element

Results of N-1 at 11:20:

- The C:HRA:T402 transformer is overloadable. The solution for the case of N-1 non-fulfilment is to coordinate with the distribution company to reduce consumption at the 220 kV level (e.g., in the area of c:VIT:T402) and switch off the transformer C:CHT:T202.
- The connection of the Řeporyje–Výškov 110 kV areas led to a significant reduction of N-1 V411/V208.

Tables 2.18 and 2.19 present the N-1 report from the ČEPS control system at 11:42, after the disconnection of the Výškov–Řeporyje 110 kV areas.

Kontingence	N-1%	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Zařízení
C:V411:1	114.5	572.6	72.6	346.5	0.0	69.3	+226.1	+45.2	C:HRA:T402
C:V445:1	98.8	1422.3	0.0	850.5	0.0	59.1	+571.8	+39.7	D8:ROH:T442
C:CST:T401	98.0	490.0	0.0	346.5	0.0	69.3	+143.5	+28.7	C:HRA:T402
C:V446:1	92.9	2066.7	0.0	1347.8	0.0	60.6	+718.9	+32.3	C:V445:1
C:CHD:T401	90.7	317.5	0.0	168.6	0.0	48.2	+148.9	+42.5	C:CHD:T403
C:CHD:T403	90.7	317.3	0.0	148.6	0.0	42.5	+168.7	+48.2	C:CHD:T401
C:V405:1	89.3	1977.8	0.0	1723.9	0.0	77.9	+253.9	+11.5	C:V411:1
C:V052:1	88.7	2515.4	0.0	1985.4	0.0	70.0	+530.0	+18.7	C:HRD:4:nSR...
C:HRA:T402	88.4	1957.5	0.0	1723.9	0.0	77.9	+233.6	+10.6	C:V411:1
C:V420:1	87.7	1942.0	0.0	1723.9	0.0	77.9	+218.1	+9.9	C:V411:1
C:V223:1	87.1	1927.5	0.0	1723.9	0.0	77.9	+203.6	+9.2	C:V411:1
C:V433:1	86.9	1924.3	0.0	1723.9	0.0	77.9	+200.4	+9.0	C:V411:1
C:V459:1	84.8	1877.1	0.0	1723.9	0.0	77.9	+153.2	+6.9	C:V411:1
D8:V572:1	82.9	1194.3	0.0	871.2	0.0	60.5	+323.1	+22.4	D8:ROH:T441
C:V417:1	82.5	1826.0	0.0	1723.9	0.0	77.9	+102.1	+4.6	C:V411:1
C:V458:1	82.5	1825.9	0.0	1723.9	0.0	77.9	+102.0	+4.6	C:V411:1
C:V480:1	82.5	1825.7	0.0	1723.9	0.0	77.9	+101.8	+4.6	C:V411:1
C:V443:1	81.9	1812.2	0.0	1723.9	0.0	77.9	+88.3	+4.0	C:V411:1
C:V402:1	81.2	1798.1	0.0	1723.9	0.0	77.9	+74.2	+3.3	C:V411:1
C:V412:1	80.9	1791.6	0.0	1723.9	0.0	77.9	+67.7	+3.1	C:V411:1
C:V444:1	80.9	1791.2	0.0	1723.9	0.0	77.9	+67.3	+3.0	C:V411:1
C:V221:1	80.9	1790.5	0.0	1723.9	0.0	77.9	+66.6	+3.0	C:V411:1
C:V460:1	80.8	1788.9	0.0	1723.9	0.0	77.9	+65.0	+2.9	C:V411:1
C:V449:1	80.8	1788.8	0.0	1723.9	0.0	77.9	+64.9	+2.9	C:V411:1
D2:V465B:1	80.3	1777.1	0.0	1723.9	0.0	77.9	+53.2	+2.4	C:V411:1
Z:V456:1	80.1	1772.5	0.0	1723.9	0.0	77.9	+48.6	+2.2	C:V411:1
C:V475:1	79.5	2256.8	0.0	1985.4	0.0	70.0	+271.4	+9.6	C:HRD:4:nSR...

Table 2.18: N-1 report from the ČEPS control system at 11:42 – per relevant contingency

Zařízení	N-1%	Uzel1	Uzel2	Limit	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Kontingence
C:HRA:T402	114.5	C:HRA:4:...	C:HRA:2:...	500.0	572.6	72.6	346.5	0.0	69.3	+226.1	+45.2	C:V411:1
C:V208:1	99.5	C:MIL:2:W...	C:CST:2:W3	724.0	720.6	0.0	87.7	0.0	12.1	+632.9	+87.4	C:V411:1
D8:ROH:T442	98.8	D8:ROH:4...	D8:ROH:4...	1440.0	1422.3	0.0	850.5	0.0	59.1	+571.8	+39.7	C:V445:1
C:V445:1	92.9	C:HRD:4:...	D8:ROH:4...	2225.0	2066.7	0.0	1347.8	0.0	60.6	+718.9	+32.3	C:V446:1
C:V223:1	91.9	C:HRA:2:...	C:VIT:2:W...	1165.0	1070.1	0.0	581.4	0.0	49.9	+488.6	+41.9	C:V411:1
C:VIT:2:nSP:1	91.7	C:VIT:2:W...	C:VIT:2:W...	1165.0	1068.5	0.0	576.6	0.0	49.5	+491.9	+42.2	C:V411:1
C:CHD:T403	90.7	C:CHD:4:...	C:CHD:1:...	350.0	317.5	0.0	168.6	0.0	48.2	+148.9	+42.5	C:CHD:T401
C:CHD:T401	90.7	C:CHD:4:...	C:CHD:1:...	350.0	317.3	0.0	148.6	0.0	42.5	+168.7	+48.2	C:CHD:T403
C:V446:1	90.1	C:HRA:4:...	D8:ROH:4...	2225.0	2005.5	0.0	1198.0	0.0	53.8	+807.5	+36.3	C:V445:1
C:V411:1	89.3	C:VYS:4:...	C:HRA:4:...	2214.0	1977.8	0.0	1723.9	0.0	77.9	+253.9	+11.5	C:V405:1
C:HRD:4:nSRW2:1	88.7	C:HRA:4:...	C:HRA:4:...	2837.0	2515.4	0.0	1985.4	0.0	70.0	+530.0	+18.7	C:V052:1
C:KRA:4:nKSP:1	85.4	C:KRA:4:...	C:KRA:4:...	2000.0	1708.8	0.0	333.1	0.0	16.7	+1375.7	+68.8	C:V411:1
C:HRD:T451	84.9	C:HRA:4:...	C:HRD:4:...	850.0	721.4	0.0	473.6	0.0	55.7	+247.8	+29.2	C:V446:1
C:HRD:T452	84.9	C:HRA:4:...	C:HRD:4:...	850.0	721.4	0.0	473.6	0.0	55.7	+247.8	+29.2	C:V446:1
C:CST:T401	84.0	C:CST:4:...	C:CST:2:W3	500.0	419.9	0.0	262.8	0.0	52.6	+157.1	+31.4	C:V223:1
D8:ROH:T441	82.9	D8:ROH:4...	D8:ROH:4...	1440.0	1194.3	0.0	871.2	0.0	60.5	+323.1	+22.4	D8:V572:1
C:HRD:4:ACT84:1	81.6	C:HRD:4:...	C:HRD:4:...	2530.0	2063.5	0.0	1342.3	0.0	53.1	+721.1	+28.5	C:V446:1
C:HRD:4:ACT94:1	81.5	C:HRA:4:...	C:HRA:4:...	2530.0	2062.8	0.0	1341.7	0.0	53.0	+721.1	+28.5	C:V446:1
C:HRD:4:Y1_465_K...	80.7	C:HRA:4:...	C:HRA:4:...	2837.0	2289.7	0.0	1581.3	0.0	55.7	+708.4	+25.0	C:V446:1
C:HRD:4:ACB18:1	78.8	C:HRA:4:...	C:HRA:4:...	2530.0	1994.3	0.0	1188.7	0.0	47.0	+805.7	+31.8	C:V445:1

Table 2.19: N-1 report from the ČEPS control system at 11:42 – per relevant monitored element

Results of N-1 at 11:42:

- » The C:HRA:T402 transformer is overloadable. The solution for the case of N-1 non-fulfilment is to coordinate with the distribution company to relieve consumption at the 220 kV level (e.g., in the area of c:VIT:T402) and switch off the C:CHT:T202 transformer.
- » N-1 V411/V208 increased; nevertheless, the ČEPS grid is N-1 secure.

Kontingence	N-1%	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Zařízení
C:V411:1	107.0	534.9	34.9	325.6	0.0	65.1	+209.3	+41.9	C:HRA:T402
C:V445:1	93.2	1341.5	0.0	812.7	0.0	56.4	+528.9	+36.7	D8:ROH:T442
C:CHD:T401	91.9	321.8	0.0	171.0	0.0	48.9	+150.8	+43.1	C:CHD:T403
C:CHD:T403	91.9	321.5	0.0	150.4	0.0	43.0	+171.1	+48.9	C:CHD:T401
C:CST:T401	91.4	457.1	0.0	325.6	0.0	65.1	+131.5	+26.3	C:HRA:T402
C:V446:1	87.6	1948.2	0.0	1287.4	0.0	57.9	+660.7	+29.7	C:V445:1
C:V052:1	87.2	2474.1	0.0	1903.5	0.0	67.1	+570.6	+20.1	C:HRD:4:nSR...
C:V405:1	85.6	1894.7	0.0	1642.5	0.0	74.2	+252.2	+11.4	C:V411:1
C:V420:1	83.7	1852.1	0.0	1642.5	0.0	74.2	+209.6	+9.5	C:V411:1
C:HRA:T402	83.6	1851.4	0.0	1642.5	0.0	74.2	+208.9	+9.4	C:V411:1
C:V433:1	82.9	1835.3	0.0	1642.5	0.0	74.2	+192.8	+8.7	C:V411:1
D8:V572:1	82.9	1193.5	0.0	875.5	0.0	60.8	+318.0	+22.1	D8:ROH:T441
C:V223:1	82.5	1826.8	0.0	1642.5	0.0	74.2	+184.3	+8.3	C:V411:1
C:V459:1	80.9	1790.4	0.0	1642.5	0.0	74.2	+147.8	+6.7	C:V411:1
C:V480:1	80.5	1782.5	0.0	1642.5	0.0	74.2	+140.0	+6.3	C:V411:1
C:V458:1	78.6	1740.4	0.0	1642.5	0.0	74.2	+97.9	+4.4	C:V411:1

Table 2.20: N-1 report in SCOPT[6] (extended OA with IDCF offline model) at 11:50 – per relevant contingency

Zařízení	N-1%	Uzel1	Uzel2	Limit	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Kontingence
C:HRA:T402	107.0	C:HRA:4:...	C:HRA:2:...	500.0	534.9	34.9	325.6	0.0	65.1	+209.3	+41.9	C:V411:1
C:V208:1	95.1	C:MIL:2:W2	C:CST:2:W3	724.0	688.3	0.0	65.0	0.0	9.0	+623.4	+86.1	C:V411:1
D8:ROH:T442	93.2	D8:ROH:4...	D8:ROH:4...	1440.0	1341.5	0.0	812.7	0.0	56.4	+528.9	+36.7	C:V445:1
C:CHD:T403	91.9	C:CHD:4:...	C:CHD:1:...	350.0	321.8	0.0	171.0	0.0	48.9	+150.8	+43.1	C:CHD:T401
C:CHD:T401	91.9	C:CHD:4:...	C:CHD:1:...	350.0	321.5	0.0	150.4	0.0	43.0	+171.1	+48.9	C:CHD:T403
C:V445:1	87.6	C:HRD:4:...	D8:ROH:4...	2225.0	1948.2	0.0	1287.4	0.0	57.9	+660.7	+29.7	C:V446:1
C:HRD:4:nSRW2:1	87.2	C:HRD:4:...	C:HRA:4:...	2837.0	2474.1	0.0	1903.5	0.0	67.1	+570.6	+20.1	C:V052:1
C:V223:1	87.1	C:HRA:2:...	C:VIT:2:W2	1165.0	1014.4	0.0	549.3	0.0	47.2	+465.1	+39.9	C:V411:1
C:VIT:2:nSP:1	87.0	C:VIT:2:W1	C:VIT:2:W2	1165.0	1013.2	0.0	545.7	0.0	46.8	+467.5	+40.1	C:V411:1
C:V411:1	85.6	C:VYS:4:...	C:HRA:4:...	2214.0	1894.7	0.0	1642.5	0.0	74.2	+252.2	+11.4	C:V405:1
C:V446:1	84.9	C:HRD:4:...	D8:ROH:4...	2225.0	1888.2	0.0	1142.5	0.0	51.3	+745.7	+33.5	C:V445:1
D8:ROH:T441	82.9	D8:ROH:4...	D8:ROH:4...	1440.0	1193.5	0.0	875.5	0.0	60.8	+318.0	+22.1	D8:V572:1
C:KRA:4:nKSP:1	80.4	C:KRA:4:W1	C:KRA:4:W2	2000.0	1608.2	0.0	300.8	0.0	15.0	+1307.4	+65.4	C:V411:1
C:HRD:T452	80.2	C:HRD:4:...	C:HRD:4:...	850.0	681.7	0.0	453.6	0.0	53.4	+228.1	+26.8	C:V446:1
C:HRD:T451	80.2	C:HRD:4:...	C:HRD:4:...	850.0	681.7	0.0	453.6	0.0	53.4	+228.1	+26.8	C:V446:1
C:CST:T401	78.0	C:CST:4:W1	C:CST:2:W3	500.0	390.0	0.0	240.3	0.0	48.1	+149.8	+30.0	C:V223:1

Table 2.21: N-1 report in SCOPT (extended OA with IDCF offline model) at 11:50 – per relevant monitored element

Results of N-1 and cascade in SCOPT at 11:50:

» The C:HRA:T402 transformer is overloadable. The solution for the case of N-1 non-fulfilment is to coordinate with the distribution company to reduce consumption at the 220 kV level (e.g., in the area of c:VIT:T402) and switch off the C:CHT:T202 transformer.

» The calculation results using the SCOPT model do not contain any N-1 non-fulfilment and do not indicate any risk of cascade:

- › line loaded above 110 %;
- › transformer loaded above 125 %;
- › busbar coupler loaded above the tripping current set on the overcurrent protection.

6 SCOPT is a ČEPS tool used to calculate N-1, cascade and automatically propose measures in case of non-compliance with N-1. The calculation takes place once every 15 minutes at 5, 20, 35 and 50 minutes in each hour.

11:50 DSA

The online version of the DSA tool, used for real-time operation, calculates all scenarios without applying critical scenario selection every minute based on the real-time model in the control system.

Before the V411 outage, the online DSA tool did not detect any violation in dynamic stability (CCT less than 100 ms) at TPP Ledvice unit 6.

Power plant	Generator	CCT (ms)	Line	Substation
EDAL	HG2	129	V438	SLV4
EDAL	HG2	129	V437	SLV4
EDAL	HG2	130	V435	SLV4
EDAL	HG2	130	V436	SLV4
EDAL	HG2	131	V433	SLV4
EDAL	HG4	175	V436	SLV4
EDAL	HG4	175	V435	SLV4
EDAL	HG4	175	V433	SLV4
EDAL	HG4	175	V438	SLV4
EDAL	HG4	175	V437	SLV4
EDAL	HG3	175	V433	SLV4
EDAL	HG3	175	V438	SLV4
EDAL	HG3	175	V437	SLV4
EDAL	HG3	175	V436	SLV4
EDAL	HG3	175	V435	SLV4
EDST	HG2	178	V458	KRA4
EDST	HG2	178	V402	KRA4
ETEM	TG2	178	V475	KOC4
EDUK	TG42	179	V437	SLV4
EDUK	TG42	179	V438	SLV4
EDUK	TG41	179	V437	SLV4
EDUK	TG41	179	V438	SLV4
EDUK	TG22	179	V437	SLV4
EDUK	TG22	179	V438	SLV4
EDUK	TG31	179	V438	SLV4
EDUK	TG31	179	V437	SLV4
EDUK	TG32	179	V438	SLV4
EDUK	TG32	179	V437	SLV4
EDUK	TG12	179	V437	SLV4
EDUK	TG12	179	V438	SLV4
EDUK	TG11	179	V437	SLV4
EDUK	TG11	179	V438	SLV4
EDUK	TG21	179	V438	SLV4
EDUK	TG21	179	V437	SLV4
EDUK	TG31	179	V433	SLV4
EDUK	TG42	180	V435	SLV4
EDUK	TG42	180	V433	SLV4
EDUK	TG42	180	V436	SLV4
EDUK	TG41	180	V435	SLV4
EDUK	TG12	180	V433	SLV4
EDUK	TG41	180	V433	SLV4
EDUK	TG41	180	V436	SLV4
EDUK	TG11	180	V433	SLV4
EDUK	TG31	180	V435	SLV4
EDUK	TG31	180	V436	SLV4
EDUK	TG12	180	V435	SLV4
EDUK	TG12	180	V436	SLV4
EDUK	TG32	180	V435	SLV4
EDUK	TG11	180	V435	SLV4
EDUK	TG32	180	V433	SLV4
EDUK	TG32	180	V436	SLV4
EDUK	TG11	180	V436	SLV4
EDUK	TG21	180	V435	SLV4
EDUK	TG21	180	V436	SLV4
EDUK	TG21	180	V433	SLV4
EDUK	TG22	180	V435	SLV4
EDUK	TG22	180	V436	SLV4
EDUK	TG22	180	V433	SLV4
EDST	HG2	181	V401	KRA4
ETEM	TG2	187	V473	KOC4
ETEM	TG2	188	V474	KOC4
ELED	TG6	251	V480	CHT4
EPR2	TG23	285	V446	HRA4
EPR2	TG23	286	V412	HRA4
EPR2	TG23	287	V430	HRA4
EPR2	TG23	287	V461	HRA4
EPR2	TG23	288	V411	HRA4
EPR2	TG23	288	V420	HRA4
EPR2	TG25	331	V411	HRA4
ECHV	TG4	331	V400	TYN4
EPOC	TG6	332	V480	VYS4
EPR2	TG25	332	V412	HRA4
EPR2	TG25	332	V430	HRA4
EPOC	TG2	332	V480	VYS4
EPR2	TG25	332	V420	HRA4
EPR2	TG25	332	V461	HRA4
EPR2	TG25	332	V446	HRA4
EPOC	TG2	332	V411	VYS4
EPOC	TG6	333	V428	VYS4
EPOC	TG6	333	V450	VYS4
EPOC	TG6	333	V419	VYS4
EPOC	TG6	333	V410	VYS4
EPOC	TG2	333	V450	VYS4
EPOC	TG2	333	V428	VYS4
EPOC	TG6	333	V411	VYS4
EPOC	TG2	333	V419	VYS4
EPOC	TG2	333	V410	VYS4
ECHV	TG4	379	V401	TYN4
EPR2	TG25	600	V445	HRD4
EPR2	TG23	600	V445	HRD4

Table 2.22: Results of the online DSA for the state at 11:50

Tables 2.23 and 2.24 present the N-1 report from the ČEPS control system at 11:51, 25 s before the outage of line V411.

Kontingence	N-1%	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Zařízení
C:V411:1	110.6	553.2	53.2	331.2	0.0	66.2	+222.0	+44.4	C:HRA:T402
C:V445:1	95.9	1380.9	0.0	824.8	0.0	57.3	+556.1	+38.6	D8:ROH:T442
C:CST:T401	93.1	465.7	0.0	331.2	0.0	66.2	+134.6	+26.9	C:HRA:T402
C:CHD:T401	90.3	315.9	0.0	167.7	0.0	47.9	+148.2	+42.3	C:CHD:T403
C:CHD:T403	90.2	315.7	0.0	147.9	0.0	42.2	+167.8	+48.0	C:CHD:T401
C:V446:1	90.0	2003.4	0.0	1308.8	0.0	58.8	+694.6	+31.2	C:V445:1
C:V052:1	88.4	2507.3	0.0	1977.4	0.0	69.7	+529.9	+18.7	C:HRD:4:nSR...
C:V405:1	87.4	1935.8	0.0	1699.7	0.0	76.8	+236.1	+10.7	C:V411:1
C:V420:1	86.9	1923.1	0.0	1699.7	0.0	76.8	+223.4	+10.1	C:V411:1
C:HRA:T402	86.8	1921.4	0.0	1699.7	0.0	76.8	+221.7	+10.0	C:V411:1
C:V433:1	86.1	1906.9	0.0	1699.7	0.0	76.8	+207.2	+9.4	C:V411:1
C:V223:1	85.5	1893.9	0.0	1699.7	0.0	76.8	+194.2	+8.8	C:V411:1
C:V459:1	82.8	1832.2	0.0	1699.7	0.0	76.8	+132.5	+6.0	C:V411:1
D8:V572:1	82.1	1181.8	0.0	863.6	0.0	60.0	+318.2	+22.1	D8:ROH:T441
C:V480:1	81.9	1812.8	0.0	1699.7	0.0	76.8	+113.1	+5.1	C:V411:1
C:V417:1	81.1	1796.5	0.0	1699.7	0.0	76.8	+96.8	+4.4	C:V411:1
C:V458:1	80.6	1783.7	0.0	1699.7	0.0	76.8	+84.0	+3.8	C:V411:1
C:V443:1	80.5	1783.3	0.0	1699.7	0.0	76.8	+83.6	+3.8	C:V411:1
C:V402:1	80.0	1772.1	0.0	1699.7	0.0	76.8	+72.4	+3.3	C:V411:1
C:V412:1	80.0	1771.2	0.0	1699.7	0.0	76.8	+71.6	+3.2	C:V411:1
C:V221:1	79.8	1766.8	0.0	1699.7	0.0	76.8	+67.1	+3.0	C:V411:1

Table 2.23: N-1 report from ČEPS control system at 11:51 – per relevant contingency

Zařízení	N-1%	Uzel1	Uzel2	Limit	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Kontingence
C:HRA:T402	110.6	C:HRA:4:...	C:HRA:2:...	500.0	553.2	53.2	331.2	0.0	66.2	+222.0	+44.4	C:V411:1
C:V208:1	98.2	C:MIL:2:W...	C:CST:2:W3	724.0	710.9	0.0	90.0	0.0	12.4	+620.9	+85.8	C:V411:1
D8:ROH:T442	95.9	D8:ROH:4...	D8:ROH:4...	1440.0	1380.9	0.0	824.8	0.0	57.3	+556.1	+38.6	C:V445:1
C:CHD:T403	90.3	C:CHD:4:...	C:CHD:1:...	350.0	315.9	0.0	167.7	0.0	47.9	+148.2	+42.3	C:CHD:T401
C:CHD:T401	90.2	C:CHD:4:...	C:CHD:1:...	350.0	315.7	0.0	147.9	0.0	42.2	+167.8	+48.0	C:CHD:T403
C:V445:1	90.0	C:HRD:4:...	D8:ROH:4...	2225.0	2003.4	0.0	1308.8	0.0	58.8	+694.6	+31.2	C:V446:1
C:V223:1	88.9	C:HRA:2:...	C:VIT:2:W...	1165.0	1035.2	0.0	557.1	0.0	47.8	+478.1	+41.0	C:V411:1
C:VIT:2:nSP:1	88.8	C:VIT:2:W...	C:VIT:2:W...	1165.0	1034.2	0.0	552.5	0.0	47.4	+481.7	+41.4	C:V411:1
C:HRD:4:nSRW2:1	88.4	C:HRA:4:...	C:HRA:4:...	2837.0	2507.3	0.0	1977.4	0.0	69.7	+529.9	+18.7	C:V052:1
C:V411:1	87.4	C:VYS:4:...	C:HRA:4:...	2214.0	1935.8	0.0	1699.7	0.0	76.8	+236.1	+10.7	C:V405:1
C:V446:1	87.3	C:HRA:4:...	D8:ROH:4...	2225.0	1942.3	0.0	1159.3	0.0	52.1	+783.0	+35.2	C:V445:1
C:HRD:T452	82.4	C:HRA:4:...	C:HRD:4:...	850.0	700.7	0.0	460.7	0.0	54.2	+240.0	+28.2	C:V446:1
C:HRD:T451	82.4	C:HRA:4:...	C:HRD:4:...	850.0	700.7	0.0	460.7	0.0	54.2	+240.0	+28.2	C:V446:1
D8:ROH:T441	82.1	D8:ROH:4...	D8:ROH:4...	1440.0	1181.8	0.0	863.6	0.0	60.0	+318.2	+22.1	D8:V572:1
C:KRA:4:nKSP:1	81.8	C:KRA:4:...	C:KRA:4:...	2000.0	1636.5	0.0	288.7	0.0	14.4	+1347.8	+67.4	C:V411:1
C:CST:T401	79.8	C:CST:4:...	C:CST:2:W3	500.0	399.2	0.0	249.6	0.0	49.9	+149.6	+29.9	C:V223:1

Table 2.24: N-1 report from ČEPS control system at 11:51 – per relevant monitored element

Results of N-1 at 11:51:

- » The C:HRA:T402 transformer is overloadable. The solution for the case of N-1 non-fulfilment is to coordinate with the distribution company to relieve consumption at the 220 kV level (e.g., in the area of c:VIT:T402) and switch off the C:CHT:T202 transformer.
- » Immediately before the V411 outage, the N-1 criterion is met: V411/V208 98.2 %, V411/HRA:T402 110.6 %.[7]

7 Due to the overloadability of HRA:T402 120 %/3 h, the N-1 criterion is met, and corrective action would be taken only after the V411 outage using the overload capacity time of 3 h.

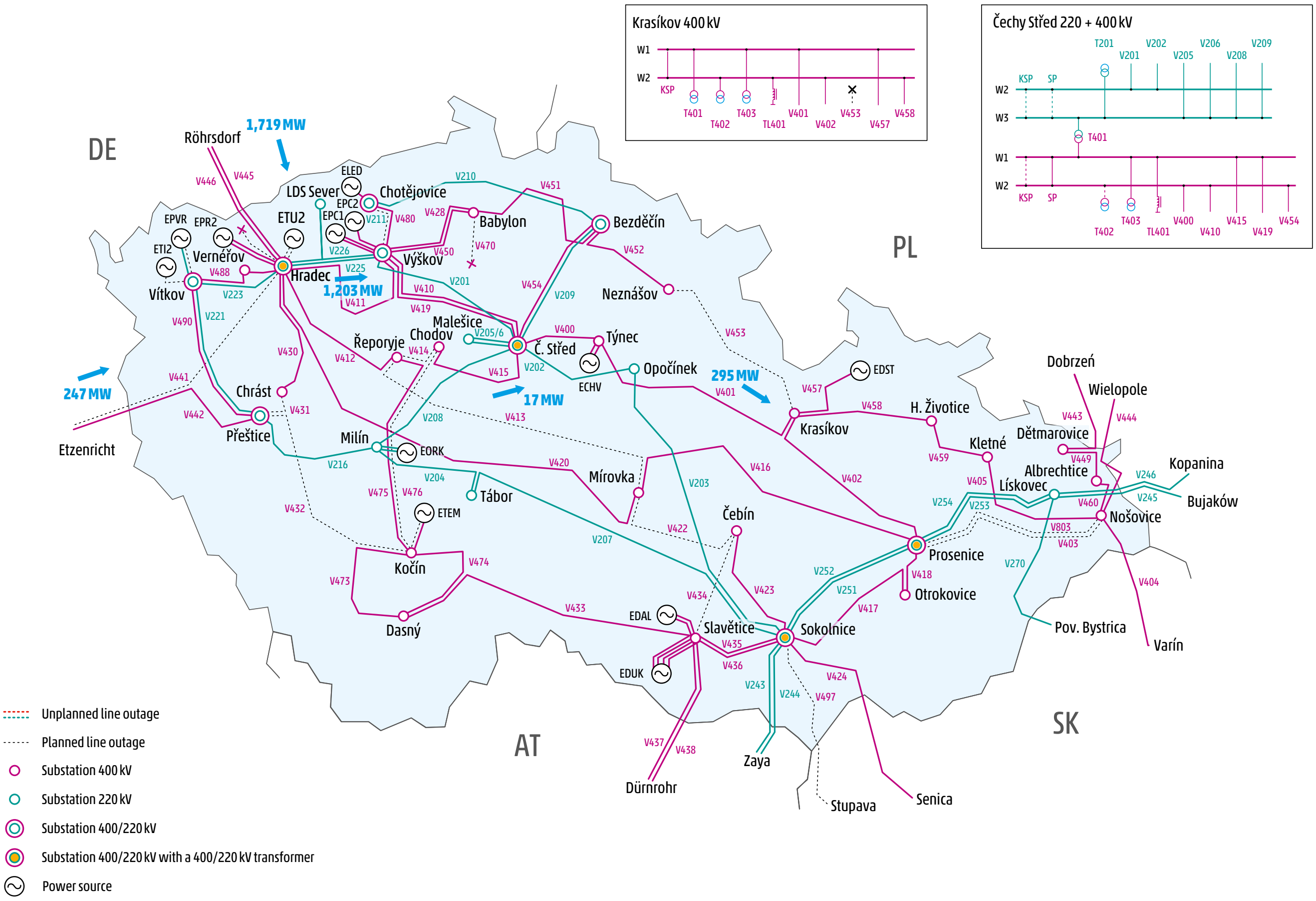


Figure 2.3: Situation of the Czech Republic transmission system on 4 July 2025 at 11:51

	V411/Výškov	V208/Čechy Střed	V401/Krasíkov
P [MW]	1,203	17	295
Q [Mvar]	–181	32	2
I [A]	1,680	90	392

Table 2.25: Power flow on lines feeding the affected area at 11:51

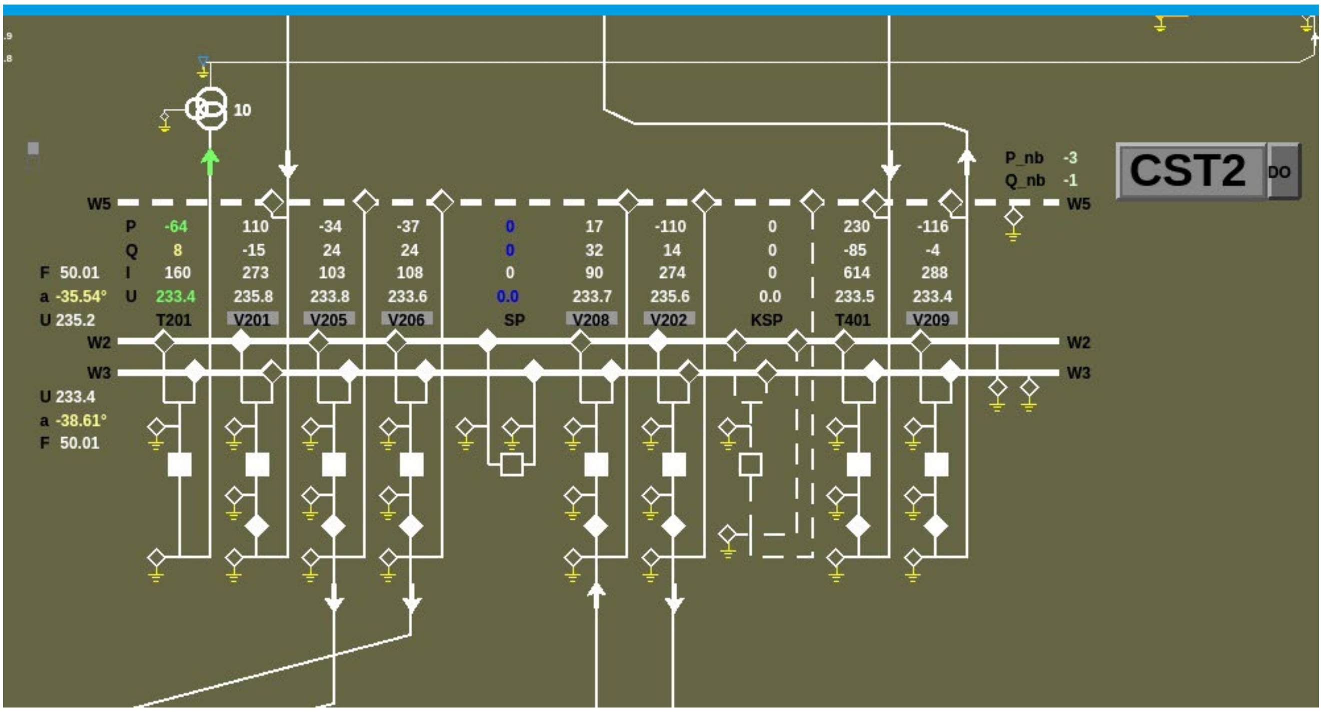


Figure 2.4: Scheme of the Čechy Střed 220 kV substation at 11:51

Implemented reconfiguration:

- Busbar W2 – V201, V202.
- Busbar W3 – T201CST, V205, V206, V208, V209, T401.

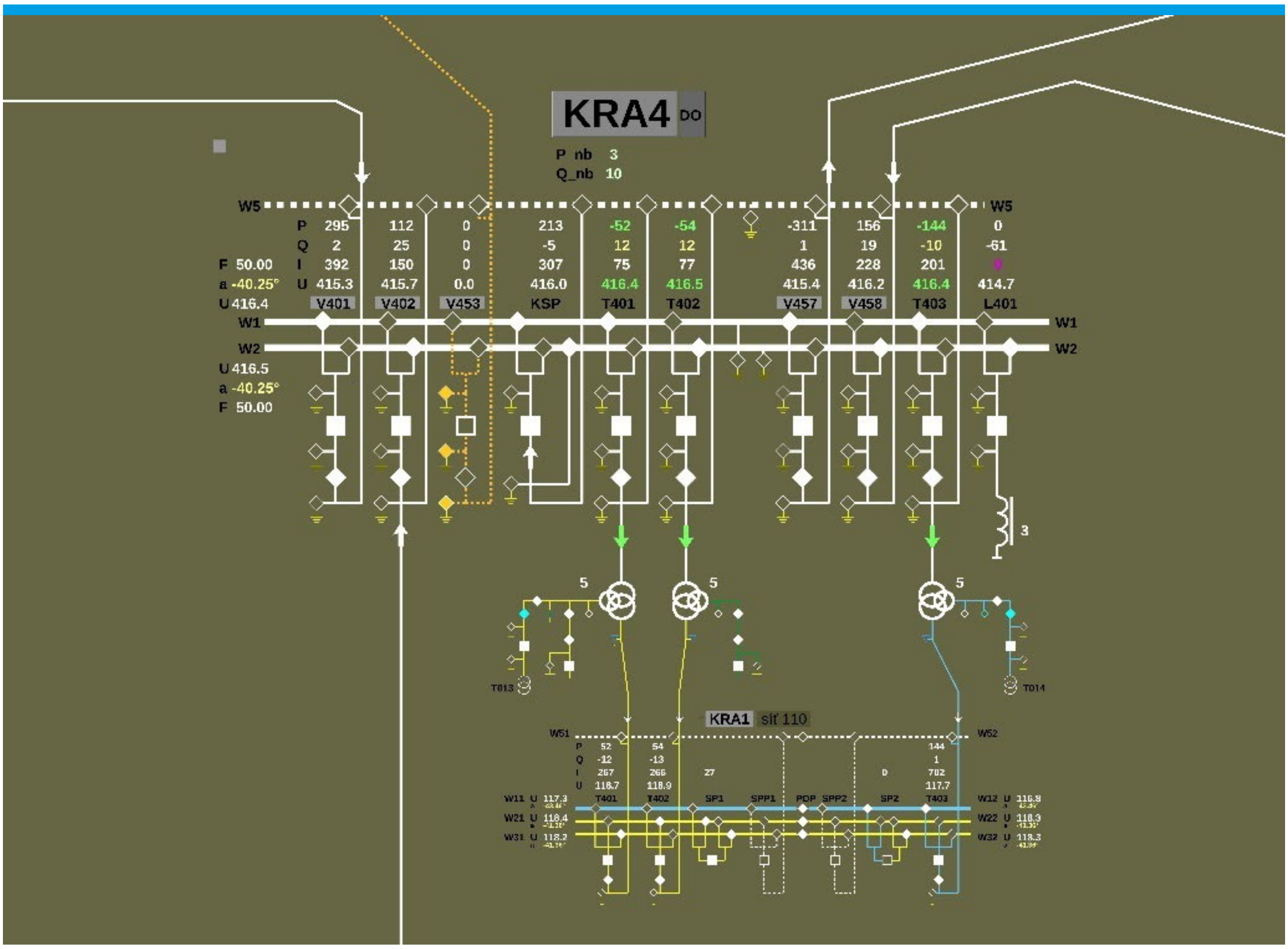


Figure 2.5: Scheme of Krasíkov 400 kV substation at 11:51

The Krasíkov 400 kV substation was not included in the basic connection per the valid internal guideline due to the ongoing investment project for line V453, which occurred just before the V411 outage.

For the sake of operational security in the event of differential protection of busbars and readiness for a possible reconfiguration of the substation to reduce voltage, the dispatchers operated the substation in the following connection:

» Busbar W1 – V401, T401, V457, T403, KSP.

» Busbar W2 – V402, T402, V458, L401, KSP.

In this connection, the substation was prepared to switch off the V402 or V458 lines due to high voltage when the EDST was not in operation.

In this context, the substation was prepared to shut down lines V402 or V458 due to high voltage if the EDST was not in operation.

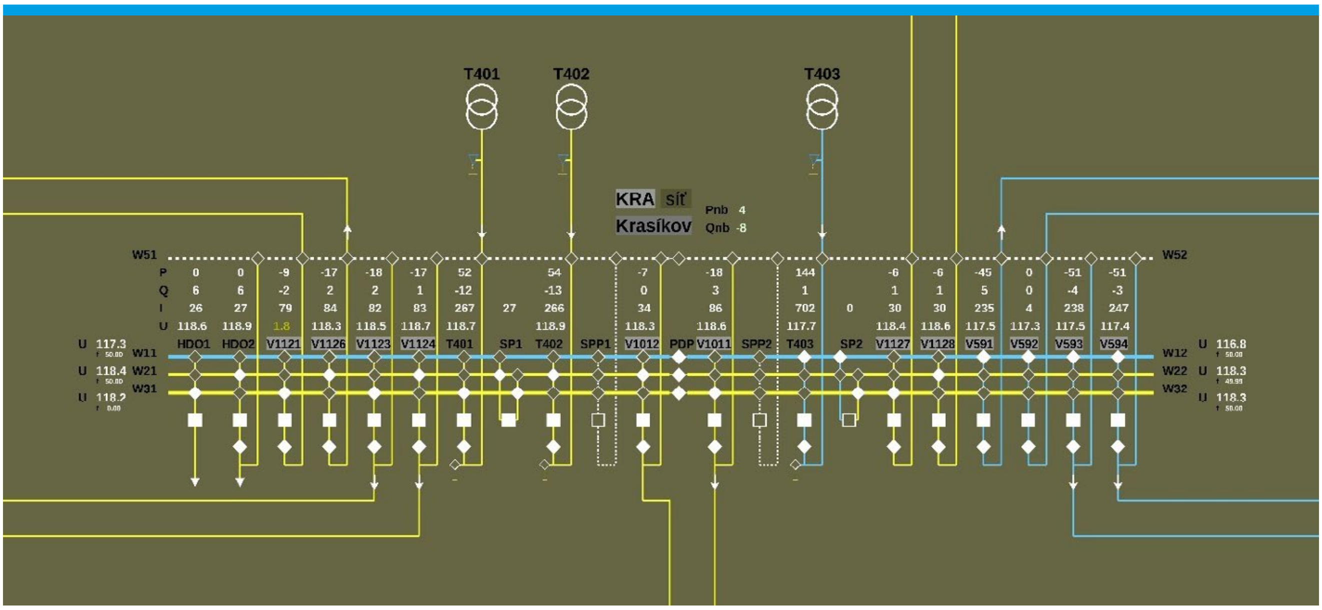


Figure 2.6: Scheme of 110 kV Krasíkov substation

The T401KRA and T402KRA transformers and the 110 kV distribution area operated in parallel connection. The busbar coupler SP1 at the Krasíkov 110 kV substation was switched on and supplying the ČEZd Východ area, while T403KRA was in single operation and supplying the ČEZd Morava area.

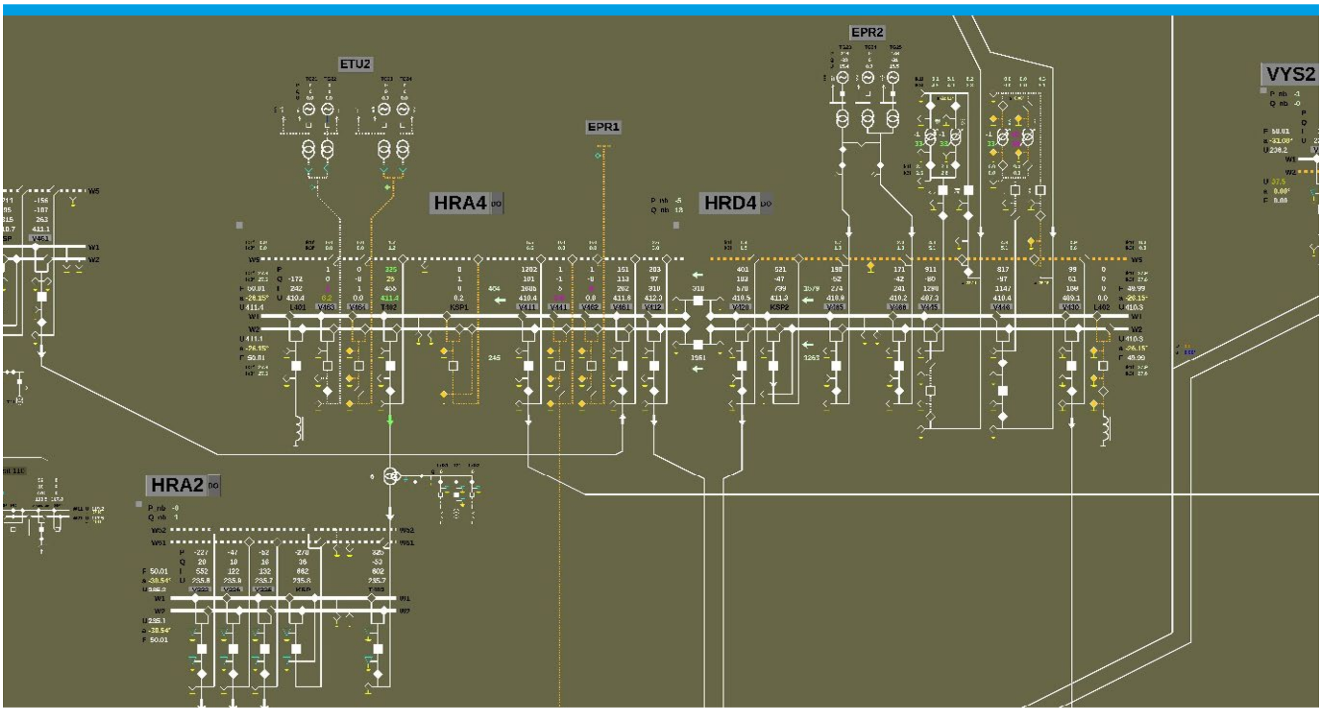


Figure 2.7: Scheme of 400 kV Hradec substation at 11:51

Since many elements of the Hradec 400 kV substation were switched off, the connection of the Hradec substation was modified from the basic configuration.

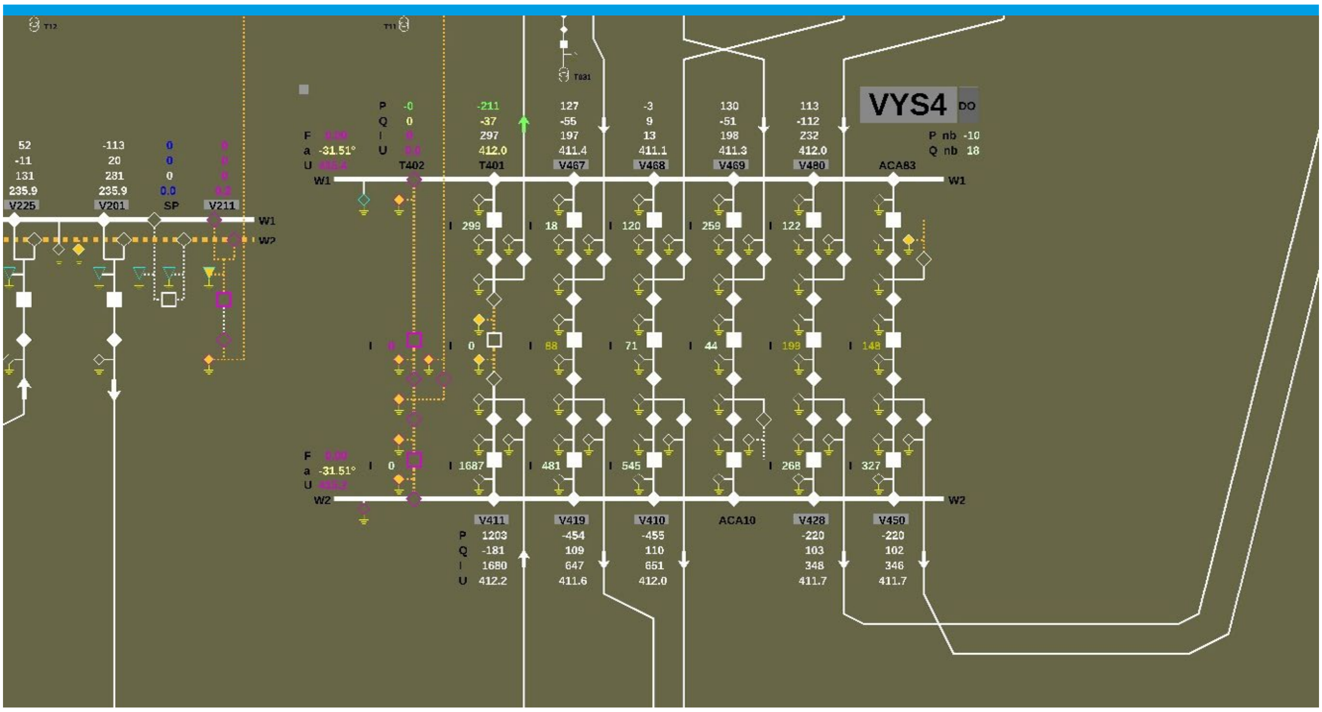


Figure 2.8: Scheme of 400 kV Výškov substation

Except for the T402VYS transformer that was switched off for replacement, the 400 kV Výškov substation was in basic connection.

2.1.6 Unplanned outages

There were no unplanned outages in the ČEPS grid before the event on 4 July 2025.

2.2 Weather conditions

The weather on 4 July 2025 in the Czech Republic was partly clear to cloudy, with showers in places. Daytime temperatures ranged from 23 to 27 °C and nighttime temperatures from 14 to 18 °C, with south-westerly winds of 2 to 6 m/s.

The weather in the Czech Republic had no impact on the failure of the overhead line V411. The following figures present additional information on the weather conditions.

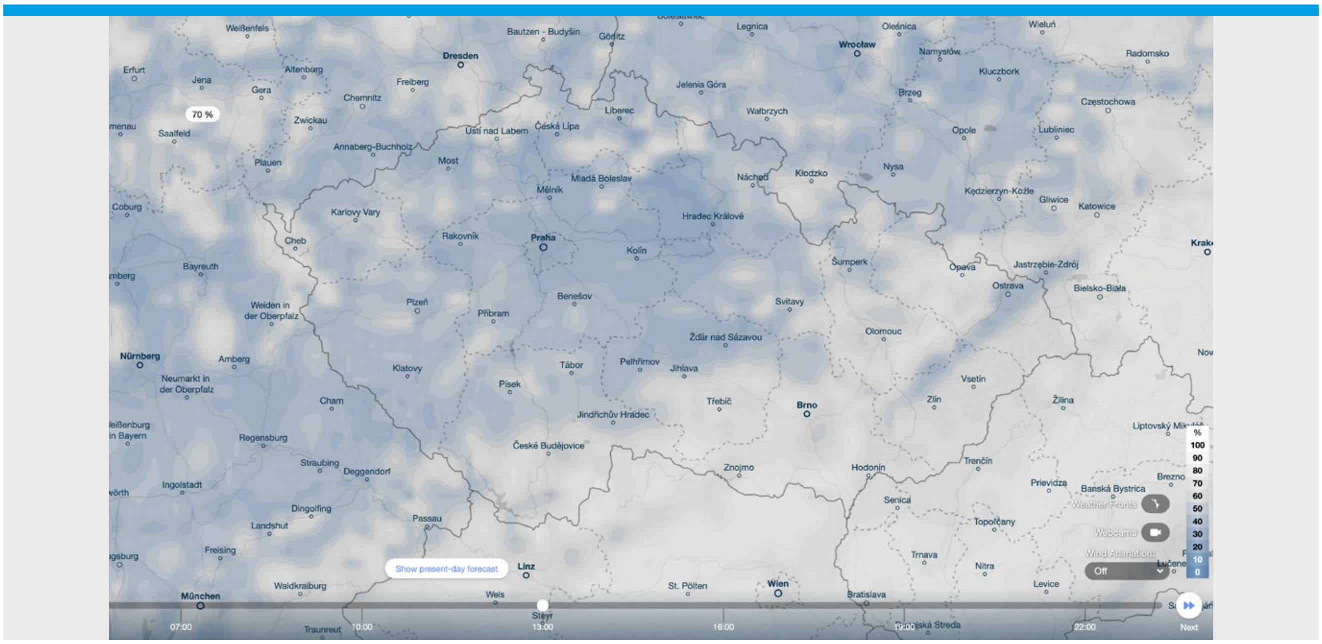


Figure 2.9: Cloudiness in the Czech Republic on 4 July 2025 (source: https://www.ventusky.com)

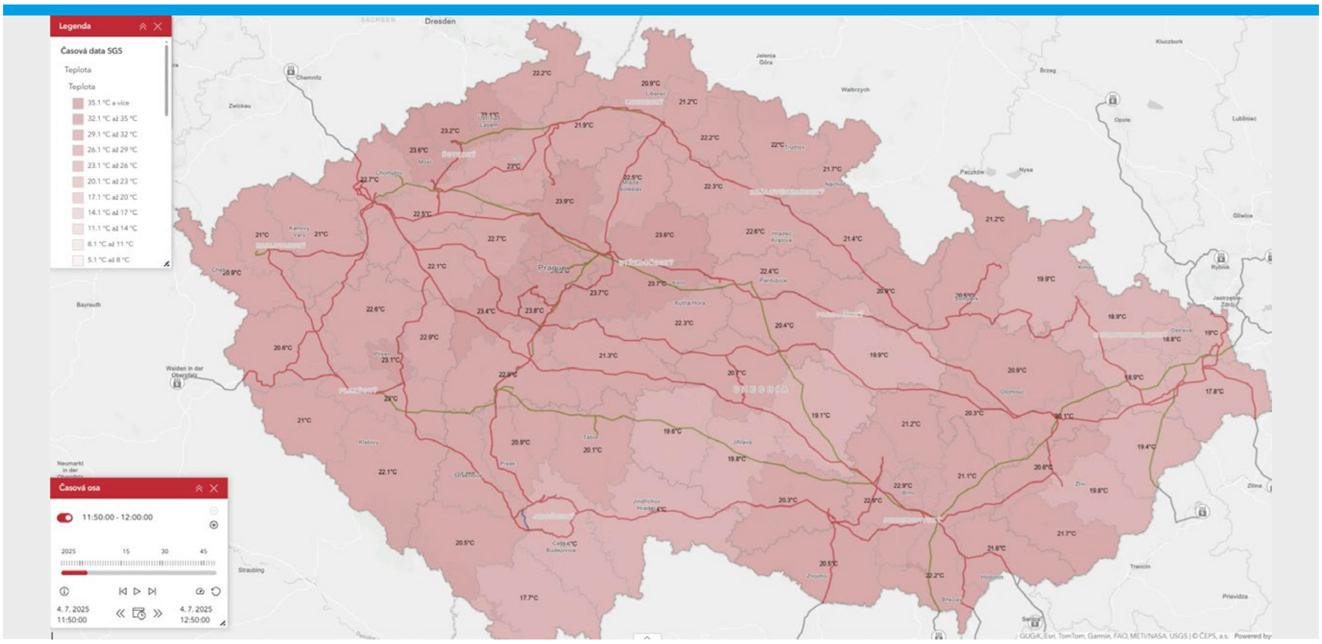


Figure 2.10: Temperature in the Czech Republic on 4 July 2025 (source: SGS ČEPS)

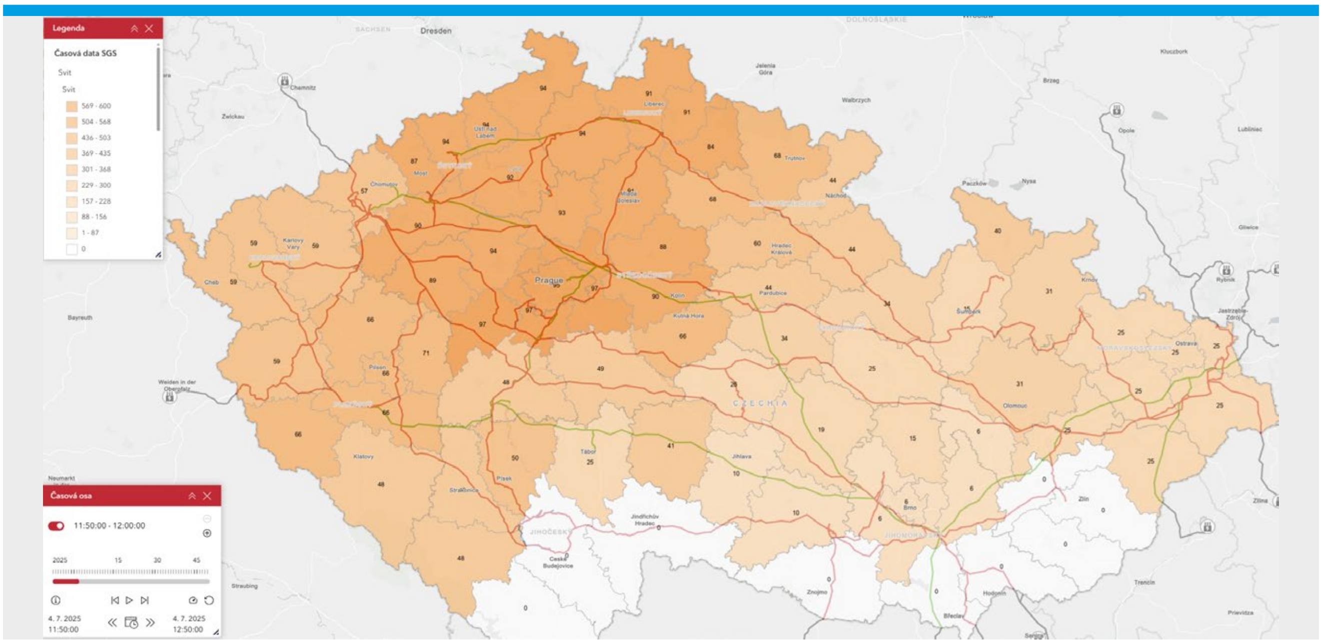


Figure 2.11: Sunshine in the Czech Republic on 4 July 2025 (source: SGS ČEPS)

Figure 2.12: Wind gusts in the Czech Republic on 4 July 2025 (source: https://www.ventusky.com)

2.3 Market situation

The average day-ahead price in the Czech Republic on 4 July 2025 was 98.22 €/MWh, 6.8 % higher than the average price in July 2025 (91.88 €/MWh).

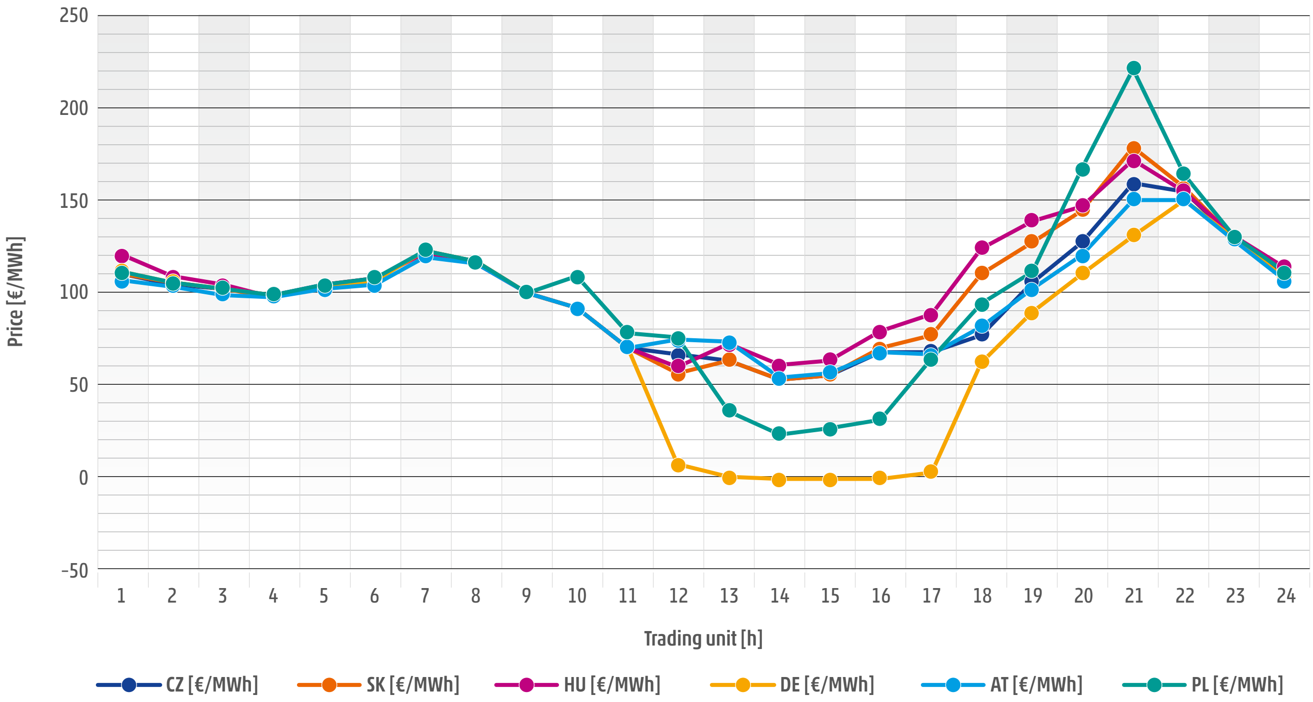


Figure 2.13: Flow-based day-ahead market coupling

The Czech electricity market operated under stable and predictable conditions throughout the day, with price movements largely reflecting regional dynamics within the coupled market. The average price of 98.22 €/MWh positioned the Czech market slightly below the regional mean, indicating a balanced supply-demand situation.

During the early afternoon, prices dipped to a daily low of 52.71 €/MWh, coinciding with similar downward trends in neighbouring countries. In the evening, prices surged to a peak of 158.84 €/MWh, reflecting increased consumption during post-working hours.

This peak was part of a broader regional trend, indicating synchronised demand patterns and potential transmission constraints or limited generation flexibility across Central and Eastern Europe.

From a system operation perspective, the day can be classified as operationally standard, with no significant disruptions, imbalances or market failures. The Czech market responded effectively to regional price signals and maintained alignment with neighbouring markets.

2.3.1 Load patterns

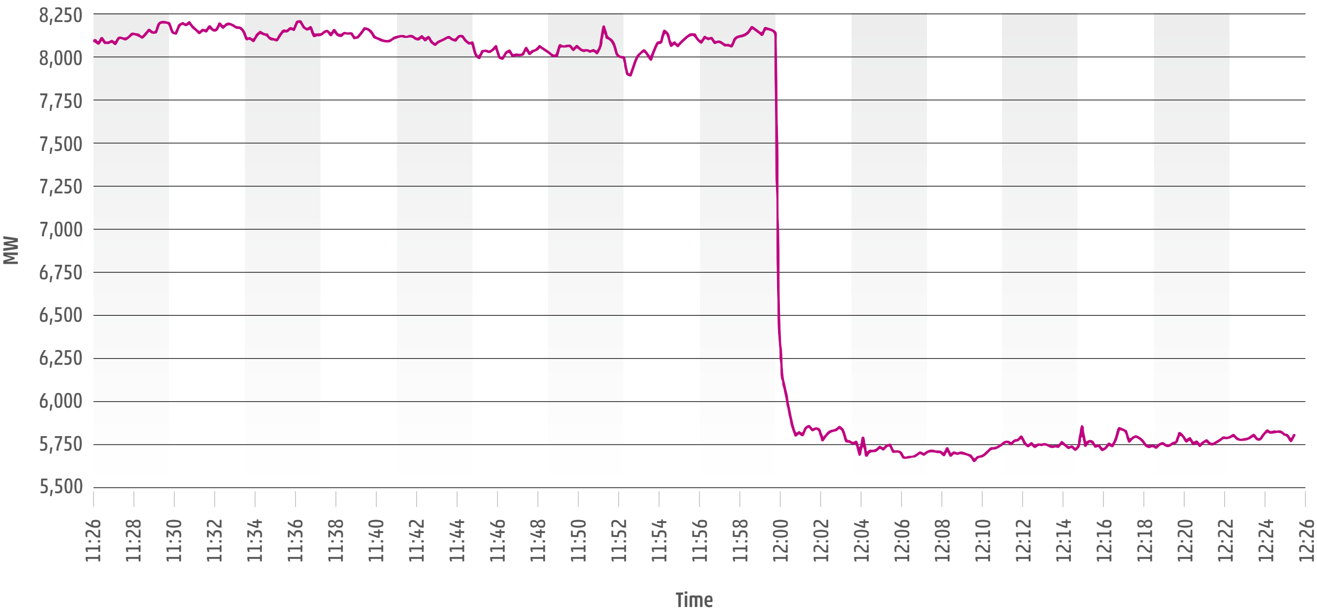


Figure 2.14: Load pattern in the Czech Republic on 4 July 2025

Before switching off the overhead line V411 at 11:51:08, the load on the electricity grid in the Czech Republic was approximately 8,200 MW.

The load value in Figure 2.14 is calculated based on the production and balance values. Most production is metered; for renewable sources, approximately one-third is measured, and two-thirds are calculated based on location and metered renewables. This unmetered part of production can introduce an error into the load value.

2.3.2 Production patterns

Figure 2.15 shows that the total generation at 11:51 was 7,150 MW. The largest share of production came from NPPs at approximately 3,077 MW, photovoltaic power plants at approximately 1,973 MW, and thermal power plants at approximately 1,815 MW.

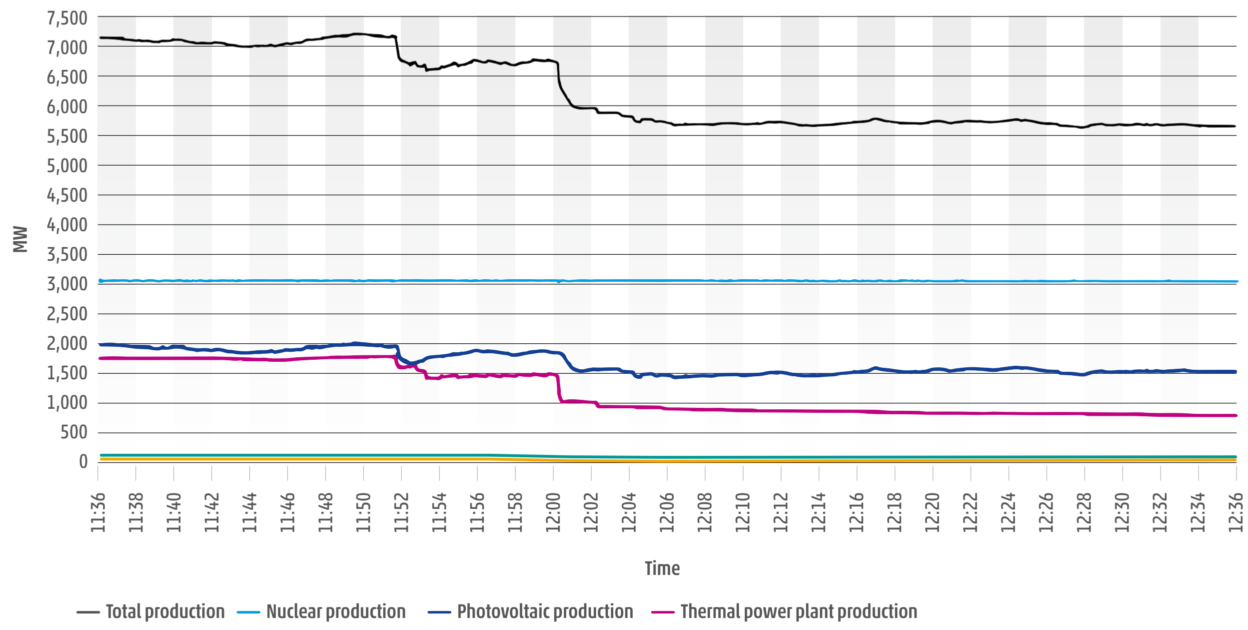


Figure 2.15: Production pattern in the Czech Republic on 4 July 2025

Figure 2.16 shows the voltage in all 400 kV substations in the Czech Republic between 11:51 and 00:00. The voltage in the affected area was within limits and did not exceed the permissible limits anywhere.

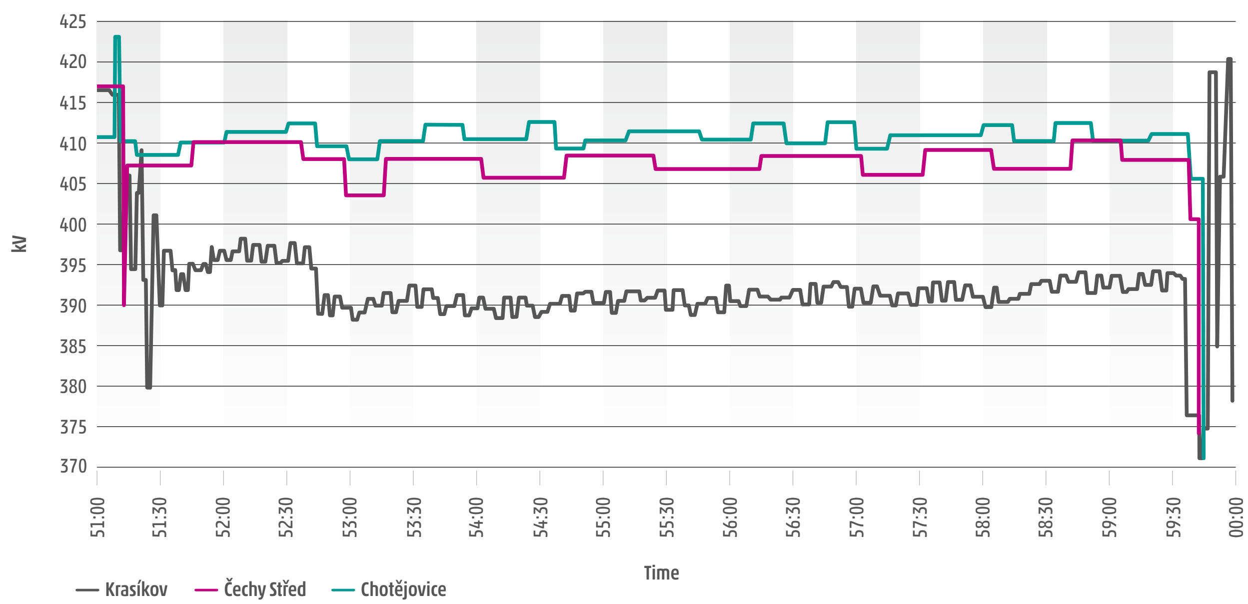


Figure 2.16: Voltage in 400 kV substations between 11:51 and 00:00 in the Czech Republic on 4 July 2025

2.3.3 Cross-border flows: scheduled commercial and physical flows

The following figures shows the real and scheduled flows on the borders with neighbouring TSOs, as well as the real and scheduled balance. Before the fault on line V411, the Czech Republic was importing around 1,600 MW (scheduled 1,524 MW).

There can be significant differences between market and real flows at the border because ČEPS is located in the middle of the interconnected continental European zone, and loop flows influence real flows.

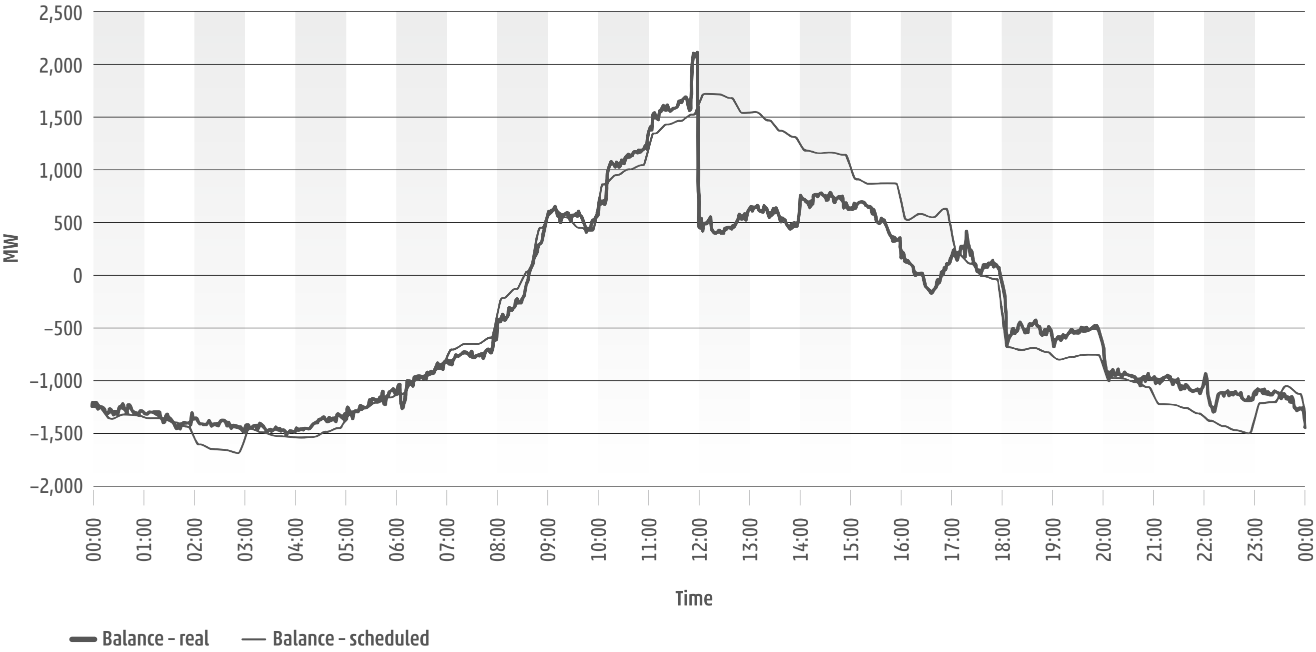


Figure 2.17: Real and scheduled balance in the Czech Republic on 4 July 2025

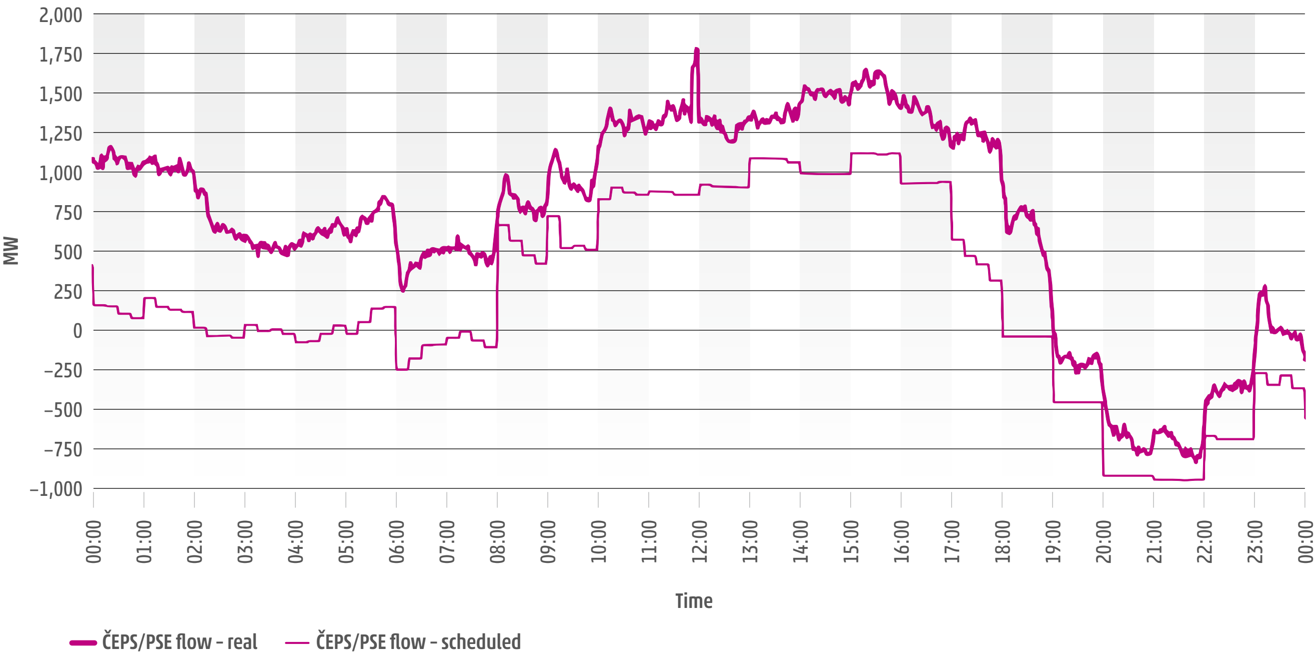


Figure 2.18: Real and scheduled flow between ČEPS and PSE on 4 July 2025

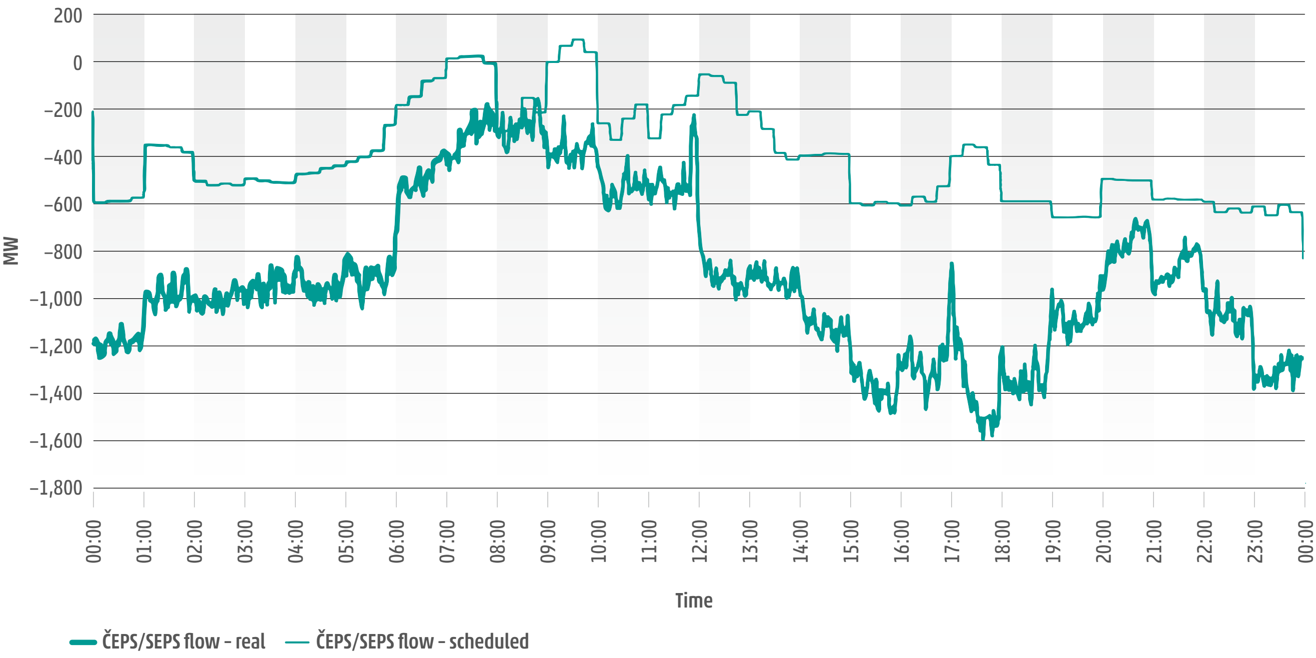


Figure 2.19: Real and scheduled flow between ČEPS and SEPS on 4 July 2025

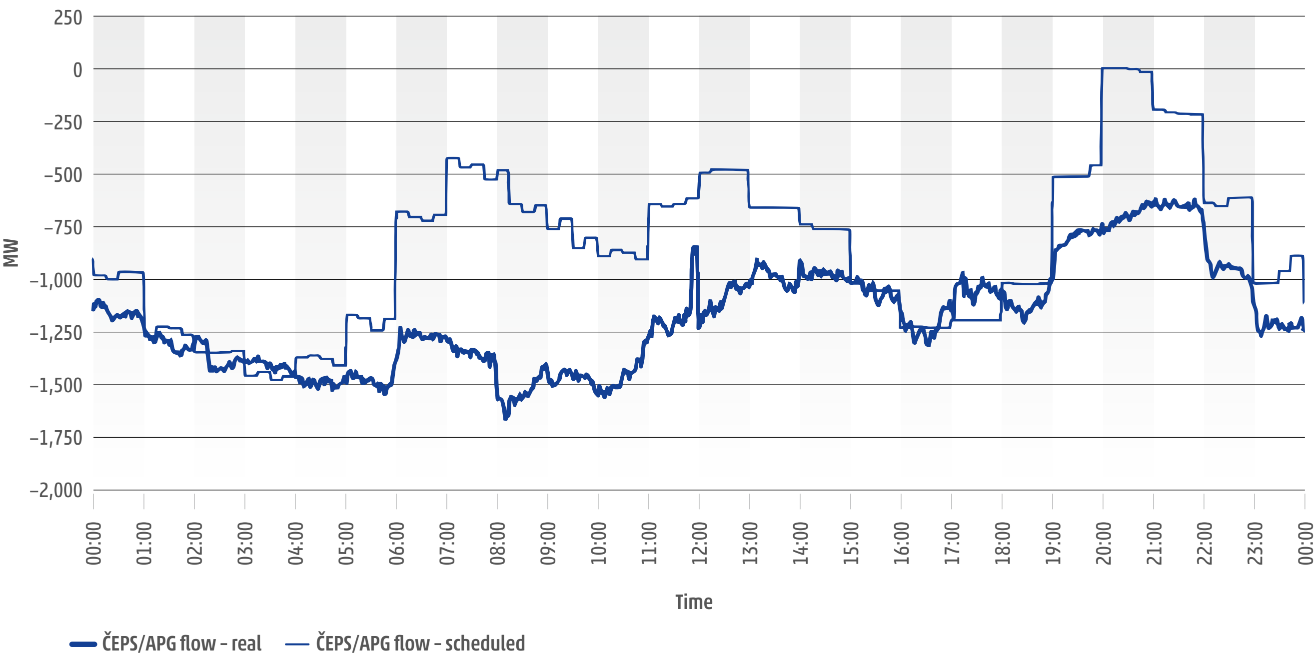


Figure 2.20: Real and scheduled flow between ČEPS and APG on 4 July 2025

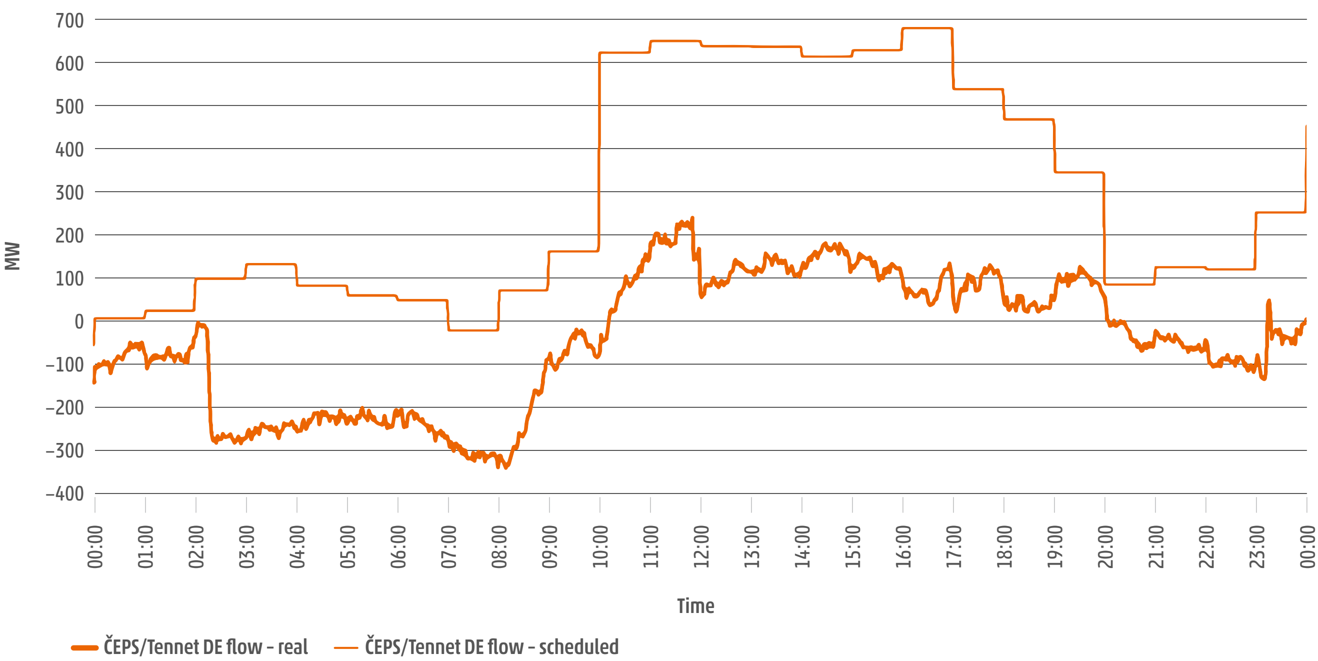


Figure 2.21: Real and scheduled flow between ČEPS and TenneT DE on 4 July 2025

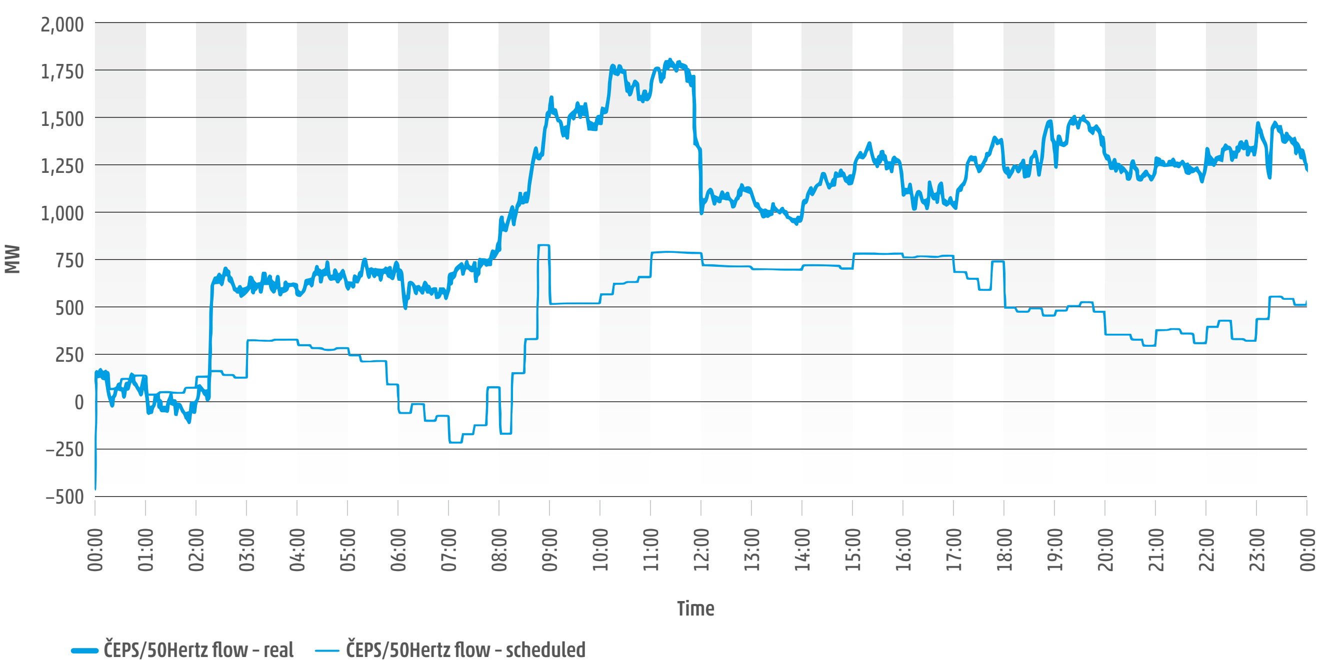


Figure 2.22: Real and scheduled flow between ČEPS and 50Hertz on 4 July 2025

11:51 – Power balance situation in the region

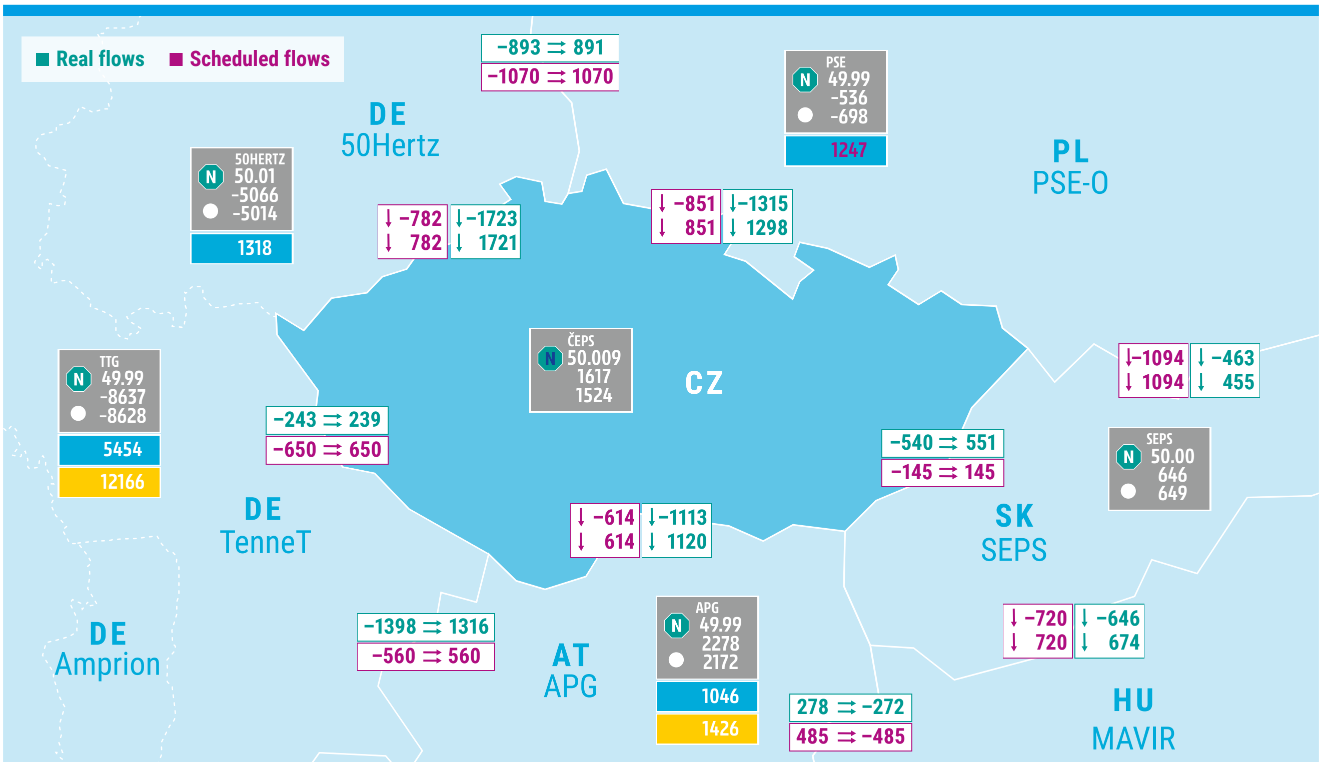


Figure 2.23: Power balance situation in the region on 4 July 2025 at 11:51

3 EVOLUTION OF SYSTEM CONDITIONS DURING THE EVENT

3.1 Factual sequence of events

- **11:51:06:187 –** Line V411 fault detected in phase L2 by protections.
- **11:51:07.559 –** Following the unsuccessful automatic reclosing attempt in phase 2, circuit breakers of line V411 at the VYS4 and HRA4 substations were tripped in all phases.
- **11:51:08 –** Ledvice unit power plant 6 transitioned from standard power control mode to island operation mode (droop speed control mode) based on a locally recorded frequency (speed) deviation exceeding 200 mHz.[8]
- **11:51:11 –** Ledvice power plant unit 4 transitioned from standard power control mode to island operation mode (droop speed control mode) based on a locally recorded frequency (speed) deviation exceeding 200 mHz.
- **11:51:12 –** Počerady power plant units 2 and 6 transitioned from standard power control mode to island operation mode (droop speed control mode) based on a locally recorded frequency (speed) deviation exceeding 200 mHz.
- **11:51:46 –** Ledvice power plant unit 6[9] boiler outage caused by steam temperature behind the high-pressure bypass stations (information provided by the power plant owner).

  Summary of operational parameters at this time

  - The failure of line V411, the immediate reduction in production in both the transmission and distribution systems, and the resulting overload of line V208 and other elements led to an emergency state, according to Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (SOGL).
  - The current on line V208 exceeded 900 A, which is the measurement range of the current converters at the Čechy Střed and Milín 220 kV substations. (I_{max} = 724 A according to dynamic rating).
  - Line V223 current was 1,180 A (I_{max} = 1,165 A according to dynamic rating).
  - The busbar coupler at the Vítkov 220 kV substation had a current of 1,195 A (I_{max} = 1,165 A).
  - The busbar coupler at the Krasíkov 400 kV substation had a current of 2,100 A (I_{max} = 2,000 A; I_{trip} = 2,880 A).

- **11:52 –** Table 3.1 and 3.2 present the N-1 report from the ČEPS control system (the list is not complete).

  - Due to immediate production outages in both the transmission and distribution grid (between 340 – 440 MW)
    - Identified in the transmission system: 127 MW
    - Identified in the distribution system (so far): 160 MW
  - There were overloaded elements even in N-0:
    - 220 kV line V208: 126.1 % (912 A estimated value)
    - Autotransformer T402 at the 400 kV Hradec substation: 119.3 % (within transitory admissible overloading limits)
    - Busbar coupler at the Krasíkov 400 kV substation: 105.1 %

Accordingly, at this stage, the grid was not secure even in the absence of an additional N-1 contingency.

8 Refers to the frequency deviation from the nominal value of 50 Hz. This setting is applied to all units that provide island operation capability service.

9 This unit is certified for providing non-frequency ancillary service island operation capability.

Kontingence	N-1%	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Zařízení
C:V401:1	**DIVERGENT**	DIVER...	DIVER...	DIVER...	DIVER...	DIVERG...	DIVER...	DIVERG...	
C:V400:1	**DIVERGENT**	DIVER...	DIVER...	DIVER...	DIVER...	DIVERG...	DIVER...	DIVERG...	
C:V402:1	**209.6**	1517.7	793.7	912.8	188.8	126.1	+604.9	+83.6	C:V208:1
C:V405:1	**199.8**	1446.4	722.4	912.8	188.8	126.1	+533.6	+73.7	C:V208:1
C:V459:1	**174.2**	1261.1	537.1	912.8	188.8	126.1	+348.3	+48.1	C:V208:1
C:V458:1	**168.6**	1221.0	497.0	912.8	188.8	126.1	+308.2	+42.6	C:V208:1
C:V417:1	**167.4**	1212.1	488.1	912.8	188.8	126.1	+299.3	+41.3	C:V208:1
C:V420:1	**148.5**	1074.8	350.8	912.8	188.8	126.1	+162.0	+22.4	C:V208:1
C:V418:1	**146.9**	1063.7	339.7	912.8	188.8	126.1	+150.9	+20.8	C:V208:1
C:V433:1	**138.9**	694.5	194.5	596.5	96.5	119.3	+98.0	+19.6	C:HRA:T402
C:VIT:T201	**135.3**	979.2	255.2	912.8	188.8	126.1	+66.4	+9.2	C:V208:1
C:V208:1	**133.5**	2670.8	670.8	2101.7	101.7	105.1	+569.2	+28.5	C:KRA:4:nKS...
C:V444:1	**133.1**	963.8	239.8	912.8	188.8	126.1	+51.0	+7.0	C:V208:1
C:V443:1	**132.6**	959.8	235.8	912.8	188.8	126.1	+47.0	+6.5	C:V208:1
C:V460:1	**131.2**	949.8	225.8	912.8	188.8	126.1	+37.0	+5.1	C:V208:1
C:V449:1	**131.2**	949.6	225.6	912.8	188.8	126.1	+36.8	+5.1	C:V208:1
C:TAB:T201	**130.8**	947.3	223.3	912.8	188.8	126.1	+34.5	+4.8	C:V208:1
C:V412:1	**130.2**	942.9	218.9	912.8	188.8	126.1	+30.1	+4.2	C:V208:1
C:PRE:T202	**129.5**	937.8	213.8	912.8	188.8	126.1	+25.0	+3.4	C:V208:1
C:V202:1	**128.9**	933.4	209.4	912.8	188.8	126.1	+20.6	+2.8	C:V208:1
Z:V456:1	**128.9**	933.2	209.2	912.8	188.8	126.1	+20.4	+2.8	C:V208:1
C:V201:1	**128.8**	932.8	208.8	912.8	188.8	126.1	+20.0	+2.8	C:V208:1
C:V223:1	**127.9**	2557.9	557.9	2101.7	101.7	105.1	+456.2	+22.8	C:KRA:4:nKS...
Z:V412:1	**127.7**	924.8	200.8	912.8	188.8	126.1	+12.0	+1.7	C:V208:1
Z:V413:1	**127.7**	924.6	200.6	912.8	188.8	126.1	+11.8	+1.6	C:V208:1
C:OPO:T202	**127.6**	924.2	200.2	912.8	188.8	126.1	+11.4	+1.6	C:V208:1
D2:V465B:1	**127.6**	923.7	199.7	912.8	188.8	126.1	+10.9	+1.5	C:V208:1
C:V207:1	**127.5**	637.4	137.4	596.5	96.5	119.3	+40.9	+8.2	C:HRA:T402
Z:V400:1	**127.3**	922.0	198.0	912.8	188.8	126.1	+9.2	+1.3	C:V208:1
C:V435:1	**127.3**	921.5	197.5	912.8	188.8	126.1	+8.7	+1.2	C:V208:1
C:V436:1	**127.3**	921.3	197.3	912.8	188.8	126.1	+8.5	+1.2	C:V208:1
C:CHR:T401	**127.1**	920.2	196.2	912.8	188.8	126.1	+7.4	+1.0	C:V208:1
C:V430:1	**127.1**	920.2	196.2	912.8	188.8	126.1	+7.4	+1.0	C:V208:1
L:V410:1	**127.1**	920.2	196.2	912.8	188.8	126.1	+7.4	+1.0	C:V208:1
Q:V492:1	**127.1**	920.0	196.0	912.8	188.8	126.1	+7.2	+1.0	C:V208:1
D2:V465A:1	**127.0**	919.8	195.8	912.8	188.8	126.1	+7.0	+1.0	C:V208:1
Q:V493:1	**127.0**	919.2	195.2	912.8	188.8	126.1	+6.4	+0.9	C:V208:1
C:OPO:T201	**126.9**	919.0	195.0	912.8	188.8	126.1	+6.2	+0.9	C:V208:1
D8:V568:1	**126.9**	918.8	194.8	912.8	188.8	126.1	+6.0	+0.8	C:V208:1
D8:V567:1	**126.9**	918.8	194.8	912.8	188.8	126.1	+6.0	+0.8	C:V208:1
Q:V408:1	**126.9**	918.7	194.7	912.8	188.8	126.1	+5.9	+0.8	C:V208:1
Q:V495:1	**126.9**	918.5	194.5	912.8	188.8	126.1	+5.7	+0.8	C:V208:1
C:HRD:T4512_TAP+5	**126.8**	918.0	194.0	912.8	188.8	126.1	+5.2	+0.7	C:V208:1
C:HRD:T45x_TAP+5	**126.8**	918.0	194.0	912.8	188.8	126.1	+5.2	+0.7	C:V208:1
O:V436B:1	**126.8**	917.8	193.8	912.8	188.8	126.1	+5.0	+0.7	C:V208:1
C:V270:1	**126.7**	917.3	193.3	912.8	188.8	126.1	+4.5	+0.6	C:V208:1
C:VER:T401	**126.7**	917.1	193.1	912.8	188.8	126.1	+4.3	+0.6	C:V208:1
Q:V407:1	**126.6**	916.9	192.9	912.8	188.8	126.1	+4.1	+0.6	C:V208:1
C:V203:1	**126.5**	916.0	192.0	912.8	188.8	126.1	+3.2	+0.4	C:V208:1
O:V443B:1	**126.5**	915.6	191.6	912.8	188.8	126.1	+2.8	+0.4	C:V208:1
D8:V554:1	**126.4**	915.4	191.4	912.8	188.8	126.1	+2.6	+0.4	C:V208:1
D8:V553:1	**126.4**	915.4	191.4	912.8	188.8	126.1	+2.6	+0.4	C:V208:1
C:PRE:T401	**126.4**	915.3	191.3	912.8	188.8	126.1	+2.6	+0.4	C:V208:1
C:V473:1	**126.4**	915.2	191.2	912.8	188.8	126.1	+2.4	+0.3	C:V208:1
O:V435A:1	**126.4**	914.8	190.8	912.8	188.8	126.1	+2.0	+0.3	C:V208:1
Z:V212:1	**126.3**	914.7	190.7	912.8	188.8	126.1	+1.9	+0.3	C:V208:1
Q:V440:1	**126.3**	914.6	190.6	912.8	188.8	126.1	+1.8	+0.3	C:V208:1
C:V474:1	**126.3**	914.6	190.6	912.8	188.8	126.1	+1.8	+0.2	C:V208:1
C:V253:1	**126.3**	914.4	190.4	912.8	188.8	126.1	+1.6	+0.2	C:V208:1
C:V254:1	**126.3**	914.4	190.4	912.8	188.8	126.1	+1.6	+0.2	C:V208:1
C:LIS:T202	**126.3**	914.4	190.4	912.8	188.8	126.1	+1.6	+0.2	C:V208:1
C:V252:1	**126.3**	914.3	190.3	912.8	188.8	126.1	+1.5	+0.2	C:V208:1
C:V251:1	**126.3**	914.3	190.3	912.8	188.8	126.1	+1.5	+0.2	C:V208:1
C:LIS:T203	**126.3**	914.2	190.2	912.8	188.8	126.1	+1.4	+0.2	C:V208:1
D2:V226:1	**126.2**	914.0	190.0	912.8	188.8	126.1	+1.2	+0.2	C:V208:1

Table 3.1: N-1 report from the ČEPS control system at 11:52 – per relevant contingency

Zařízení	N-1% ▲	Uzel1	Uzel2	Limit	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Kontingence
	DIVERGENT			0.0	DIVER...	DIVER...	DIVER...	DIVER...	DIVERG...	DIVERG...	DIVERG...	C:V400:1
C:V208:1	**209.6**	C:MIL:2:W...	C:CST:2:W3	724.0	1517.7	793.7	912.8	188.8	126.1	+604.9	+83.6	C:V402:1
C:HRA:T402	**139.5**	C:HRA:4:...	C:HRA:2:...	500.0	697.5	197.5	596.5	96.5	119.3	+100.9	+20.2	C:V420:1
C:V405:1	**135.0**	C:KLT:4:...	C:NOS:4:...	1968.0	2656.3	688.3	1369.0	0.0	69.6	+1287.3	+65.4	C:V402:1
C:KRA:4:nKSP:1	**133.5**	C:KRA:4:...	C:KRA:4:...	2000.0	2670.8	670.8	2101.7	101.7	105.1	+569.2	+28.5	C:V208:1
C:V223:1	**128.0**	C:HRA:2:...	C:VIT:2:W...	1165.0	1491.1	326.1	1157.7	0.0	99.4	+333.3	+28.6	C:V402:1
C:VIT:2:nSP:1	**127.9**	C:VIT:2:W...	C:VIT:2:W...	1165.0	1489.5	324.5	1155.9	0.0	99.2	+333.6	+28.6	C:V402:1
C:V402:1	**119.3**	C:KRA:4:...	C:PRN:4:...	2338.0	2788.8	450.8	1219.6	0.0	52.2	+1569.2	+67.1	C:V405:1
C:V216:1	**118.9**	C:PRE:2:W1	C:MIL:2:W...	845.0	1005.0	160.0	688.3	0.0	81.5	+316.7	+37.5	C:V402:1
C:V417:1	**115.3**	C:OTR:4:...	C:SOK:4:...	2000.0	2305.8	305.8	1013.8	0.0	50.7	+1291.9	+64.6	C:V405:1
C:V458:1	**111.0**	C:HZI:4:W...	C:KRA:4:...	2000.0	2220.0	220.0	965.8	0.0	48.3	+1254.3	+62.7	C:V402:1
C:V459:1	**104.0**	C:HZI:4:W...	C:KLT:4:...	2265.0	2356.0	91.0	1090.6	0.0	48.1	+1265.5	+55.9	C:V402:1
C:KLT:4:nKSP:1	**103.2**	C:KLT:4:...	C:KLT:4:...	2400.0	2477.0	77.0	1204.8	0.0	50.2	+1272.2	+53.0	C:V402:1
C:OTR:4:nKSP:1	**101.1**	C:OTR:4:...	C:OTR:4:...	2000.0	2021.6	21.6	742.8	0.0	37.1	+1278.8	+63.9	C:V405:1
C:V207:1	**95.2**	C:TAB:2:W1	C:SOK:2:...	856.0	814.8	0.0	337.7	0.0	39.4	+477.1	+55.7	C:V223:1
C:MIL:2:nSP:1	**94.7**	C:MIL:2:W...	C:MIL:2:W...	1600.0	1515.8	0.0	911.2	0.0	57.0	+604.6	+37.8	C:V402:1
C:HZI:4:nKSP:1	**93.1**	C:HZI:4:W...	C:HZI:4:W...	2530.0	2356.1	0.0	1089.1	0.0	43.0	+1267.0	+50.1	C:V402:1
C:HRA:2:nKSP:1	**90.9**	C:HRA:2:...	C:HRA:2:...	1800.0	1636.5	0.0	1332.1	0.0	74.0	+304.4	+16.9	C:V402:1
C:CHD:T403	**90.0**	C:CHD:4:...	C:CHD:1:...	350.0	315.0	0.0	167.7	0.0	47.9	+147.3	+42.1	C:CHD:T401
C:CHD:T401	**90.0**	C:CHD:4:...	C:CHD:1:...	350.0	314.9	0.0	146.9	0.0	42.0	+168.1	+48.0	C:CHD:T403
C:V444:1	**87.6**	C:NOS:4:...	Z:WIE:4:...	2000.0	1752.9	0.0	1017.4	0.0	50.9	+735.6	+36.8	C:V443:1
C:V203:1	**83.8**	C:OPO:2:...	C:SOK:2:...	756.0	633.6	0.0	71.1	0.0	9.4	+562.5	+74.4	C:HRA:T402
C:V418:1	**83.2**	C:OTR:4:...	C:PRN:4:...	2243.0	1866.0	0.0	601.6	0.0	26.8	+1264.4	+56.4	C:V405:1
C:NOS:4:nKSP:1	**82.0**	C:NOS:4:...	C:NOS:4:...	2000.0	1639.5	0.0	547.2	0.0	27.4	+1092.3	+54.6	C:V402:1
C:V401:1	**81.5**	C:TYN:4:...	C:KRA:4:...	2312.0	1883.9	0.0	1360.1	0.0	58.8	+523.8	+22.7	C:V208:1
C:V443:1	**81.5**	C:DET:4:...	Z:DBN:4:...	2000.0	1629.4	0.0	1155.3	0.0	57.8	+474.1	+23.7	C:V444:1
C:V204:1	**81.1**	C:MIL:2:W...	C:TAB:2:W1	852.0	690.6	0.0	233.2	0.0	27.4	+457.4	+53.7	C:V223:1
C:V435:1	**79.7**	C:SLV:4:...	C:SOK:4:...	2000.0	1594.8	0.0	908.2	0.0	45.4	+686.6	+34.3	C:V436:1

Table 3.2: N-1 report from the ČEPS control system at 11:52 – per relevant monitored element

» **11:52:45 –** Ledvice power plant unit 6 lost 292 MW of active power output from the generator (compared to the pre-incident level), while the generator remained synchronised with the system. The delay between the boiler outage at 11:51:46 and the loss of power was caused by residual steam accumulation in the boiler, which kept residual steam available even after the boiler tripped.

» **11:52:51 –** The Počerady power plant informs the ČEPS operator that units TG2 and TG6 have switched to island operation mode (droop speed control mode). The ČEPS operator informs about the event in the grid.

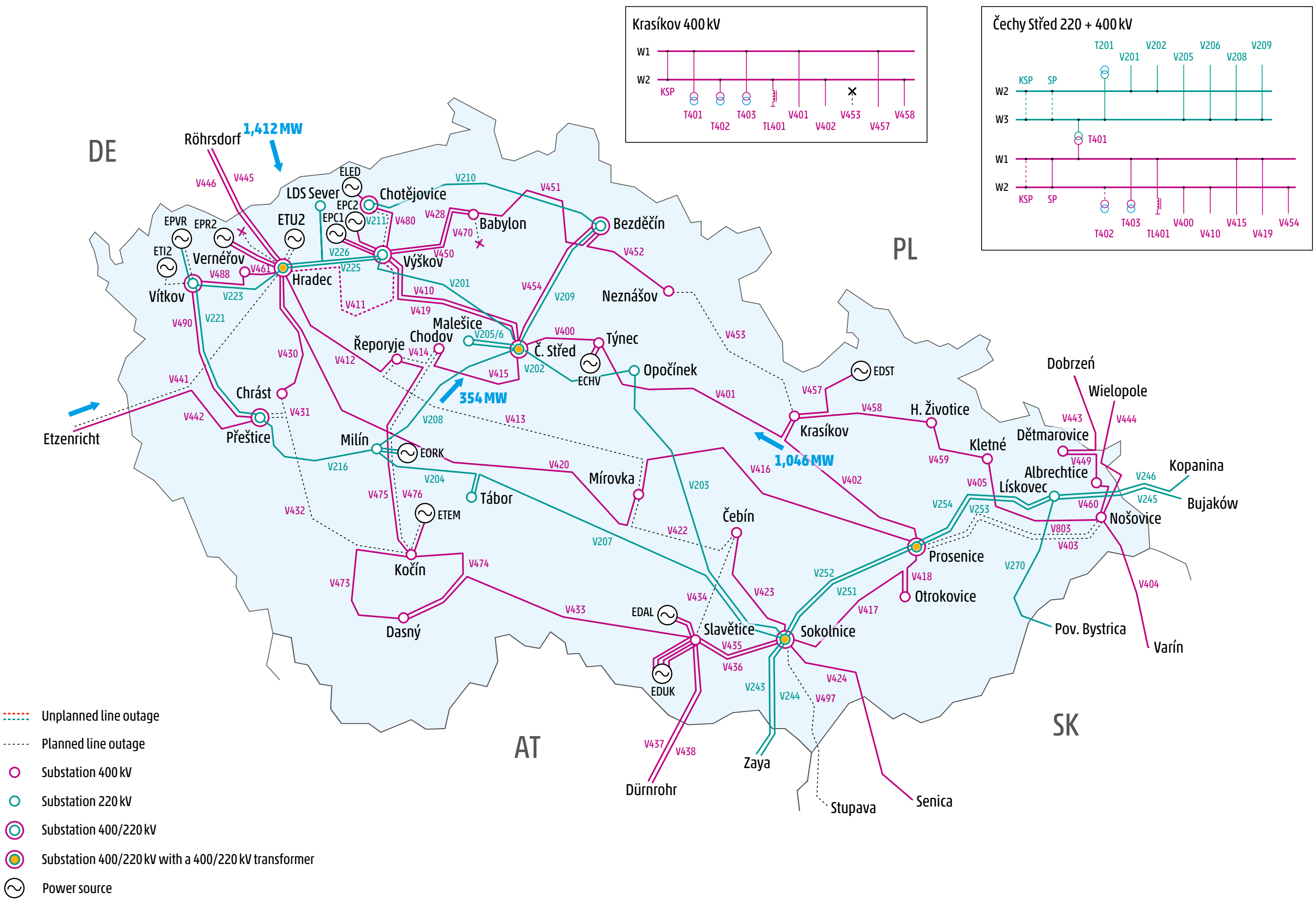


Figure 3.1: Situation of the Czech Republic transmission system on 4 July 2025 at 11:53

	V411/ Výškov	V208/ Čechy Střed	V401/Krasíkov
P [MW]	0	354	–1,046
Q [Mvar]	0	–131	167
I [A]	0	>900	1,594

Table 3.3: Power flow on lines feeding the affected area at 11:53

11:53:00 – 11:59:00

» Physical overload up to:

› 220 kV line V208: 142.9 % (1,035 A estimated value)

› Autotransformer T402 at the Hradec 400 kV substation: 121.6 %

› Busbar coupler at the Krasíkov 400 kV substation: 115.5 %

» The main reason for the increase in loading was a further decrease in production (between 11:52 and 11:53, Ledvice unit 6 lost a further 182 MW of production, effectively losing all active power output).

» 11:55 – Table 3.4 and 3.5 present the N-1 report from the ČEPS control system (the list is not complete).

Kontingence	N-1%	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Zařízení
C:V405:1	DIVERGENT	DIVER...	DIVER...	DIVER...	DIVER...	DIVERG...	DIVER...	DIVERG...	
C:V402:1	DIVERGENT	DIVER...	DIVER...	DIVER...	DIVER...	DIVERG...	DIVER...	DIVERG...	
C:V401:1	DIVERGENT	DIVER...	DIVER...	DIVER...	DIVER...	DIVERG...	DIVER...	DIVERG...	
C:V400:1	DIVERGENT	DIVER...	DIVER...	DIVER...	DIVER...	DIVERG...	DIVER...	DIVERG...	
C:V459:1	207.6	1502.9	778.9	1034.7	310.7	142.9	+468.1	+64.7	C:V208:1
C:V417:1	201.1	1455.7	731.7	1034.7	310.7	142.9	+421.0	+58.1	C:V208:1
C:V458:1	196.8	1425.1	701.1	1034.7	310.7	142.9	+390.4	+53.9	C:V208:1
C:V418:1	170.7	1235.8	511.8	1034.7	310.7	142.9	+201.1	+27.8	C:V208:1
C:V420:1	165.9	1201.5	477.5	1034.7	310.7	142.9	+166.7	+23.0	C:V208:1
C:VIT:T201	151.8	1099.4	375.4	1034.7	310.7	142.9	+64.7	+8.9	C:V208:1
C:V433:1	150.8	1092.1	368.1	1034.7	310.7	142.9	+57.3	+7.9	C:V208:1
C:V444:1	150.2	1087.2	363.2	1034.7	310.7	142.9	+52.5	+7.2	C:V208:1
C:V208:1	150.0	2999.4	999.4	2310.4	310.4	115.5	+689.0	+34.4	C:KRA:4:nKS...
C:V443:1	149.2	1080.1	356.1	1034.7	310.7	142.9	+45.3	+6.3	C:V208:1
C:V460:1	148.1	1072.1	348.1	1034.7	310.7	142.9	+37.4	+5.2	C:V208:1
C:V449:1	148.1	1072.0	348.0	1034.7	310.7	142.9	+37.3	+5.1	C:V208:1
C:V412:1	146.7	1061.8	337.8	1034.7	310.7	142.9	+27.0	+3.7	C:V208:1
C:PRE:T202	146.6	1061.4	337.4	1034.7	310.7	142.9	+26.6	+3.7	C:V208:1
Z:V456:1	145.7	1054.8	330.8	1034.7	310.7	142.9	+20.1	+2.8	C:V208:1
C:V202:1	145.7	1054.5	330.5	1034.7	310.7	142.9	+19.8	+2.7	C:V208:1
C:TAB:T201	145.6	1054.2	330.2	1034.7	310.7	142.9	+19.5	+2.7	C:V208:1
C:V201:1	145.6	1053.9	329.9	1034.7	310.7	142.9	+19.2	+2.7	C:V208:1
Z:V412:1	144.6	1046.7	322.7	1034.7	310.7	142.9	+12.0	+1.7	C:V208:1
Z:V413:1	144.5	1046.5	322.5	1034.7	310.7	142.9	+11.7	+1.6	C:V208:1
D2:V465B:1	144.4	1045.4	321.4	1034.7	310.7	142.9	+10.7	+1.5	C:V208:1
C:OPO:T202	144.3	1044.9	320.9	1034.7	310.7	142.9	+10.2	+1.4	C:V208:1
Z:V400:1	144.2	1044.1	320.1	1034.7	310.7	142.9	+9.4	+1.3	C:V208:1
C:V435:1	144.2	1044.0	320.0	1034.7	310.7	142.9	+9.2	+1.3	C:V208:1
C:V436:1	144.2	1043.7	319.7	1034.7	310.7	142.9	+9.0	+1.2	C:V208:1
Q:V492:1	144.0	1042.4	318.4	1034.7	310.7	142.9	+7.7	+1.1	C:V208:1
D2:V465A:1	143.9	1041.7	317.7	1034.7	310.7	142.9	+7.0	+1.0	C:V208:1
Q:V493:1	143.9	1041.6	317.6	1034.7	310.7	142.9	+6.8	+0.9	C:V208:1
L:V410:1	143.9	1041.5	317.5	1034.7	310.7	142.9	+6.8	+0.9	C:V208:1
Q:V408:1	143.8	1041.1	317.1	1034.7	310.7	142.9	+6.4	+0.9	C:V208:1
C:CHR:T401	143.8	1041.0	317.0	1034.7	310.7	142.9	+6.3	+0.9	C:V208:1
C:OPO:T201	143.8	1040.9	316.9	1034.7	310.7	142.9	+6.2	+0.9	C:V208:1
Q:V495:1	143.7	1040.7	316.7	1034.7	310.7	142.9	+6.0	+0.8	C:V208:1
C:V430:1	143.7	1040.6	316.6	1034.7	310.7	142.9	+5.9	+0.8	C:V208:1
D8:V567:1	143.7	1040.1	316.1	1034.7	310.7	142.9	+5.4	+0.7	C:V208:1
D8:V568:1	143.7	1040.1	316.1	1034.7	310.7	142.9	+5.4	+0.7	C:V208:1
C:HRD:T45x_TAP+5	143.6	1039.8	315.8	1034.7	310.7	142.9	+5.1	+0.7	C:V208:1
C:HRD:T4512_TAP+5	143.6	1039.8	315.8	1034.7	310.7	142.9	+5.1	+0.7	C:V208:1
C:V270:1	143.6	1039.6	315.6	1034.7	310.7	142.9	+4.9	+0.7	C:V208:1
O:V436B:1	143.6	1039.5	315.5	1034.7	310.7	142.9	+4.8	+0.7	C:V208:1
Q:V407:1	143.5	1039.2	315.2	1034.7	310.7	142.9	+4.5	+0.6	C:V208:1
C:VER:T401	143.5	1038.7	314.7	1034.7	310.7	142.9	+4.0	+0.6	C:V208:1
C:V203:1	143.5	1038.6	314.6	1034.7	310.7	142.9	+3.9	+0.5	C:V208:1
C:V473:1	143.3	1037.1	313.1	1034.7	310.7	142.9	+2.4	+0.3	C:V208:1
D8:V553:1	143.2	1037.0	313.0	1034.7	310.7	142.9	+2.3	+0.3	C:V208:1
D8:V554:1	143.2	1037.0	313.0	1034.7	310.7	142.9	+2.3	+0.3	C:V208:1
O:V443B:1	143.2	1036.8	312.8	1034.7	310.7	142.9	+2.1	+0.3	C:V208:1
Z:V212:1	143.2	1036.7	312.7	1034.7	310.7	142.9	+1.9	+0.3	C:V208:1
O:V435A:1	143.2	1036.6	312.6	1034.7	310.7	142.9	+1.9	+0.3	C:V208:1
Q:V440:1	143.2	1036.6	312.6	1034.7	310.7	142.9	+1.9	+0.3	C:V208:1
C:PRE:T401	143.2	1036.6	312.6	1034.7	310.7	142.9	+1.8	+0.3	C:V208:1
C:V474:1	143.2	1036.5	312.5	1034.7	310.7	142.9	+1.8	+0.2	C:V208:1
C:LIS:T202	143.1	1036.4	312.4	1034.7	310.7	142.9	+1.6	+0.2	C:V208:1
C:V253:1	143.1	1036.3	312.3	1034.7	310.7	142.9	+1.6	+0.2	C:V208:1
C:V254:1	143.1	1036.3	312.3	1034.7	310.7	142.9	+1.5	+0.2	C:V208:1
C:V252:1	143.1	1036.1	312.1	1034.7	310.7	142.9	+1.4	+0.2	C:V208:1
C:V251:1	143.1	1036.1	312.1	1034.7	310.7	142.9	+1.4	+0.2	C:V208:1
Q:V429:1	143.1	1035.9	311.9	1034.7	310.7	142.9	+1.2	+0.2	C:V208:1
C:V454:1	143.1	1035.9	311.9	1034.7	310.7	142.9	+1.2	+0.2	C:V208:1
D2:V226:1	143.1	1035.9	311.9	1034.7	310.7	142.9	+1.1	+0.2	C:V208:1
C:LIS:T203	143.1	1035.8	311.8	1034.7	310.7	142.9	+1.1	+0.2	C:V208:1
D2:SCH:T421	143.0	1035.7	311.7	1034.7	310.7	142.9	+0.9	+0.1	C:V208:1
Z:V409:1	143.0	1035.6	311.6	1034.7	310.7	142.9	+0.9	+0.1	C:V208:1

Table 3.4: N-1 report from the ČEPS control system at 11:55 – per relevant monitored element

Zařízení	N-1%	Uzel1	Uzel2	Limit	N-1	Přes N-1	N-0	Přes N-0	N-0%	Rozdíl	Rozdíl%	Kontingence
	DIVERGENT			0.0	DIVER...	DIVER...	DIVER...	DIVER...	DIVERG...	DIVERG...	DIVERG...	C:V400:1
C:V208:1	207.6	C:MIL:2:W...	C:CST:2:W3	724.0	1502.9	778.9	1034.7	310.7	142.9	+468.1	+64.7	C:V459:1
C:KRA:4:nKSP:1	150.0	C:KRA:4:...	C:KRA:4:...	2000.0	2999.4	999.4	2310.4	310.4	115.5	+689.0	+34.4	C:V208:1
C:HRA:T402	139.9	C:HRA:4:...	C:HRA:2:...	500.0	699.7	199.7	596.7	96.7	119.3	+103.0	+20.6	C:V420:1
C:V223:1	125.5	C:HRA:2:...	C:VIT:2:W...	1165.0	1462.0	297.0	1191.2	26.2	102.2	+270.8	+23.2	C:V459:1
C:VIT:2:nSP:1	125.4	C:VIT:2:W...	C:VIT:2:W...	1165.0	1461.0	296.0	1190.2	25.2	102.2	+270.9	+23.3	C:V459:1
C:V405:1	120.2	C:KLT:4:...	C:NOS:4:...	1968.0	2364.9	396.9	1459.3	0.0	74.1	+905.7	+46.0	C:V417:1
C:V402:1	115.7	C:KRA:4:...	C:PRN:4:...	2338.0	2704.5	366.5	1339.8	0.0	57.3	+1364.7	+58.4	C:V459:1
C:V216:1	115.4	C:PRE:2:W1	C:MIL:2:W...	845.0	974.9	129.9	728.8	0.0	86.2	+246.1	+29.1	C:V459:1
C:V417:1	111.4	C:OTR:4:...	C:SOK:4:...	2000.0	2227.4	227.4	1100.4	0.0	55.0	+1127.0	+56.4	C:V459:1
C:V207:1	99.9	C:TAB:2:W1	C:SOK:2:...	856.0	855.1	0.0	357.9	0.0	41.8	+497.3	+58.1	C:V223:1
C:OTR:4:nKSP:1	97.9	C:OTR:4:...	C:OTR:4:...	2000.0	1957.7	0.0	840.5	0.0	42.0	+1117.3	+55.9	C:V459:1
C:V458:1	96.6	C:HZI:4:W...	C:KRA:4:...	2000.0	1931.3	0.0	1052.0	0.0	52.6	+879.3	+44.0	C:V417:1
C:V401:1	95.2	C:TYN:4:...	C:KRA:4:...	2312.0	2201.4	0.0	1563.6	0.0	67.6	+637.8	+27.6	C:V208:1
C:MIL:2:nSP:1	93.4	C:MIL:2:W...	C:MIL:2:W...	1600.0	1494.8	0.0	1027.5	0.0	64.2	+467.3	+29.2	C:V459:1
C:CHD:T403	91.8	C:CHD:4:...	C:CHD:1:...	350.0	321.4	0.0	171.0	0.0	48.8	+150.4	+43.0	C:CHD:T401
C:CHD:T401	91.8	C:CHD:4:...	C:CHD:1:...	350.0	321.2	0.0	150.0	0.0	42.9	+171.2	+48.9	C:CHD:T403
C:V459:1	91.6	C:HZI:4:W...	C:KLT:4:...	2265.0	2074.6	0.0	1182.7	0.0	52.2	+891.9	+39.4	C:V417:1
C:V204:1	91.4	C:MIL:2:W...	C:TAB:2:W1	852.0	778.8	0.0	304.4	0.0	35.7	+474.4	+55.7	C:V223:1
C:KLT:4:nKSP:1	91.1	C:KLT:4:...	C:KLT:4:...	2400.0	2187.2	0.0	1294.7	0.0	53.9	+892.5	+37.2	C:V417:1
C:V444:1	89.4	C:NOS:4:...	Z:WIE:4:...	2000.0	1788.5	0.0	1046.6	0.0	52.3	+741.9	+37.1	C:V443:1
C:HRA:2:nKSP:1	89.2	C:HRA:2:...	C:HRA:2:...	1800.0	1604.8	0.0	1349.8	0.0	75.0	+255.0	+14.2	C:V459:1
C:V400:1	87.3	C:CST:4:...	C:TYN:4:...	2351.0	2051.7	0.0	1438.1	0.0	61.2	+613.6	+26.1	C:V208:1
C:TYN:4:nKSP:1	85.6	C:TYN:4:...	C:TYN:4:...	2400.0	2054.3	0.0	1415.1	0.0	59.0	+639.2	+26.6	C:V208:1
C:V203:1	82.8	C:OPO:2:...	C:SOK:2:...	756.0	626.3	0.0	77.1	0.0	10.2	+549.2	+72.6	C:HRA:T402
C:V443:1	82.6	C:DET:4:...	Z:DBN:4:...	2000.0	1651.7	0.0	1160.2	0.0	58.0	+491.5	+24.6	C:V444:1
C:HZI:4:nKSP:1	82.0	C:HZI:4:W...	C:HZI:4:W...	2530.0	2074.6	0.0	1182.7	0.0	46.7	+891.9	+35.3	C:V417:1
C:V435:1	81.9	C:SLV:4:...	C:SOK:4:...	2000.0	1638.6	0.0	930.5	0.0	46.5	+708.1	+35.4	C:V436:1
C:NOS:4:nKSP:1	81.9	C:NOS:4:...	C:NOS:4:...	2000.0	1638.6	0.0	636.8	0.0	31.8	+1001.8	+50.1	C:V443:1
C:V436:1	81.7	C:SLV:4:...	C:SOK:4:...	2000.0	1633.5	0.0	917.9	0.0	45.9	+715.6	+35.8	C:V435:1
C:V418:1	80.5	C:OTR:4:...	C:PRN:4:...	2243.0	1806.2	0.0	701.6	0.0	31.3	+1104.6	+49.2	C:V459:1
D8:ROH:T441	77.5	D8:ROH:4...	D8:ROH:4...	1440.0	1115.4	0.0	820.2	0.0	57.0	+295.2	+20.5	D8:V572:1

Table 3.5: N-1 report from the ČEPS control system at 11:55 – per relevant monitored element

Immediately after the V411 outage, dispatchers began to address the fault. The analysis of the operational situation was complicated by the state of Ledvice unit 6, where the circuit breaker remained closed until 11:59:47, even though the unit had zero active power following the boiler trip.

The Počerady power plant immediately reported the transition to droop speed control mode of both units in operation. ČEPS operators were unable to identify specific power-generating modules that lost active power, and thus the cause of the system imbalance. Some of the modules are connected to the distribution system and do not send real-time data to the TSO's control system.

To address the overload on V208, the dispatchers first sought topological measures (reconfiguration) and then verified the solution by calculating the change in the output of the power-generating modules in operation (redispatching) in the simulation environment (also known as "study mode") of the control system.

They were unable to find an effective topological measure in the rapidly changing, deteriorating situation, and they assessed the activation of redispatching production sources as time-consuming and therefore ineffective for addressing the severe overload on V208.

11:58:25

The ČEPS operator asks the ČEZ technical centre[10] about the status of the Ledvice power plants (units 4 and 6).

- Ledvice power plant unit 4 is in island operation mode (droop speed control mode).
- Ledvice power plant unit 6 is in outage, with zero power, and the generator circuit breaker is still closed.

11:59:44

The ČEPS operator switched off the significantly overloaded line V208 to prevent permanent damage to the line.

10 ČEZ is the owner of the power plants.

11:59:47

- » Krasíkov 400 kV substation busbar coupler switched off by the overcurrent relay (setting 2,880 A/3 s).
- » The 400/110 kV T401KRA transformer at the Krasíkov substation switched off at the 110 kV level by the distribution company's distance protection (T401KRA was the last connection to supply the deficit island 1,800 MW and therefore was tripped by its protection).
  - › Creation of a deficit island (approximately 1,800 MW):
    - – Substations in the island: Babylon 400 kV, Bezděčín 400 kV, Chodov 400 kV, Chotějovice 220 and 400 kV, Čechy Střed 220 and 400 kV, Krasíkov 400 kV, Malešice 220 kV, Neznášov 400 kV, Týnec 400 kV, Výškov 400 kV.

11:59:48

Pumped-storage EDST HG2 switched off by protection from the pumping mode.

11:59:49

- » V016 unit line to the Ledvice unit 6 power plant switched off at the CHT4 substation.
- » Line V984 switched off at the 110 kV CHT1 substation (unit line of Ledvice unit 4 power plant).
- » Line V472 switched off (unit line of the Chvaletice unit 4 power plant), unit successfully tripped to the house-load supply.
- » Line V467 switched off at the VYS4 substation (unit line of the Počerady unit 2 power plant), unit successfully tripped to the house-load supply/
- » Line V469 switched off at the VYS4 substation (unit line of the Počerady unit 6 power plant), unit successfully tripped to the house-load supply.

11:59:50

Ledvice unit 4 power plant generator circuit breaker switch off.

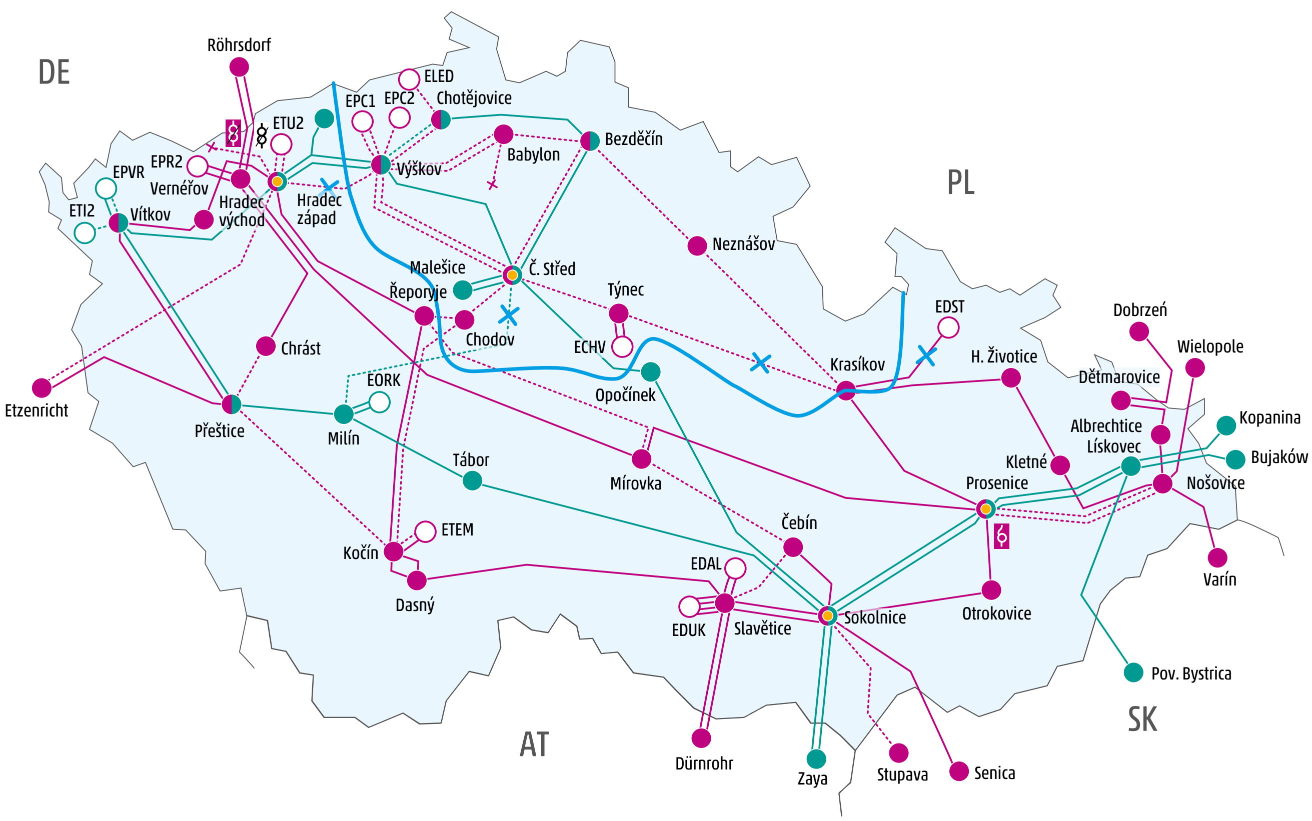
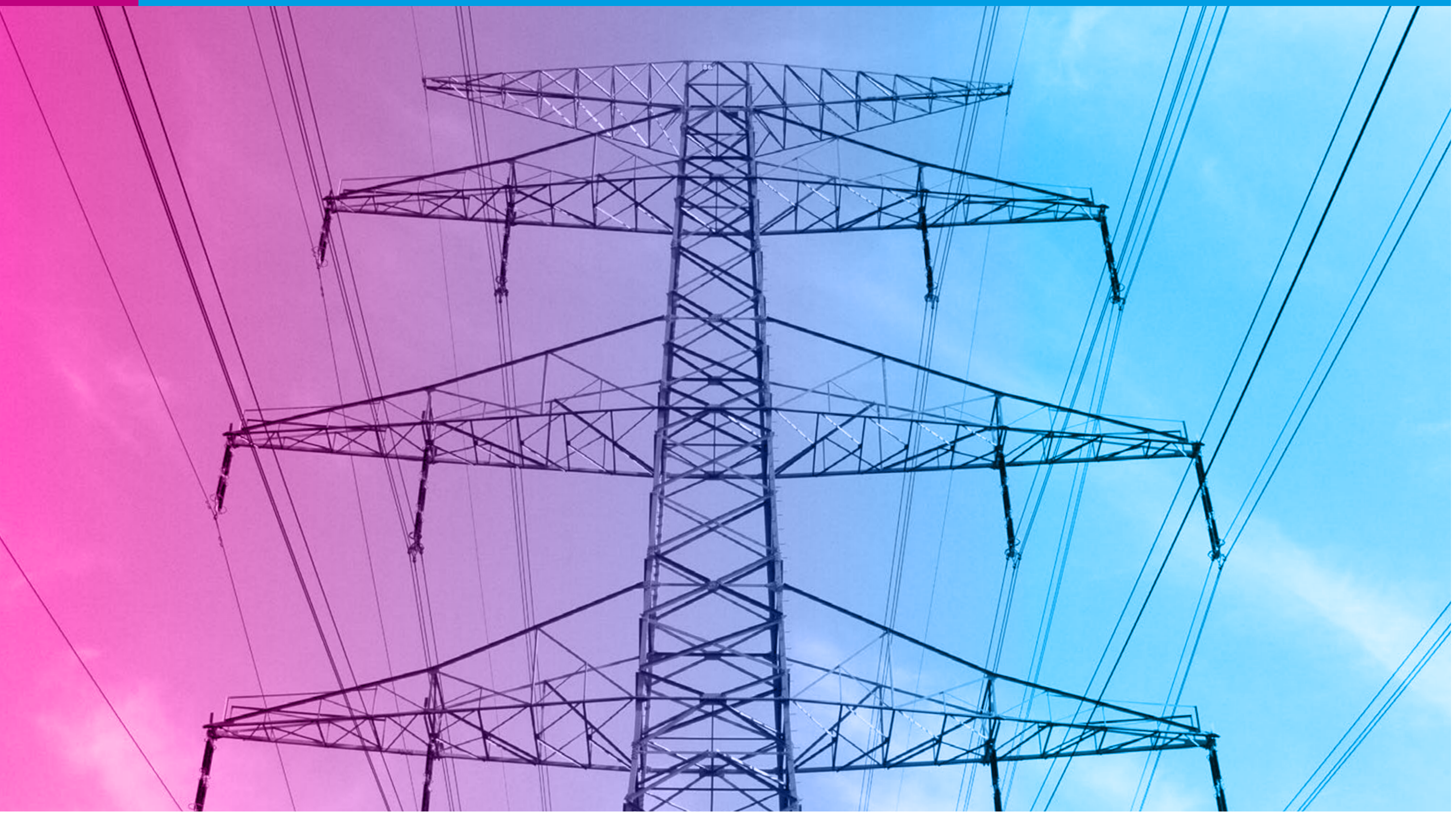


Figure 3.2: Situation of the Czech Republic transmission system on 4 July 2025 with indication of the area affected by the fault



11:59:51

- Ledvice unit 6 power plant generator circuit breaker switch off.
- Chvaletice unit 4 power plant generator circuit breaker incorrectly signalled switch off (unit 4 still in operation on house load supply).

12:00

The ČEZ technical centre informs about the shutdown of the Ledvice unit 4 power plant and the plan to shut down the pumping at the Dlouhé stráně pump storage. Before hanging up, the ČEPS operator mentions that the pump storage has gone out.

12:00:48

The operator of the Temelin NPP inquires about the status of the network. The ČEPS operator informs about a major fault in the grid, which is currently being resolved.

12:01:36

The ČEPS operator inquires about the status of the Počerady 1 power plant after the failure. The operator of Počerady 1 confirms the failure of unit 2 and unit 6TG6, with no unit remaining in operation for self-consumption.

12:02:20

The ČEPS operator receives information from the ČEZ technical centre about the plan to shut down the Dalešice pump storage. The ČEPS shift leader informs the ČEZ technical centre about the major outage. The ČEZ technical centre asks whether the change of Dalešice operation (from pumping to generation) will worsen the operation.

12:04:42

Počerady 2 power plant operator asks what is happening. The ČEPS grid operator informs about a large-scale outage and asks about the status of the Počerady 2 units. The power plant's house load is supplied from the diesel generator. After applying voltage to the unit lines, they can start up.

12:06:20

The Powertica (power plant operator and ancillary service provider) operator asks why the power plants are in island operation mode. The ČEPS network operator requests summary information on the status of the units and when they could start up.

12:08:21

EAS traffic light set to "emergency", critical event

Figure 3.3 to Figure 3.6 show active and reactive power flow and current on the element supplying the affected area for the period from 11:50 to 12:00.

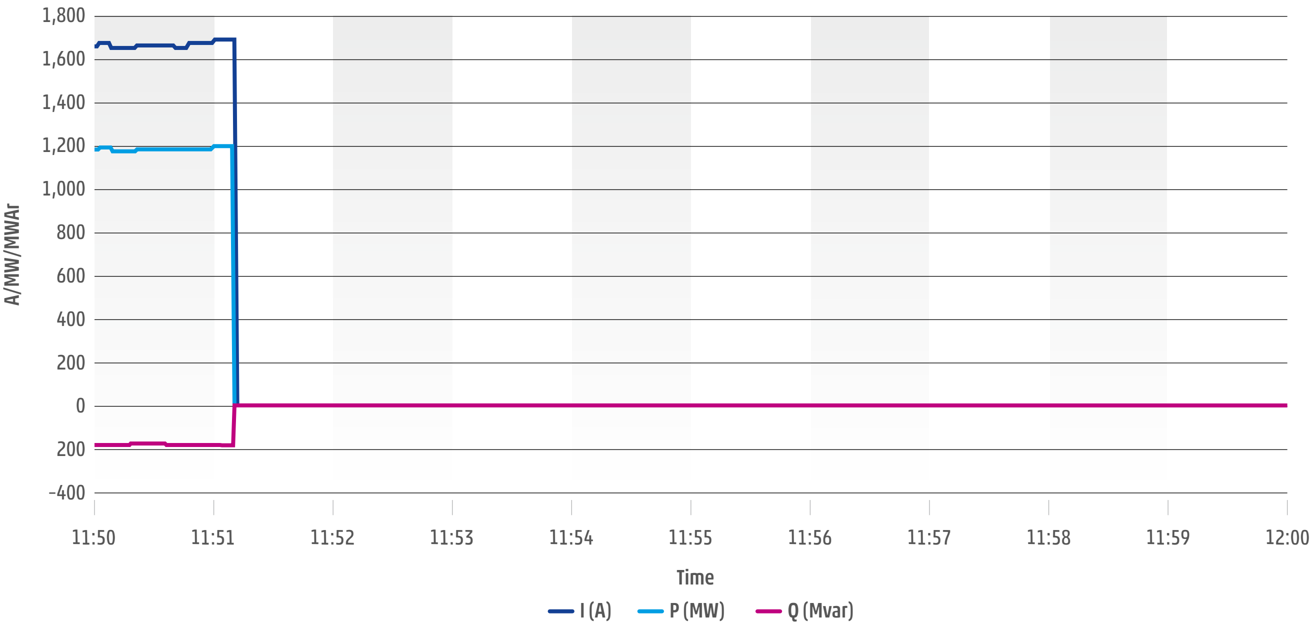


Figure 3.3: Current, active and reactive power on Výškov line V411

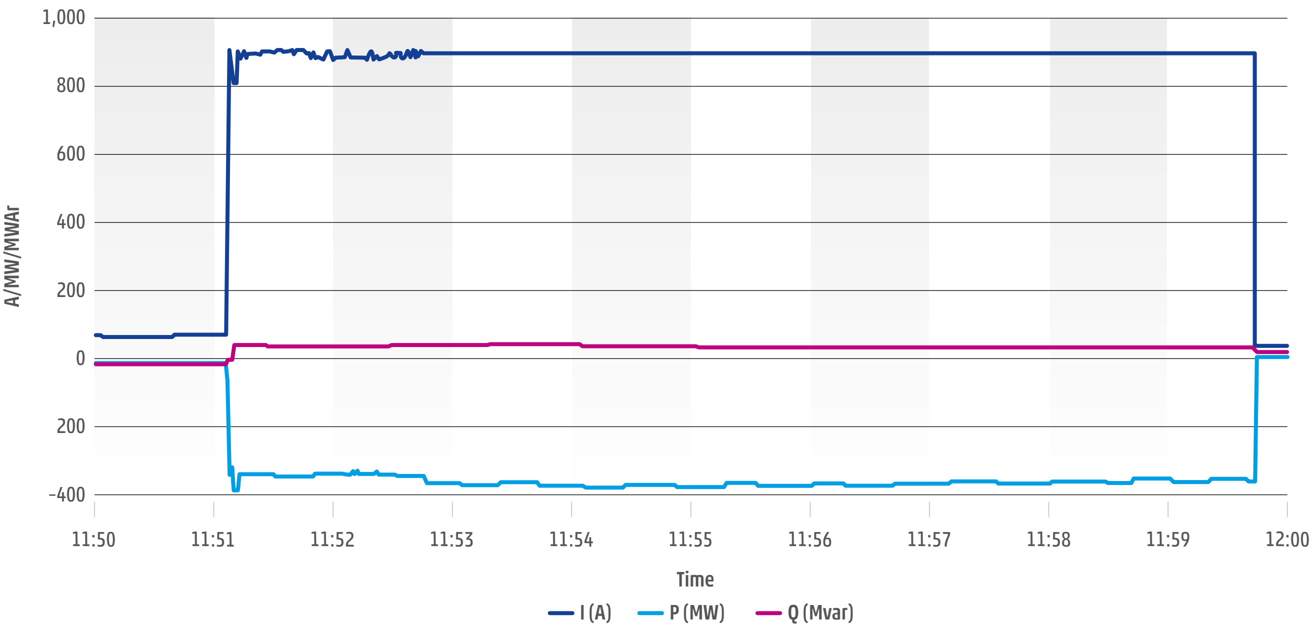


Figure 3.4: Current, active and reactive power on Milín line V208

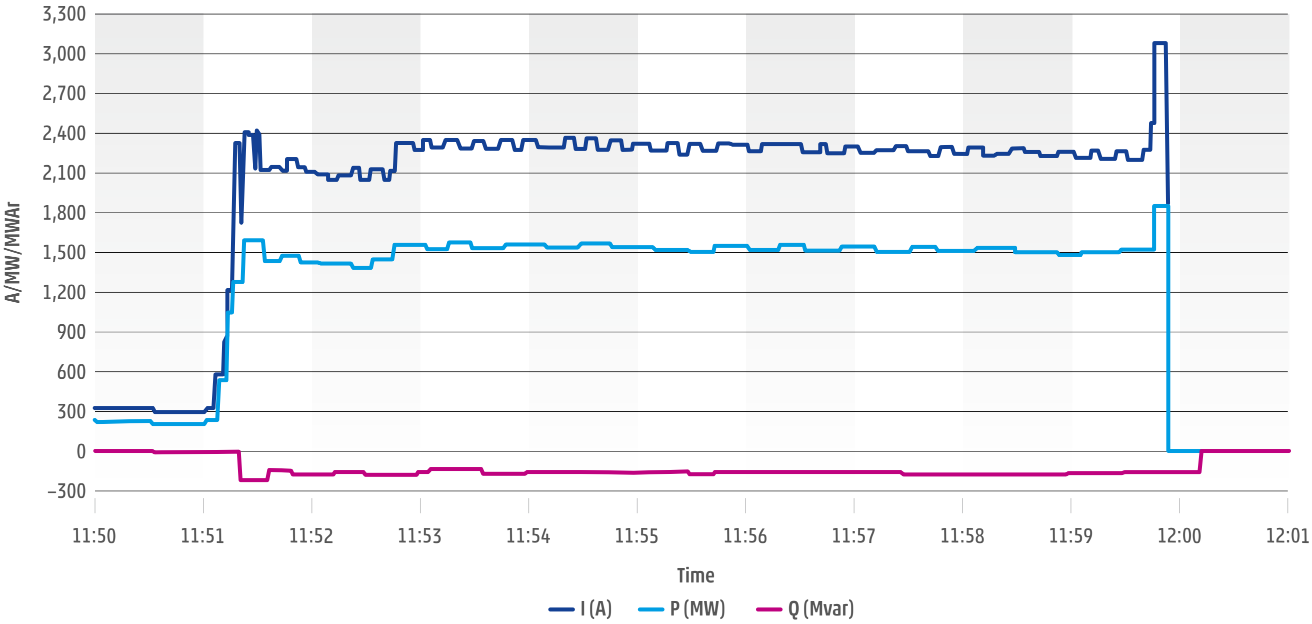


Figure 3.5: Current, active and reactive power on KSP Krasíkov

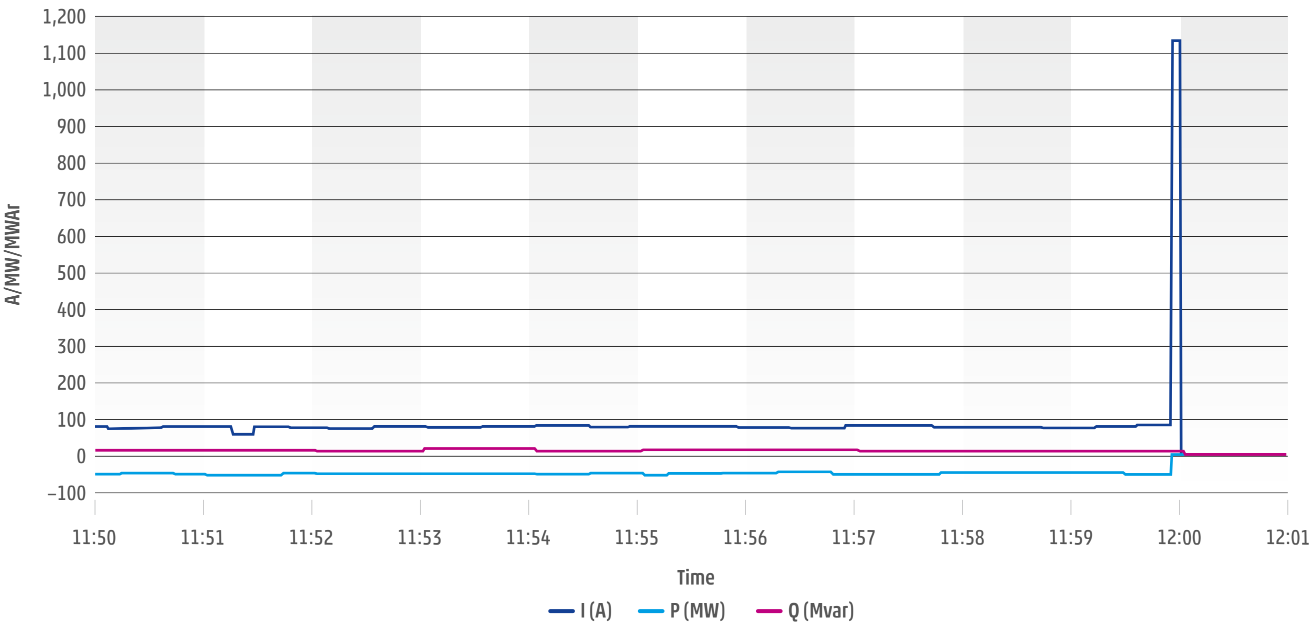


Figure 3.6: Current, active and reactive power on Krasíkov T401 transformer

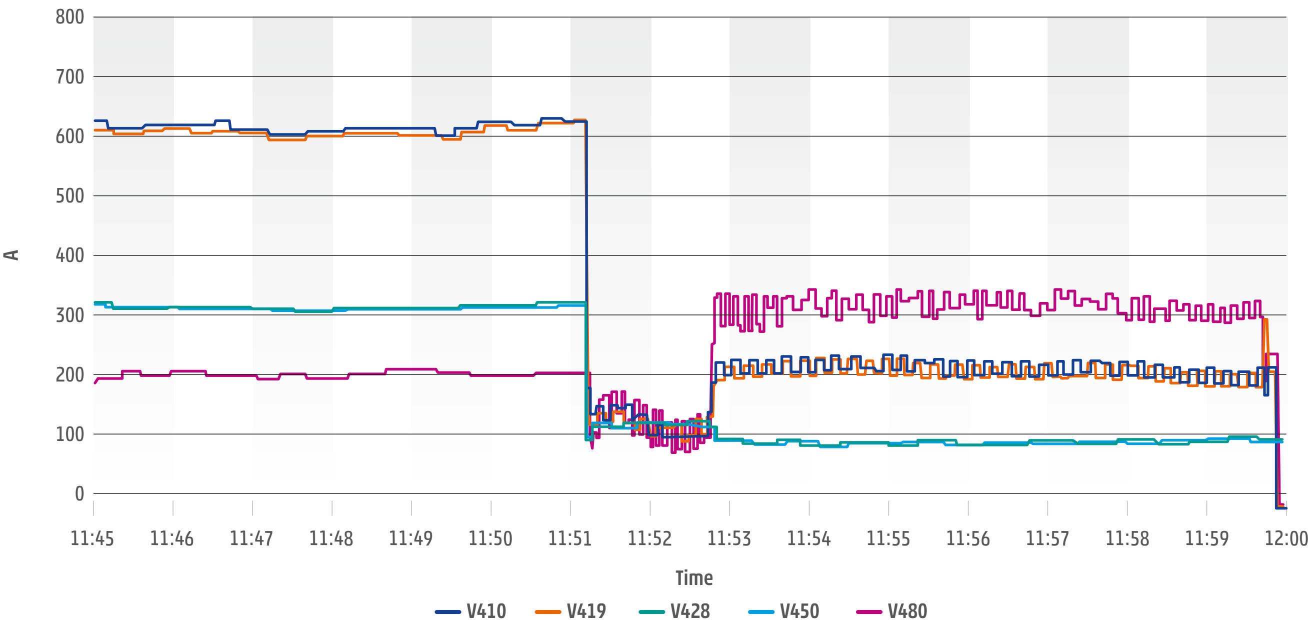


Figure 3.7: Flows on lines in the Výškov substation

3.2 Generation and load

Almost immediately after the V411 outage, production decreased at both the transmission and distribution grids (between 340 and 440 MW, according to ČEPS data).

11:52

» Identified in the transmission system:

- › Decrease in the power of the Ledvice unit 6 power plant of about 110 MW, due to boiler outage.
- › Decrease in the power of the Počerady power plant of 17 MW. This was probably the result of tracking a lower initial opening of control valves during the transition to droop speed control mode after a transient event caused by an active power surge following the V411 outage and a greater opening of bypass stations, although the exact cause remains under investigation.

» Identified in the distribution system (so far)

- › ČEZd 150 MW (including Ledvice unit 4 power plant, approximately 25 MW), reason unknown.
- › PREdi 10 MW, reason unknown.

This production further decreased in output at the Ledvice power plant unit 6.

11:53

Decrease in the output of the Ledvice power plant unit 6 by another 182 MW due to boiler outage.

12:00

After the island's collapse, all sources operating on it were lost. The total volume of shutdown production was approximately 1,200–1,400 MW (according to ČEPS data).

» Identified in the transmission system

- › Decrease in the output of unit 6 of the Ledvice power plant by 292 MW.
- › Power plant Počerady 262 MW.
- › Power plant Chvaletice 125 MW.

» Identified in the distribution system (so far), decrease in the output of sources by:

- › 397 MW ČEZd.
- › 51 MW PREdi.
- › 16 MW EG.D.

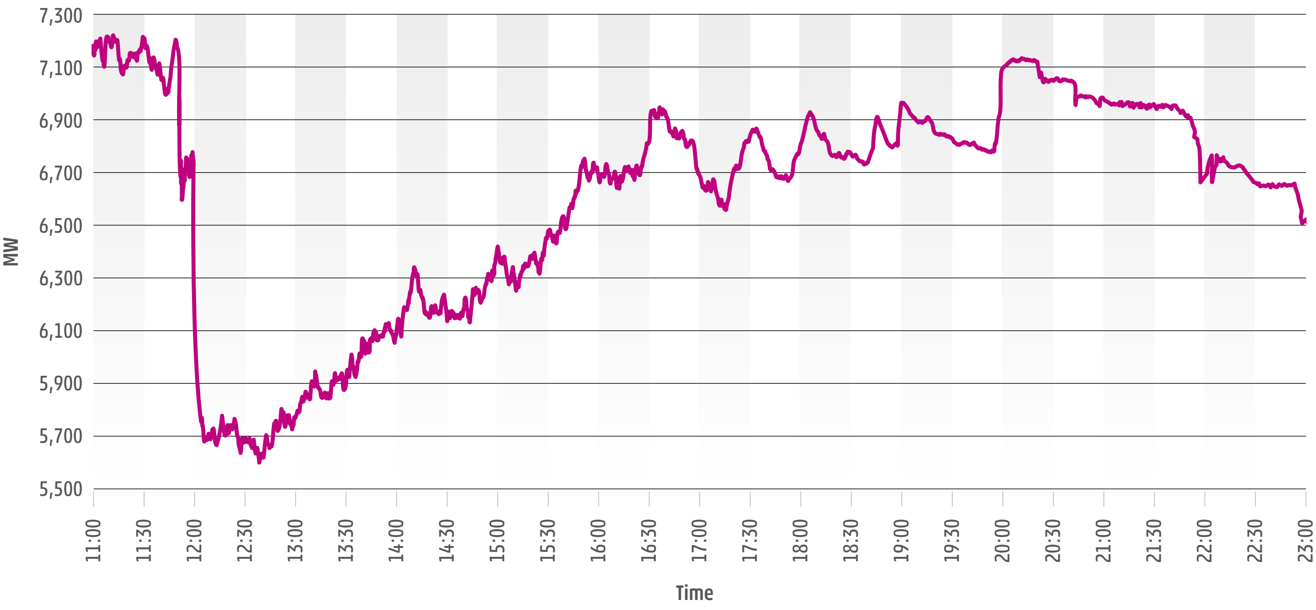


Figure 3.8: Total generation in the Czech Republic power system

Unlike production, there was no reduction in consumption after the V411 line failure. The load was around 8,100 MW. After the island's collapse, the load dropped from approximately 8,144 MW to 5,900 MW, reflecting a difference of 2,244 MW (according to ČEPS data).

The load remained at this value until approximately 12:42, when it was gradually restored at the distribution system level. Based on information from the DSOs, the restoration process at the distribution system level was completed at 17:35.

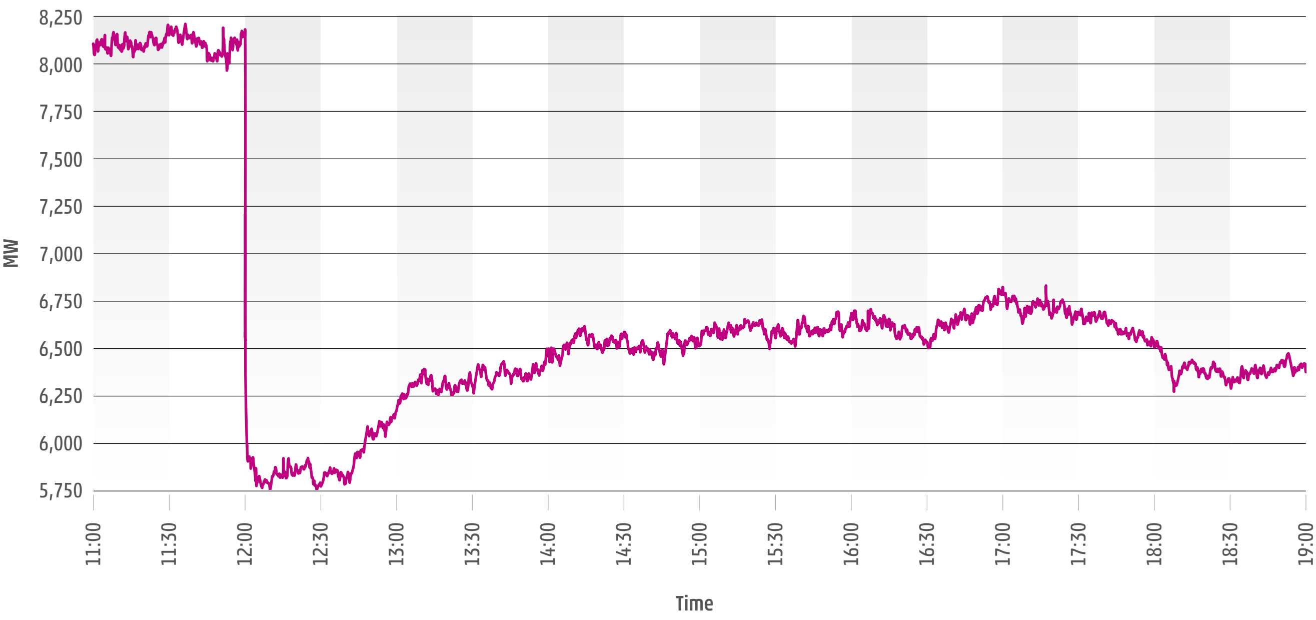


Figure 3.9: Total load in the Czech power system (source: ČEPS data)

Based on information from distribution companies, the total consumption loss was 1,988 MW.

3.3 Island operation capability as the ancillary service

Since the previous chapters discussed the island operation (IO) control mode of the units, this chapter provides a more detailed description of its principles.

3.3.1 Definition and purpose of the service

The IO capability provides support during emergency or critical system conditions in the power system. Its primary goal is to ensure that selected grid areas remain operational even when disconnected from the rest of the transmission system. By enabling autonomous operation of an isolated section, the service helps maintain supply to essential loads, supports system restoration procedures and enhances overall grid resilience. Since the service is based on transitioning to proportional (droop) speed control mode, it allows the unit to operate even in a parallel-connected area regardless of whether a true topological island is formed.

3.3.2 Technical and operational requirements for IO capability

The requirements for providing IO capability are divided into four principal areas:

- » A. Transition to island operation control mode (droop speed control mode).
- » B. Operation in island operation control mode (droop speed control mode).
- » C. Reconnection of the island to the rest of the grid (transition from island operation control mode back to normal control mode).
- » D. Availability and verification of the service.

A. Transition to island operation control mode

The transition from normal parallel operation to island operation control mode (IOCM) involves a sudden change in system frequency and an imbalance of active and reactive power. The generating unit must be capable of ensuring a stable and automatic transition according to the following conditions:

- » The unit's control system shall automatically switch to droop speed control mode suitable for IO conditions.
- » Any participation in the automatic frequency restoration reserve (aFRR) or other remote active power control must be temporarily disconnected.
- » The unit must also allow remote control via the ČEPS regulator designed for IO, which controls units operating in droop speed control mode.
- » The generating unit must ensure stable adjustment of rotational speed to the new island frequency.
- » In the case of significant system separation, the unit must be capable of self-supply operation (operation on house-load) or complete disconnection from the external grid if frequency deviations exceed the allowed limits.
- » The transition is to be automatically detected by a frequency relay, following the prescribed frequency plan (below 49.8 Hz or above 50.2 Hz).

B. Operation in island operation control mode

During IO, the generating unit must ensure stable, coordinated operation within the isolated system segment and autonomously regulate active and reactive power output in response to system frequency and voltage variations.

Key functional requirements include the following:

- The unit shall be capable of stable parallel cooperation with other generating units forming the island.
- The response of active and reactive power to changes in frequency and voltage must remain adequate and stable, even under non-nominal conditions.
- The unit's active power output in steady-state conditions shall follow the idealised dependency of turbine power Pid on frequency deviation Δf, as given by:

$$P_{id} = P_0 - \frac{100}{S}\frac{P_n}{f_n}\Delta f$$

Where:

- S – governor droop (recommended range: 4–8 %, allowed range: 4–10 %);
- P_0 – power output of the generating module prior to transition to island mode, or the value corresponding to the base position of the regulating elements (e.g., control valves for steam turbines, fuel controller for gas turbines or guide vanes/runner blades for hydro turbines), provided that the operator has adjusted the output upon TSO dispatcher request.

The unit must be capable of autonomous regulation of frequency, voltage and load changes, without relying on external control loops, unlike during regular interconnected operation.

C. Reconnection of the island to the transmission system

For safe synchronisation and reintegration of the island with the rest of the grid, the generating unit must meet the following operational criteria:

- Maintain stable IO for at least 2 h.
- Smoothly adjust and regulate the island frequency as instructed by the TSO dispatcher to achieve synchronous conditions.
- If synchronisation occurs at a transmission substation, the generating unit must be capable of energising the busbar and maintaining stable voltage control during synchronisation.

D. Availability and service monitoring

The IO service provider must ensure continuous readiness and compliance with certification requirements:

- Periodic certification tests must be conducted to demonstrate the unit's capability to perform IO in accordance with the prescribed parameters.
- The provider must allow on-site inspections by the TSO to verify technical preparedness and control system configuration.
- During operation, the following parameters shall be continuously monitored and recorded:
  - switching of control modes (transition to/from IOCM);
  - IOCM status;
  - frequency measurements;
  - confirmation of remote-control commands;
  - other relevant telemetry signals required by the TSO.

3.3.3 Testing and verification of IO capability

The generating unit operator must demonstrate both technical and control system readiness for IO operation through a set of prescribed verification tests. Certification measurements are conducted once every 5 years (for units providing black start capability simultaneously, this period can be shortened to 3 years).

The certification test comprises the IO–Δn test (by simulating rotational speed) and IO–transition to house-load operation (so-called shutdown test).

IO–Δn test

This test is carried out on a generating unit synchronised with the power system. The frequency entering the IO controller from the power system essentially does not differ from the standard 50 Hz frequency. The rotational speed simulation test consists of several partial measurements and sub-tests. These are used to verify the generating unit's response to various types of fluctuations in real island operation, as well as the correct functionality of the designed IO system.

1. Transition to island operation control mode

The purpose of the test is to verify the unit's behaviour during the transition to IOCM. Since the frequency of the power system at the moment of transition to IO is practically nominal (50 Hz), the switch to IO should occur with no power impact. Any current deviation of the ES frequency from the nominal value might result in a corresponding power jump of the unit.

Depending on the unit's current capabilities, the transition to IO should be tested at least at two different power levels of the generating unit using a simulated islanding signal. It is recommended that one of the tested levels be the generating unit's nominal power level.

2. Simulated step changes in rotational speed

The purpose of the test is to verify the behaviour of the generating unit during step changes in the droop speed controller's setpoint frequency (rotational speed). In this mode, the generating unit does not operate in closed-loop power control. Changes in the rotational speed setpoint result in adjustments to the opening of the unit control valves.

The unit output is influenced not only by changes in the speed setpoint but also by other external factors (e.g., instantaneous steam inlet conditions, power system frequency fluctuations, etc.).

The generating unit is typically loaded with step signals for rotational speed changes at the upper, middle and lower values of the agreed power range for testing the unit's IO to make the test as representative as possible.

3. Simulated continuous changes in rotational speed

The purpose of the test is to verify the correct behaviour of the unit's bypass stations, the available reserve for instantaneous active power changes across the entire IO control range and the correctness and functionality of the applied IOCM algorithm.

This test represents a comprehensive examination of the generating unit's behaviour across its full power range. It begins with a step change in rotational speed, followed by a linear continuous change until the upper or lower active power limit of the generating unit is reached.

4. Switching the generating unit to the normal control structure

The purpose of the test is to verify the unit's behaviour during the transition from IOCM to the generating unit's normal operating mode.

The transition from IOCM is tested at least at two different power levels of the generating unit. The transition should be smooth and stable, without significant or abrupt changes in the unit's active power output.

IO–transition to house-load operation test

This is a disconnection test (or so-called shutdown test) in which the generating unit, previously automatically switched to droop speed control mode during the test, is shut down from its nominal active power level and transitions to the minimum load level defined by the unit's house load. The test itself comprises several sub-measurements:

The test itself consists of several sub-measurements:

» 1. Disconnection test from nominal active power to the unit's house-load level.
» 2. Operation at house-load level and variation of load caused by switching a large motor on and off.
» 3. Synchronisation of the unit operating in IOCM with the power system at the transmission system substation.
» 4. Transition of the unit to normal operating mode.

During the test, the unit does not receive information about the status of the unit evacuation line circuit breaker at the substation. As a result, it transitions to house-load operation mode based on the record from the run-over protection system.

3.4 System's dynamic behaviour during the event

Prior to the incident, no extraordinary dynamic behaviour was recorded in the system.

Immediately before the incident, line V411 was loaded to approximately 1,200 MW, with power flowing from the Hradec substation to the Výškov substation. The tripping of line V411 redistributed power flows within the system, causing a power surge that affected nearby generation. From the perspective of nearby synchronous generators, there was a transition from the power control mode to the IOCM (droop speed control mode). The following units, connected to the transmission system, were affected:

» TPP Ledvice unit 6
» TPP Počerady units 2 and 6

IOCM (droop speed control mode) was also activated on the following units operating within the distribution system (at the 110 kV voltage level):

» TPP Ledvice unit 4
» TPP Opatovice unit 5

The transition to the IOCM (droop speed control mode) was based on local frequency measurements from individual units. The switch to the IOCM (droop speed control mode) is triggered by a frequency deviation of ±200 mHz from the nominal value of 50 Hz. After the transition, the units change their control mode and remain connected to the grid.

The following series of graphs illustrates the dynamic behaviour of the TPP Ledvice unit 6. The graph of active power output shows periodic oscillations for unit 6 at TPP Ledvice. Such oscillations are not present in the telemetered active power data transmitted to the ČEPS dispatching control system.

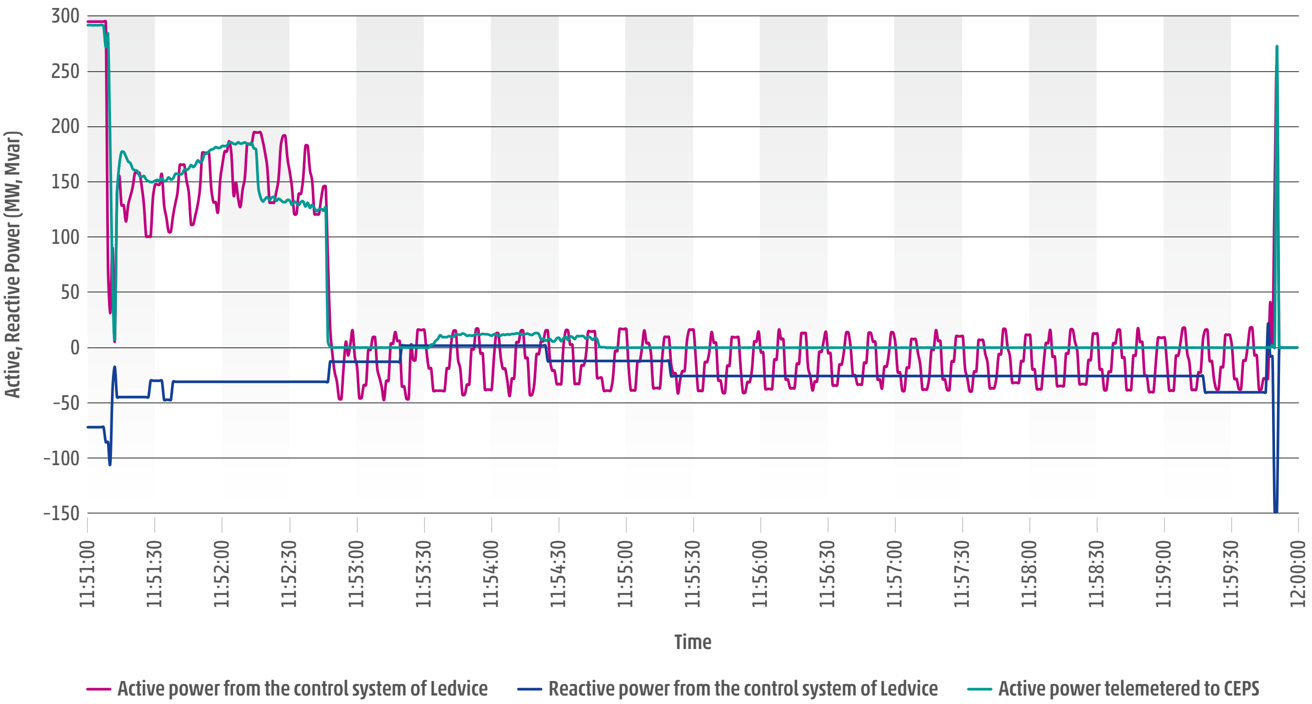


Figure 3.10: Trend of power output at generator terminals of ELED unit 6 from 11:51 to 12:00

According to the power plant's statement, the cause of the difference between the signals is as follows (translated into English by ČEPS):

"We assume that the issue arises during signal validation in the TCS (Turbine Control System) when the input signals are oscillating, which was exactly the case here. A 1-second filter is included in the validation loop. We would like to emphasise again that each of the three input signals is connected to a different input card. Each card is read at a different moment in time. However, the validation block evaluates all three signals simultaneously. This means it processes samples that are time-shifted, and in the case of oscillating input signals combined with the implemented 1-second filter, this can cause the observed issue."

For comparison, Figure 3.11 shows measurements from the control system of unit 6 and line V016. The measurement on line V016 is adjusted for the power plant house load. The graph clearly shows that the measurements overlap, and the line measurement also indicates oscillations (even with a shorter period) in the active power of generator unit 6.

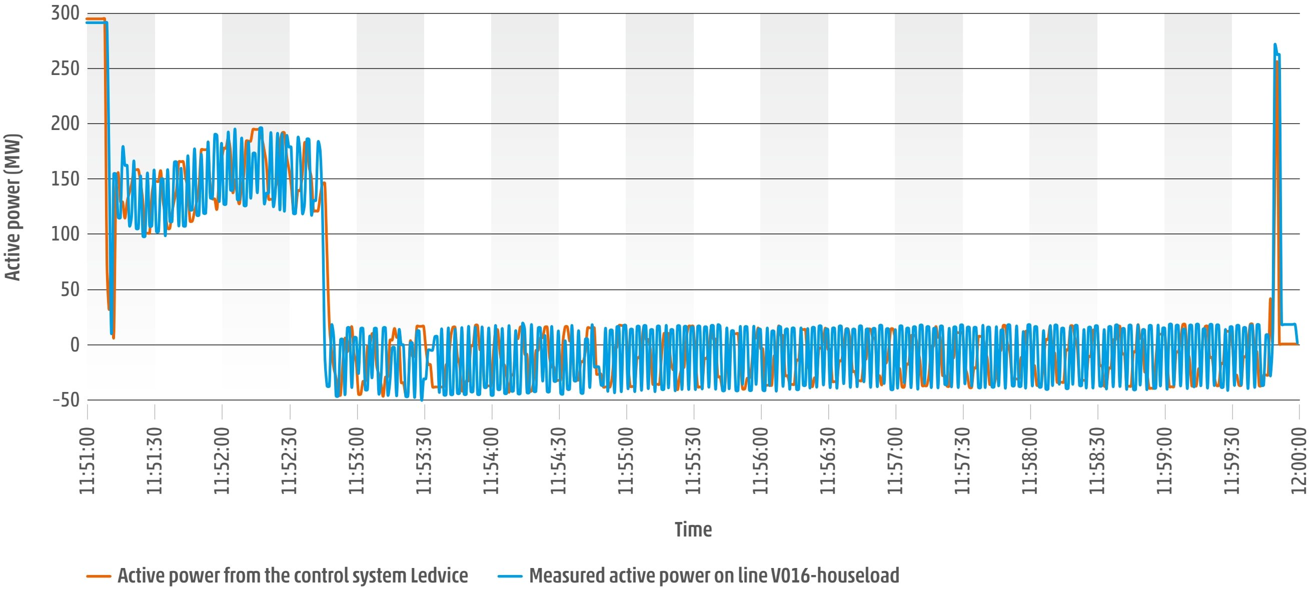


Figure 3.11: Comparison of the active power trend of the generator with the measurement on line V016 adjusted for the house load of ELED from 11:51 to 12:00

According to the statement from TPP Ledvice, at 11:51:46, a boiler outage occurred due to the activation of protection triggered by a high-temperature steam signal behind the high-pressure bypass stations. This was caused by an unforeseen technical fault in one of the high-pressure steam temperature control valves in the turbine bypasses steam piping. The valve failed to open due to an actuator motor malfunction, which was specifically caused by a defective relay.

At 11:52:45, the turbogenerator was shut down with a delay determined by the boiler's immediate steam output at the time of the trip. The generator remained synchronised with the system, with zero turbine power, because the criteria for reverse power flow protection were not met due to oscillations in the generator's active power output. The generator was disconnected from the grid during the frequency collapse of the separated part of the system, triggered by frequency protection upon detecting underfrequency at 11:59:51.

The following graphs show the turbogenerator speed profile at TPP Ledvice unit 6. Figure 3.12 displays the period from 11:51 to 12:00, capturing both the V411 outage event and the subsequent frequency collapse in the affected part of the grid. The graph also shows that even after the boiler outage, the generator remained synchronised with the grid (i.e., operating at synchronous speed). For unit 6, it is a two-pole turbogenerator; therefore, the synchronous speed corresponding to a 50 Hz grid frequency is 3,000 rpm. Small oscillations are also visible in the speed profile after the V411 outage. For better clarity, a zoomed-in view of the generator speed at the time of the V411 outage was also created.

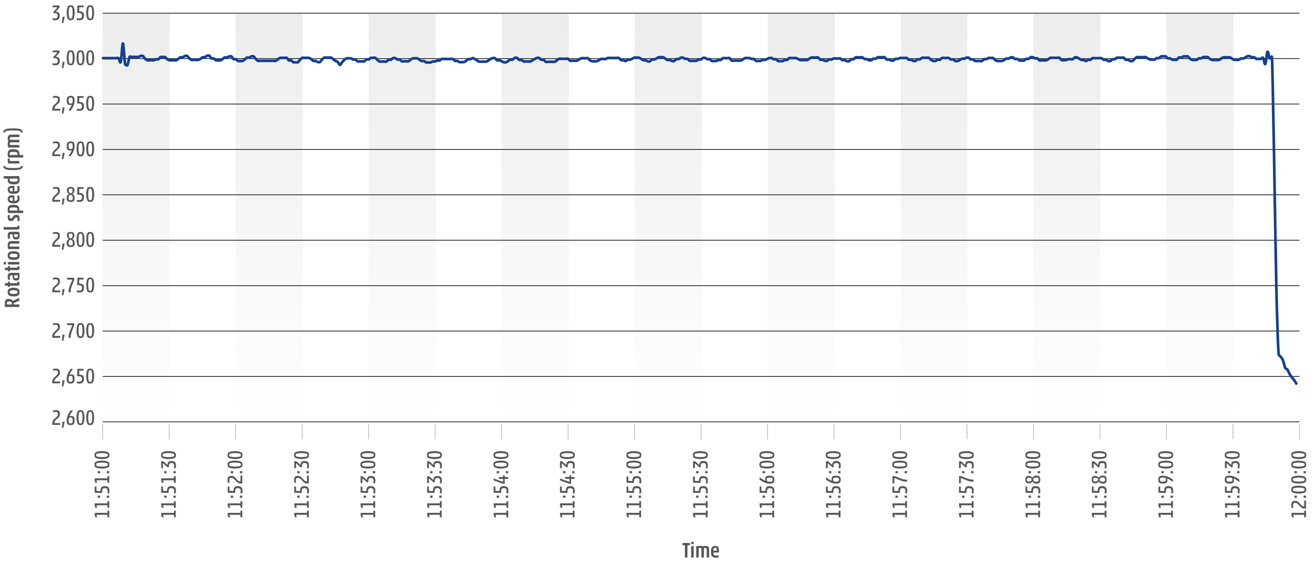


Figure 3.12: Trend of measured turbogenerator speed of ELED unit 6 from 11:51 to 12:00

From the speed measurement, it is evident that a transient change was recorded following the outage of line V411, during which the rotor speed reached approximately 3,016 rpm at 11:51:09.

Since a frequency deviation of 200 mHz as a threshold for transition to droop speed control mode corresponds to 12 rpm, unit 6 recorded a deviation greater than the set limit.

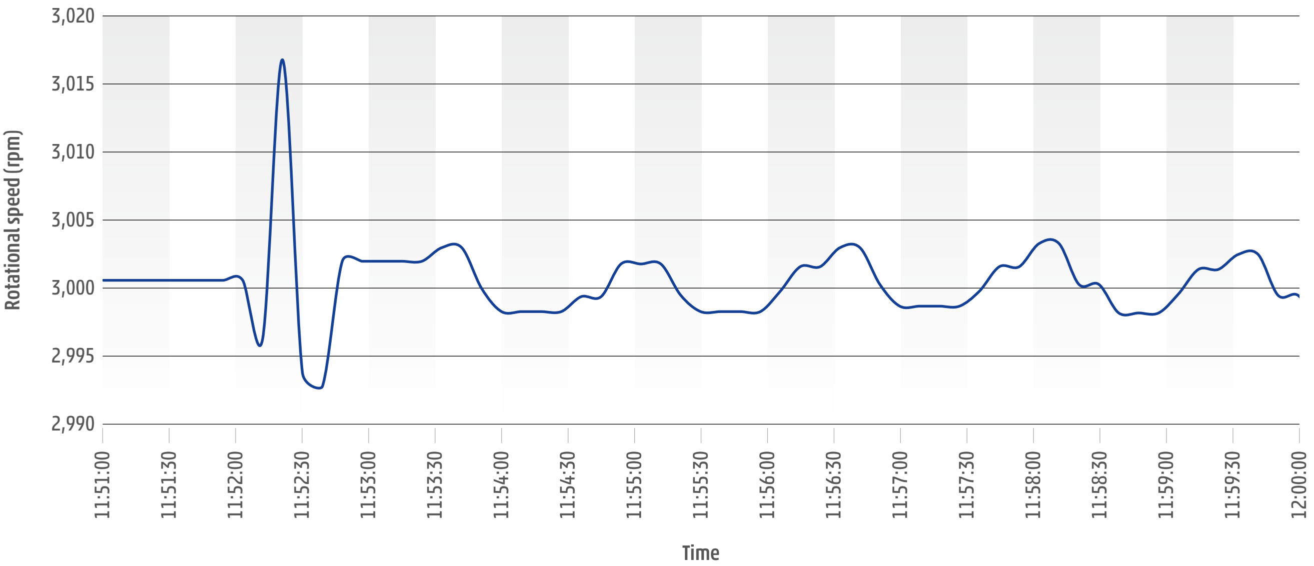


Figure 3.13: Zoomed view of speed measurement during the V411 outage

The following graphs show profiles of the opening of bypass stations and control valves of the TPP Ledvice unit 6. The graphs show that changes in the variables occurred already after the V411 outage.

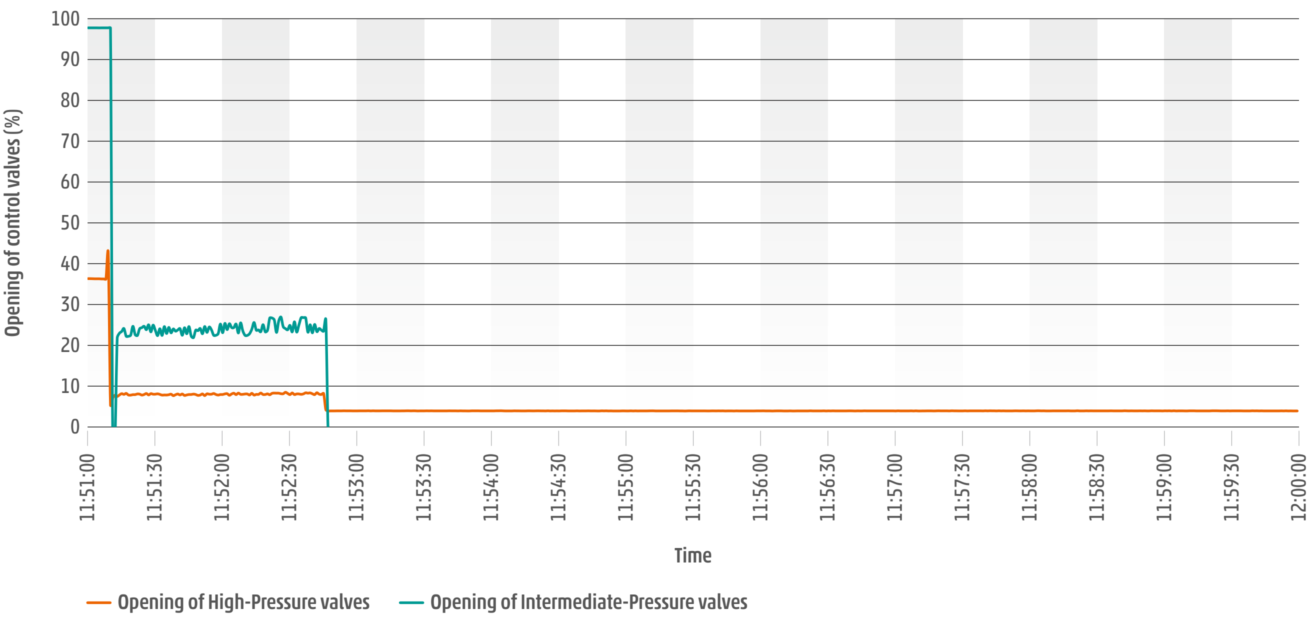


Figure 3.14: Trend of control valves opening for ELED unit 6 from 11:51 to 12:00

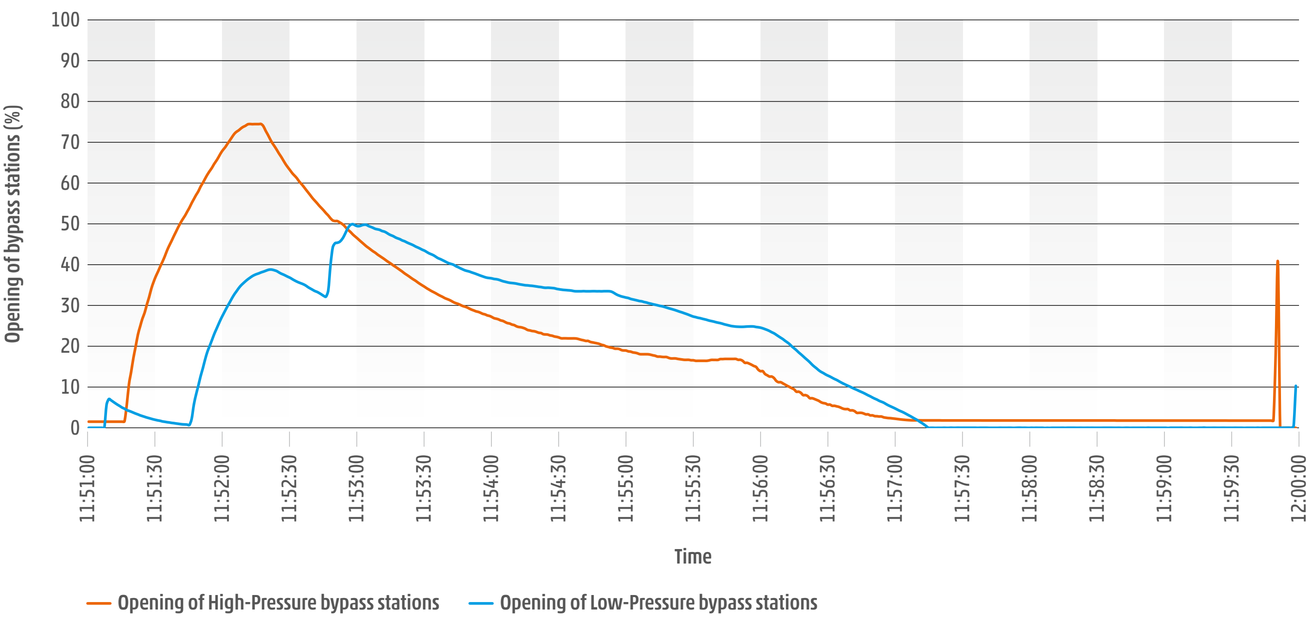


Figure 3.15: Trend of bypass stations opening for ELED unit 6 from 11:51 to 12:00

From the perspective of dynamic behaviour affecting the system's operation, the behaviour of TPP Ledvice unit 4, connected to the distribution network at the 110 kV level, is further shown. It should be noted that the power plant sent the data from its control system for unit 4 with the following remark:

> *"Due to the possibilities of monitoring feedback, loading historical trends, and the operating mode of Unit 4 in Island Operation Control Mode, not all time-aligned data can be considered fully relevant; some potential inconsistencies need to be further investigated as far as possible."*

Figure 3.16 shows the output of the TPP Ledvice unit 4 generator, again compared with the values from the Ledvice power plant control system and the telemetered values to the ČEPS dispatch control system. From the trends, it is evident that unit 4 experienced oscillations, and the output active power telemetered to the ČEPS dispatch control system differs from the output power recorded in the power plant control system. Therefore, it is also more difficult to calculate the total loss of active power generation after the V411 outage.

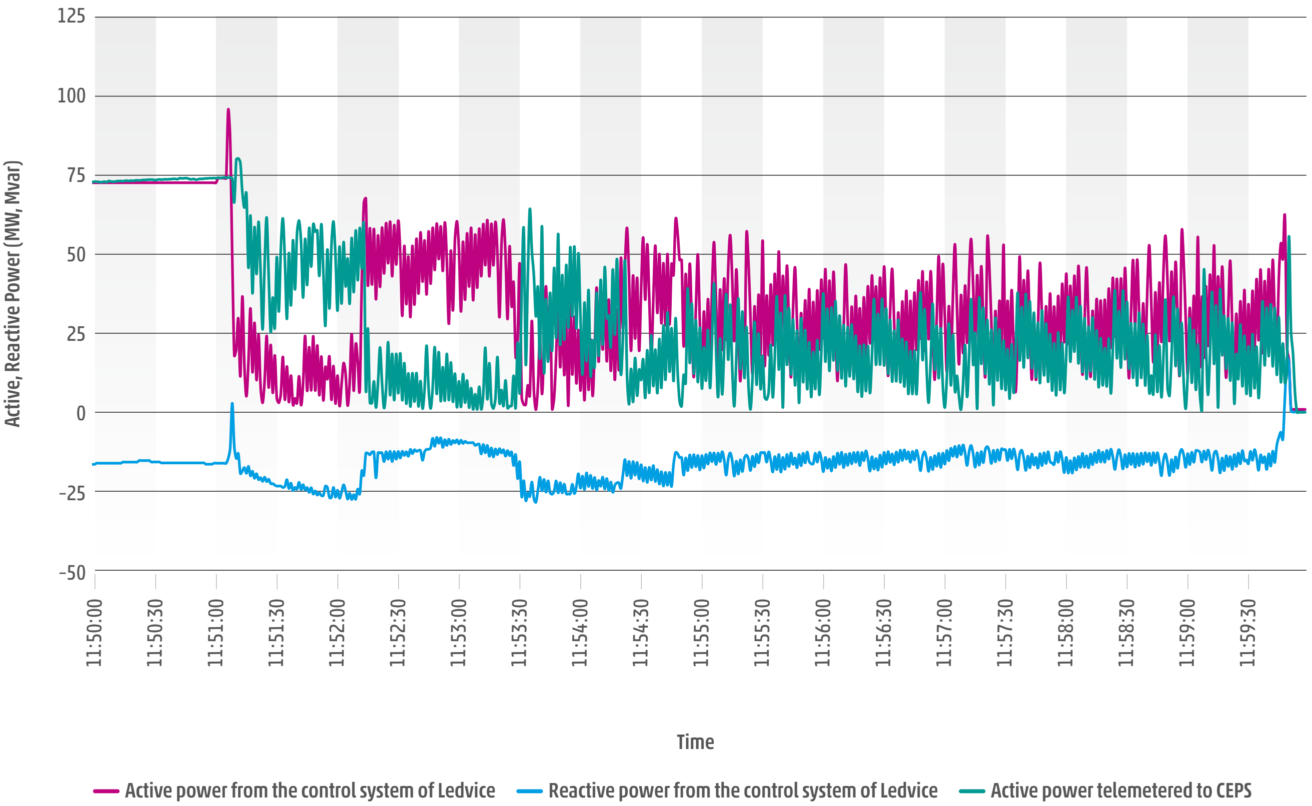


Figure 3.16: Trend of power output at generator terminals of ELED unit 4 from 11:50 to 12:00

According to the power plant statement, unit 4 of TPP Ledvice had a droop setting of 0 % in droop speed control mode, meaning that the proportional speed controller's gain was theoretically infinite. Such a gain would theoretically mean that, for any positive frequency deviation from 50 Hz, the unit would drop to zero active power, and for any negative deviation, it would go to its maximum available output. The gain is limited in practice by the mechanical equipment's capabilities. This droop setting represents an inappropriate setup.

It should also be noted that, according to the Transmission System Grid Code, the droop setting for IOCM should be in the range of 4–10 %. However, unit 4 of TPP Ledvice is not certified for IO capability as an ancillary service, as it is connected to the distribution system. ČEPS does not procure this service from units connected to the distribution system, which also implies that the unit is not subject to regular certification for IO capability, as are units providing this service in the transmission system.

According to the power plant statement, the reason for the differences between the telemetered active power and the active power from the control system of Ledvice for unit 4 is as follows (again translated from Czech):

> *"The sent active power values come from one of three measurements taken before evaluation in the control system. These three values are then validated within the control system, a median of the three is calculated, and only afterward is the signal used for regulation and sent to the terminal.*[11] *Due to incorrectly configured droop settings, which caused an overload of the control system's computational capacity, the signal from the terminal cannot be considered valid. It should be noted that the active power value, when the unit is operating in Island Operation Control mode, is not applied in any regulation."*

Oscillations are also evident in the opening of the turbine control valves on TPP Ledvice unit 4 following the V411 trip and the switch to droop speed control mode.

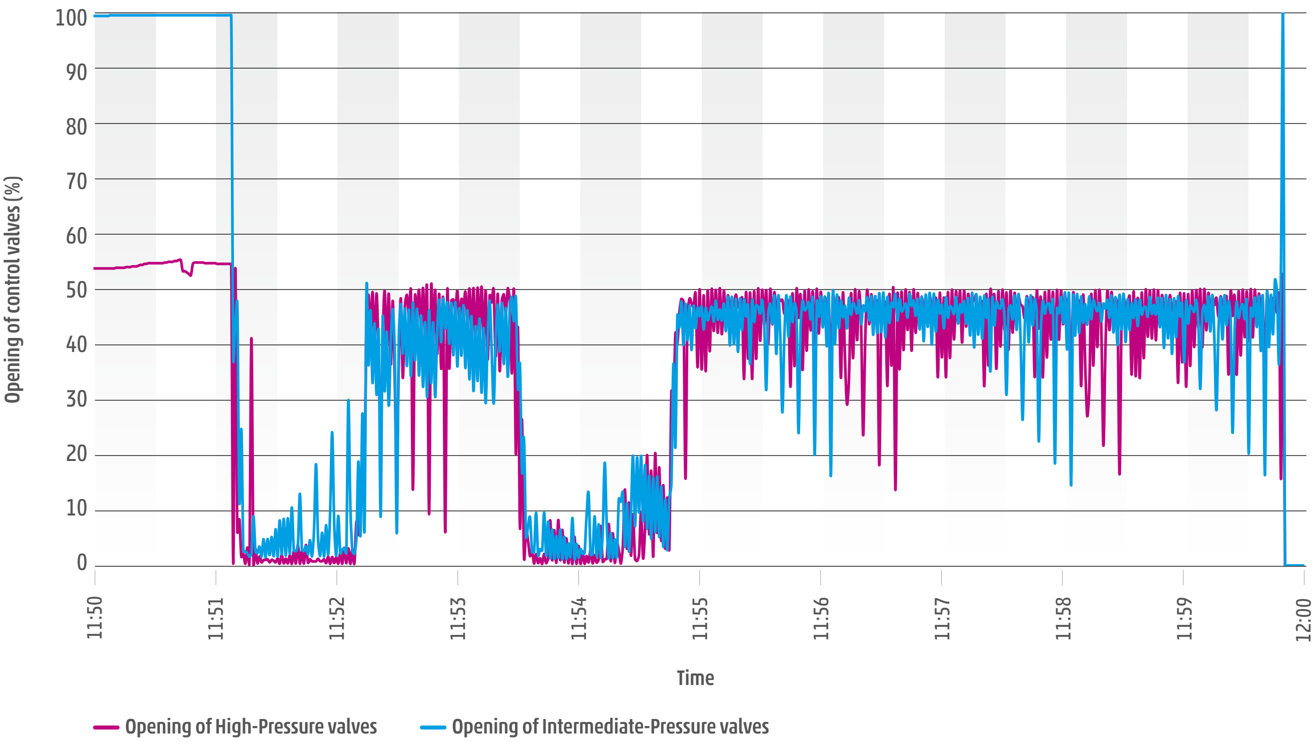


Figure 3.17: Trend of control valves opening for ELED unit 4 from 11:50 to 12:00

Regarding the grid's behaviour, Figure 3.18 shows frequency measurements from the WAMS system at the Čechy Střed substation between 11:50 and 12:00, with a displayed granularity of 50 samples per second. This is the only substation in the transmission system area equipped with WAMS measurement that was affected by a voltage outage at 11:59.

The graph clearly shows the moment when line V411 was disconnected at 11:51:08, which caused a frequency oscillation in the area. Although the frequency value stabilised around the nominal value 50 Hz after the disconnection of line V411 – since the affected part of the grid remained synchronously connected to the surrounding system – frequency oscillations are still visible. Figure 3.19 therefore shows a zoomed-in view of the frequency measurement over a 10-second interval, revealing ongoing oscillations with a period of approximately 1 s with a peak-to-peak amplitude of 30 mHz.

11 The values from the terminal are values telemetered to the ČEPS dispatch control system. The terminal of the power plant is a technical device for the control of the units and for communication with other systems, including the ČEPS dispatch control system.

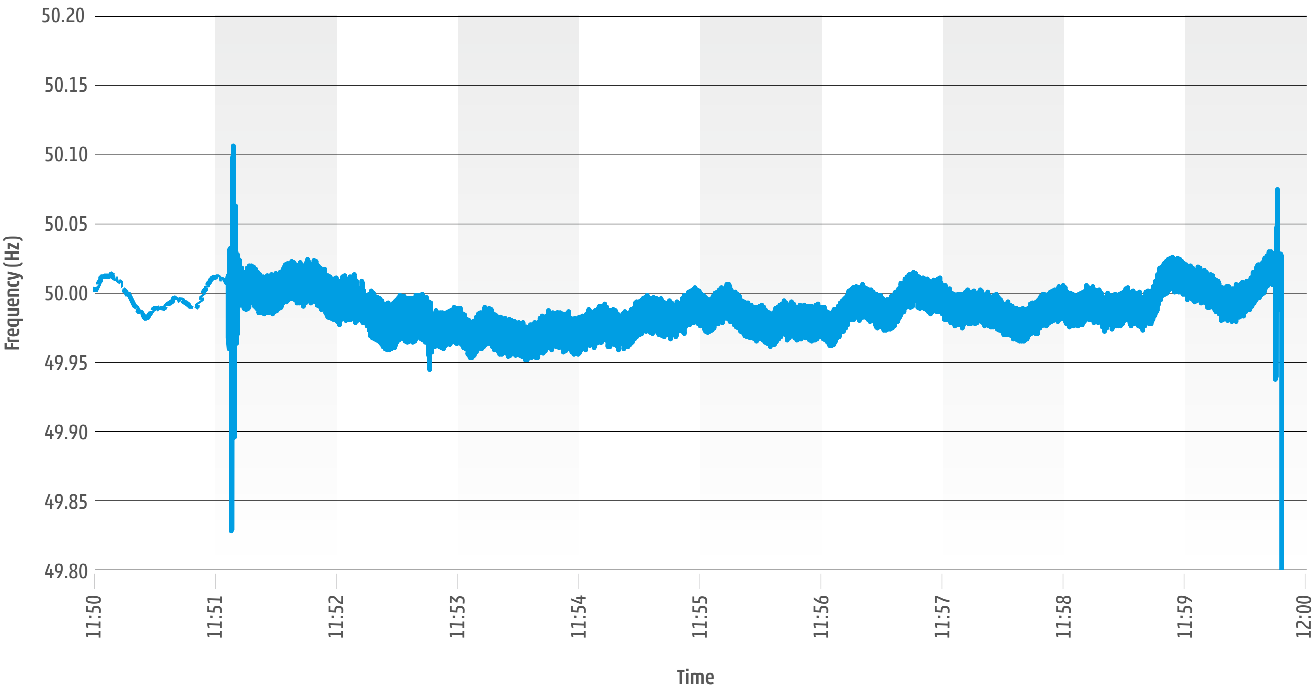


Figure 3.18: WAMS frequency measurement at the CST substation in the V400 line bay from 11:50 to 12:00

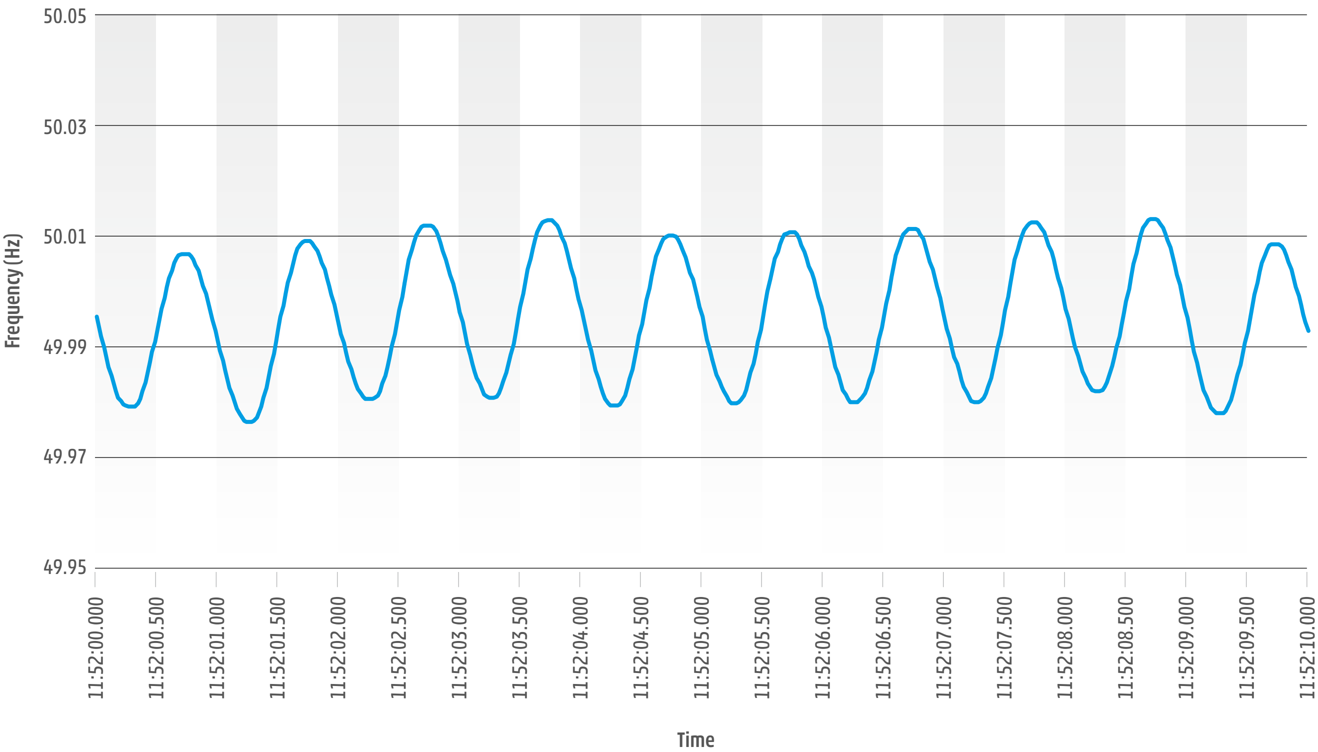


Figure 3.19: Zoomed-in view of the WAMS frequency measurement at the CST substation in the V400 line bay

This oscillation was observed only in the area (at least according to available WAMS measurements) that was subsequently affected by a voltage outage. The graph below shows frequency measurements from the Hradec substation, which the V411 line connects to. The data is taken from the V412 Hradec–Řeporyje line bay.

In this waveform, oscillations following the V411 outage are not visible. Furthermore, the frequency measurement from the Hradec substation clearly shows that a frequency deviation greater than 200 mHz was recorded during the V411 line outage, representing the WAMS measurement closest to the V411 line.

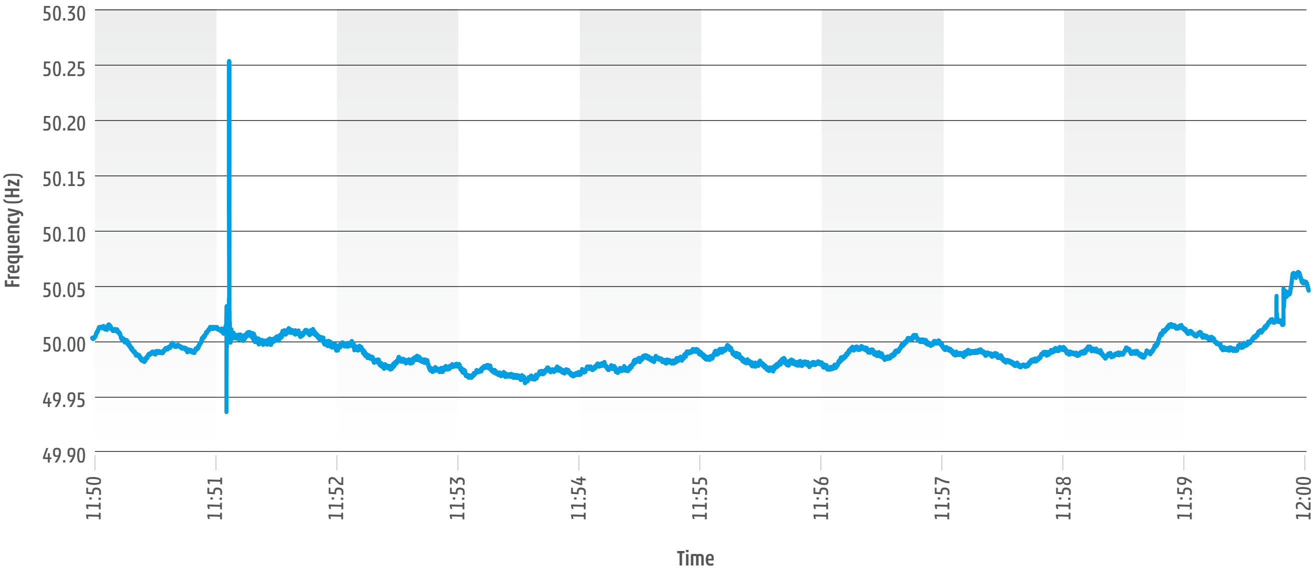


Figure 3.20: WAMS frequency measurement at the HRA substation in the V412 line bay from 11:50 to 12:00

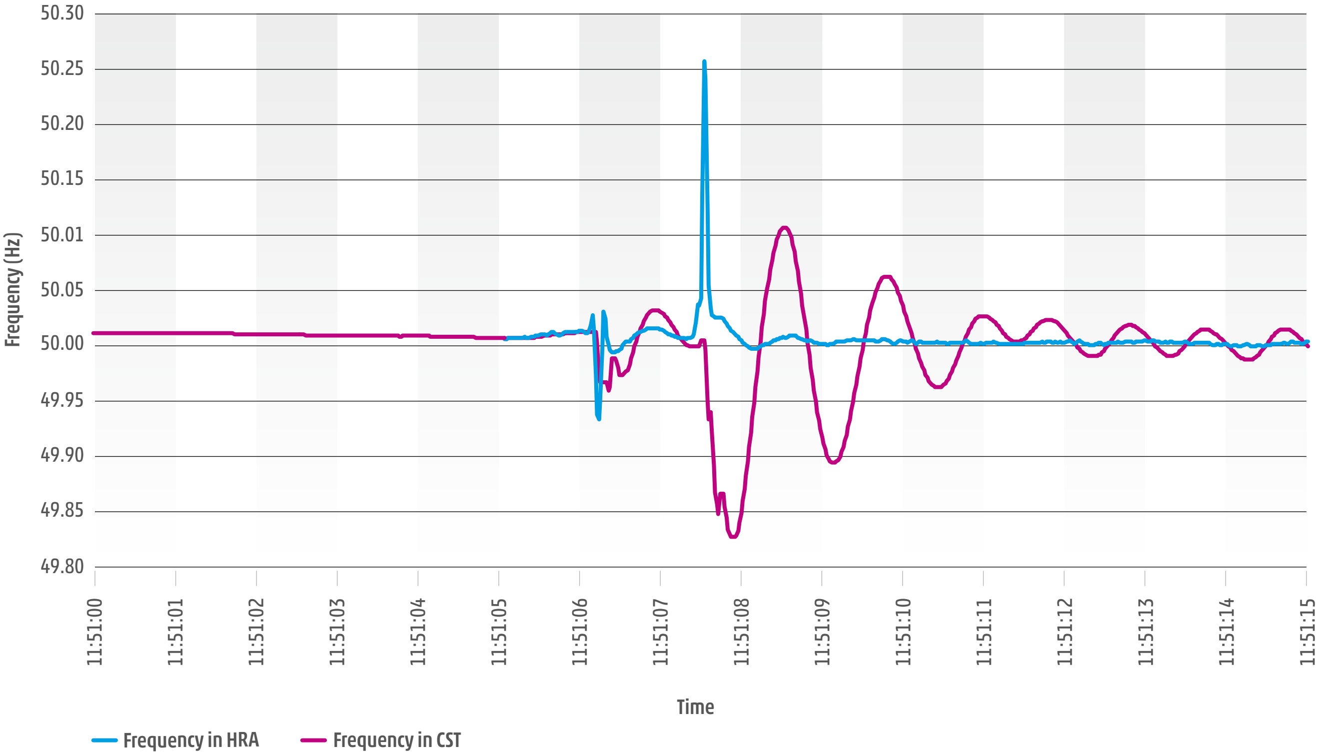


Figure 3.21: Zoomed-in view of the frequency profile during the V411 outage

From the V411 outage at 11:51 until the collapse of the affected part of the grid at 11:59, the frequency remained within normal operating limits.

As mentioned above, the WAMS measurement in the area affected by the voltage outage is installed at the Čechy Střed substation. The following course of the frequency collapse of the already-formed deficit island after the Krasíkov busbar coupler was switched off at 11:59:47 is also taken from this measurement.

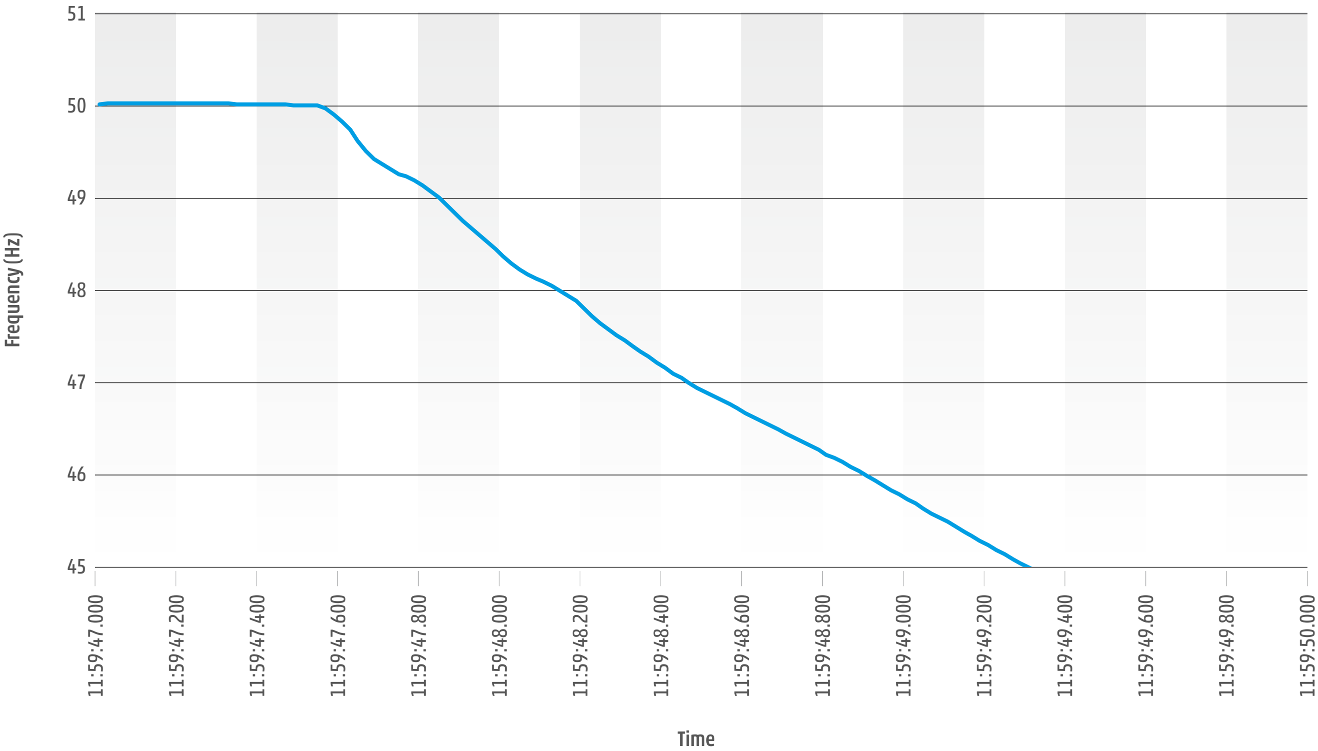


Figure 3.22: Recorded frequency collapse in the WAMS frequency measurement at the CST substation

Based on WAMS frequency measurements, the rate of change of frequency (RoCoF) value was also calculated as the mean value over a 500-ms interval. The RoCoF value during the frequency collapse is shown in Figure 3.23. The highest recorded RoCoF value was around −3.5 Hz/s.

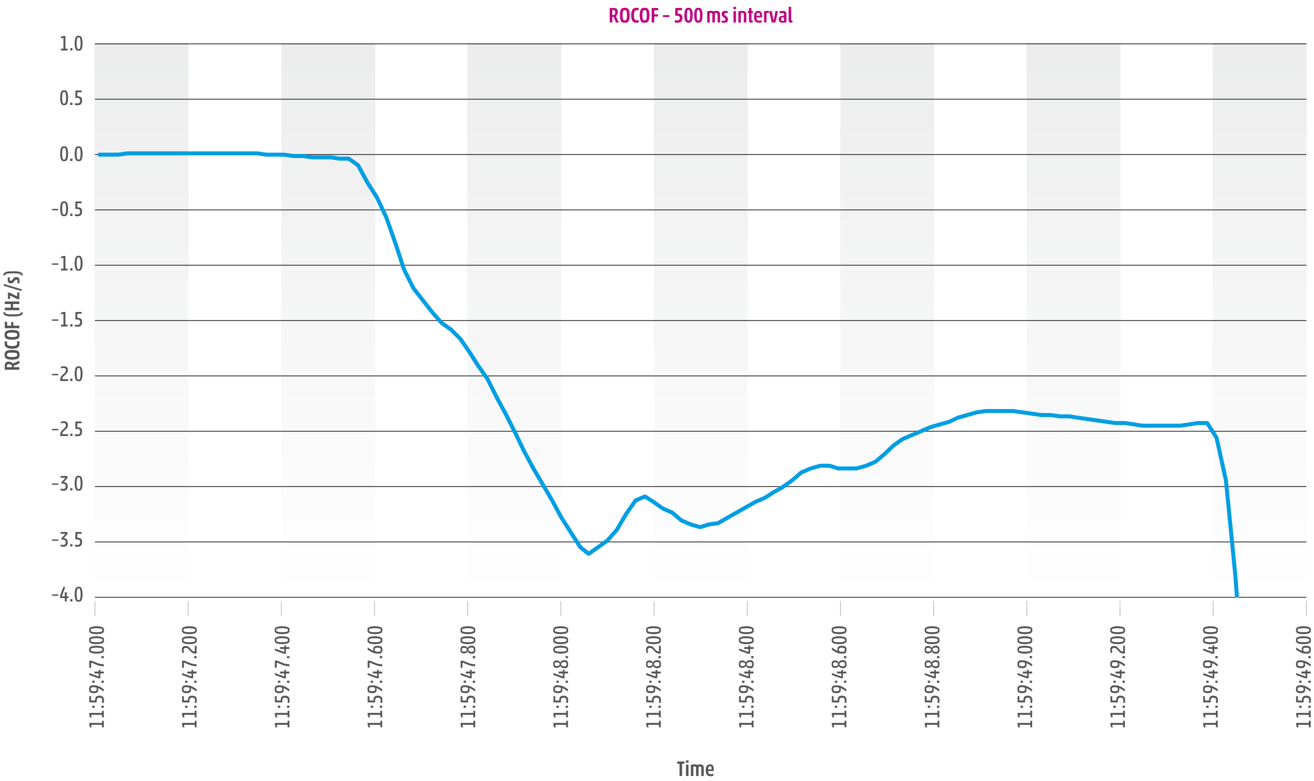


Figure 3.23: RoCoF profile during the frequency collapse

During the frequency collapse, all steps of the load frequency demand disconnection scheme were activated based on data from DSO. Overall, 766 MW of load was disconnected as part of the shedding process.

The LFDD scheme is implemented as a six-step system in accordance with the Commission Regulation (EU) 2017/2196.

Due to the high RoCoF value and the significant deficit of the resulting islanded operation – estimated at approximately 1,800 MW based on the power flow through the busbar coupler at the Krasíkov substation at the time of its disconnection – even the activation of LFDD was insufficient to prevent the final collapse. Figure 3.24 illustrates the expected activation sequence of individual LFDD steps.

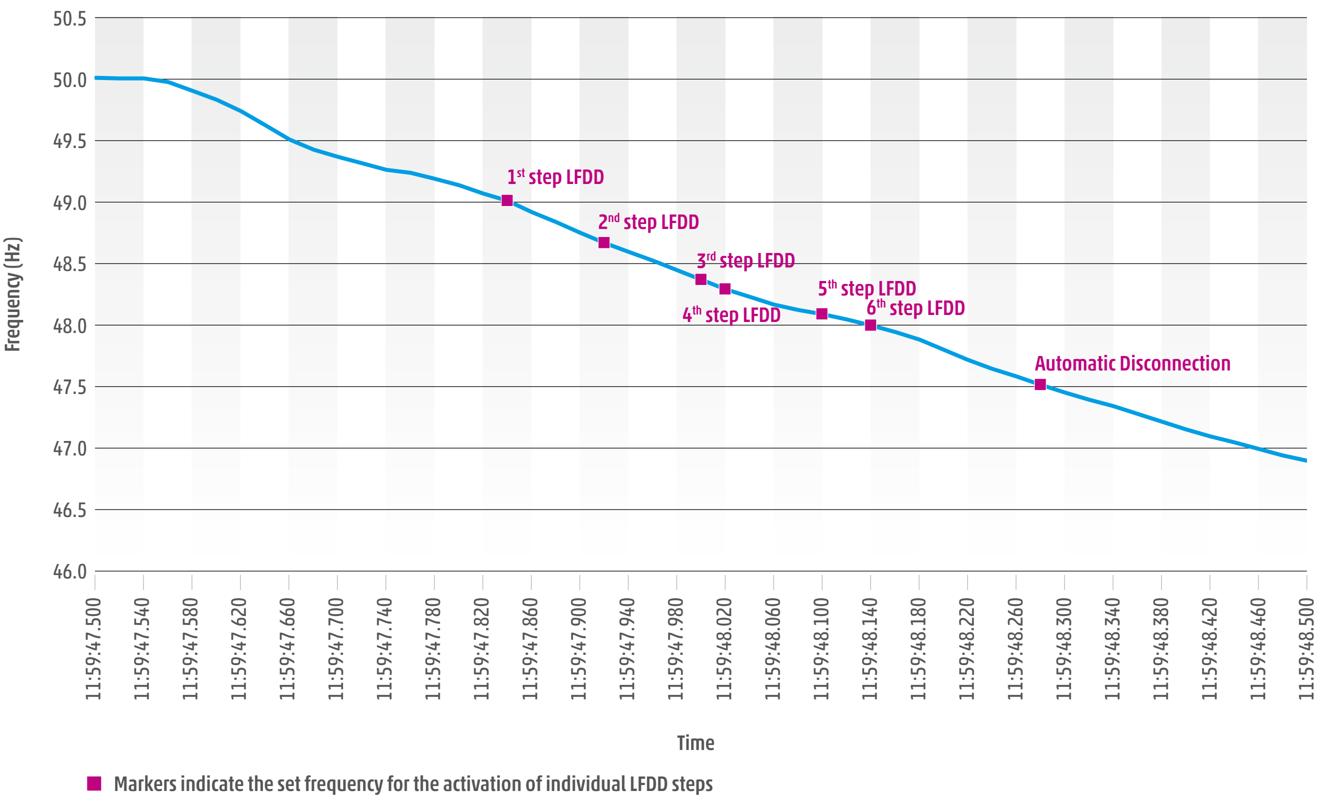


Figure 3.24: Frequency profile during the frequency collapse with indication of the set limits for LFDD steps

The graph clearly shows that due to the rapid frequency drop, there was insufficient time to activate all steps of LFDD. The time difference between reaching the frequency threshold for activating each step is as follows:

LFDD steps	Time difference (ms)	Total time to disconnection (ms)
1-2	80	440
2-3	80	360
3-4	20	280
4-5	80	260
5-6	40	180
6-disconnection	140	140

Table 3.6: The time intervals for reaching a set frequency level for the activation of individual LFDD steps during the frequency collapse

During the frequency collapse, the units connected to the transmission system were successfully switched to house-load operation in the affected part of the grid. Specifically, this concerns units 2 and 6 of TPP Počerady and unit 4 of TPP Chvaletice. The generator of Dlouhé stráně pump storage was disconnected from pumping mode.

The following table shows the measured voltage values at individual substations that were affected by the subsequent voltage outage, in one-minute intervals from 11:50 to 12:00. These are substations operating at the 400 kV and 220 kV voltage level.

Substation name (Busbar/line)	11:50	11:51	11:52	11:53	11:54	11:55	11:56	11:57	11:58	11:59	12:00
Babylon (W1)	415.3	415.1	415.0	409.8	412.1	414.8	413.1	415.4	413.8	415.2	0.0
Bezděčín (W1)	418.2	418.3	416.3	413.1	415.2	413.2	413.4	414.1	413.7	415.4	0.2
Chodov (W11)	415.6	415.6	415.6	415.6	416.0	415.6	409.4	409.0	409.5	410.3	0.0
Chotějovice (W11)	410.8	410.8	410.0	409.6	410.5	410.3	410.4	412.4	411.0	410.3	0.0
Čechy Střed (W1)	417.0	416.8	410.1	403.5	408.0	408.4	406.8	408.4	409.2	410.3	0.0
Krasíkov (W1)	415.5	416.4	396.6	389.7	389.6	390.3	389.2	392.3	392.5	391.6	385.0
Neznášov (W1)	418.8	418.8	415.8	415.8	414.8	416.0	415.3	416.6	415.3	414.8	0.0
Týnec (W1)	416.7	416.7	411.1	405.2	404.7	405.3	404.2	405.7	406.4	406.9	0.0
Výškov (V419)	411.6	411.6	413.1	410.7	412.6	410.6	410.9	410.9	413.2	412.9	0.0

Table 3.7: Measured voltage at impacted 400 kV substations from 11:50 to 12:00

Substation name (Busbar)	11:50	11:51	11:52	11:53	11:54	11:55	11:56	11:57	11:58	11:59	12:00
Bezděčín (W1)	231.6	231.6	222.7	218.5	219.6	217.7	218.6	217.9	218.4	218.7	0.1
Chotějovice (W1)	230.7	230.4	222.8	218.8	219.1	215.9	218.0	218.4	218.7	218.5	0.3
Čechy Střed (W3)	233.4	233.4	223.4	219.5	220.0	220.4	220.6	220.2	221.0	221.0	0.0
Malešice (W11)	234.3	234.1	224.2	222.4	221.9	221.1	221.6	223.0	223.2	222.7	0.0

Table 3.8: Measured voltage at impacted 220 kV substations from 11:50 to 12:00

Although the V411 outage caused a redistribution of power flows, leading to changes in voltage levels, no voltage deviations beyond the normal operating range were observed.

The lowest voltage values at the 400 kV level was consistently recorded at the Krasíkov substation, at around 390 kV.

3.5 Protection system performance during the event

Just as in any electrical system, the basic objectives that one aims to achieve with the design, setup and maintenance of a protection system in large interconnected power systems are to avoid dangerous situations for people, limit the damage to the components of the electrical system when an anomaly or failure occurs, minimise the consequences of the discontinuity of service in any network situation and mitigate the risk of transient instability in the transmission network. In this section, the operation of the protection system will be analysed using available data, primarily the SCADA event lists and the disturbance fault recordings (DFRs).

Sequence of events

All indicated times are GPS-based times from protections.
They might differ from the times indicated by SCADA in the rest of the report.

11:51:06.187

One subconductor from the bundled phase conductor of phase 2 of the line V411 broke and fell to the ground. The length of the line is 45.4 km.

Distance protection relays detected a fault 15 km from the HRA4 substation and 35 km from the VYS4 substation. The fault was ultimately located 14 km from the HRA4 substation. The fault was switched off in 81 ms.

Figure 3.25: Photo of the fallen conductor

11:51:06.268

The fault current flow to the affected phase of line V411 was interrupted by opening circuit breakers in phase 2 at both ends.

11:51:07.559

Following the unsuccessful automatic reclosing attempt, circuit breakers of the line V411 at the VYS4 and HRA4 substations were tripped in all phases. The protection system operated in accordance with its setting.

In the area of the future island, a loss of generated power occurred in both transmission- and distribution-connected systems.

11:59:44.066

Based on a manual command from the SCADA, issued by the dispatcher, the transmission line V208 was disconnected by opening a circuit breaker at the CST2 substation. Prior to the disconnection of line V208, current measurements exceeded the measuring transducer's range. The line loading must have exceeded 900 A. The line has a nominal ampacity of 650 A. Nevertheless, the mathematical dynamic line rating model (DLR) is applied. According to DLR, actual ampacity was Imax = 724 A. No protection relays of the line V208 operated, in accordance with their settings.

11:59:44.488

Overcurrent protection pickup in a busbar coupler at the KRA4 substation. The busbar coupler was connecting two busbars. Transmission line V401, together with the unit line to the Dlouhé stráně pump storage hydroelectric power plant (EDST), was connected to one of the busbars. The remaining two transmission lines were connected to the other busbar. The pump storage plant was operating in pumping mode. The overcurrent protection setting is 2,880 A, with an operating time delay of 3 s. The relay's drop-out ratio is 0.95. The nominal current of the busbar coupler is 2,000 A. The peak current during protection initiation was 2,810 A in phase L2, which falls within the manufacturer's specified tolerance of 5 % of the configured setting.

11:59:47.486

The overcurrent protection at the KRA4 substation issued a trip signal to the busbar coupler circuit breaker. At the time of tripping, the highest current was still 2,780 A. The overcurrent protection operated in accordance with its settings. The reason was an exceedance of the defined current limit of 2,880 A for a duration longer than 3 s. After the protection has been activated, the measured current must decrease to 0.95 times the set value, i.e., 0.95 × 2,880 = 2,736 A, to allow the time-delay element to reset and prevent tripping within the configured time. Since the feeder was still carrying a current of 2,780 A when the trip command was issued to the circuit breaker, the feeder was tripped.

11:59:47.534

The circuit breaker in the busbar coupler at the KRA4 substation was tripped in all three phases.

11:59:47.574

The distance protection of the T401 transformer at the KRA4 substation issued a trip signal. The T401KRA and T402KRA transformers were connected to different busbars on the primary side and were operating in parallel. After the busbar coupler on the primary side was tripped, current began to flow between the busbars through these transformers. The transformer T401 was overloaded, causing the measured impedance to enter the protected zone in the direction toward the transformer, where the distance protection operates without delay. The load encroachment setting is 20.3 Ohms, corresponding to a secondary-side current of 3,110 A at a measured voltage of 63.2 kV. Converted to the primary side via the T401KRA transformer with tap position 7 (400/133 kV), this equals 1,030 A. According to the fault recorder, which records current on the primary side, the current flowing through the transformer was 1,130 A. The nominal current of the transformer on the primary side is 505 A. The distance relay operated in accordance with its settings.

11:59:47.607

The T401KRA transformer was tripped in all three phases. **Islanding conditions were initiated.**

11:59:48.319

Dlouhé stráně (EDST) pump storage: Opening of the HG2 EDST generator circuit breaker. Disconnection of HG2 EDST from pumping mode. The tripping impulse was triggered by the frequency protection with a setting of 48.5 Hz and a delay of 0.1 s. This configuration represents the frequency protection of the motor generator in pumping mode. Although the frequency dropped below the activation threshold of other frequency protections set according to the defence plan, the frequency drop was so rapid that the preceding protection levels did not have time to activate.

Threshold value f [Hz]	Time delay t [s]	Function
>53.0	1	Trip of the HG
>52.1	60	Trip of the HG
<49.8	1	Controlled shutdown
<49.2	1	Trip of the HG
<48.5	0.1	Trip of the HG

Table 3.9: Setting of frequency protection for pumping mode for the pumped-storage Dlouhé stráně

11:59:49.346

Ledvice coal-fired power plant (ELED): The transfer trip command was received from the TG6 generator to the circuit breaker of the V016 unit line at CHT4. The tripping impulse was triggered by the frequency protection. When the frequency deviated by −2.5 Hz from the nominal value, it sent the impulse to trip the circuit breaker.

Threshold value f [Hz]	Time delay t [s]	Function
49.8	0	Island control mode
47.5	1	Trip to house-load operation

Table 3.10: Frequency protection setting for the Ledvice coal-fired power plant (ELED)

11:59:49.349

Chvaletice coal-fired power plant (ECHV): The transfer trip command was received from the TG4 generator to the circuit breaker of the V472 unit line at TYN4. The frequency protection triggered the tripping impulse. When the frequency deviated by −2.5 Hz from the nominal value, it sent the impulse to trip the circuit breaker.

Threshold value f [Hz]	Time delay t [s]	Function
53.0	6	Trip to house-load operation
53.0	30	Trip of the TG
50.2	0	Island control mode
49.8	0	Island control mode
47.5	1	Trip to house-load operation
46.5	30	Trip of the TG

Table 3.11: Frequency protection setting for the Chvaletice coal-fired power plant (ECHV)

11:59:49.349

Počerady coal-fired power plant: The transfer trip command was received from the TG2 generator to the circuit breaker of the V467 unit line at VYS4. The frequency protection triggered the tripping impulse. When the frequency deviated by −2.5 Hz from the nominal value, it sent the impulse to trip the circuit breaker, and the generator switched to supplying its own auxiliary supply.

Threshold value f [Hz]	Time delay t [s]	Function
53.0	6	Trip to house-load operation
50.2	0	Island control mode
49.8	0	Island control mode
47.5	1	Trip to house-load operation
47.0	1.5	Trip of the TG

Table 3.12: Frequency protection setting for the Počerady coal-fired power plant (EPOC) TG2

11:59:49.367

Počerady (EPOC) coal-fired power plant: The transfer trip command was received from the TG6 generator to the circuit breaker of the V469 unit line at VYS4. The frequency protection triggered the tripping impulse. When the frequency deviated by −2.5 Hz from the nominal value, it sent the impulse to trip the circuit breaker, and the generator switched to supplying its own auxiliary supply.

Threshold value f [Hz]	Time delay t [s]	Function
53.0	6	Trip to house-load operation
50.2	0	Island control mode
49.8	0	Island control mode
47.5	1	Trip to house-load operation
47.0	1.5	Trip of the TG

Table 3.13: Frequency protection setting for the Počerady coal-fired power plant (EPOC) TG6

11:59:49.374

The circuit breaker of the V016 line at CHT4 was tripped in all three phases.

11:59:49.397

The circuit breaker of the V472 line at TYN4 was tripped in all three phases. Successful transition of TG4 ECHV to house-load operation mode.

11:59:49.397

The circuit breaker of the V467 line at VYS4 was tripped in all three phases. Successful transition of TG2 EPOC to house-load operation mode.

11:59:49.414

The circuit breaker of the V469 line at VYS4 was tripped in all three phases. Successful transition of TG6 EPOC to house-load operation mode.

4 PRELIMINARY CAUSES OF THE INITIAL FAULTS

4.1 Technical reasons and information about V411 disconnection

On 4 July 2025 at 11:51:08, the V411 line failed due to an unsuccessful reconnection (automatic recloser) in phase L2. The cause was a phase conductor failure, specifically a break in one of the cables between towers 35 and 36 near the village of Kličín.

Based on the dispatcher's instructions, a walk-through inspection was conducted, which precisely localised the failure and its extent. Subsequently, emergency repairs were initiated and completed on the same day at 22:23. The line was handed back to dispatcher control at 23:00.

The repair included:

- removal of the damaged part of the original cable (installed in 1961);
- adding a new cable of the appropriate length;
- installation of two tensile couplings;
- replacement of damaged spacers.

The cause of the wire breakage was identified as a mechanical failure. The failure occurred at the tension coupling, which was installed during an emergency repair at the beginning of December 2024.

After this repair, the dismantled wire sample was sent to the Klokner Institute of the Czech Technical University for expert examination. The test results confirmed that the tested rope meets the tensile strength requirements, to the extent corresponding to a new wire.[12]

Both the mentioned repairs (December 2024 and July 2025) were carried out by renowned companies with many years of experience in the field of construction, reconstruction and restoration of lines.

A sample of the rope from the July 2025 failure was requested and submitted to the Czech Police for examination. When ČEPS received the examined material back, specifically the ends of the broken metal conductor equipped with a tensile coupling, it submitted it for further expert examination to a certified laboratory.

The Klokner Institute of the Czech Technical University confirmed the findings that the tensile coupling showed an insufficiently tight connection. The mechanical connection of the steel core of the rope was properly tight, but the connection of the aluminium part of the conductor was insufficiently tight, resulting in higher contact resistance. The heat generated by the electrical current affected the mechanical properties of the steel core during operation, which subsequently caused the rope to break and the conductor to fall.

Following the incident on 4 July 2025, an extraordinary aerial thermal imaging inspection of the V411 line was conducted. The detected defects were eliminated at the nearest planned line outage.

12 The results apply for the wire itself and are not necessarily applicable to the tensile coupling.

Figure 4.1: Photo of the tensile coupling

Figure 4.2: Photo of the end of the conductor

4.2 Information on generation disconnection

Following the tripping of line V411, a significant amount of generation was lost in the Czech system, mainly in the affected area, despite operational parameters – namely voltage and frequency – returning to normal values. In the minutes following the tripping of V411, the decrease in generation in the affected area continued, with a loss of transmission-connected unit 6 at the Ledvice power plant and unidentified distribution-connected generation. Chapter 3 discusses the disconnection of generation in detail. Unfortunately, the causes of distributed generation disconnection remain largely unknown due to missing data.

5 RESTORATION PROCESS

5.1 Restoration sequences

At 11:59:47, the busbar coupler at the Krasíkov 400 kV substation and the 400 kV/110 kV T401 transformer at the Krasíkov110 kV substation were tripped due to overloading. This led to the separation from the grid of eight 400 kV substations and three 220 kV substations. The IO was unbalanced and immediately collapsed.

Immediately after the incident, dispatchers initiated the top-down restoration strategy. They gathered information on the condition of the Počerady and Chvaletice power plants in the affected area, which remained in the house-load operation mode, with the aim of exploring all possible restoration options.

During the restoration process, the dispatcher is obliged to follow the internal procedure that has been created with respect to the possible physical phenomenon called ferroresonance.

This means dispatchers strictly follow the top-down restoration strategy: whenever they energise a busbar in a substation by reconnecting an OHL, they must switch a transformer and request connecting a load of approximately 15 MW at a 400 kV substation and 10 MW at a 220 kV substation.

At 12:19, the dispatcher reconnected the 400 kV OHL (Krasíkov–Týnec) V401 to restore voltage at the Týnec 400 kV substation, mainly to continue energising the rest of the affected substations. With the voltage on the busbars at the Týnec 400 kV substation, the dispatcher synchronised the Chvaletice unit 4 powerplant and energised other blocks' house load at 12:41.

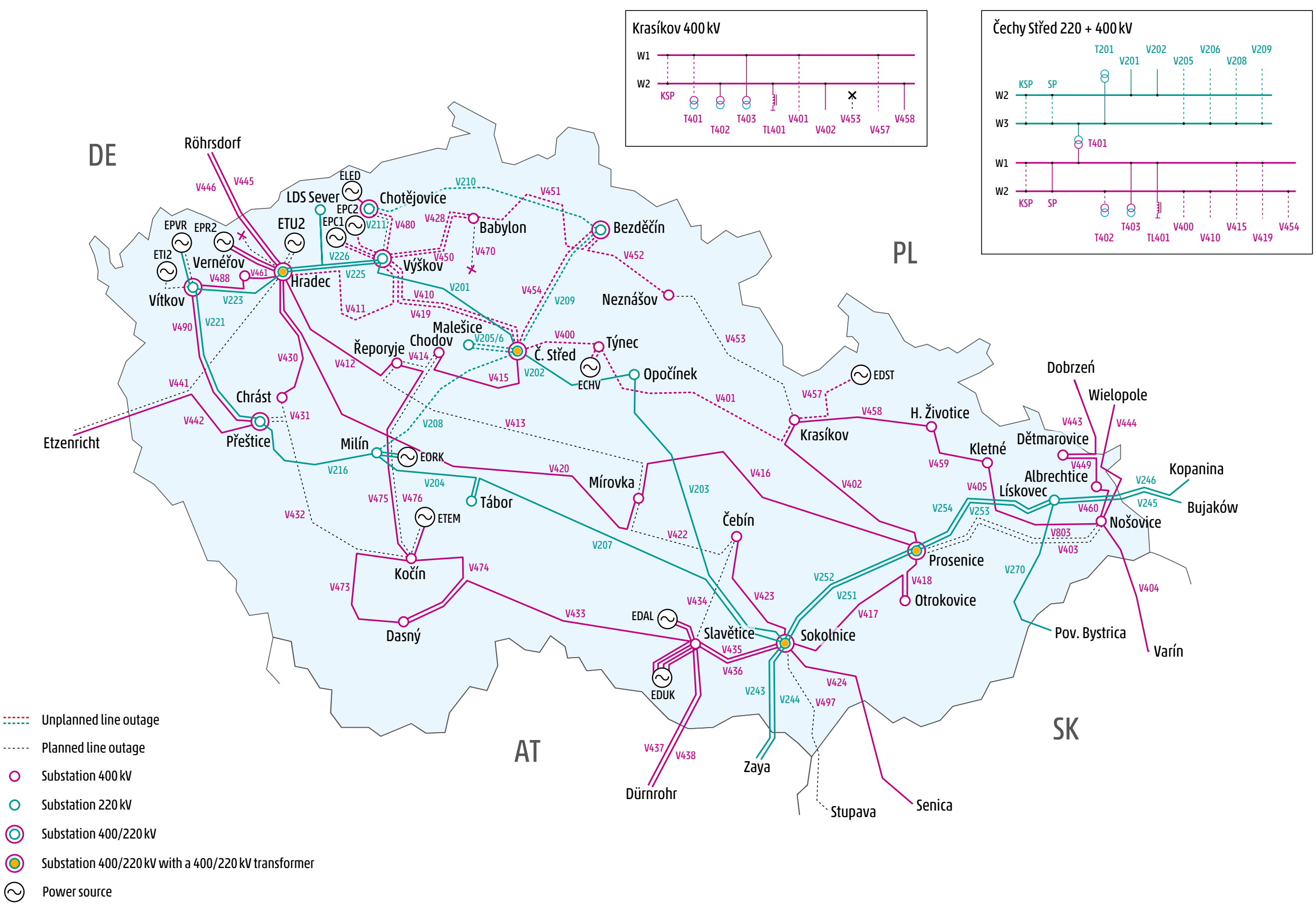


Figure 5.1: Situation of the Czech Republic transmission system on 4 July 2025 at 12:00

At 12:21, ČEPS operators received information about the instability of the house-load operation of the Počerady power plant. The power plant requested energising at least one 110 kV line to feed their consumption. The ČEPS operator ordered the operator of the 110 kV grid to set up a path from the Vernéřov 110 kV substation to the 110 kV substation of the Počerady power plant to secure the household load operation.

Simultaneously, dispatchers were restoring the voltage of the 220 kV grid. First, they coupled two main busbars in the Čechy Střed 220 kV substation, closing the busbar coupler that had been open after the reconfiguration implemented before the incident. Subsequently, the dispatcher reconnected the Milín–Čechy Střed 220 kV OHL V208. At 12:30, two 220 kV parallel OHLs V205/V206 (Čechy Střed–Malešice) were reconnected together with both 220 kV transformers in 220 kV Malešice substation to energise the Malešice110 kV substation to restore the load in Prague. Once the Čechy Střed 220 kV substation was energised, the dispatcher reconnected the Čechy Střed–Bezděčín 220 kV OHL V209 and then the Bezděčín–Chotějovice 220 kV OHL V210 to restore the load in this area.

At 12:51:22, the dispatcher reconnected the Týnec–Čechy Střed 400 kV OHL V400 and then switched on the 400 kV/110 kV T403 transformer to restore the load. At that time, the dispatchers had to decide whether it was better to have two isolated paths (first: Milín 220 kV substation–Milín–Čechy Střed 220 kV OHL V208–Čechy Střed 220 kV substation–Čechy Střed–Malešice 220 kV parallel OHLs V205/V206–Malešice 220 kV substation; second: Krasíkov 400 kV substation–Krasíkov–Týnec 400 kV OHL V401–Týnec–Čechy Střed 400 kV OHL V400–Čechy Střed–Chodov 400 kV OHL V415 or couple them. They decided to secure the restoration of the load in Prague by coupling the two paths. Therefore, at 12:57, dispatchers reconnected the 400 kV/220 kV transformer, connecting the Čechy Střed 400 and 220 kV substation.

At 13:01, the dispatcher reconnected the Čechy Střed–Chodov 400 OHL V415 to energise the busbars in the Chodov GIS 400 kV substation. Subsequently, in cooperation with the DSO, they energised two 400 kV/110 kV transformers (T401 and T403) to restore the load in Prague.

At 13:11, the dispatcher reconnected the Čechy Střed–Výškov 400 kV OHL V419, and one busbar at the Výškov 400 kV substation was energised for the possibility of synchronising units 2 and 6 of the Počerady thermal power plant, which remained in house-load operation. After a short break needed for stabilisation at the Počerady power plant, the dispatcher closed the circuit breaker on the Výškov–Počerady 400 kV line V467 and synchronised unit 2 to the grid.

At 13:24, the dispatcher reconnected the Čechy Střed–Bezděčín 400 kV OHL V454, and at 13:35, the transformer at the Bezděčín 400 kV substation to restore the load.

At 13:30, the dispatcher energised the second busbar at the Výškov 400 kV substation. At 13:38, the dispatcher energised the T401 transformer at the 400 kV Výškov substation.

At 13:42, the dispatcher implemented a reconfiguration at the Čechy Střed 220 kV substation, separating its two nodes to prevent N-1 violation, especially on the 220 kV OHL V201 (Výškov–Čechy Střed, 114 % N-1 violation) and the 400 kV/220 kV transformer T402 at the Hradec substation (115 % N-1 violation).

At 13:50, the dispatcher reconnected the Výškov–Chotějovice 400 kV OHL V480 and then the 400 kV/110 kV transformer T402 at the Chotějovice substation. At 13:53, the dispatcher switched on the Chotějovice–Ledvice 400 kV line V016 to energise the house load of unit 6 of TPP Ledvice.

At 13:56, the dispatcher reconnected the Výškov–Babylon 400 kV OHL V428. There was a technical problem causing the unavailability of the remote control at the Babylon 110 kV substation from the DSO's control room. Therefore, the ČEPS dispatcher could not continue switching operations to energise transformers at the Babylon 400 kV substation.

At 14:05, the dispatcher closed the busbar coupler at the Čechy Střed 400 kV substation to energise the second busbar and the variable shunt reactor connected to this busbar.

At 14:09, the dispatcher reconnected the Bezděčín–Neznašov 400 kV OHL V452, which led to energising the busbars at the Neznašov 400 kV substation. Subsequently, the dispatcher energised the T402 transformer at the Neznašov substation.

By 14:09, all 400 kV and 220 kV substations in the affected area were energised.

At 14:12, the dispatcher reconnected the Babylon–Bezděčín 400 kV OHL V451.

At 14:16, the dispatcher closed the circuit breaker on the 400 kV line V468 at the Výškov substation to energise the house load of CCGT Počerady 2, with the aim of starting as soon as possible.

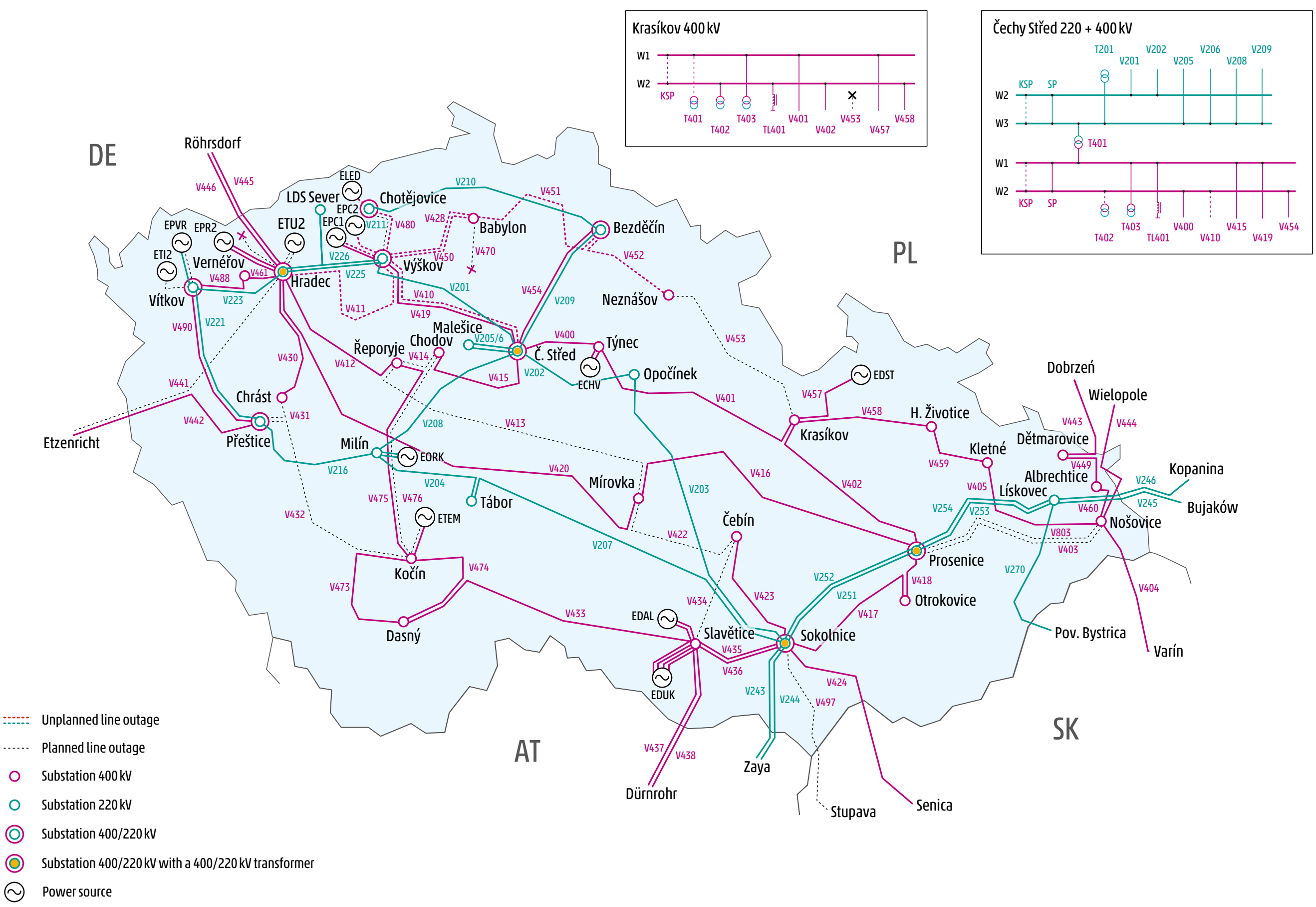


Figure 5.2: Situation of the Czech Republic transmission system on 4 July 2025 at 13:30

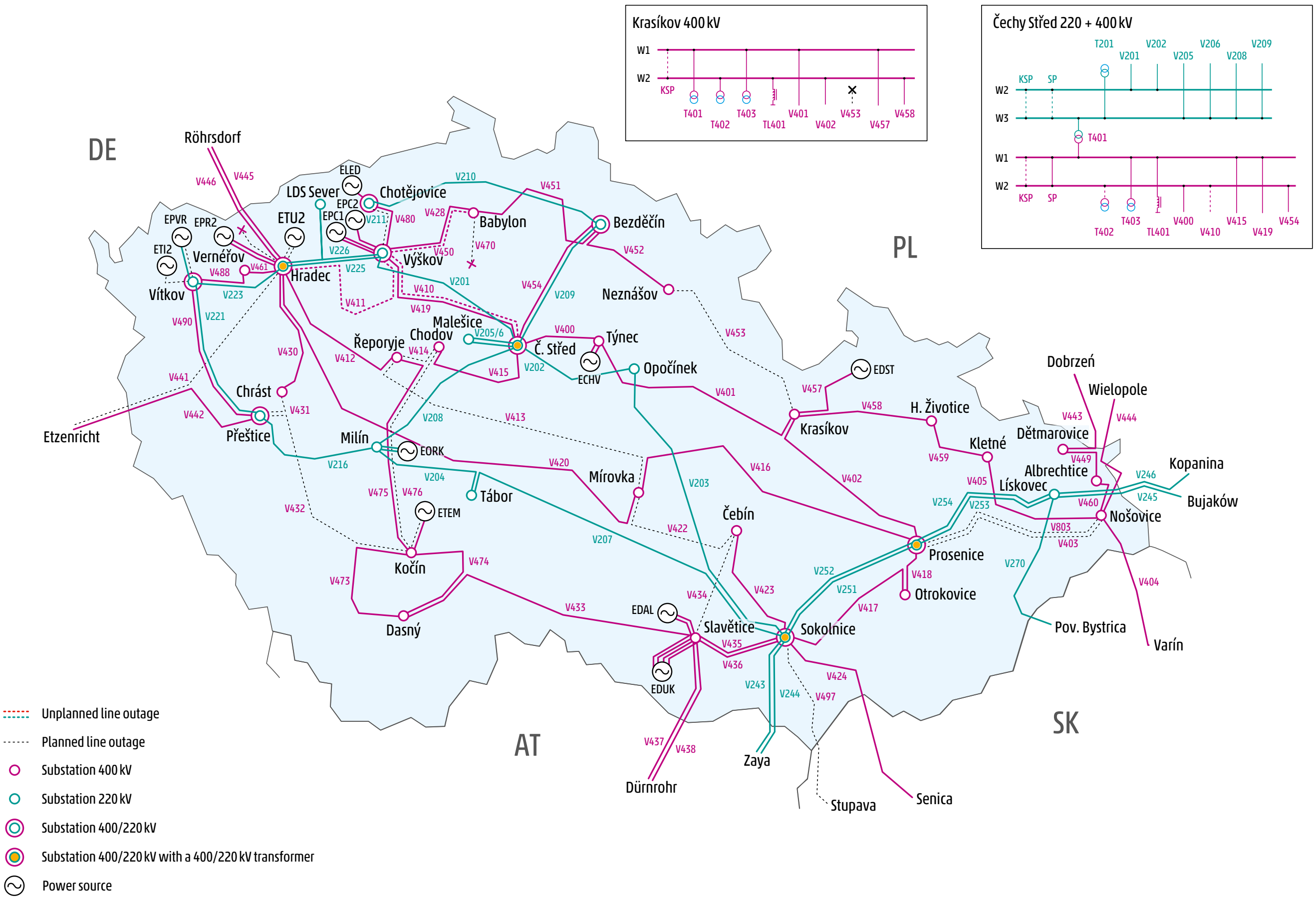


Figure 5.3: Situation in the Czech Republic transmission system on 4 July 2025 at 15:10

At 14:20, the dispatcher obtained information that CCGT Počerady 2 would be able to synchronise around 15:00.

At 14:20, the dispatcher ordered the DSOs to stop connecting new loads until the start of CCGT Počerady 2. The reason was a very high N-1 violation (up to 180 %) on the 220 kV line V208.

At 14:40, the dispatcher switched on the T401 transformer at the Krasíkov 400 kV substation.

At 15:00, the ČEPS crisis team commenced its meeting.

At 15:10, the DSO for the northern part of the Czech Republic fixed the technical issue with the control of the 110 kV Babylon substation, so dispatchers switched on both transformers there.

At 15:37, the dispatcher switched on the 400 kV/110 kV transformer T402 at the Bezděčín substation.

At 17:35, the dispatcher obtained information from DSOs that the load was fully restored.

At 23:00, the repair of the broken conductor on the OHL V411 was completed; therefore, the dispatcher could initiate its switching on.

At 23:13, the Hradec–Výškov 400 kV OHL V411 was reconnected.

5.2 Communication and coordination during the restoration process

Immediately after the outage, all area dispatchers made several phone calls to exchange and share information with DSOs and power plants. As far as they had complex knowledge of the situation, they defined the restoration strategy and set the critical situation message in EAS, together with the change to the Emergency state. Subsequently, dispatchers made more than 200 phone calls, mainly to DSOs and power plants, throughout the restoration process.

The dispatchers were regularly in touch with the synchronous area monitor Amprion, TSCNET and with neighbouring TSOs. At 12:05, Amprion contacted the ČEPS control centre regarding the significant deficit in the ČEPS control area.

They received information about the incident in the grid and the ongoing restoration process. At 12:30, the operator of TSCNET contacted the control centre of ČEPS with a question about the change of system state to Emergency. He was informed about the significant outage in the Czech transmission system.

At 13:22 and 14:23, Amprion received updates on the status of restoration, the cause of the incident, and the status of the unaffected part of the system, including the supply to the NPP's house load. The NPP's house load supply was not affected by the incident. At 17:50, the ČEPS operator informed TSCNET of the completed grid restoration and preparedness for the DACF process. He explained that the line V411 would be operational in the next few hours.

5.3 Generation recovery actions

At 12:21, ČEPS operators received information about instability in the house-load operation of the Počerady power plant. They requested energising of at least one 110 kV line to feed their consumption. The ČEPS operator ordered the operator of the 110 kV grid to establish a path from the Vernéřov 110 kV substation to the 110 kV substation of the Počerady power plant to secure household load operation. At 12:51, the dispatcher obtained information about the secured supply of the house load of the Počerady power plant from the 110 kV grid (supplied from the Vernéřov110 kV substation), resulting in a prolonged time in this house-load operation mode.

With energisation of the busbars at the Týnec 400 kV substation, the dispatcher planned to synchronise unit 4 of the Chvaletice power plant. There was a minor misunderstanding due to the interpretation of the state of this block in the dispatcher's SCADA, but after reaching a common agreement with the Chvaletice operator on the unit's actual state, the dispatcher successfully synchronised unit 4 to the grid at 12:41.

At 12:45:36, the dispatcher reconnected the 400 kV OHL (Krasíkov–Dlouhé Stráně) to energise the Dlouhé Stráně 400 kV substation and the pump storage's house load.

At 12:46:35, the dispatcher closed the circuit breaker of the 400 kV OHL V471 (Týnec–Chvaletice units 1 and 2) to energise its house load and be ready to synchronise the generator to the grid and support the restoration of load in the affected area.

At 13:01, the dispatcher inquired about the real state of unit 4 at the Chvaletice thermal power plant, and at 13:06 ordered unit 4 to switch from droop speed control mode to power control mode and started ramping up from 5 MW to 100 MW. At 13:18, the dispatcher ordered the unit 4 operator to manually lower the generator's excitation due to a fault in the automatic voltage control signalised in SCADA. At 13:27, unit 4 reached 100 MW.

In cooperation with the operator of the Počerady thermal power plant, the dispatcher synchronised unit 2 to the grid at 13:26. The dispatcher was informed of technical problems with the system for transporting coal to the boiler, Therefore, unit 2's available power was limited to 120 MW at that time. The dispatcher ordered the unit 2 operator to switch the turbine controller from droop speed control to power control and the excitation controller to automatic voltage control.

At 13:29, the dispatcher inquired with the operator of TPP Chvaletice about the time required for starting and ramping another unit. The operator of TPP Chvaletice replied that it takes at least 4 h, so Unit 2 and Unit 1 could be synchronised at 17.30. He promised that they would try to speed it up.

At 13:37, the operator of the ČEZ generation control centre requested synchronisation of the pump storages at Dlouhé stráně and Dalešice. The ČEPS dispatcher rejected the Dlouhé stráně power plant's pumping mode because it would have affected the affected area.

At 13:41, the dispatcher inquired about other possibilities for increasing power in the area of the Výškov and Chotějovice substations. The operator of the ČEZ control centre replied that unit 4 of TPP Ledvice (connected to DS) would be able to synchronise in 4 h, unit 6 of TPP Ledvice in 6 h, and CCTG Počerady 2 would be able to start in 1 h.

At 13:45, the dispatcher synchronised unit 6 of TPP Počerady to the grid in cooperation with the operator of TPP and requested switching the turbine controller from droop speed control mode to power control mode, and the excitation controller to automatic voltage control.

At 13:50, the dispatcher ordered the operator of TPP Počerady to increase the power on units 2 and 6 up to 120 MW, the maximum available power due to constraints on coal transportation.

At 14:14, TPP Počerady units 2 and 6 reached 120 MW each.

At 15:13, the operator of TPP Počerady offered to increase unit 6's power. The limitation on the power was no longer valid, as they had repaired the system for transporting coal, but they faced another issue with the desulfurisation system. The dispatcher decided not to increase power without desulfurisation at that time because the imminent synchronisation of the Počerady 2 CCTG was announced.

At 15:18, unit 21 of CCGT Počerady 2 (gas turbine) synchronised to the grid.

At 15:23, unit 22 of CCGT Počerady 2 (gas turbine) synchronised to the grid.

At 16:12, unit 20 of CCGT Počerady 2 (steam turbine) synchronised to the grid.

At 16:32, unit 4 of TPP Ledvice announced the ongoing preparation for synchronisation.

At 16:58, the dispatcher cancelled the ban on pumping of the Dlouhé Stráně power plant. At 17:07, Dlouhé Stráně started pumping.

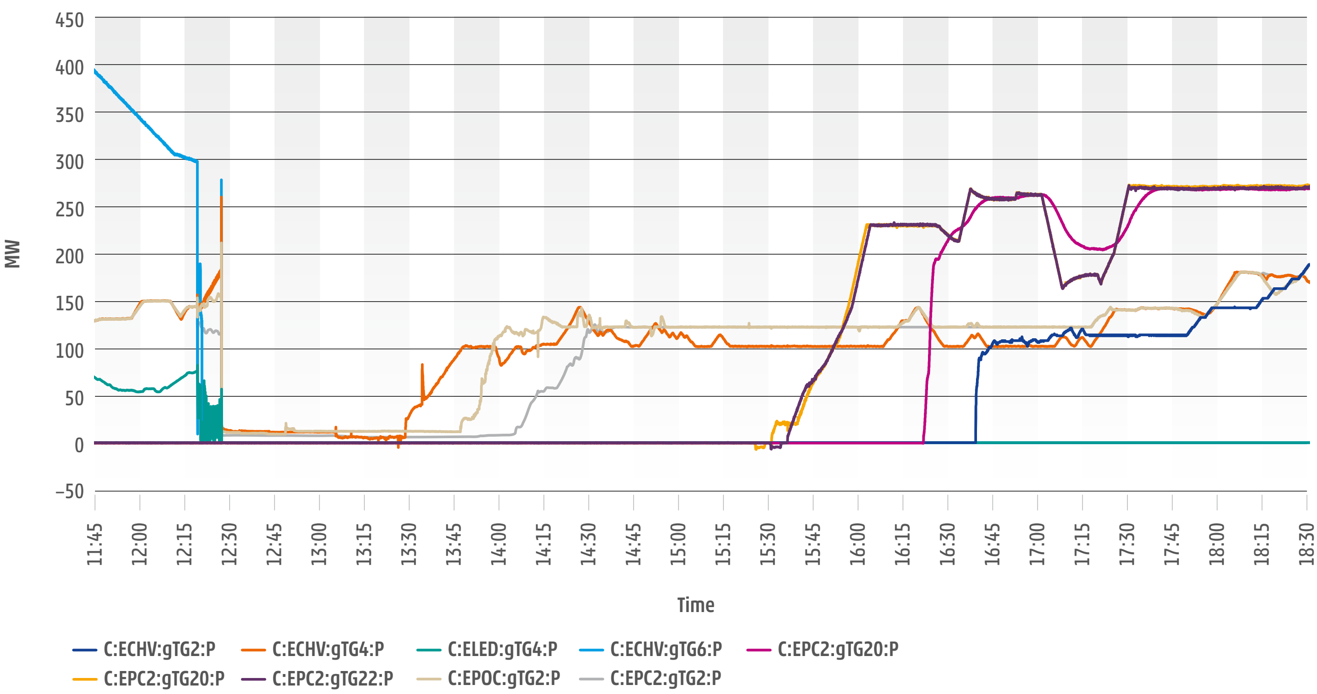


Figure 5.4: Active power output of generating units

5.4 Load recovery actions

The restoration of the load began in a DSO–TSO cooperative effort immediately after the incident.

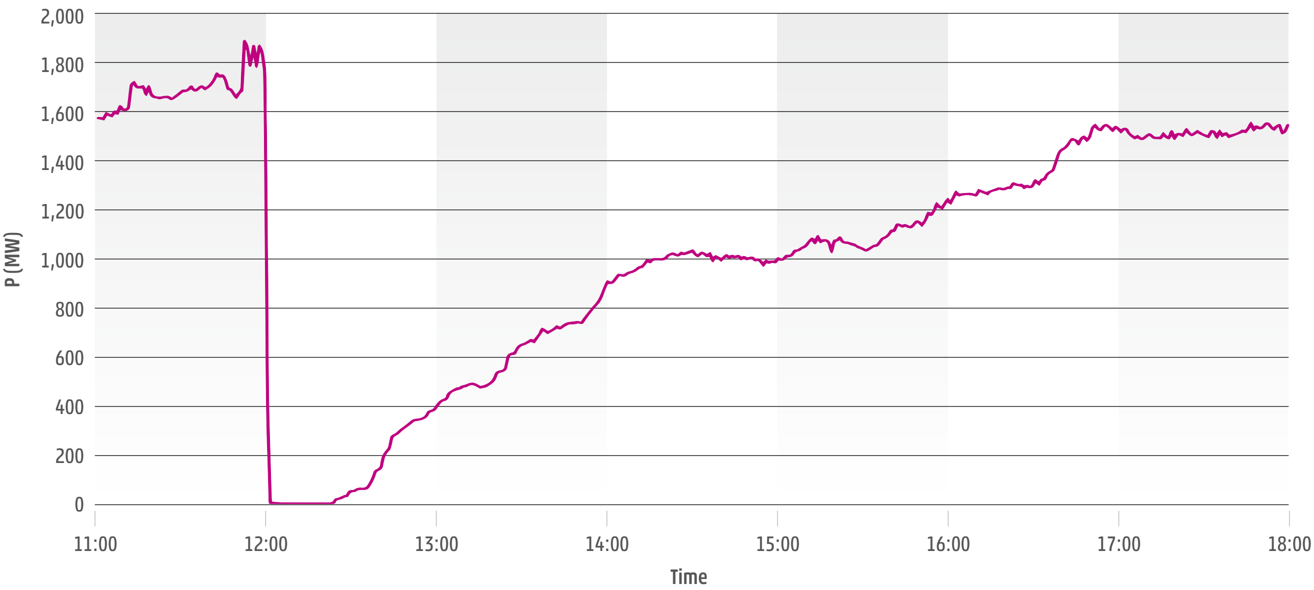


Figure 5.5: Load restoration

Krasíkov

The consumption of the T401 and T402 400 kV/110 kV transformers was not affected by the incident since they were coupled at the 110 kV substation. After the outage of the T401 transformer all the consumption was supplied by the T402 transformer.

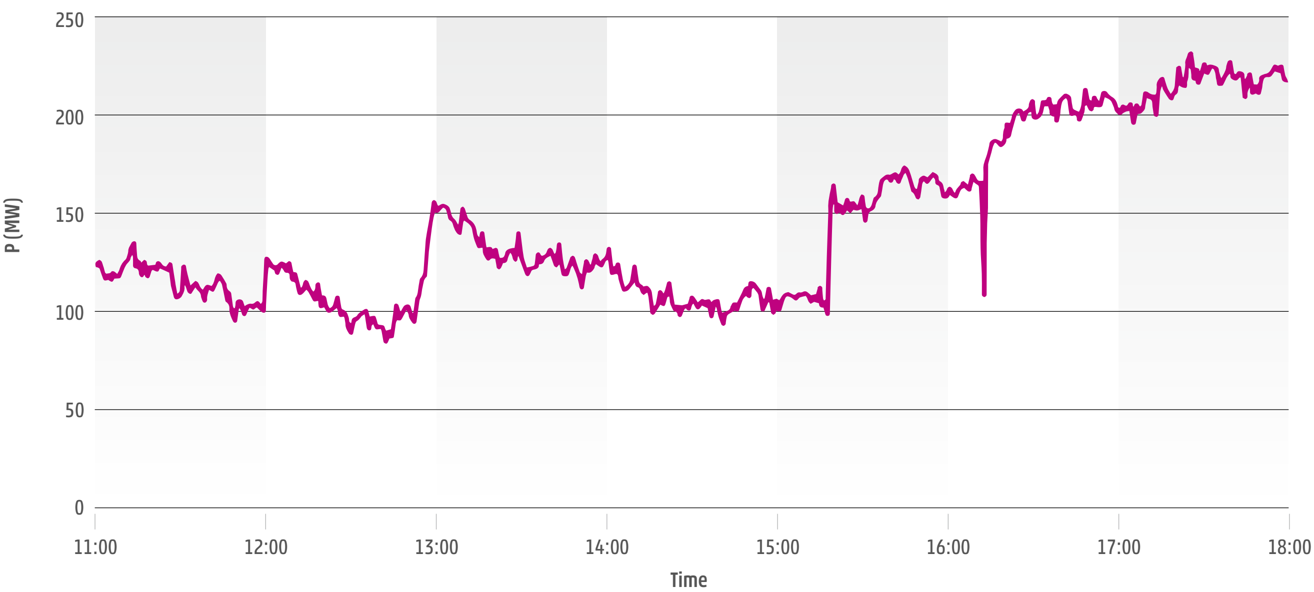


Figure 5.6: Load restoration of the T401 and T402 400 kV/110 kV transformers

The T403 400 kV/110 kV transformer was connected to the affected busbar of the Krasíkov 400 kV substation. Therefore, the 110 kV area connected to this transformer was without voltage after the incident.

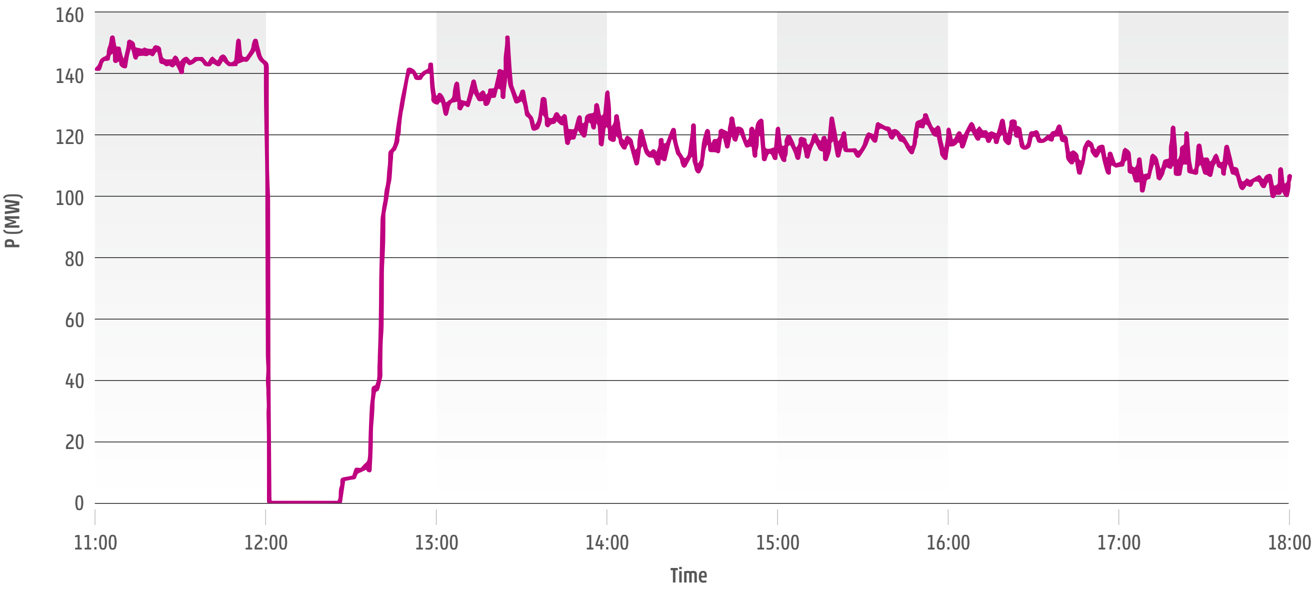


Figure 5.7: Load restoration of the T403KRA 400 kV/110 kV transformer

Týnec

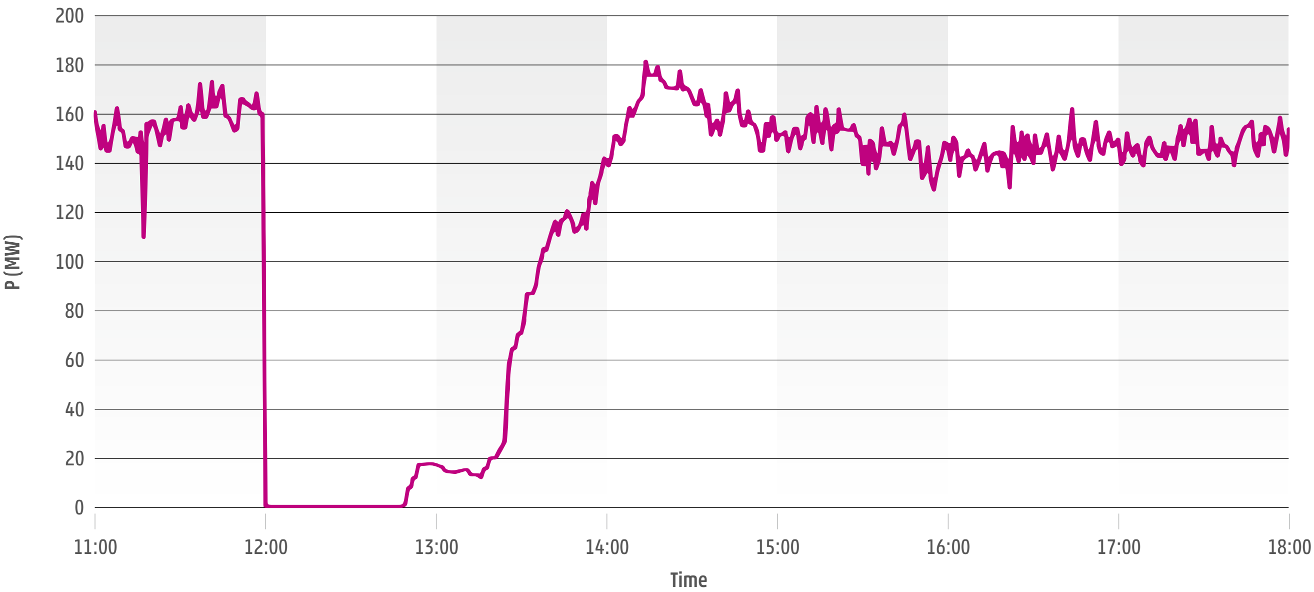


Figure 5.8: Load restoration of the T401TYN and T403TYN 400 kV/110 kV transformers

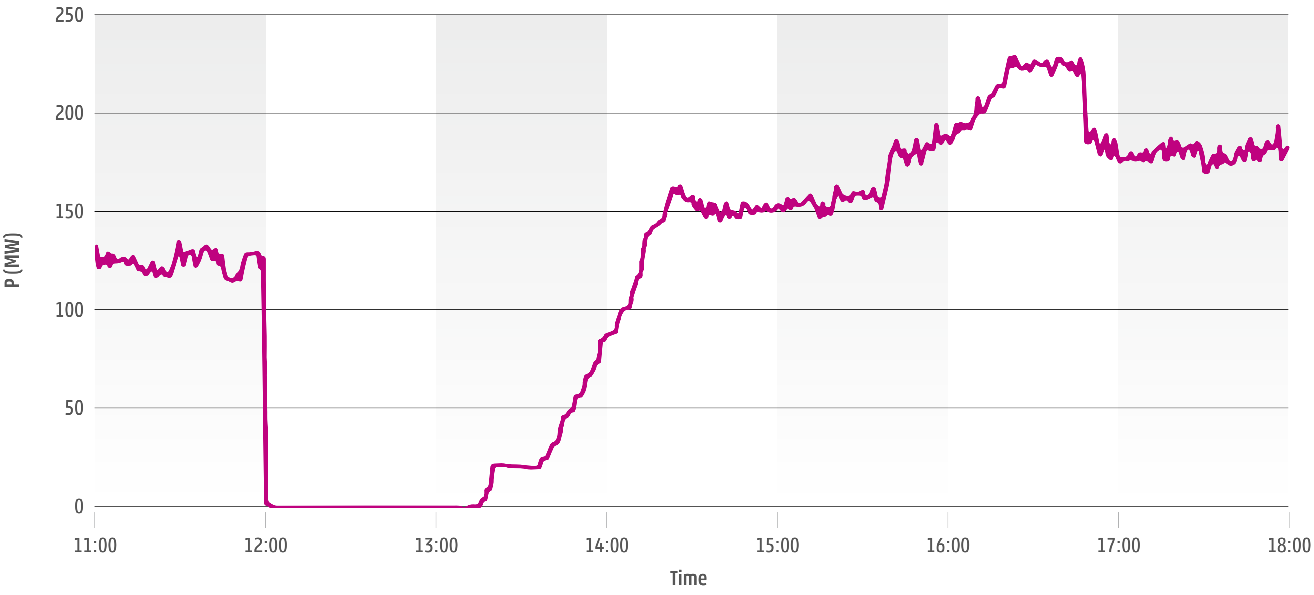


Figure 5.9: Load restoration of the T403CST 400 kV/110 kV transformer

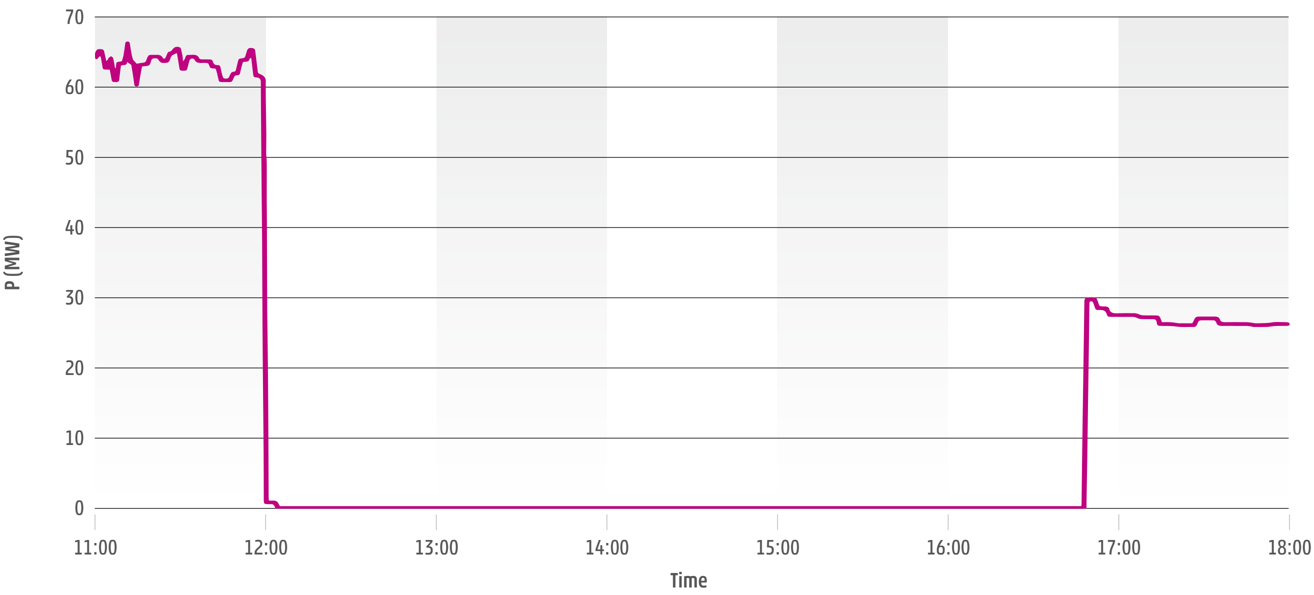


Figure 5.10: Load restoration of the T201CST 220 kV/110 kV transformer

Malešice

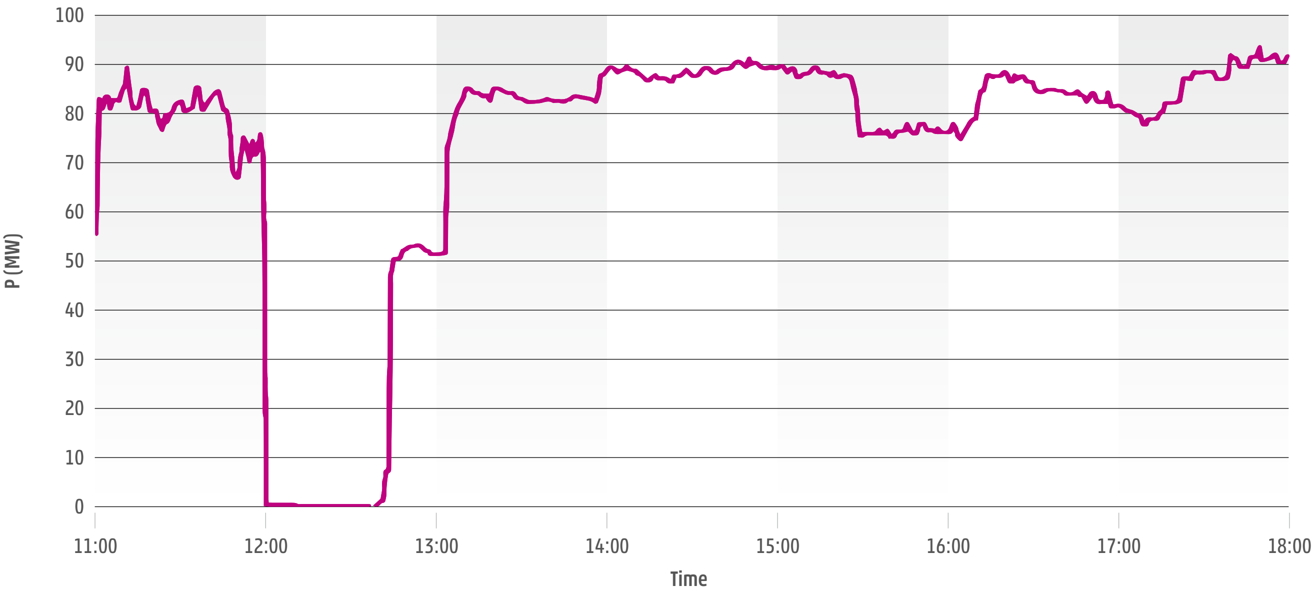


Figure 5.11: Load restoration of the T201MAL and T202MAL 220 kV/110 kV transformers

Chodov

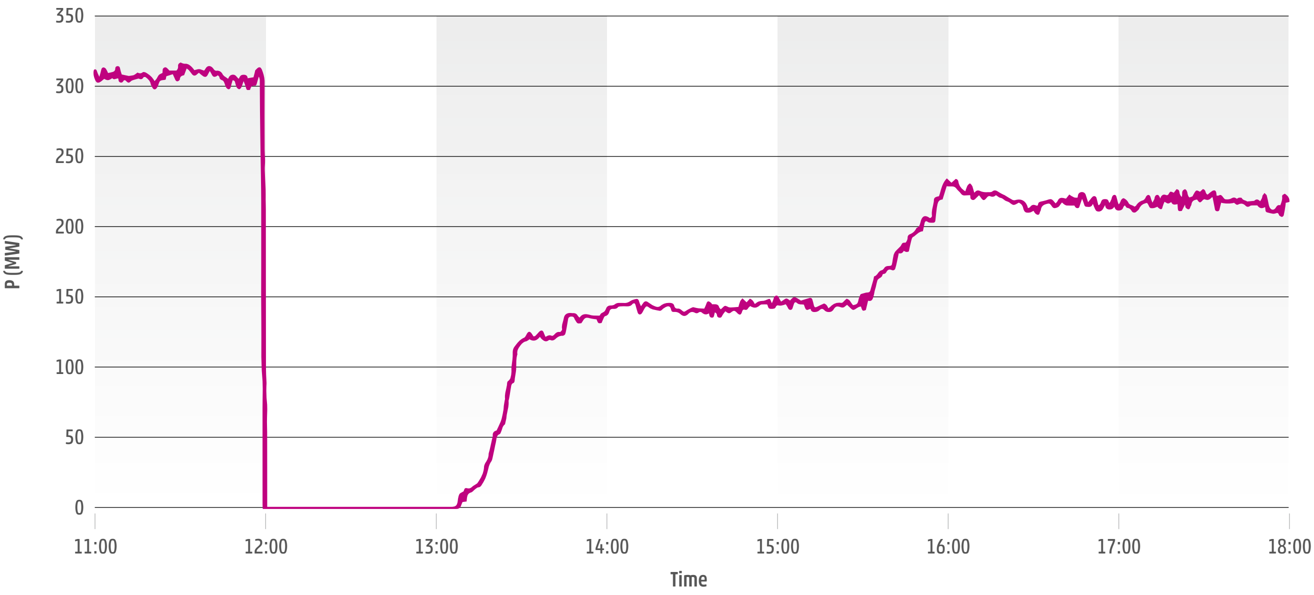


Figure 5.12: Load restoration of the T401CHD and T403CHD 400 kV/110 kV transformers

Výškov

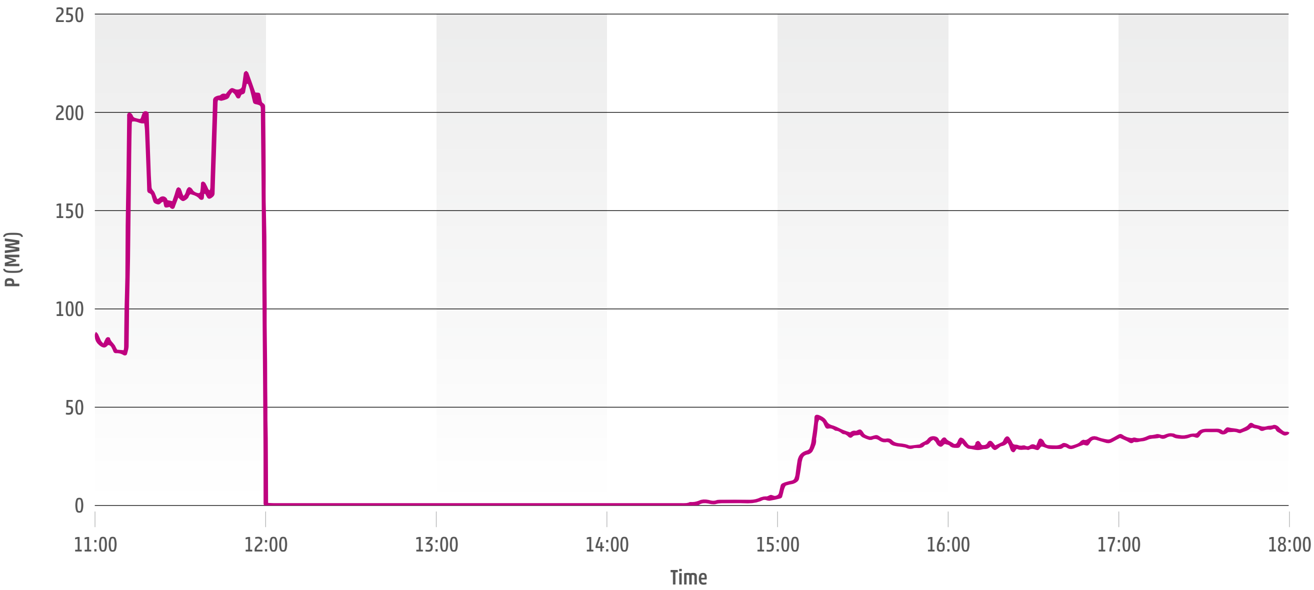


Figure 5.13: Load restoration of the T401VYS 400 kV/110 kV transformer

Chotějovice

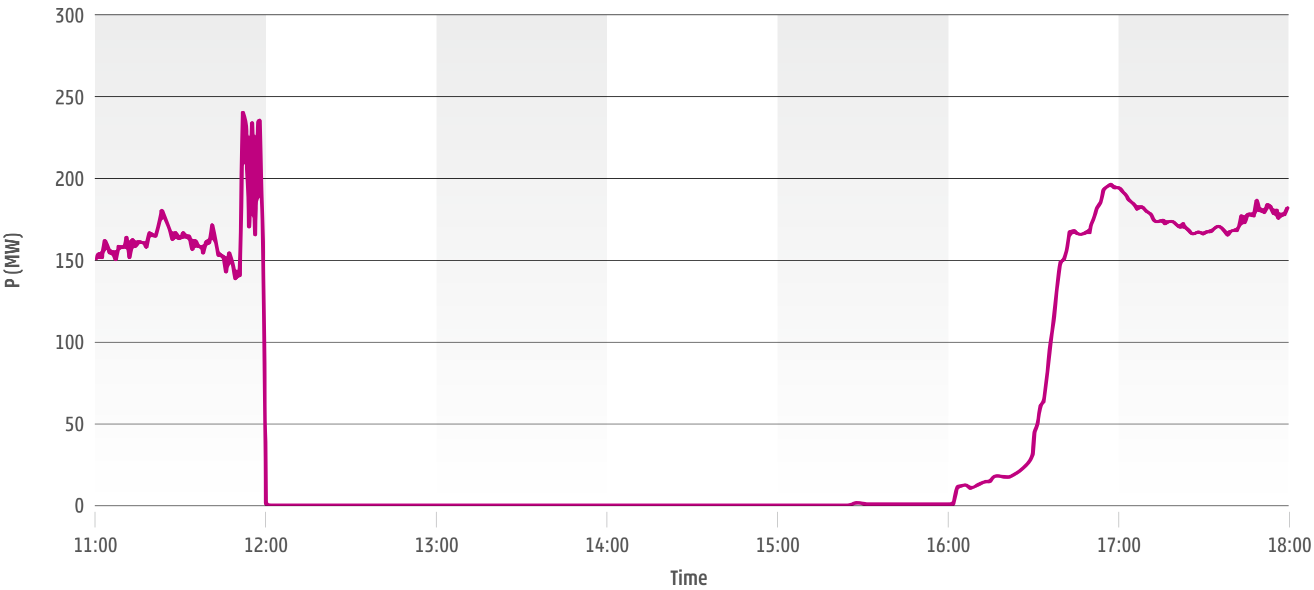


Figure 5.14: Load restoration of the T402CHT 400 kV/110 kV transformer

Babylon

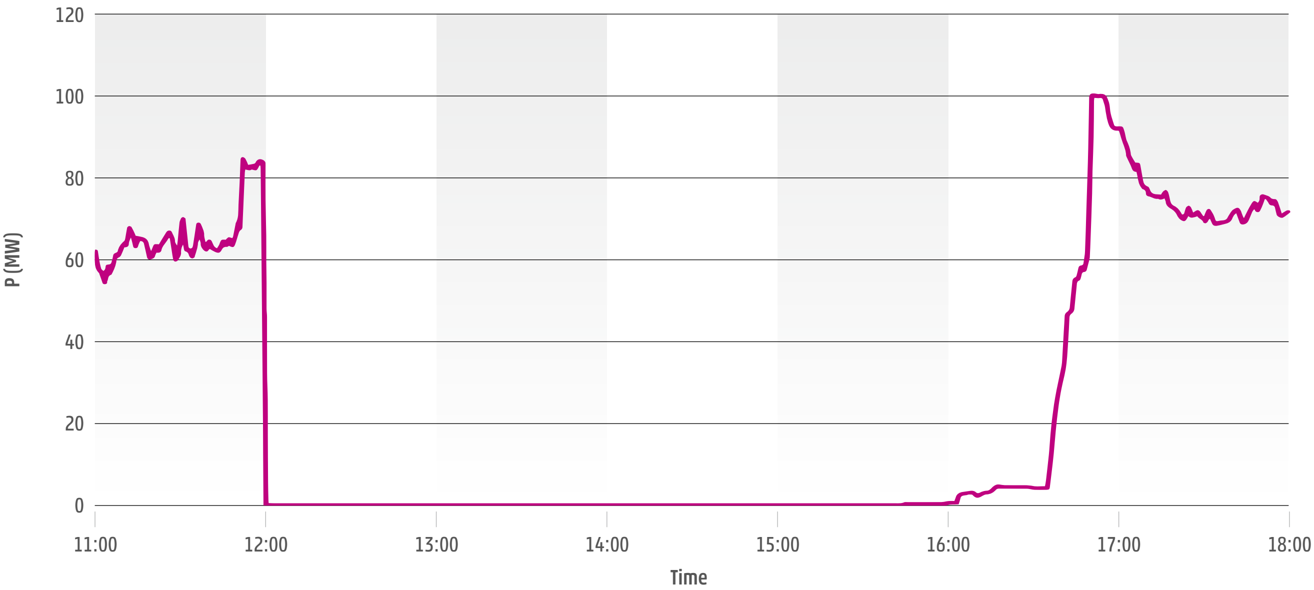


Figure 5.15: Load restoration of the T402BAB and T403BAB 400 kV/110 kV transformers

Bezděčín

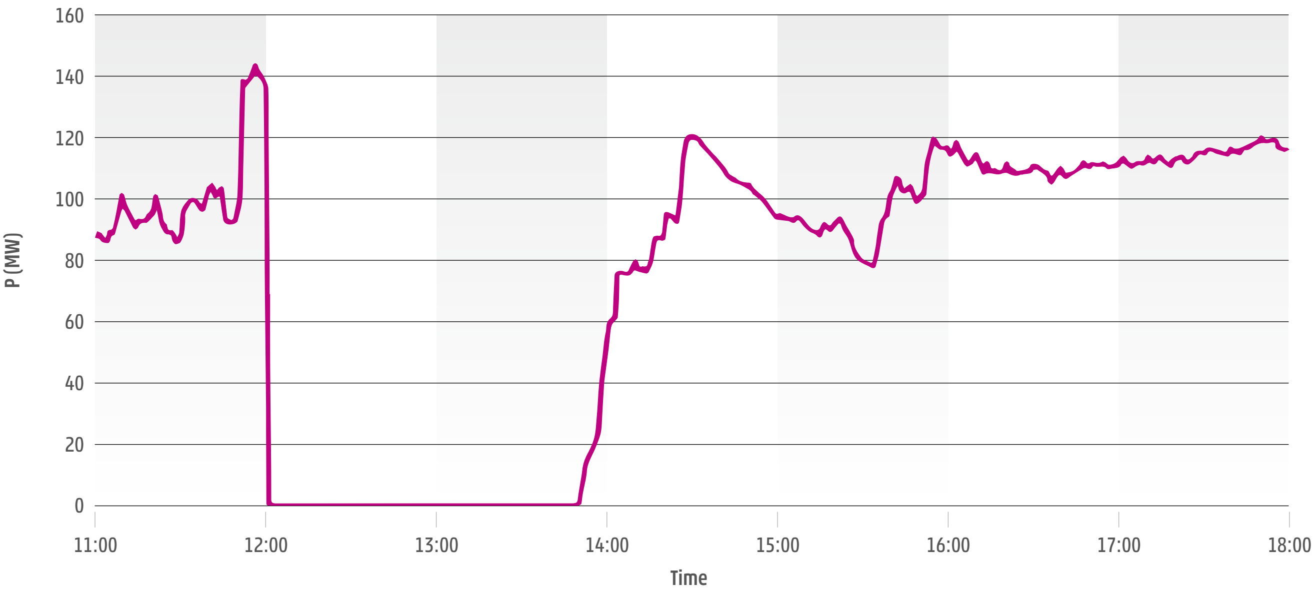


Figure 5.16: Load restoration of the T401BEZ 400 kV/110 kV transformer

Řeporyje

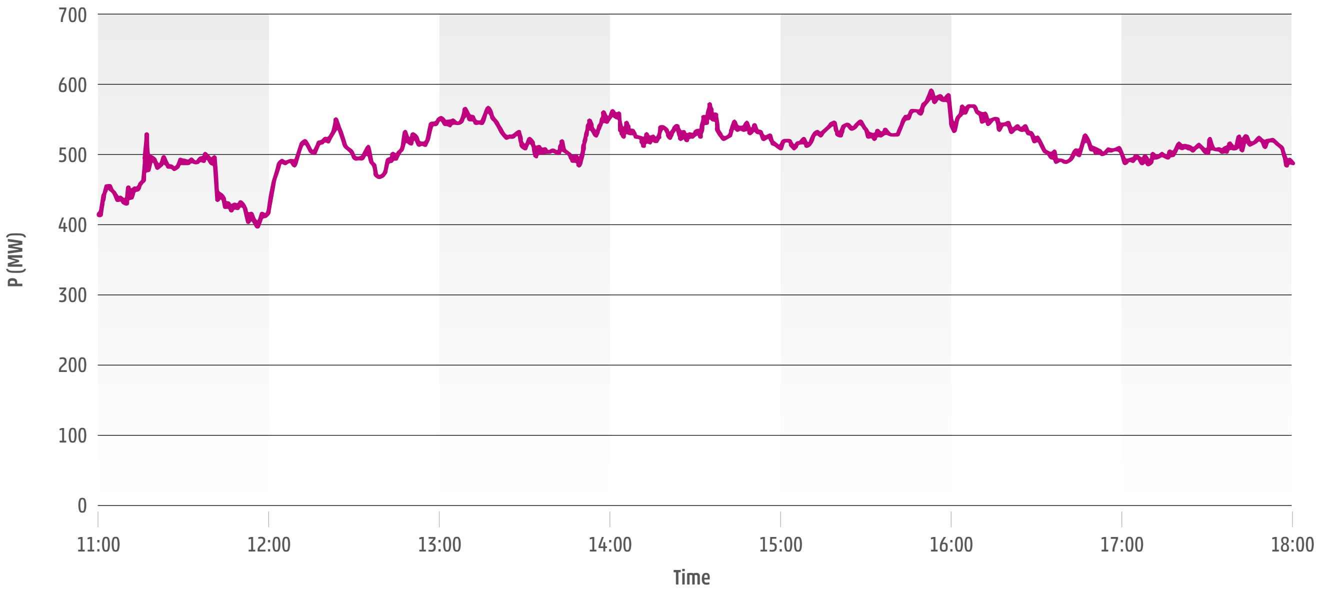


Figure 5.17: Load restoration of the T401REP, T403REP and T404REP 400 kV/110 kV transformers

Vernéřov

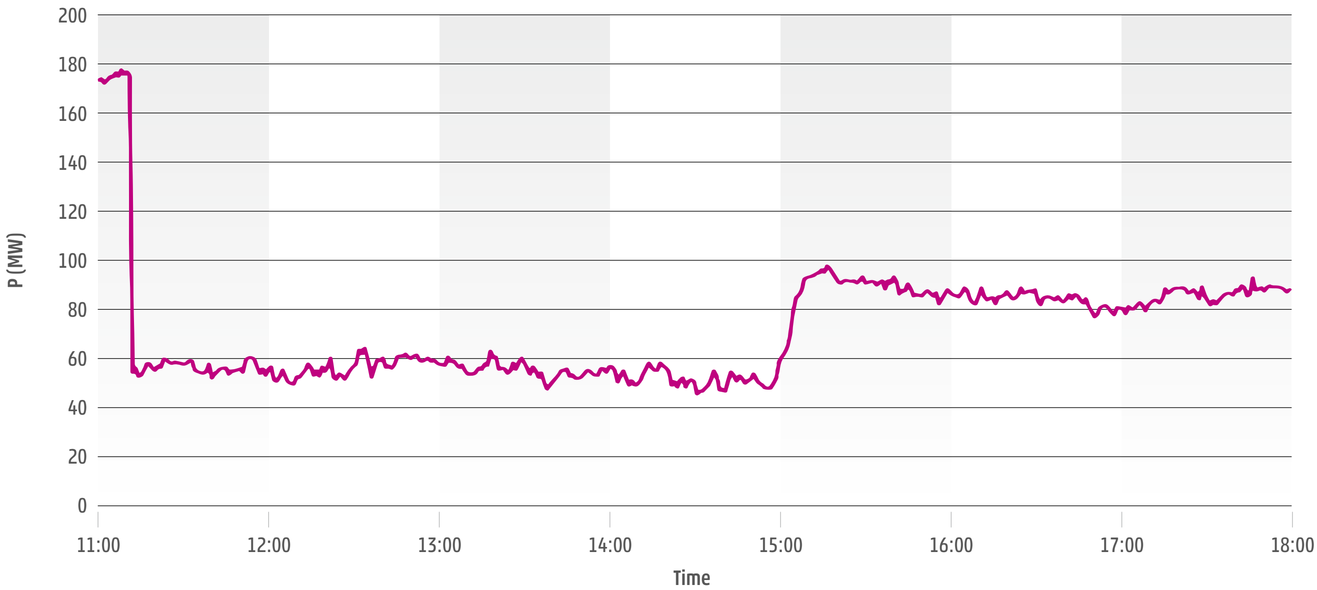


Figure 5.18: Load restoration of the T401VER 400 kV/110 kV transformer

Opočínek

The DSO restored the load in the Neznašov area by connecting to the 220 kV/110 kV transformer at the Opočínek substation.

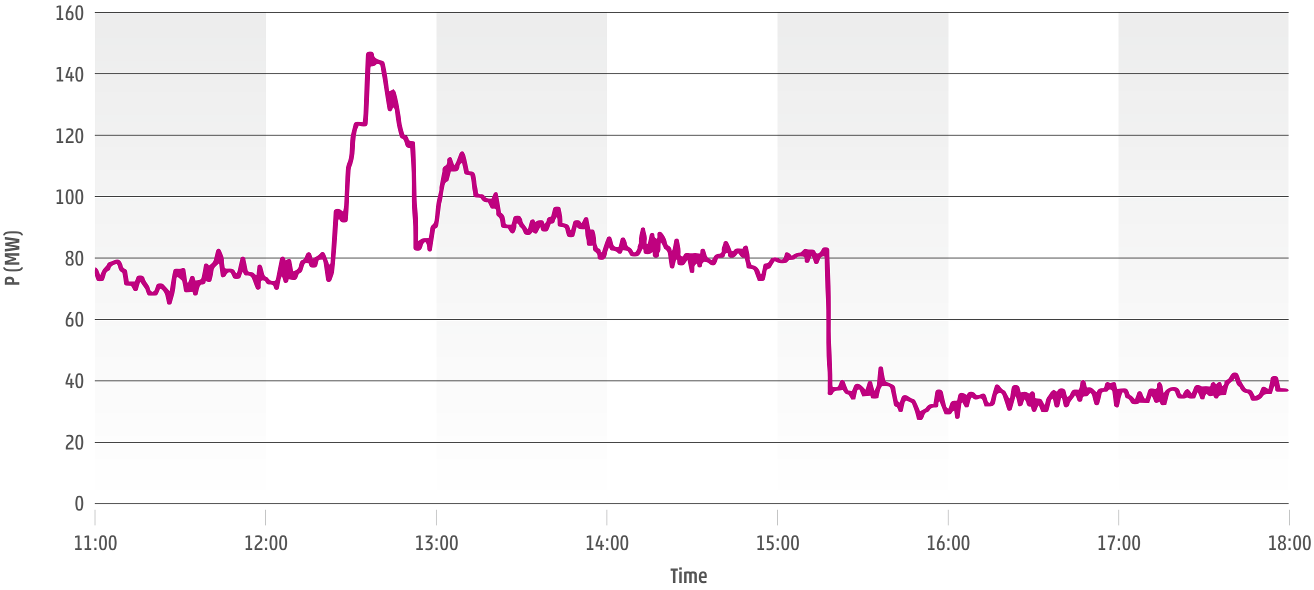


Figure 5.19: Load restoration of the T202OPO 220 kV/110 kV transformer

5.5 End of restoration

At 17:35, the dispatcher received information from DSOs about the complete restoration of the load.

5.6 Balancing during restoration

Balancing bid volumes on 4 July 2025 in the Czech Republic LFC area:

- aFRR+: 264 MW
- aFRR-: 236 MW
- mFRR+: 476 MW
- mFRR-: 78 MW
- mFRR5 (specific product): 203 MW

ČEPS dimensioning in the positive direction was 962 MW. Overall, ČEPS had 943 MW of available bids, reflecting a lower volume due to an outage of a unit providing mFRR5 (30 MW). The outage was not related to the incident.

In the negative direction, dimensioning was 301 MW. Available bids in the negative direction were 312 MW.

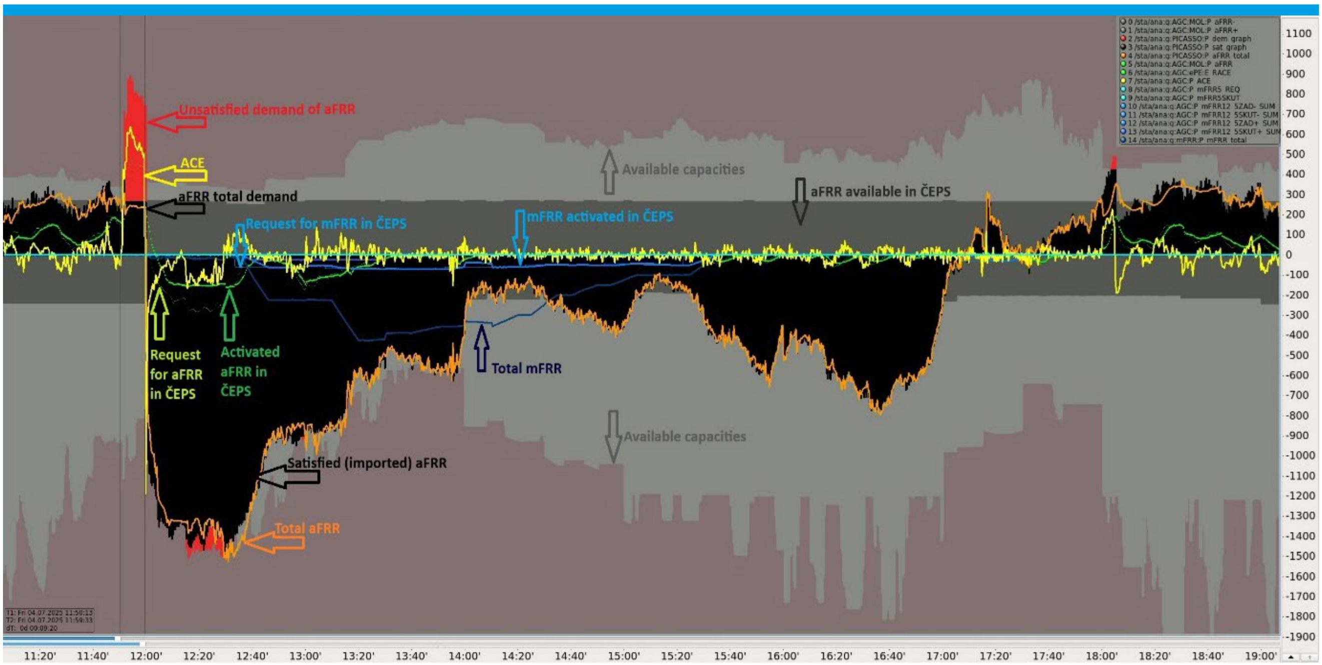


Figure 5.20: Balancing activities during the event and restoration process

- After line V411 tripping (11:51):
  - The Czech Republic LFC area was in deficit following the loss of generation.
  - All aFRR+ in CZ was activated.
  - About 500 MW aFRR+ demand was unsatisfied.
- After the loss of the island (11:59):
  - The Czech Republic LFC area was in surplus following the loss of demand.
  - Peak balancing energy demand was 1,520 MW.
  - All demand covered by aFRR- and mFRR-.
- LFC remained operational in normal state (P/f) and connected to MARI and PICASSO.
- ČEPS maintained a connection to the MARI and PICASSO platforms:
  - 2,578 MWh aFRR- imported (mainly from Germany).
  - 556 MWh mFRR- imported (mainly from Belgium).

MTU	Reserve Type	Direction	Offered (MW)	Avg. activated in CZ (MW)[1]	Avg. imported aFRR (MW)	Average CBMP (€/MWh)
04/07/2025 11:45:00	aFRR	Up	264.00	516.83	36.67	8,646.86
04/07/2025 11:45:00	aFRR	Down	236.00	5.88	0.00	85.00
04/07/2025 12:00:00	aFRR	Up	264.00	0.00	0.00	1,992.98
04/07/2025 12:00:00	aFRR	Down	228.35	154.71	1,034.12	–1,373.17
04/07/2025 12:15:00	aFRR	Up	262.42	0.00	0.00	85.00
04/07/2025 12:15:00	aFRR	Down	193.75	251.93	1,124.74	–12,255.68
04/07/2025 12:30:00	aFRR	Up	247.09	0.00	0.00	70.00
04/07/2025 12:30:00	aFRR	Down	198.17	49.77	1,044.19	–295.04
04/07/2025 12:45:00	aFRR	Up	261.12	0.00	0.00	70.00
04/07/2025 12:45:00	aFRR	Down	190.73	86.27	791.62	–752.16
04/07/2025 13:00:00	aFRR	Up	264.00	0.00	0.00	70.00
04/07/2025 13:00:00	aFRR	Down	205.85	93.31	699.66	–552.77
04/07/2025 13:15:00	aFRR	Up	263.38	0.00	0.00	70.00
04/07/2025 13:15:00	aFRR	Down	201.62	47.51	465.21	–23.53
04/07/2025 13:30:00	aFRR	Up	261.65	0.00	0.00	125.00
04/07/2025 13:30:00	aFRR	Down	183.63	1.28	365.13	0.24
04/07/2025 13:45:00	aFRR	Up	262.63	0.03	0.00	36.50
04/07/2025 13:45:00	aFRR	Down	210.39	20.71	368.70	–27.21
04/07/2025 14:00:00	aFRR	Up	261.10	0.58	0.00	105.20
04/07/2025 14:00:00	aFRR	Down	200.68	0.00	188.66	54.37
04/07/2025 14:15:00	aFRR	Up	262.38	1.04	0.00	86.74
04/07/2025 14:15:00	aFRR	Down	209.64	0.00	156.46	37.37
04/07/2025 14:30:00	aFRR	Up	260.72	0.81	0.00	98.57
04/07/2025 14:30:00	aFRR	Down	198.07	0.00	262.78	42.91
04/07/2025 14:45:00	aFRR	Up	260.37	0.00	0.00	93.71
04/07/2025 14:45:00	aFRR	Down	195.60	0.03	340.26	34.27
04/07/2025 15:00:00	aFRR	Up	259.83	0.00	0.00	103.15
04/07/2025 15:00:00	aFRR	Down	189.75	0.04	189.18	51.05
04/07/2025 15:15:00	aFRR	Up	259.00	0.00	0.00	107.97
04/07/2025 15:15:00	aFRR	Down	186.00	0.40	178.78	55.68

Table 5.1: Aggregated aFRR results

[1] Including netting.

MTU	Reserve Type	Direction	Offered (MW)	Activated in CZ (MW)	mFRR imported (MW)	CBMP (€/MWh)
04/07/2025 11:45:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 11:45:00	mFRR	Down	78.00	0.00	0.00	N/A
04/07/2025 12:00:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 12:00:00	mFRR	Down	78.00	0.00	0.00	N/A
04/07/2025 12:15:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 12:15:00	mFRR	Down	78.00	0.00	0.00	N/A
04/07/2025 12:30:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 12:30:00	mFRR	Down	78.00	0.00	0.00	N/A
04/07/2025 12:45:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 12:45:00	mFRR	Down	78.00	62.00	36.80	−424.12
04/07/2025 13:00:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 13:00:00	mFRR	Down	78.00	53.00	138.00	−250.00
04/07/2025 13:15:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 13:15:00	mFRR	Down	78.00	69.00	147.00	−916.88
04/07/2025 13:30:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 13:30:00	mFRR	Down	78.00	71.00	331.00	−2,000.00
04/07/2025 13:45:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 13:45:00	mFRR	Down	78.00	71.00	318.00	−1,999.00
04/07/2025 14:00:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 14:00:00	mFRR	Down	78.00	59.00	288.00	−934.99
04/07/2025 14:15:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 14:15:00	mFRR	Down	78.00	59.00	296.00	−450.00
04/07/2025 14:30:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 14:30:00	mFRR	Down	78.00	49.00	241.00	−427.96
04/07/2025 14:45:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 14:45:00	mFRR	Down	78.00	52.00	151.00	−250.00
04/07/2025 15:00:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 15:00:00	mFRR	Down	78.00	43.00	98.00	−350.00
04/07/2025 15:15:00	mFRR	Up	706.00	0.00	0.00	N/A
04/07/2025 15:15:00	mFRR	Down	78.00	52.00	57.00	−150.47

Table 5.2: Aggregated mFRR results

5.7 Market suspension and restoration

ČEPS suspended market activities in accordance with the Rules for Suspension and Restoration of Market Activities.[13] During the suspension of market activities, it was not possible to allocate cross-border capacity for intraday trading, thereby affecting the continuous intraday cross-border trading via SIDC for the trading interval on 4 July 2025 from 13:30 to 24:00. The ČEPS control centre performed a halt of cross-border intraday trading via XBID operational procedures at 12:19 on all cross-border profiles, and thus the actual affected trading intervals were from 13:30.

In the context of the suspension of market activities, ČEPS decided to stop the allocation of cross-border intraday trading capacity in accordance with Article 35(2) of the NCER. ČEPS assessed that the continuation of this market activity would significantly reduce the effectiveness of the restoration process to a normal or alert state, as it was unclear whether ČEPS would be able to provide the agreed cross-border exchanges.

The suspension of market activities during the 13:30 to 24:00 trading interval on 4 July 2025 had a positive impact on the management of the Czech Republic's transmission system during the incident analysed. Thanks to this measure, there was no change in the trading balance during the analysed incident, and the ČEPS control centre could thus better leverage the predictable state of the electricity system to more effectively stop the fault's propagation and restore the system faster.

The suspension of cross-border trading also affected intraday trading for the following day (5 July 2025), namely by suspending cross-border trading in the SIDC continuous trading (until 22:28 on 4 July), as well as in the IDA 1 auction (organised on 4 July at 15:00) and IDA 2 (organised on 4 July at 22:00) for all trading slots on 5 July 2025, where zero cross-border capacity was offered for these auctions.

However, the aforementioned suspension of cross-border trading under IDA 1 and IDA 2 had only a limited impact on electricity market participants. Cross-border trading was subsequently allowed under the downstream intraday continuous trading and under IDA3.

Subsequently, a state of emergency was declared for the entire territory of the Czech Republic at 15:45, with retroactive effect from 12:00, in accordance with §54 of Act No. 458/2000 Coll. This led to the non-functionality of the marketplace and the inability to register execution diagrams, thereby implicitly suspending market activities, offering the possibility of ensuring a balanced trading position by the clearing entity and ensuring adjustments to the clearing entity's trading position. In such a case, the market operator clears imbalances for each assessment interval in a special regime pursuant to Article 31(1) of Decree No 408/2015 Coll. of the Electricity Market Rules. The agreed quantities of electricity in this regime shall be deemed to be zero pursuant to paragraph 2 of the same decree. Therefore, the impact of the suspension of market activities on market participants was non-existent, as the allocation results for the interval were assessed in accordance with Article 31(2) of the decree, regardless of the suspension.

Immediately after the suspension of market activities, ČEPS initiated the communication procedure defined in Article 38 of the NCER. As it was not possible to make the notification and other updates related to the suspension of market activities on the ČEPS website, ČEPS informed all affected entities through the Crisis Communication System (SKK) in accordance with Article 38(4) of the NCER. ČEPS sent the following message via the SKK to the affected entities by SMS and email at 15:55: "ČEPS 04.07.2025 12:00 informs about the suspension of market activities in accordance with Article 35 of Commission Regulation (EU) 2017/2196. Estimated duration is 8 hours". Therefore, this fulfilled the requirements set out in Article 38(3) of the NCER.

13 Available from https://www.ceps.cz/cs/nc-er

Neighbouring TSOs and all nominated electricity market operators were informed of the suspension of the allocation of cross-border capacity for intraday trading through the XBID_JOINT_OTH_02 – Internal and External Communications common communication procedure.[14]

At 20:00, ČEPS informed about the postponement of the expected end of the emergency state to 22:00, thus providing an update on the transmission restoration process in accordance with Article 38(2)(d). Subsequently, at 22:28, it informed via SKK about the end of the suspension of market activities, and at 22:30, it informed about the end of the emergency state with effect from 5 July 2025 at 00:00.

Neighbouring TSOs and all nominated electricity market operators were informed about the restoration of the allocation of cross-border capacity for intraday trading with effect for trading intervals from 5 July 2025 at 00:00 via the XBID_JOINT_OTH_02 – Internal and External Communications common communication procedure. This fulfilled the obligation under Article 38(3)(f) to notify the TSO that the transmission system had been returned to a normal or alert state.

14 Available from https://www.nemo-committee.eu/continuous

6 REGIONAL COORDINATION PROCESSES

There are five RCCs and one regional security coordinator (RSC) established in Europe. The RCCs are Baltic RCC, TSCNET, SEleNe CC, Coreso and Nordic RCC, and the RSC is SCC. They are tasked with carrying out the operational planning tasks defined in EU Regulation 2019/943. Pan-European tasks are provided jointly or on a rotational basis. Regional tasks for the Central Europe System Operation Region are provided by TSCNET or in cooperation with Coreso.

None of the RCC tasks identified a specific security risk for the Czech transmission system for the relevant hours on 4 July 2025, and the grid was considered N-1 secure:

» The short-term adequacy (STA) assessment validates whether the reliably available generation capacity is sufficient to meet expected consumption, considering both upward and downward regulation needs. The calculation is performed daily for the upcoming seven days. ČEPS participates in the cross-regional STA process, where all TSOs are required to submit input data daily. The process is executed automatically and monitored by the RCCs in rotation. In addition, a regional STA process may be triggered if the deterministic calculation indicates a potential adequacy issue for the upcoming three days. Such situations are rare.

In the days leading up to the incident, no regional STA process was triggered, and the cross-regional process did not identify any adequacy issues in the Czech Republic for the day of the incident.

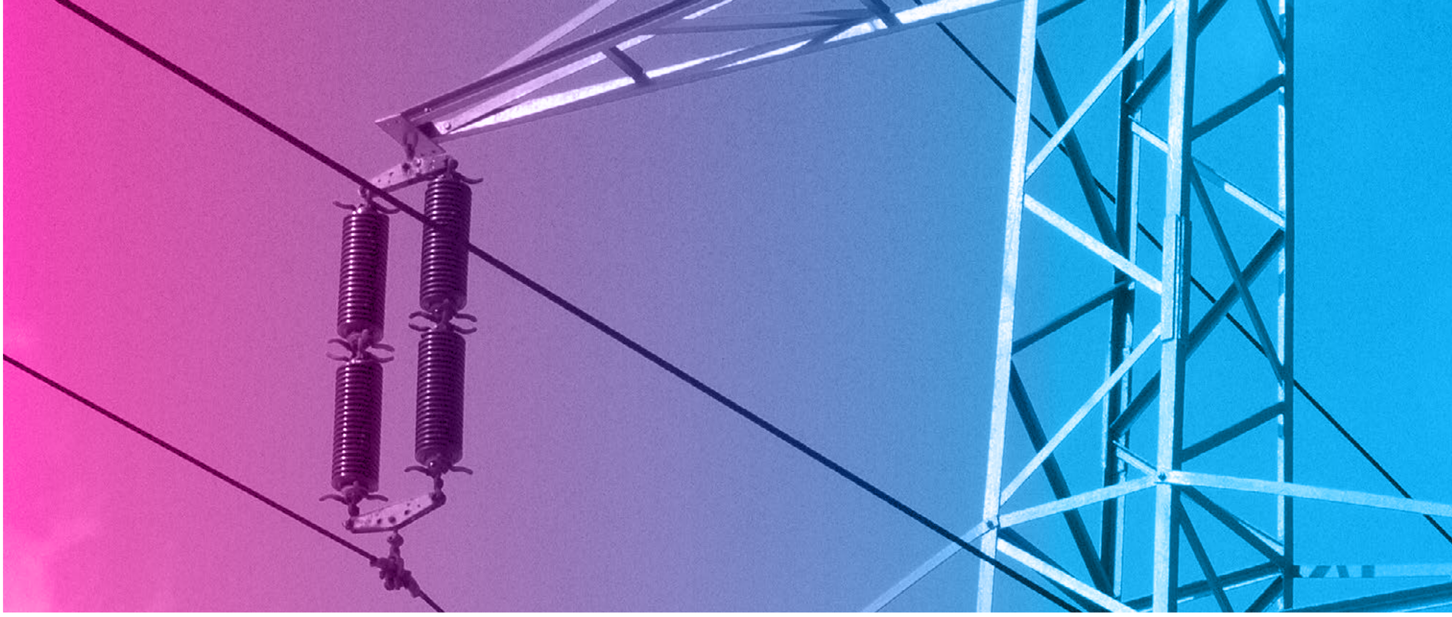
» The outage planning coordination (OPC) ensures information exchange among all Central European TSOs on a yearly, monthly, and weekly basis regarding planned outages. Additionally, RCCs assess the compatibility of the different outage plans.

All ČEPS elements in coordination that were switched off on 4 July 2025 were included in the shared unavailability plans and were agreed by the partners. In addition, ČEPS also informed the partners about the outage of grid elements that are not coordinated but may be of interest to other TSOs. These disconnections are only shared with each other but are not mutually agreed upon.

» Both day-ahead (DA) and intraday (ID) coordinated capacity calculation (CCC) processes were successfully completed for the day of the incident. Required input data for CCC processes was complete and valid. The DA and ID CCC processes were completed, and the results were delivered for 4 July 2025 before the incident. Thus, the CCC processes executed for 4 July 2025 were not affected by the incident.

Despite the incident occurring concurrently with the initiation of the DACC process for 6 July 2025, the designed execution of the CCC process remained intact. The successful completion of the DA CCC process for 6 July 2025 confirms that no disruptive impact was experienced on the DA CCC process.

The processes of intraday capacity calculations for 5 July 2025 at 15:00 and 22:00 were not affected by the incident. All potential risks associated with cross-zonal capacity allocation during the incident period (including auctions for 5 July 2025) were addressed by suspending intraday trading for multiple MTUs in the Czech Republic bidding zone in accordance with the requirements set out in Article 35 of Commission Regulation (EU) 2017/2196 of 24 November 2017 establishing a network code for electricity emergencies and restoration.



» ČEPS contributes to the regional two-day-ahead, one-day-ahead and intraday processes by providing IGMs in the UCTE data exchange format. All these models were submitted to RCCs on time and in the required quality, and all necessary calculations were performed including them.

» The legacy security analysis on the DACF and IDCF models was carried out successfully. At the end of the TSCNET's DACF process, the participating TSOs consider the grid N-1 secure, and the congestion-free model criterion is met if the N-1 loading is below 103 % for tie lines and below 120 % for internal elements. This was the case for all Czech lines after corrective measures were implemented. Detected congestions for the 400/220 kV transformers at the Hradec and Čechy Střed substations were either within the transitory admissible thermal limits (temporarily tolerable) and resolvable through curative measures. Hence, the Czech grid was considered N-1 secure. No unusual differences were observed between the cross-border flows in the DACF and IDCF models and the flows in real time. The results of the ČEPS local security analysis conducted in real time before the incident were fairly consistent with those from the regional processes. This, together with the detailed results, is available in chapter 2.

The coordinated security analysis based on the pan-European Common Grid Model in the CGMES format is not yet live.

A CGM Action Plan has been in place since April 2024 to enhance CGM creation in CGMES format and data quality, building on earlier efforts to resolve persistent issues with IGM validation and inclusion.

» For all regional security analyses performed, the loss of line V411 with additional loss of generation was not considered as an ordinary contingency in the sense of CSAm Art. 7. Only the loss of line V411 alone was considered. Line V208, which was overloaded during the incident, was not considered a cross-border relevant network element (XNE) under CSAm Art. 15 and was not considered for the OPC and CCC processes. It was, however, considered during the DACF and IDCF processes, which confirmed the N-1 security even for this internal element.

» Additionally, there are other RCC tasks[15] under EU Regulation 2019/943 in operation that contribute to grid security. However, they are more long-term and less connected with the specific incident.

15 The other tasks are supporting the consistency assessment of TSOs' defence plans and restoration plans (Art. 37(1)(d)), training and certification of staff (Art. 37(1)(g)), regional incident analysis and reporting (Art. 37(1)(i)), identifying regional crisis scenarios (Art. 37(1)(m)) and calculating maximum entry capacity (Art. 37(1)(o)). More details about the RCC tasks in operation are available in the annual Central Europe SOR Report from TSCNET and Coreso.

7 INCIDENT CLASSIFICATION BASED ON ICS METHODOLOGY

The ICS methodology was originally developed in accordance with Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009, which has since been replaced by Article 30 of Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast), to fulfil the objectives and the security indicator requirements laid out in Article 15 of SOGL. The definitions and concepts in this methodology are in line with Articles 15 and 18 of the SOGL and further extended to describe the real-time situation of the TSO system.

Table 7.1 shows the ICS criteria from the methodology and the corresponding scale, ordered by descending priority. An incident can comprise multiple events and meet various ICS criteria. In this case, the highest criterion decides the scale of the incidents.

For a scale 2 or 3 incident, an investigation is conducted by an ICS expert panel. While only the highest-priority criterion is relevant for determining the scale, the other criteria are also assessed.

Scale 0 Noteworthy incident		Scale 1 Significant incident		Scale 2 Extensive incident		Scale 3 Major incident / 1TSO	
Priority / Short definition (Criterion short code)		Priority / Short definition (Criterion short code)		Priority / Short definition (Criterion short code)		Priority / Short definition (Criterion short code)	
#20	Incidents on load (L0)	#11	Incidents on load (L1)	#2	Incidents on load (L2)	#1	Blackout (OB3)
#21	Incidents leading to frequency degradation (F0)	#12	Incidents leading to frequency degradation (F1)	#3	Incidents leading to frequency degradation (F2)		
#22	Incidents on transmission network elements (T0)	#13	Incidents on transmission network elements (T1)	#4	Incidents on transmission network elements (T2)		
#23	Incidents on power generating facilities (G0)	#14	Incidents on power generating facilities (G1)	#5	Incidents on power generating facilities (G2)		
		#15	N-1 violation (ON1)	#6	N violation (ON2)		
#24	Separation from the grid (RS0)	#16	Separation from the grid (RS1)	#7	Separation from the grid (RS2)		
#25	Violation of standards on voltage (OV0)	#17	Violation of standards on voltage (OV1)	#8	Violation of standards on voltage (OV2)		
#26	Reduction of reserve capacity (RRC0)	#18	Reduction of reserve capacity (RRC1)	#9	Reduction of reserve capacity (RRC2)		
#27	Loss of tools and facilities (LT0)	#19	Loss of tools and facilities (LT1)	#10	Loss of tools and facilities (LT2)		

Table 7.1: Incident classification scale

7.1 RCC investigation threshold

The RCC post-operation and post-disturbances analysis and reporting (RIAR) methodology has been developed to define the respective RCC task in accordance with Article 37(1)(i) of the Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity.

This methodology foresees an RCC investigation in addition to the work of the expert panel if both of the following criteria are met:

» a TSO has moved from a normal or alert system state to an emergency system state as a result of actions taken by another TSO being in emergency, blackout or restoration system state; and

» the incident has been confirmed as at least scale 2, as defined by the ICS methodology.

Post-analysis confirmed that no TSO in the area entered the emergency system state as a result of this incident.

7.2 Scale of incident

The highest-violated ICS criterion during this incident was a scale 2 incident on load (L2). This criterion is met if more than 10 % but less than 50 % of the load is lost (compared to the pre-incident load). In this incident, 2,300 MW of load was lost, which is 28 % of the demand before the incident (8,200 MW) in the ČEPS control area. In addition to the lost load, there were several other criteria violations as listed below.

At 11:51:08 CEST, a T1 incident occurred, resulting in the loss of the 400 kV line V411. Within seconds, there was a below scale G violation with a loss of 340–440 MW.

This resulted in ON1, a deviation from operational security limits due to the thermal overload of the 220 kV line V208.

After the manual disconnection of the 220 kV line V208 at 11:59:44, a T1 occurred again when a 400 kV busbar coupler and a 400 kV/110 kV transformer in substation Krasíkov tripped, resulting in a scale 1 separation from the grid (RS1). The subsequent loss of all remaining generation on the separated island violated the G1 criteria, and the loss of load resulted in a scale 2 loss of load (L2) violation.

Criterion	Scale	ČEPS
OB	3	Not Violated
L	2	X
	1	
	0	
F	2	Not Violated
	1	
	0	
	BS	
T	2	
	1	X
	0	
G	2	
	1	X
	0	
	BS	X

Criterion	Scale	ČEPS
ON	2	
	1	X
RS	2	
	1	X
	0	
OV	2	Not violated
	1	
	0	
	BS	
RRC	2	Not violated
	1	
	0	
LT	2	Not violated
	1	

Table 7.1: ICS criteria violations during the incident. ICS criteria violations only occurred in ČEPS control area.

Each violated ICS criterion has an X in the cell. The scales shown are 0–3 and below-scale (BS).
There was no violation of the ICS OB, OV, F, RRC and LT criteria.

8 NEXT STEPS

The Expert Panel will now work on the final report in accordance with the ICS methodology. To perform this task, the Expert Panel will continue to request the necessary data for the investigation of the incident. To the extent that the necessary data are provided, the final report will include additional information on the causes of the generation disconnection.

Additionally, the final report will include at least:

- » an evaluation of the activated remedial actions and measures from the system defence plan;
- » an evaluation of the actions of TSO employees in charge of the real-time operation of the transmission system;
- » conclusions and the explanations of the reasons for the incident;
- » recommendations based on the investigation's conclusions.

The Expert Panel will also identify which of these recommendations should be implemented only by ČEPS or by other TSOs to prevent such an event from occurring in the future.

The final report is expected to be available by June 2026, although this timeline is purely indicative, as it will depend on the availability of data and the complexity of the analysis to be conducted.

LIST OF ABBREVIATIONS

aFRR	automatic frequency restoration reserve
CCT	critical clearing time
CCC	coordinated capacity calculation
DA	day-ahead
DACF	day-ahead congestion forecast
DFRs	disturbance fault recordings
DLR	dynamic line rating
DSA	dynamic stability assessment
DSO	distribution system operator
EAS	ENTSO-E Awareness System
ID	intraday
IO	island operation
IOCM	island operation control mode
LFDD	low-frequency demand disconnection
NPP	nuclear power plant
OPC	outage planning coordination
RCC	regional coordination centre
RoCoF	rate of change of frequency
SGU	significant grid user
SOGL	Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation
STA	Short-term adequacy
TSO	Transmission system operator
XNE	cross-border relevant network element

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