Polskie Sieci Elektroenergetyczne

Analysis of Polish Allocation Constraints

Comparison of historical data and NoAC simulations

Case – Jun - Dec '22

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Context of the analysis

- CORE DA CCM prescribes the obligation to study the effect of Allocation Constraints on market and power system operations
  - PSE was granted the ability to apply AC for 2 years;
  - According to DA CCM for CORE CCR Article 7(3)(b)(i):
    - *in case the external constraint had a non-zero shadow price in more than 0.1% of hours in a quarter, provide to the CCC a report analyzing: (i) for each DA CC MTU when the external constraint had a non-zero shadow price the loss in economic surplus due to external constraint and the effectiveness of the allocation constraint in preventing the violation of the underlying operational security limits;*
  - 18 months after CORE DA FB is implemented, PSE and other CORE TSOs must prepare an amendment of the CORE CCM in order to extend the use of AC;
- The analysis carried out by PSE consists of two main elements:
  - **Analysis using Simulation Facility**
    - Simulating market results in absence of AC and comparing it with historical data with AC applied
    - The data covers period from 09.06.2022 to 31.12.2022;
    - The only difference between historical and NoAC simulations was removal of Polish Allocation Constraints;
  - **Analysis of secure operation of the Polish power system**
    - This was done by comparing the historical reserve levels and the simulated reserve levels (in absence of AC)
    - When required reserve levels were not met, costs of necessary remedial measures were estimated (for simulated case without AC)
    - Reserve requirements used in this analysis are the least conservative ones
      - For upward reserves: it is assumed that remedial measures would be needed only if reserves fall below 1000 MW (reference incident), which is much less than the required 9% (as in the Polish Grid Code)
      - For downward reserves: 500 MW is assumed

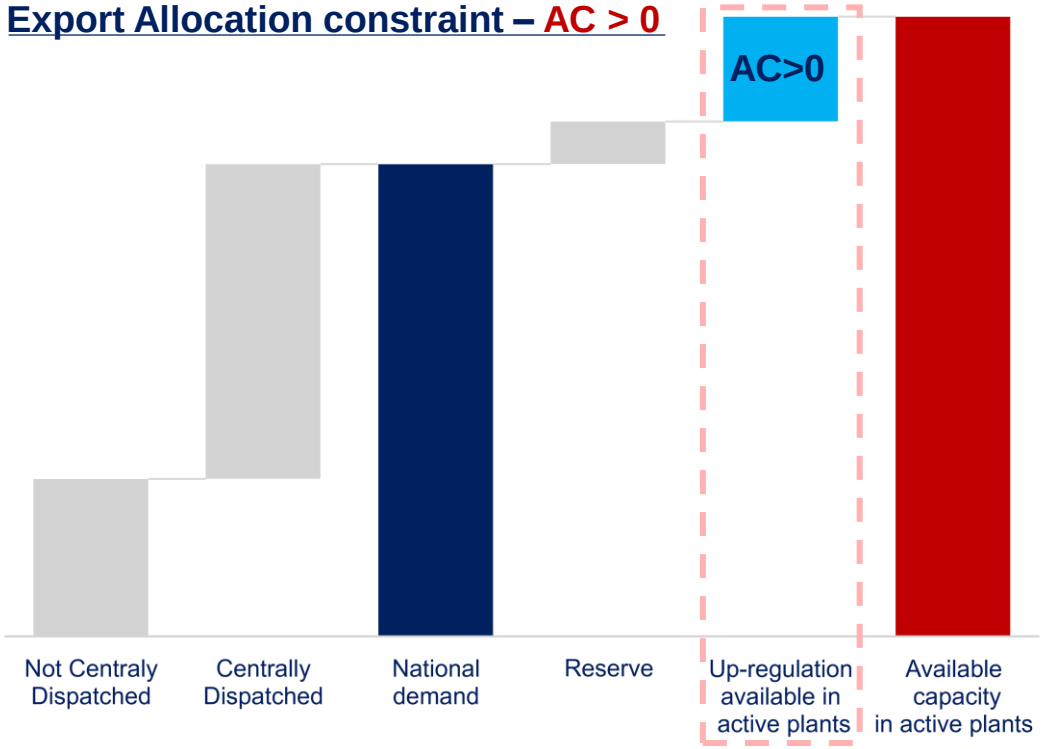
Reminder

- What are Allocation Constraints, as defined in CACM?
  - Article 2.6:
    - *‘allocation constraints’ means the constraints to be respected during capacity allocation to maintain the transmission system within operational security limits and have not been translated into cross-zonal capacity or that are needed to increase the efficiency of capacity allocation;*
  - Article 2.7:
    - *‘operational security limits’ means the acceptable operating boundaries for secure grid operation such as thermal limits, voltage limits, short-circuit current limits, frequency and dynamic stability limits*
  - Article 23.3:
    - *If TSOs apply allocation constraints, they can only be determined using:*
      - *(a) constraints that are needed to maintain the transmission system within operational security limits and that cannot be transformed efficiently into maximum flows on critical network elements; or*
      - *(b) constraints intended to increase the economic surplus for single day-ahead or intraday coupling*

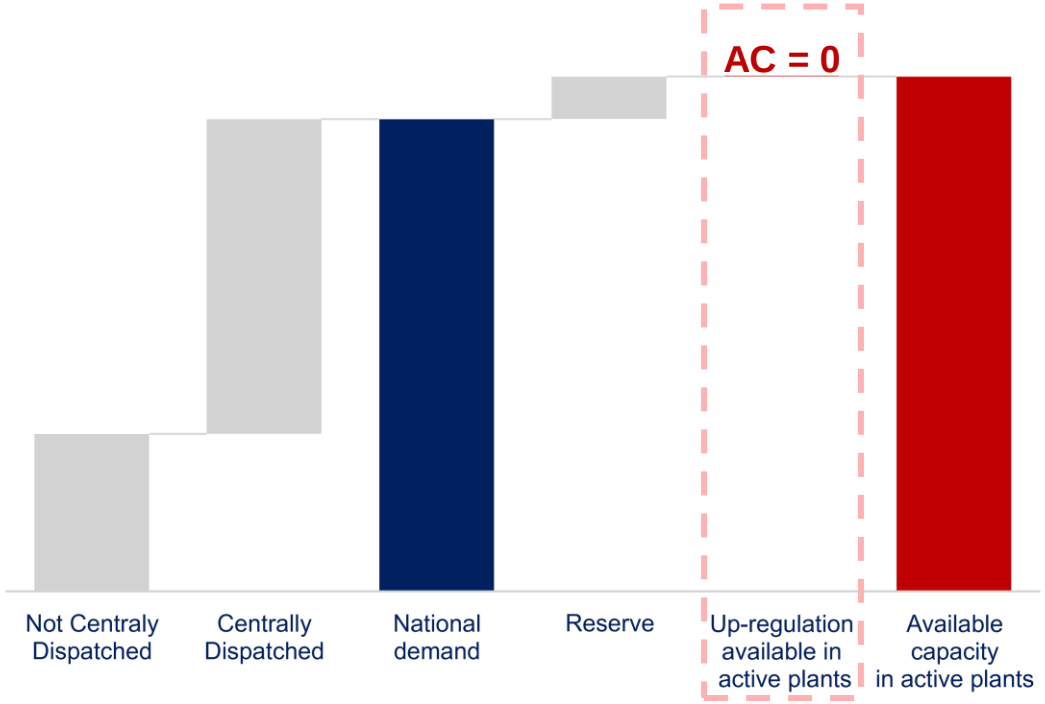
- Technical and legal justification of usage and the methodology for calculation of allocation constraints („external constraints”) are described in CORE DA CCM in Annex 1

Explanation: calculation of allocation constraint - Export direction

Export Allocation constraint – AC > 0



Export Allocation constraint – AC = 0

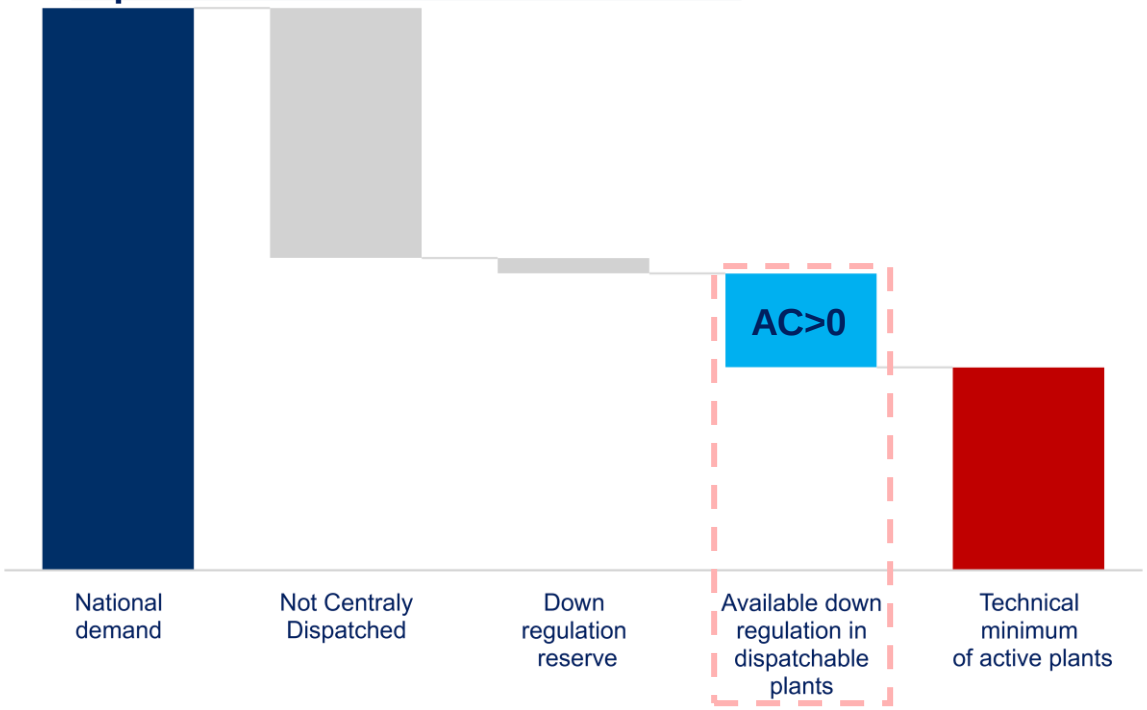


Allocation constraint for export is determined by available capacity left after ensuring that national demand is supplied.

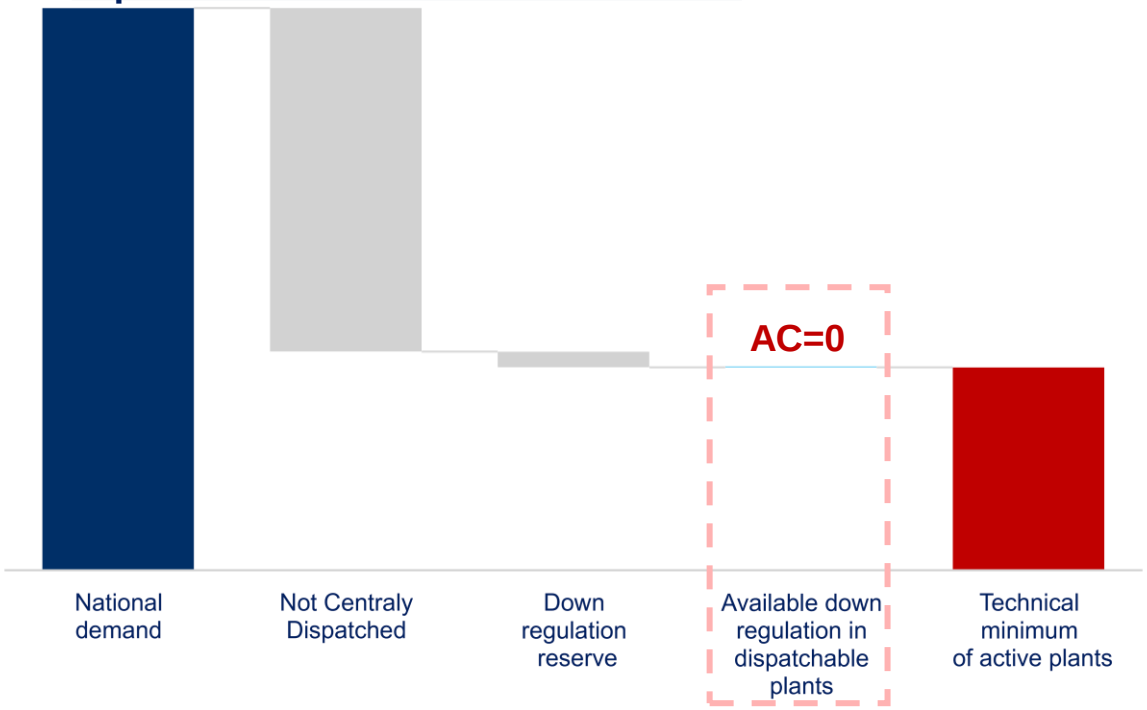
AC = 0 means that there was no spare generation beyond what is needed to meet the demand of Polish system.

Explanation: calculation of allocation constraint - Import direction

Import Allocation constraint – AC > 0



Import Allocation constraint – AC = 0



Allocation constraint for import is determined as available downward regulation after ensuring safety of the system.

AC = 0 means that power plants are operating on their technical minimum. Going below these levels is technically unfeasible due to the technical minimums of power plants and of the power system.

Analysis using Simulation Facility: social welfare change due to removal of AC

producer and consumer surplus [m€], Jun - Dec '22

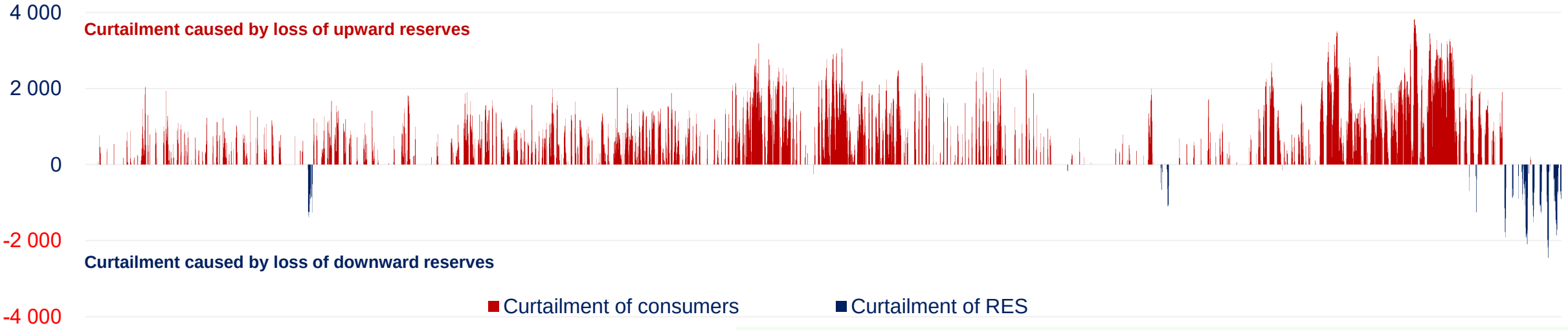
Note: Social Welfare figures need to be complemented with Value of Lost Load resulting from analysis of secure operation of the Polish power system

	Country	AT	BE	CZ	DE	FR	HR	HU	NL	PL	RO	SI	SK	CORE
Producer Surplus	With AC	2 749.64	7 651.53	4 372.74	58 479.55	28 706.64	952.24	2 506.70	10 506.55	182.08	3 304.25	151.15	1 197.99	120 761.05
	NoAC	2 714.63	7 601.05	4 230.16	57 879.05	28 538.24	934.61	2 486.58	10 427.63	686.05	3 295.33	149.26	1 192.57	120 135.16
Consumer Surplus	With AC	38 210.37	24 843.04	4 070.40	304 659.33	190 947.42	985.83	31 727.66	46 192.81	1 198.15	7 831.84	2 352.47	2 382.37	655 401.69
	NoAC	38 271.48	24 878.91	4 130.81	305 267.29	191 173.53	988.98	31 760.94	46 250.62	1 102.21	7 836.39	2 361.81	2 388.54	656 411.53
Surplus change	NoAC-AC	26.11	-14.60	-82.16	7.46	57.71	-14.48	13.17	-21.11	408.03	-4.37	7.45	0.74	383.95

Changes in Congestion Income resulting from Polish Allocation Constraints **are addressed in Congestion Income redistribution process**.

Analysis of secure operation of the Polish power system:

potential curtailment of consumers and renewable sources, hourly, Jun - Dec '22 [MW]



Curtailed energy due to absence of AC (aggregated Jun - Dec '22)

Potential curtailment of consumers and renewables is calculated by comparing simulated reserve levels after removal of AC with the required levels

In Jun - Dec '22 , without Allocation Constraints both the upward and downward reserves would be insufficient at times. Hence, there would be a many hours when consumers or renewable energy would need to be curtailed.

Consumers would need to be curtailed in 2241 hours due to loss of upward reserves, totaling to over 2184.4 GWh of curtailed demand, causing thereby substantial loss of social welfare due to unsupplied load.

RES energy would need to be curtailed in 136 hours due to loss of downward reserves, totaling to some with 103.8 GWh of curtailed RES (replaced with imports).

Social Welfare and VOLL values

Comparison of Social Welfare impact – VOLL and Surplus change [m€], Jun - Dec '22

Note that Social Welfare changes in CORE without PL is negative: -24.08 m€ in Q1 2023

Value of Lost Load* [k€/MWh]	
Households	6.6
Commerce	24.7
Services	36.9
Administration	18.3
Industry	16.2
Transport	17.4
Average VoLL	17.2
DSR price**	2.8
Price of RES compensation	0.15

Comparison of Social Welfare shall also consider costs of remedial measures for secure operation of Polish power system (VOLL for upward reserves deficiencies and RES curtailment costs for downwards reserves)

Above VOLL calculations assume very conservative costs of load curtailment, equal to DSR costs (~2800 EUR/MWh). Actual VOLL numbers for consumers are much higher (see table above with VOLL costs determined by Polish NRA).

Costs of RES curtailment are assumed at some 150 EUR/MWh (average compensation paid in the past)

When including the costs of remedial measures needed to ensure sufficient reserve level, these costs are much higher than any social welfare surplus gained in Poland or CORE.

Summary and Conclusions

- Allocation constraints do impact cross-border trading
  - In Jun - Dec '22 , **AC was the limiting factor for 78% of the hours**;
  - It must be however underlined that this was quite a special time period – height of the 2022 energy crisis;
  - Massive additional exports from Poland would completely deplete the coal stocks – simulated exports levels are thus unfeasible.
- Allocation constraints is the key tool for ensuring secure system operation in Poland
  - **In absence of AC, PL is unable to ensure sufficient availability of reserves**, both upward and downward
  - Ensuring secure operation of the Polish power system in absence of allocation constraints would **require application of remedial measures, at a very high scale**
  - Assuming the very conservative estimation (comparing against critical reserves instead of standard levels), remedial measures would need to be applied **for 48% hours**. In reality, the scale would be much higher.
- Most of the social welfare changes due to removal of allocation constraints occur in Poland
  - **Excluding Poland, CORE would lose surplus if the AC was removed;**
  - **At the same time, Poland would need to incur significant costs of remedial actions to ensure secure operation of the system (demand and RES curtailment)**
- Loss of social welfare due to RES and demand curtailment is much higher than any surplus gain
  - Loss of social welfare due to curtailment is an **order of magnitude higher** than any social welfare gain (consumers and prosumers surplus)