Hungary’s Renewable Energy Past and Future: Balancing Growth and Uncertainty

2nd State Aid Law Forum, 26th September 2025

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The recent past

Successful expansion of weather dependent renewable power generation

Electricity system | Hungary

Based on gross electricity production, the share of renewable energy sources is steadily increasing

GWh	2019	2020	2021	2022	2023	2024*
Conventional power plants						
Nuclear	16 288	16 055	15 990	15 812	15 918	16 017
Coal and coal products	4 184	3 826	3 105	3 064	2 509	2 444
Natural gas	8 700	9 091	9 653	8 873	7 279	7 091
Petroleum products	71	45	59	59	55	64
Conventional power plants total	**29 243**	**29 017**	**28 807**	**27 808**	**25 761**	**25 616**
Conventional power plants (%)	*85,3%*	*83,1%*	*79,8%*	*77,7%*	*72,5%*	*67,6%*
Renewable power plants						
Biomass	1 769	1 664	1 775	1 693	1 126	1 417
Biogas	321	324	295	315	320	324
Renewable waste	137	167	161	130	118	99
Water	219	244	212	178	222	231
Wind	729	655	664	610	646	659
Solar	1 497	2 459	3 796	4 732	6 925	9 136
Geothermal	18	16	12	4	16	11
Other	358	384	398	331	412	394
Renewable power plants total	**5 048**	**5 913**	**7 313**	**7 993**	**9 785**	**12 271**
Renewable power plants (%)	*14,7%*	*16,9%*	*20,2%*	*22,3%*	*27,5%*	*32,4%*
Total production	**34 291**	**34 930**	**36 120**	**35 802**	**35 546**	**37 887**
Import-Export	12 584	11 677	12 754	12 152	11 099	10 729
Gross energy consumption	**46 875**	**46 607**	**48 874**	**47 954**	**46 645**	**48 616**

Source: MEKH

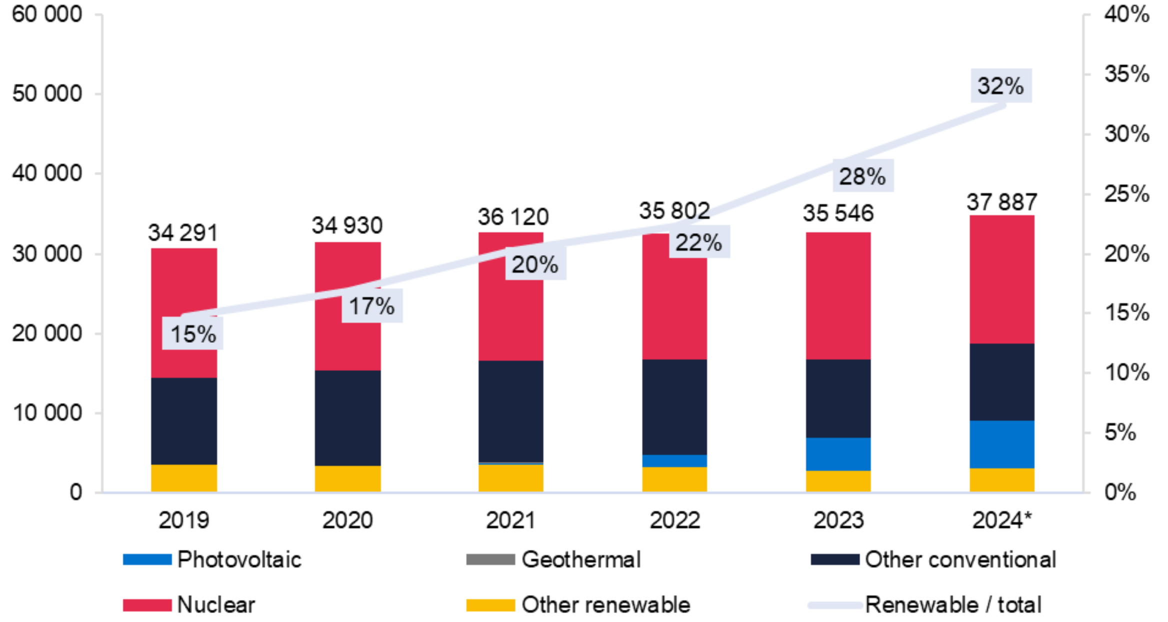
** preliminary data*

- **The gross electricity production of domestic power plants** – including small household power plants – **is estimated at 37,887 GWh in 2024**, which is 6.59% higher than the 2023 production.
- Although **nuclear energy** continues to account for the **largest share** of conventional power plants, its production has **remained flat** due to delays in the launch of the **PAKS II** project.
- Between 2019 and 2024, **the share of** electricity generated by **coal-fired power plants fell from 12.2% to 6.45%**.
- **The output generated by renewable power plants** has more than doubled in the last five years: **in 2024**, it **accounted for 32.4% of total electricity production**, generating 12,271 GWh.
- This growth is almost entirely the result of the expansion of **solar energy** investments: in 2020, it became the most significant renewable energy source, and **by 2024**, solar power plants **accounted for 24% of total production, making it the country's second largest energy source**.

Electricity system | Hungary

Photovoltaic energy accounts for an increasing share of production and installed capacity

Gross electricity generation in Hungary (GWh)



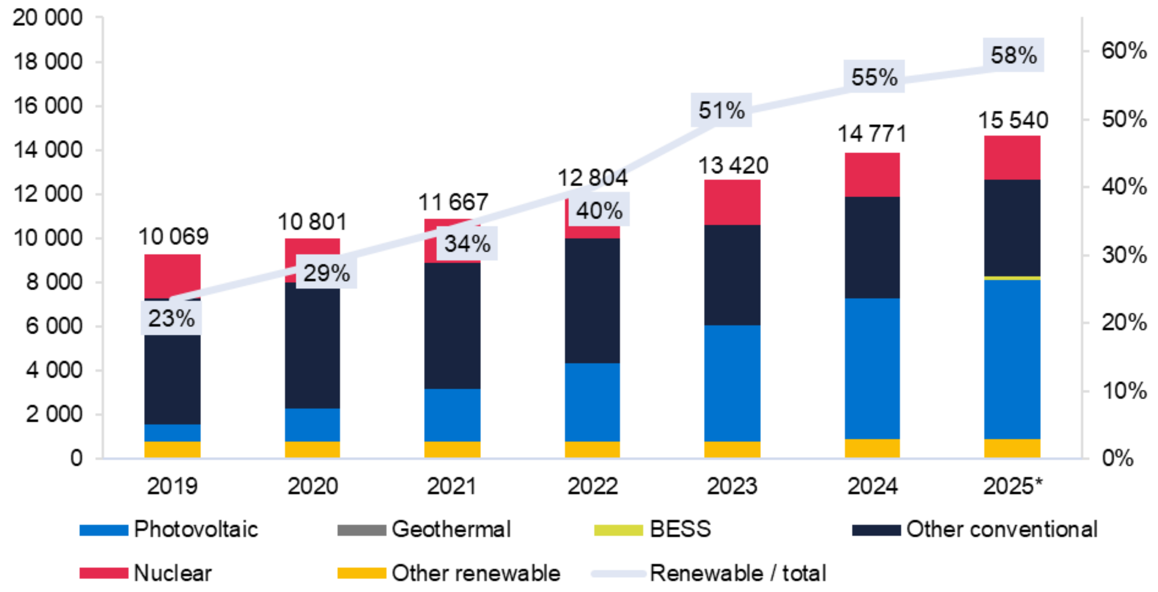
- The output generated by **photovoltaic power plants has increased more than fivefold** in the last 5 years: in 2019, it accounted for only 4% of total production, but by 2024, this **increased to 24%**. In contrast, the **energy generated by non-nuclear conventional power plants decreased from 38% to 25%**.

Source: MEKH

** preliminary data*

- The **total gross installed electrical capacity of domestic power plants was 15,540 MW** on September 1, 2025.
- Conventional power plants accounted for the majority of total gross installed electrical capacity in 2019, but this has reversed in recent years: **by 2025, renewable power plants represent 58% of the total**.

Gross installed capacity per production type (MW)



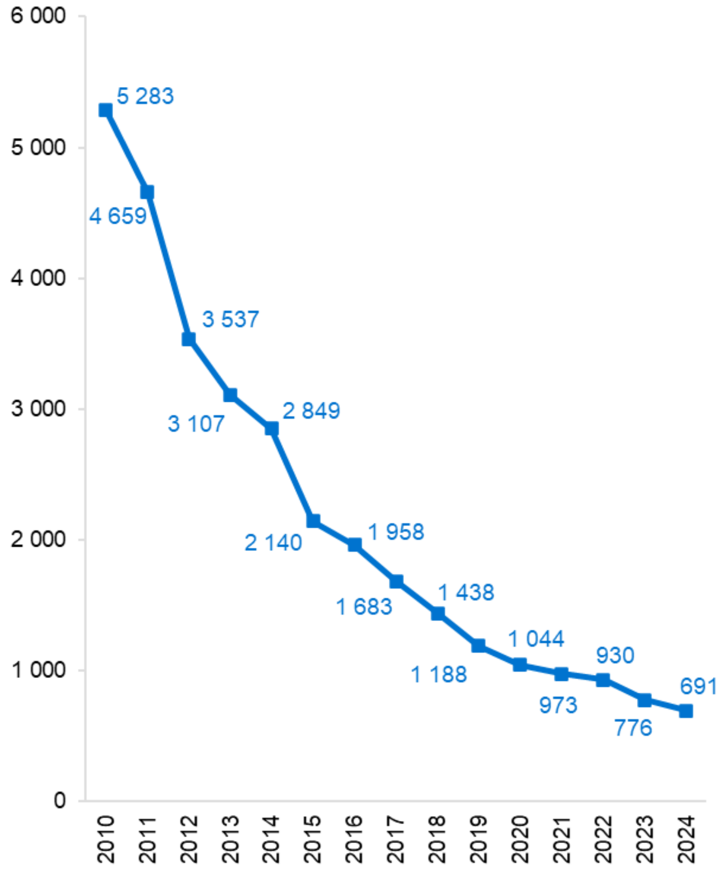
Source: Mavir

** based on data available as of 01/09/2025*

Solar power plant financing

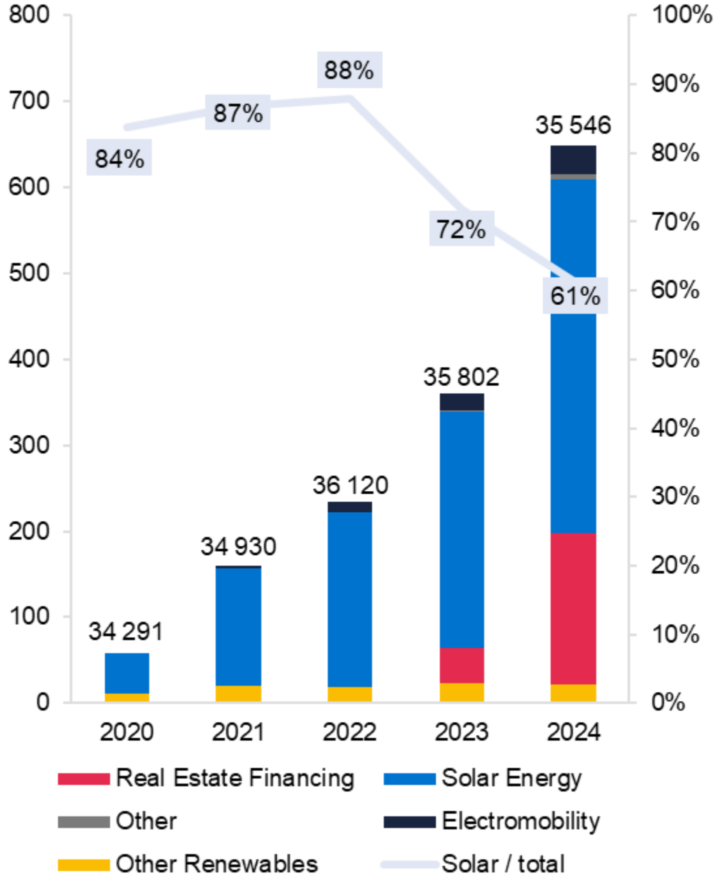
Supporting the financing of solar power plants reduced investment costs

Global weighted average total installation costs (2024 USD/kW)



Source: IRENA

Distribution of domestic exposures in the GPCR* Programme by loan purpose (bHUF)



Source: MNB * Green Preferential Capital Requirements

Evolution of Hungarian photovoltaic support schemes

- (2003 – 2016) **Feed-in-tariff scheme ("KÁT")**: Guaranteed fixed feed-in tariffs, initially dominated by biomass/CHP, PV joined later.
- (2014 – 2016) **PV boom**: Many ~0.5 MW PV plants received long-term (up to 20 years) feed-in tariff contracts.
- (2017 – 2022) **"METÁR"**: Support scheme based on premium tariff and competitive bidding which reduced support levels dramatically. Initially allowed up to 20 years of support, later reduced to 15 years.

- Thanks to numerous support programs, the photovoltaic sector can now grow and develop without any aid.
- We believe that following this pattern, **support for other renewable investments will also reduce project costs and risks**, thereby increasing their returns.

The challenge

Issues with weather dependent renewable power generation

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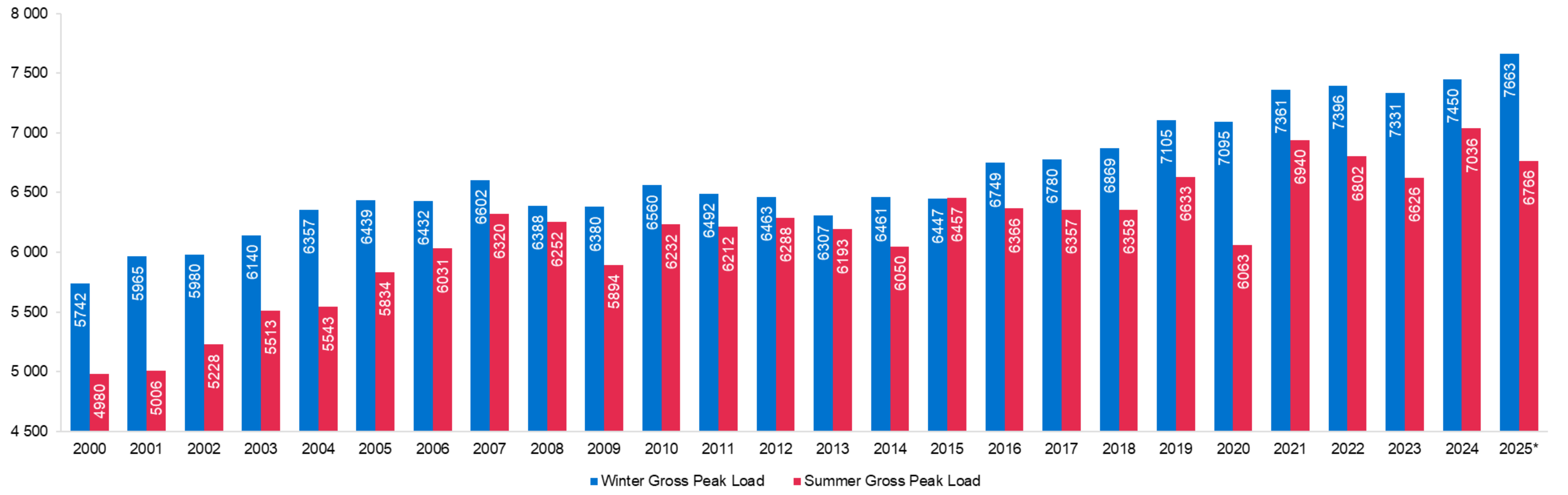
Electricity system | Hungary

Over the past 25 years, winter peak loads have generally been higher than summer peak loads

Winter and summer gross peak load 2000-2024 (MW)**



- In 2020, **installed industrial photovoltaic capacity** accounted for 20% of gross peak load, while **in 2025**, this figure had exceeded to **100%.**

Source: Mavir

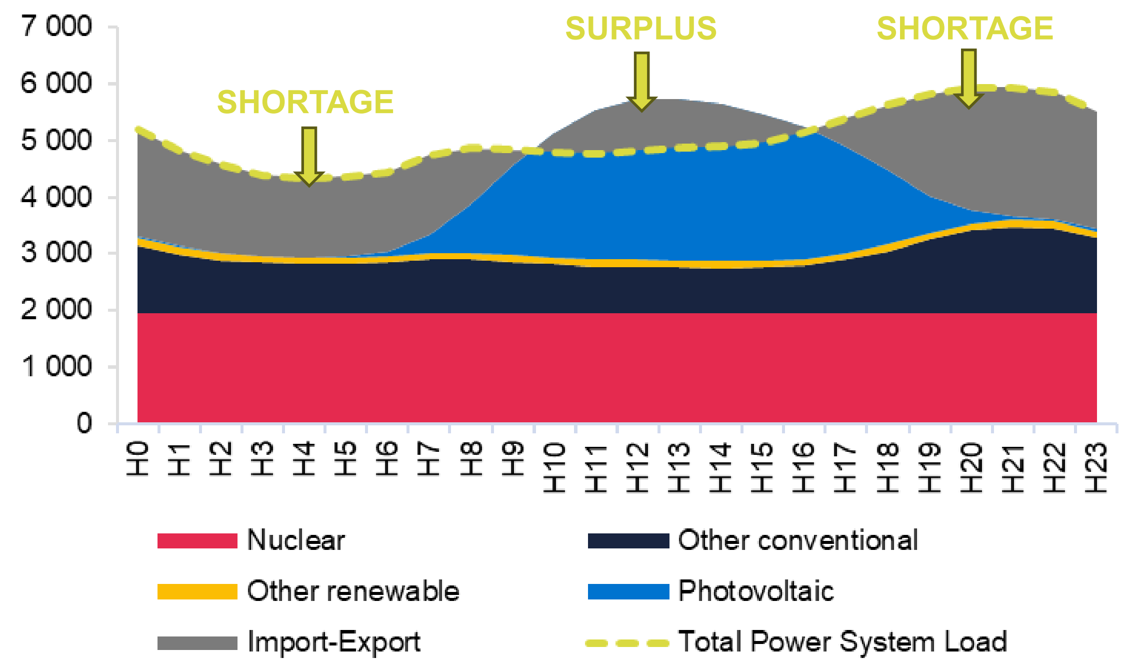
** based on data available as of 01/09/2025*

*** The values do not include the data of micro generation plant for households.*

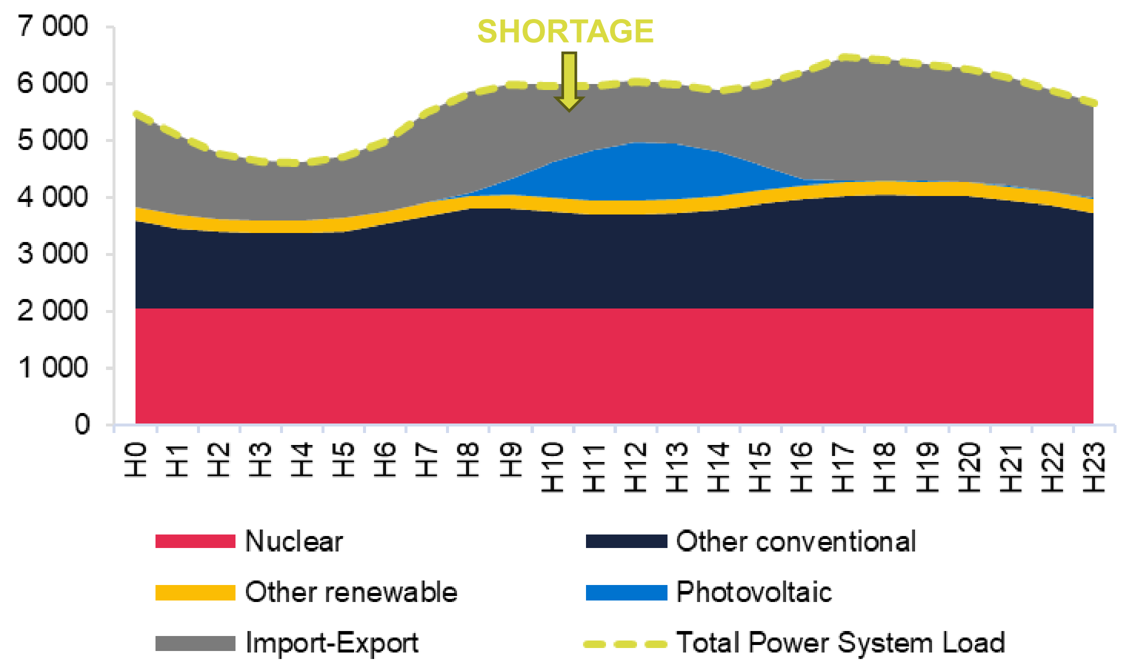
Electricity system | Hungary

The system load of renewable resources is weather-dependent, which can be seen in the difference between an average summer and winter day

Average daily gross system load, July 2024 (MW)



Average daily gross system load, December 2024 (MW)



- On an average day in July 2024, **between 10 a.m. and 4 p.m.,** renewable resources—which are mostly **photovoltaic power plants—generate more energy than the system load**.

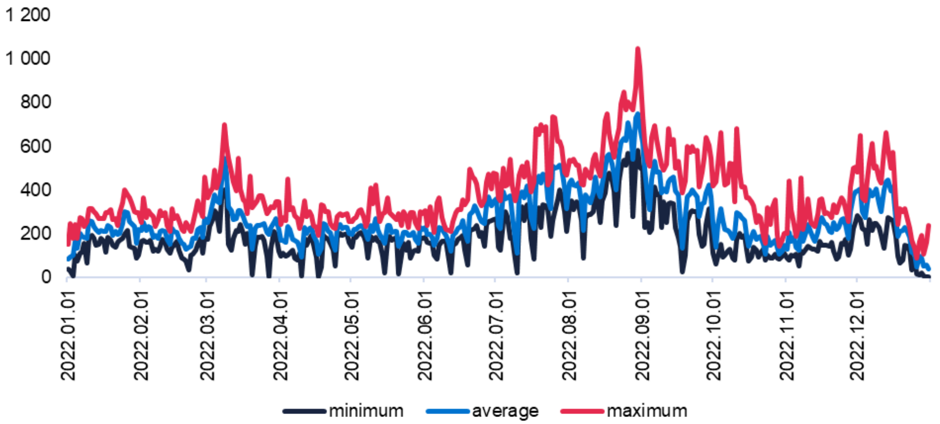
- However, **on an average winter day**, the installed capacity **cannot meet the demand**.
- A stable, predictable, and plannable energy system **requires solutions to seasonal and intraday fluctuations** caused by renewable energy sources.

Source: Mavir

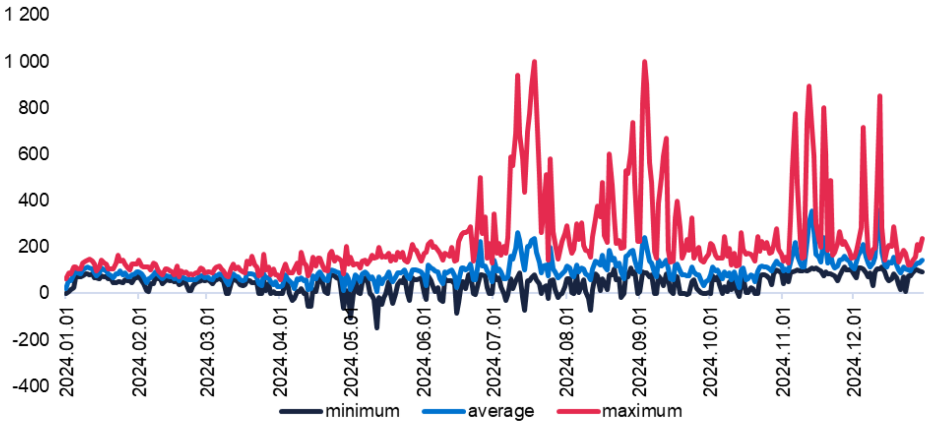
Impact of renewable energy on electricity prices

Weather-dependent energy sources increase the volatility of electricity prices

Daily min, average, and max hourly DAM prices (EUR/MWh)



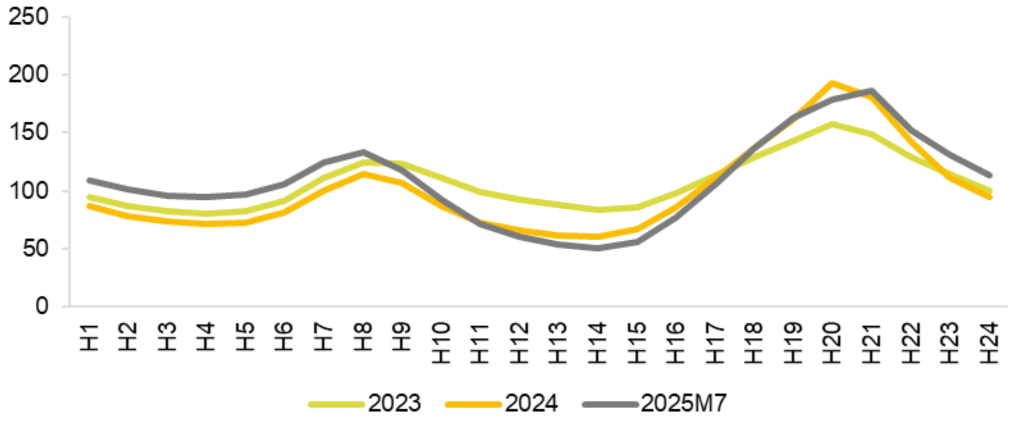
2022



2024

Source: HUPX

Annual average hourly DAM prices (EUR/MWh)



- The intraday volatility of DAM **electricity prices** show a trend of prices **rising between 8 and 9 a.m. and between 8 and 9 p.m.**, while they are lowest between 1 and 2 p.m.
- **Within a year, there are several periods when prices are significantly lower or higher than average.** However, no predictable trend that can be observed over several years is visible in these movements.
- **In 2023**, there were **19 days when negative prices were observed** on the market, **while in 2024**, this number rose to **56**. By the **end of August this year**, there had already been **50** such days.

The response

Solutions already exist to generate base load electricity from renewable sources - but subsidies are required to ignite them

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Alternative solutions

Technologies are needed that can generate green base load energy, or the role of renewables in the balancing energy market must be increased.

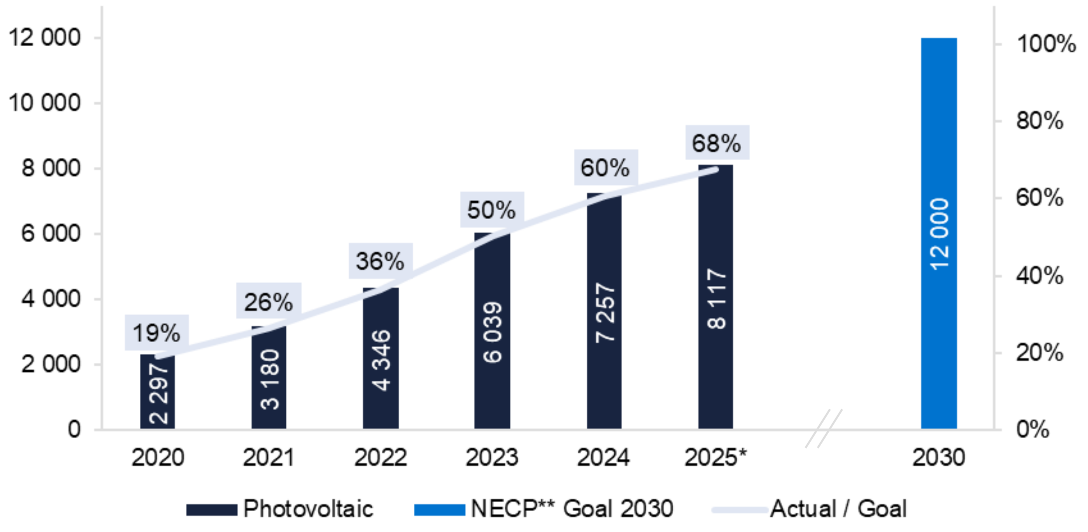
BESS	geothermal energy

ALTEO
GREENERGY
MET
MVM Zöld Generáció
MAVIR
MAGYAR VILLAMOSENERGIA-IPARI ÁTVITELI RENDSZERIRÁNYÍTÓ ZRT.

Electricity system | Hungary

Of Hungary's 2030 targets for installed capacity, solar power plants are much closer to being met than batteries

Gross installed photovoltaic capacity (MW)



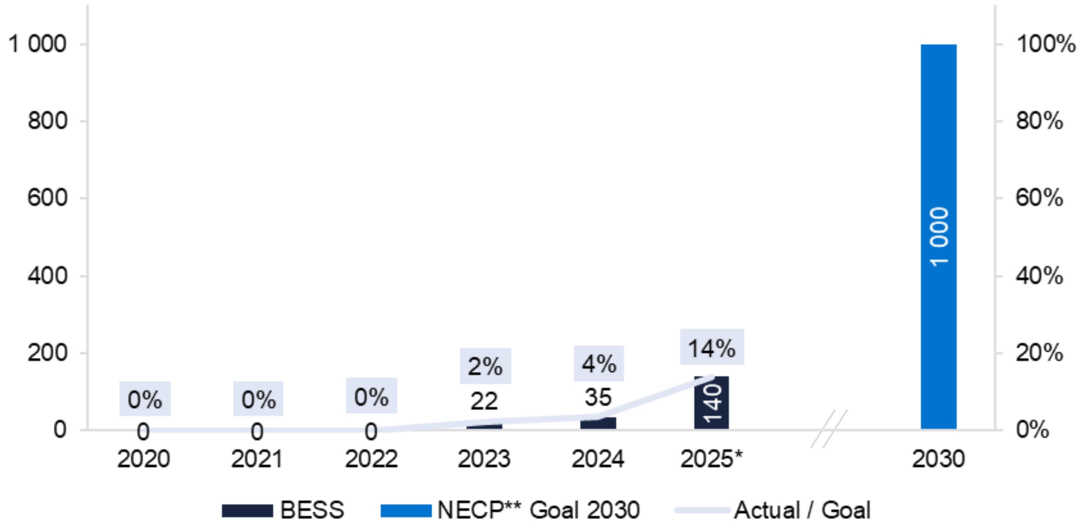
- Among renewable power plants, **photovoltaic power plants** are the most significant, with an **installed capacity of 8,117 MW by 2025**: this is **68% of the 12,000 MW target set for 2030**.
- The transition to solar energy helps achieve the decarbonization targets, but **its dependence on weather conditions has a significant impact on the demand and supply of electricity**.

Source: Mavir

** based on data available as of 01/09/2025*

*** National Energy and Climate Plan*

Gross installed BESS capacity (MW)



- Currently, the **installed capacity of the BESS** (Battery Energy Storage System) **is 140 MW**, which is **14% of the 1,000 MW target set for 2030**.
- Batteries **provide a solution to fluctuations caused by weather-dependent renewable energy sources** by storing the energy generated.
- The 52 **winners of the "METÁROLÓ" tender** closed in **2024 received support for the construction** of a total capacity **of 519 MW** by 2026.

BESS | Return calculations based on historic DAM prices

Simplified return calculations for stand alone BESS trading on DAM

Main assumptions of the calculation

- **10 MW / 20 MWh stand alone BESS** (no co-located solar power plant)
- **DAM trading** (no income from the balancing market aFFR +/-)
- With or without **transmission fee exception** (currently valid until end of 2026)
- Useful life of BESS between 8 to 12 years with **1 charging circle per day**
- **High-voltage grid connection**

Tested trading strategies

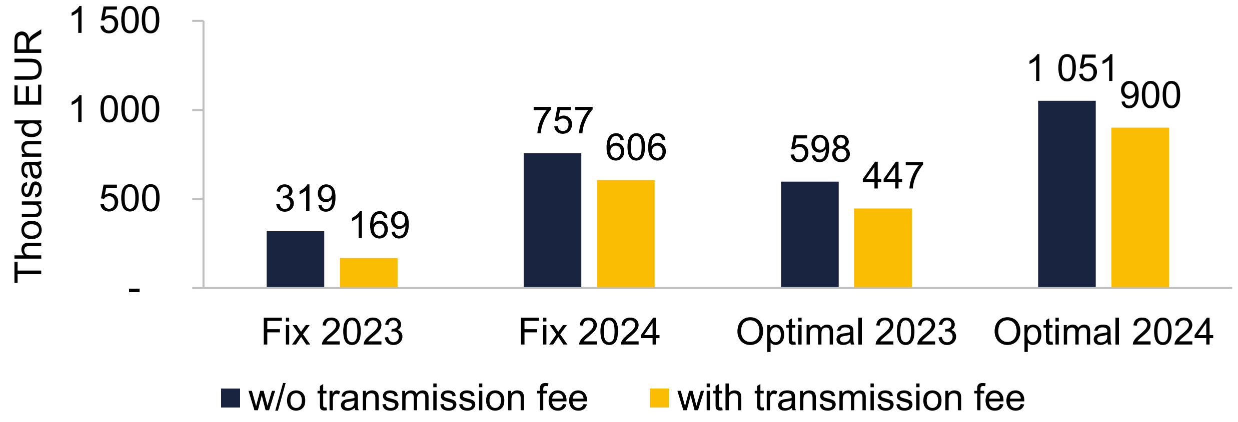
- **Fixed schedule:**
  - Charging from 12.00 pm
  - Discharging from 20.00 pm
- **„Optimal schedule”:**
  - Charging in the 2 lowest priced hour before 16.00 pm
  - Discharging in the 2 highest priced hour after 16.00 pm
- Trading results based on **2023 / 2024 DAM prices**

BESS | Return calculations based on historic DAM prices

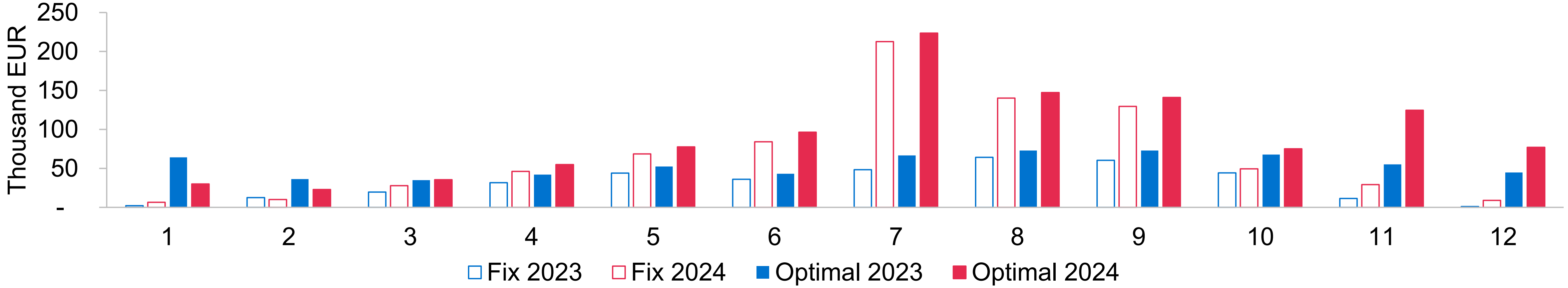
Simplified return calculations for stand alone BESS trading on DAM

- Significantly different DAM trading results with 2023 and 2024 prices
- Significantly different DAM trading results depending on the trading strategy

Result of DAM trading (with system usage fees)



Result of DAM trading by months (w/o system usage fees, thousand EUR)



BESS | Return calculations based on historic DAM prices

Simplified return calculations for stand alone BESS trading on DAM

Fix strategy, 2023 price level, w/o transmission fee

Project IRR		Useful life				
		8	9	10	11	12
CAPEX (EUR / MWh)	200 000	-15%	-12%	-10%	-8%	-6%
	250 000	-19%	-15%	-13%	-11%	-9%
	300 000	-21%	-18%	-15%	-13%	-11%
	350 000	-23%	-20%	-17%	-15%	-13%
	400 000	-25%	-22%	-19%	-16%	-14%
	450 000	-27%	-23%	-20%	-17%	-15%
	500 000	-28%	-24%	-21%	-18%	-16%

Optimal strategy, 2024 price level, w/o transmission fee

Project IRR		Useful life				
		8	9	10	11	12
CAPEX (EUR / MWh)	200 000	16%	17%	18%	19%	20%
	250 000	9%	11%	13%	14%	14%
	300 000	5%	7%	9%	10%	11%
	350 000	2%	4%	5%	7%	8%
	400 000	-1%	1%	3%	4%	5%
	450 000	-4%	-1%	1%	2%	3%
	500 000	-6%	-3%	-1%	1%	2%

Fix strategy, 2024 price level, w/o transmission fee

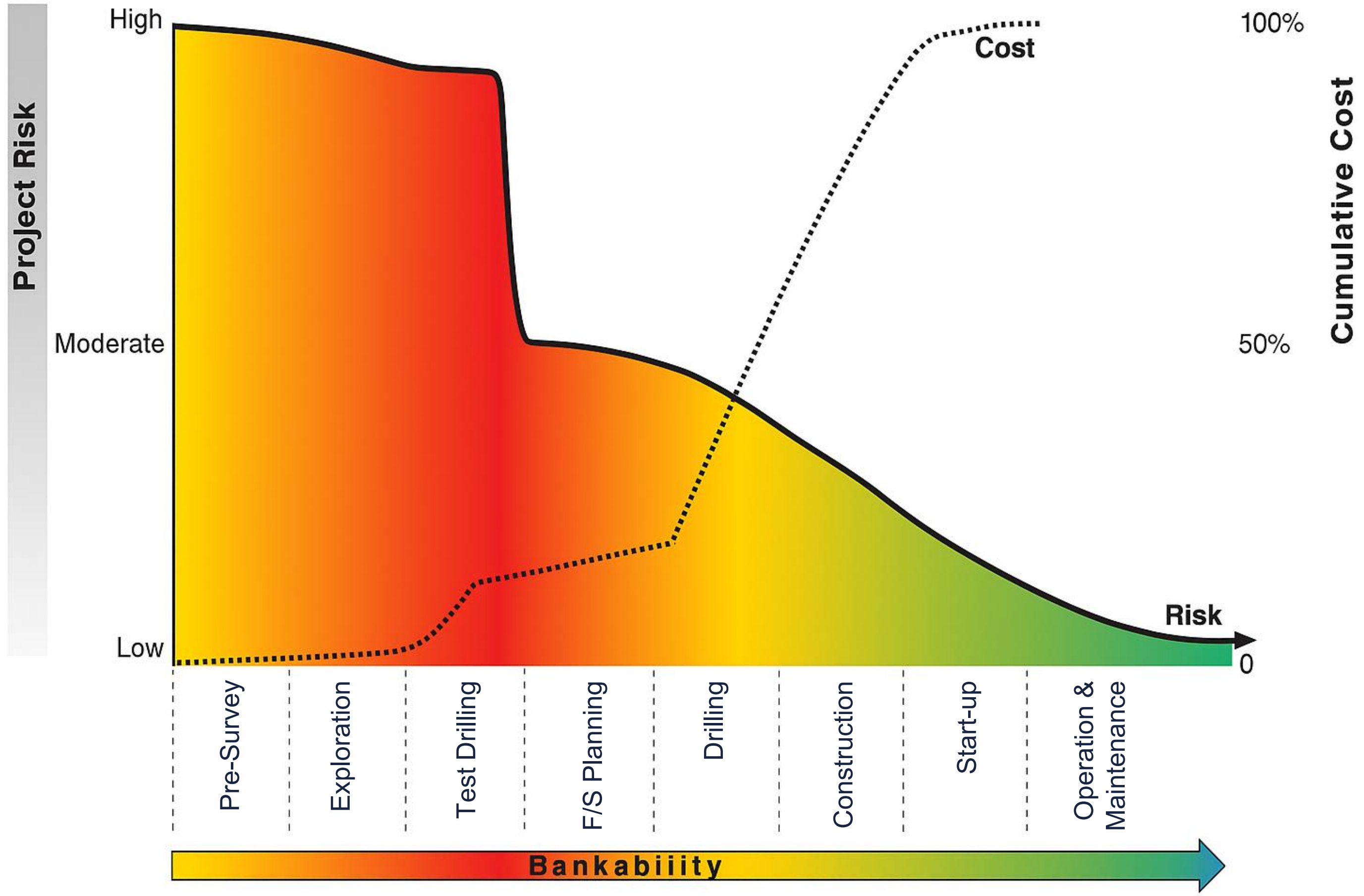
Project IRR		Useful life				
		8	9	10	11	12
CAPEX (EUR / MWh)	200 000	6%	8%	9%	10%	11%
	250 000	1%	3%	5%	6%	7%
	300 000	-3%	0%	2%	3%	4%
	350 000	-6%	-3%	-1%	0%	2%
	400 000	-9%	-6%	-3%	-2%	0%
	450 000	-11%	-8%	-5%	-4%	-2%
	500 000	-12%	-9%	-7%	-5%	-4%

Optimal strategy, 2024 price level, with transmission fee

Project IRR		Useful life				
		8	9	10	11	12
CAPEX (EUR / MWh)	200 000	11%	13%	14%	15%	16%
	250 000	5%	7%	9%	10%	11%
	300 000	1%	3%	5%	6%	7%
	350 000	-2%	0%	2%	4%	5%
	400 000	-5%	-2%	0%	1%	3%
	450 000	-7%	-4%	-2%	0%	1%
	500 000	-9%	-6%	-4%	-2%	-1%

Costs and risks of geothermal projects

Without state aid, geothermal projects have low returns due to high initial costs and risks



Project Risks

1. Resource/Exploration Risk
2. Financing Risk
3. Completion or Delay Risk
4. Operational Risk
5. Risk of Oversizing the Power Plant
6. Off-take and Price Risk
7. Regulatory and Institutional Risk

Available state aid in Hungary

- **Jedlik Ányos Energetic Program**
  - the total budget for the program is **41 billion forints**
  - the tender is under social consultation
  - Objective: to support **heat and electricity generation systems**

Thank you for your attention!

Any questions? Feel free to contact us:

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