ENERGY
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Visegrad Fund

# Energy Infrastructure Security During Climate Change-Induced Disasters in Hungary

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**Project:**
**"Energy Infrastructure Security During Climate Change-Induced Disasters"**

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REKK

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# 1 INTRODUCTION

The project, "Energy Infrastructure Security During Climate Change Induced Disasters", financed by the International Visegrad Fund, aims to strengthen Georgia's energy infrastructure resilience to climate change related natural disasters by sharing the experience and best practices of the Visegrad countries. Building on the EU-aligned regulatory, policy, and practical experience of Czechia, Hungary, Poland, and Slovakia, the project focuses on preparedness, risk mitigation, and climate resilience in the energy sector. Through applied research, joint analyses and recommendations, case studies, thematic articles, and interactive trainings delivered by Visegrad experts, the project supports capacity building and knowledge transfer tailored to Georgia's national and regional context, with the Guria region serving as a pilot area.

The project is implemented by the Elizbar Eristavi Energy Training Center NNLE, Georgia, in partnership with the following organizations:

- Association for International Affairs (AMO), Czechia
- REKK Foundation for Regional Policy Co-operation in Energy and Infrastructure (REKK), Hungary
- Institute of Urban and Regional Development (IRMiR), Poland
- Research Center of the Slovak Foreign Policy Association (SFPA), Slovakia

This case study has been developed within this project by REKK providing information on the lessons learned from the heat wave in Summer 2026 in Hungary and the lessons learned from the risk mitigation during the heat wave.

# 2 BACKGROUND

Climate change related natural disasters were not part of the Hungarian energy security policy dialogue before the summer of 2026. Hungarian population had little to no direct experience in the consequences of climate change in their daily life.

TSO-s and DSO-s had no major blackout events and those that happened (eg. due to frost of the wires or heavy wind) were mitigated within hours or a few days. Furthermore operational safety of the power system was good: the largest facility, the Paks nuclear power plant had during its 44 years of operation only one major malfunction in 2003[1] that resulted in a prolonged fallout of the 2. block.

Historically any fallout of larger power plants could be replaced by reserves or imports as Hungary has very good interconnectivity with neighbouring countries. The large share of imported electricity has been however discussed as a potential vulnerability of the system, but mainly from market perspective. There are substantial and in the last years growing differences in prices between Western and Eastern Europe. The potential mitigation options range from demand side measures (including demand shift with storage) to supply (adding more wind capacity) to the identification of bottlenecks in the TSO system of neighbouring countries. Last but not least the strengthening of the Hungarian grid requires also substantial investment, as grid scarcity is a barrier to connect more renewable production and increased consumption or prosumers to the grid.

In 2026 two major changes occurred. An agreement was reached with the European Commission on the conditions to access the EU funds that were previously frozen for Hungary. Part of these funds was earmarked for energy efficiency and grid development investments. Second, the Hungarian population for the first time witnessed the direct impact of climate change on their everyday life. Heat wave in Europe in summer 2026, drought, low water levels, scarcity in water supply for some Hungarian municipalities, wildfires and open official communication on the risk levels of the electricity system ruled the headlines and enforced behavioural changes from citizens.

The number one challenge was related to the summer heat wave, and it is a climate related challenge: water and energy supply of the country became scarce. Among the first priority tasks was to develop an emergency plan for the drought. Official communication was also directed to household consumers to rationalize their behaviour to support the system during the heat wave: on 25 June 2026 a public message was issued asking people to try to shift their consumption from the evening hours (between 18-21 pm) to earlier hours when PV production is producing close to zero price. The call reached the majority of the population, average citizens were informed about the call, and information about ways to reduce consumption were flooding the online press and the social media.

[1] https://www.parlament.hu/irom37/10849/10849.pdf

# 3 POWER SECTOR CASE STUDY

Hungary's electricity market has several distinctive characteristics that create unique challenges for system operation and market development.

The backbone of the Hungarian power system is the four-unit Paks Nuclear Power Plant, which provides approximately 2,000 MW of baseload generation capacity. System flexibility is primarily supplied by around 4200 MW of natural gas-fired power plants, complemented by biomass- and waste-fired generation as well as the Mátra lignite-fired power plant. However, due to rising EU ETS allowance prices and its ageing technology, the role of the Mátra plant in electricity generation has been gradually declining, as in 2025 only 3.5% of the country's electricity generation was coal-based[2]. Hungary has very limited hydropower resources. The country's geographical conditions are unsuitable for large-scale hydropower development, meaning that it has neither pumped-storage hydropower nor a significant conventional hydropower fleet.

With regard to variable renewable energy sources, Hungarian energy policy over the past decade has strongly favoured the deployment of solar photovoltaics (PV), while the development of new onshore wind capacity was effectively prevented through administrative restrictions. As a result, installed PV capacity exceeded 8 GW by 2025, whereas the country's installed wind capacity remained at only around 330 MW. This policy direction has recently begun to change and accelerated. While the deployment of new PV projects has become increasingly constrained because of network limitations, a target has been announced of initiating the development of approximately 4 GW of new onshore wind capacity by 2030. At the same time, Hungary is undergoing a significant expansion of grid-scale battery storage, as the deadline for MET ÁROLÓ support scheme's project completion is summer 2026. According to the NECP of Hungary[3] 1 GW of storage capacity is expected to be in operation until 2030.

One of the defining characteristics of the Hungarian electricity market is the combination of very high solar penetration and relatively limited system flexibility. During sunny summer days, the system frequently experiences periods of substantial oversupply around midday, resulting in very low wholesale electricity prices. In contrast, during the evening hours, when PV generation rapidly declines while electricity demand remains high, prices often increase sharply due to the combination of reduced available supply and strong demand.

Electricity demand of Hungary in 2025 reached 49.2 TWh[4], while domestic electricity generation amounted to 40.24 TWh[5]. Consequently, Hungary remains structurally dependent on electricity imports on an annual basis. Although total electricity consumption has increased only moderately in recent years, this growth has not been evenly distributed throughout the year.

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[2] https://ember-energy.org/data/electricity-data-explorer/?data=generation&temporal_res=yearly&entity=Hungary

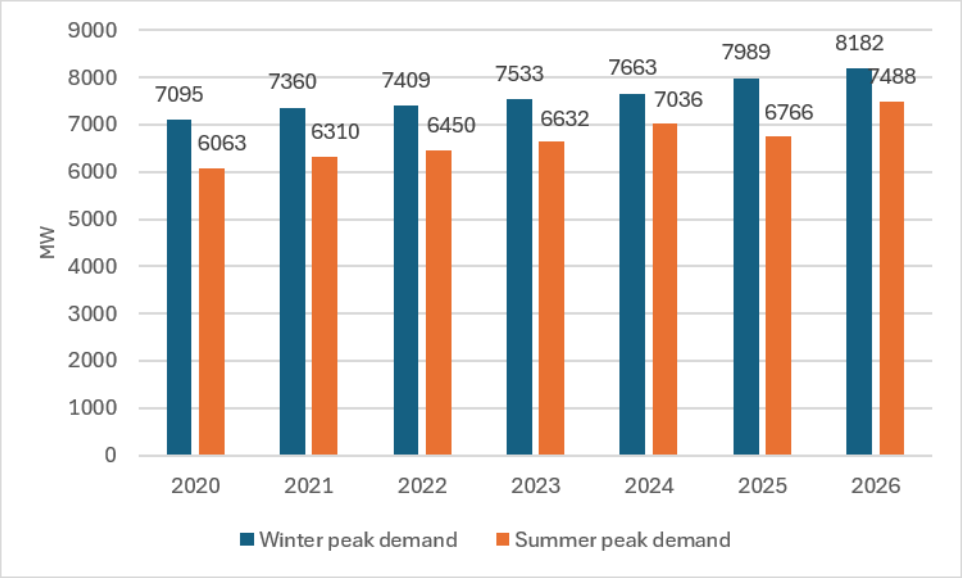
[3] https://commission.europa.eu/publications/hungary-final-updated-necp-2021-2030-submitted-2024_en

[4] https://ember-energy.org/data/electricity-data-explorer/?data=demand&temporal_res=yearly&entity=Hungary&fuel=total

[5] https://ember-energy.org/data/electricity-data-explorer/?data=generation&temporal_res=yearly&entity=Hungary

Driven by increasing electrification, both winter and summer peak demand have shown a clear upward trend, placing growing stress on the Hungarian power system during certain hours. Peak load data indicate that summer peak demand has been increasing more rapidly than winter peak demand since 2020, most likely due to the rapidly growing use of air conditioning. While the difference between winter and summer peak load was approximately 1,000 MW in 2020, this gap had narrowed to around 600 MW by 2026. Both winter and summer peak demand typically occur during the evening hours, when commercial and industrial electricity consumption remains relatively high while residential demand increases significantly as people return home from work. (1. Figure)

**1. FIGURE: WINTER AND SUMMER PEAK DEMAND IN HUNGARY 2020-2026**




*Source: Mavir, https://mavir.hu/web/mavir/rendszerterheles*

Both winter and summer peak periods can result in exceptionally high electricity prices. However, this case study focuses on summer peak events, as several additional factors further constrain system operation during these periods. First, the output of the Paks Nuclear Power Plant is frequently reduced because high river temperatures limit the availability of cooling water. Second, combined heat and power (CHP) plants, which provide an important source of dispatchable generation during the heating season, are only available to a limited extent during summer due to the absence of district heating demand and some also use the main rivers of Hungary as cooling water

High electricity prices during summer peak periods had already become a challenge for the Hungarian electricity market in 2024[6]. However, these issues became significantly more pronounced during the exceptional heatwave that affected the country at the end of June 2026, creating one of the most challenging operating conditions for the Hungarian power system in recent years.

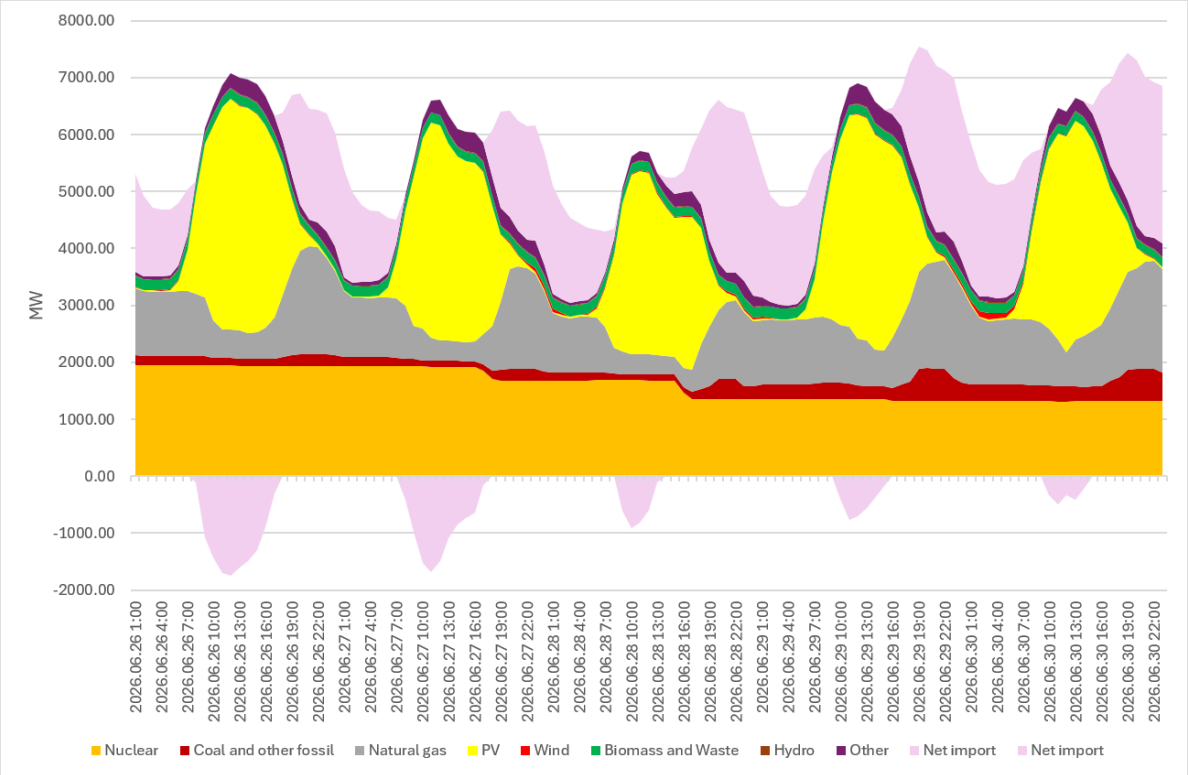
[6] https://rekk.hu/downloads/academic_publications/rekk_policybrief_hu_2024_02.pdf

On 26 June 2026, Hungary was hit by an extreme heatwave. The average daily temperature in the capital Budapest during June before 26th June was 22.0 °C, while the average daily maximum temperature was 27.23 °C. Between 26th June and the end of the month, however, the average daily temperature increased to 28.09 °C and the average daily maximum temperature reached 38.06 °C, representing exceptionally high values even by historical standards[7].

In response to the expected increase in electricity demand, Minister of National Economy and Energy, István Kapitány called on households on 25 June to reduce their electricity consumption between 18:00 and 21:00[8]. One of the main objectives of this case study is to examine how the Hungarian power system responded to this period of extreme heat and to assess whether the minister's appeal resulted in any measurable demand-side flexibility.

2. Figure presents the Hungarian electricity generation mix during the heatwave with hourly resolution. In the early days of the heatwave, a typical summer generation pattern can be observed on each day. During the morning and evening hours, Hungary was a net importer of electricity and domestic gas-fired power plants played an important role in meeting demand. Around midday, however, photovoltaic (PV) generation almost completely displaced gas-fired generation, and Hungary temporarily became a net exporter due to the high level of solar production.

**2. FIGURE: ELECTRICTY MIX OF HUNGARY IN THE HEATWAVE**




*Source: MAVIR, https://www.mavir.hu/web/mavir/energia-mix-eromuvi-termeles-primer-forrasok-szerinti-megoszlasa-es-az-import-export-szaldo-brutto-uzemiranyitasi-meresek-alapjan*

[7] https://www.timeanddate.com/weather/hungary/budapest/historic?month=6&year=2026

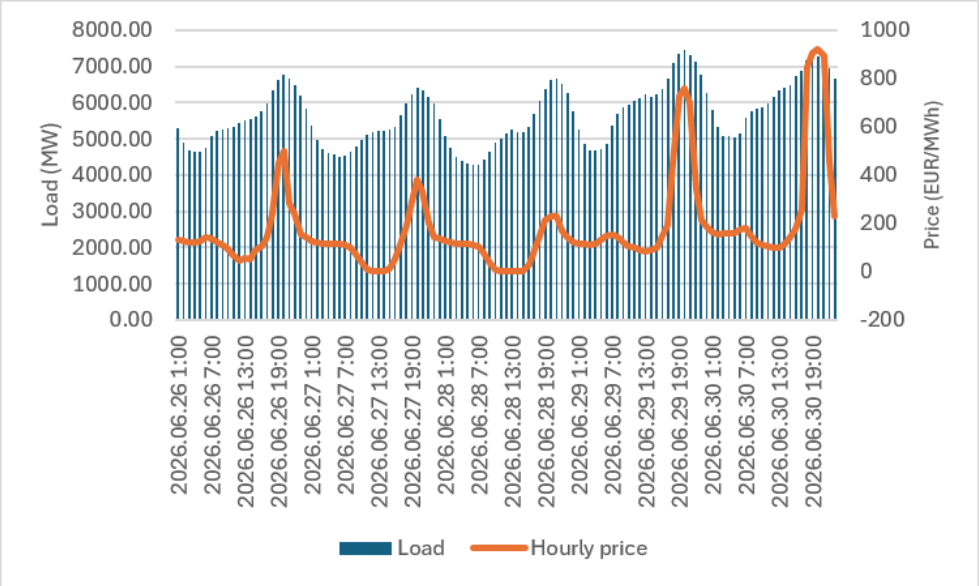
[8] https://hvg.hu/itthon/20260626_kapitany-istvan-azt-keri-aki-teheti-este-hat-es-kilenc-kozott-ne-kapcsolja-be-a-legkondit

The first day of the heatwave (Friday, 26th June) brought only moderately extreme weather conditions, which proved favourable from a system operation perspective, as electricity demand is typically lower on Fridays and especially during weekends. This pattern was also evident during the analysed period: although the heatwave intensified on Saturday, no exceptional increase in system load occurred because of the reduced weekend demand. The most challenging days for the power system were Monday and Tuesday, when the highest temperatures coincided with normal working days. On the 29th and 30th of June it is visible that the generation pattern changes as well. Even in midday there is significant natural gas-based production present, and the net export values are significantly lower too. In the evening hours coal and oil-based production also became relevant in the system.

The extreme temperatures also affected the available generation capacity. Due to the unusually warm cooling water of the Danube, the output of the Paks Nuclear Power Plant had to be reduced below its theoretical maximum of approximately 2,000 MW. At 16:00 on 27 June, nuclear generation fell to around 1,700 MW, and by the following day it had decreased further to approximately 1,350 MW. Consequently, for a significant part of the analysed period, roughly one-third of Hungary's nuclear generation capacity was unavailable, substantially increasing the stress on the power system.

Although temperatures were already very high on Saturday (27th) and Sunday (28th), system load during those hours remained relatively moderate due to the weekend. Consequently, electricity prices were not exceptionally high on those two days. In contrast, system load increased significantly on Monday and Tuesday (29th and 30th), resulting in extremely high electricity prices. (3.Figure)

**3. FIGURE: HOURLY LOAD AND WHOLESALE ELECTRICITY PRICE IN THE HEATWAVE**



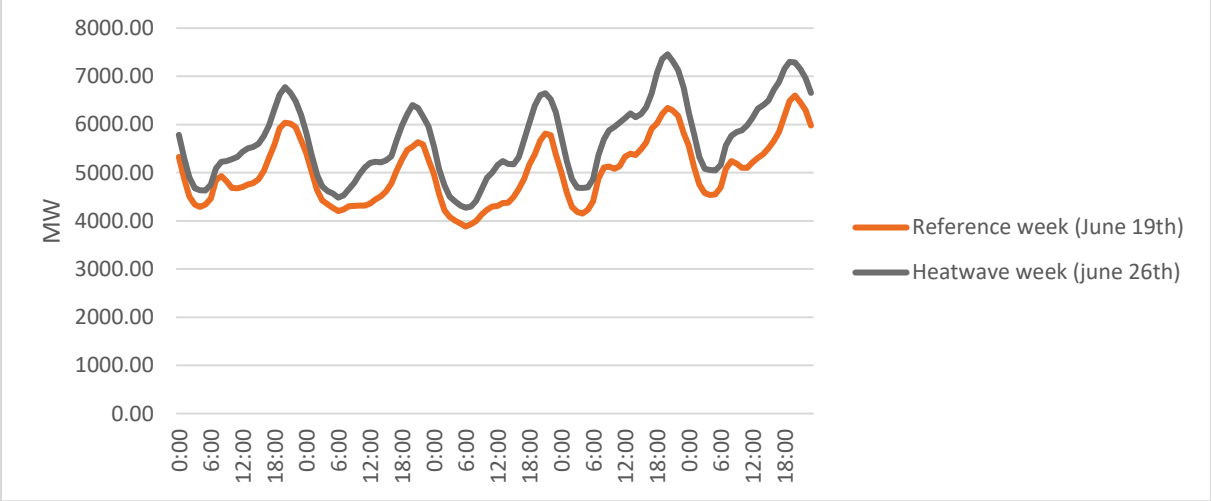

*Source: MAVIR & Ember: https://ember-energy.org/data/european-wholesale-electricity-price-data/ ; https://mavir.hu/web/mavir/rendszerterheles*

As the final part of the case study, we analyse whether the statement by Economic and Energy Minister István Kapitány had any observable impact on household electricity consumption. On 26 June, during the heatwave, the minister called on the population to reduce electricity consumption between 18:00 and 21:00, particularly by limiting the use of air conditioning and

postponing the charging of electronic devices and the operation of energy-intensive household appliances.

The heatwave lasted from 26 to 30 June, covering a Friday-to-Tuesday period. To draw meaningful conclusions about potential changes in consumer behaviour, we compare electricity consumption during this period with the corresponding Friday-to-Tuesday period one week earlier, from 19 to 23 June. This provides a useful reference period, as the preceding week was also characterised by very high temperatures. Comparing the two periods therefore allows us to assess whether there was any noticeable change in household electricity consumption following the minister's call, while reducing the influence of differences in weather conditions and the day-of-week composition.

**4. FIGURE: HOURLY LOAD VALUES ON THE REFERENCE WEEK AND THE HEATWAVE WEEK**




*Source: MAVIR: https://mavir.hu/web/mavir/rendszerterheles*

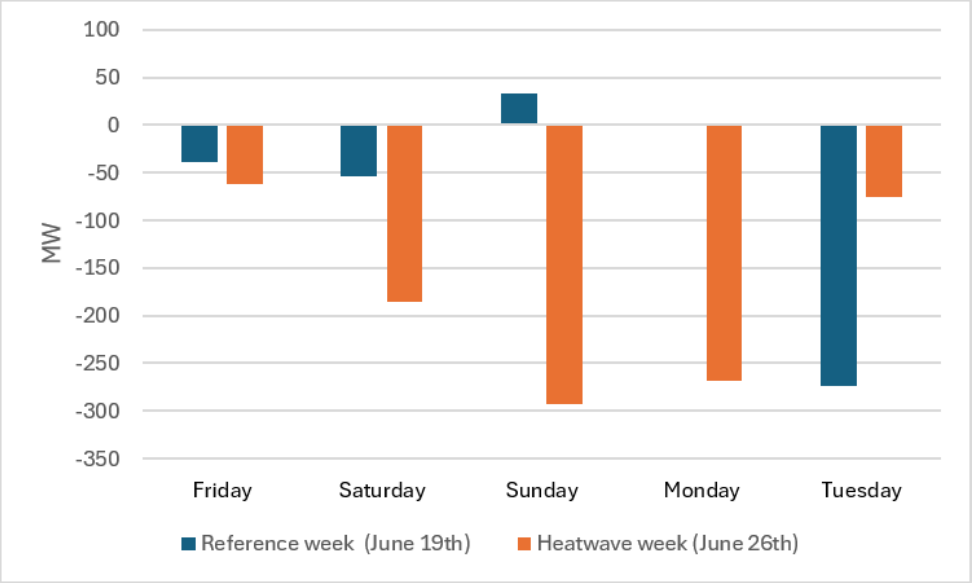
4. Figure shows the evolution of hourly electricity load in the reference week and the heatwave week. The data show that the load follows a very similar pattern in both periods, with load levels consistently higher during the heatwave week, reflecting the higher temperatures and the associated increase in electricity demand, particularly for cooling.

To capture any potential effect of Minister Kapitány's call for voluntary electricity consumption reductions, we compare the difference between day-ahead forecast load and actual load in the reference week and the heatwave week. If households responded to the minister's call by voluntarily switching off electrical devices or postponing the use of electricity-intensive appliances, actual electricity consumption between 18:00 and 21:00 during the heatwave week would be expected to be lower than the day-ahead forecast. This would result in a larger negative deviation between actual and expected load than would otherwise be observed. On the other hand, no comparable behavioural response related to the minister's statement would be expected in the reference week. Therefore, if the difference between expected and actual load during the 18:00–21:00 period is systematically larger in the heatwave week than in the reference week, this could provide an indication that households responded to the minister's call by reducing their electricity consumption.

5. Figure shows that during the analysed period, actual electricity consumption exceeded the day-ahead forecast in both the reference week and the heatwave week in most of the days. This

indicates that households consumed more electricity than MAVIR had forecast one day in advance. During the heatwave week, actual consumption was higher than the forecast on every day between 18:00 and 21:00. Comparing the two weeks, we observe that, with the exception of Tuesday, the difference between forecasted and actual consumption was consistently smaller in the reference week than in the heatwave week. In other words, during the heatwave week, actual electricity consumption exceeded the day-ahead forecast by more than during the corresponding period of the reference /week.

**5. FIGURE: AVERAGE DIFFERENCE BETWEEN THE HOURLY DAY AHEAD FORCASTED AND ACTUAL LOAD OF THE REFERENCE WEEK AND HEATWAVE WEEK BETWEEN 18:00 AND 21:00**




*Source: MAVIR: https://mavir.hu/web/mavir/rendszerterheles*

These results indicate that Minister Kapitány's call had little to no observable impact on household electricity consumption during the analysed heatwave period. The comparison suggests that voluntary, behaviour-based adjustments in electricity consumption were insufficient to produce a measurable reduction in demand during the targeted evening hours. This indicates that relying on voluntary behavioural changes alone is unlikely to provide a robust long-term solution for managing peak electricity demand in the Hungarian energy system.

# 4 CONCLUSIONS AND POLICY GOALS

The Hungarian and regional power system has developed in the last 10 years substantial PV capacity, that is dominating the daily production pattern of the country especially in the heat wave days. The change in production is accompanied by increased cooling demand, that is driving electricity demand upwards. These simultaneous effects result in exports in the mid-day hours around noon and in imports in the evening peak hours. The price of electricity within the day largely varies (from – 500 €/MWh by noon to ~900 €/MWh in the evening) as in the evening hours gas power plants set the prices.

The immediate challenge of the system in the 2026 June heat wave was addressed by a call to the households demanding voluntary behavioural change. According to our case study this has not resulted in any measurable demand reduction, even though awareness of the problem reached unprecedently wide outreach in media. Still many praise the fact that the population has been addressed as an "adult", pointing to the need to communicate about serious technical problems and system challenges honestly.

The need for price incentives is clear also in the household segment. To introduce any kind of within day tariff system a massive smart meter rollout must be started, the grid needs to be strengthened, building stock energy efficiency must be improved. The RRF funds were renegotiated. At least EUR 856,756,163.36 from the investment in the program coming from the Recovery and Resilience Facility must contribute to climate-related objectives, and at least EUR 342,702,465.34 must contribute to the digital transition[9].

RRF-10.6.-26 1. component: Development and digitalization of the power grid, 228 563 832 473 Ft (2026.07.28) MFB Hungarian Development Bank. Goal: The transmission and distribution grids are being developed or upgraded in a way that integration of a minimum capacity of 2 781 MW is ensured.

An RRF call (RRF-GS-6.7.1-26[10]) launched in July 2026 assigns 26.6 billion forint to buy and install smart meters. Applicants are the electricity DSO's[11] with a 100% RRF support. Goal is 290 680 smart meters installed by the DSOs by the end of 2026[12]. Other programs launched and to be closed by end of 2026: For the 2026-2030 auction period at least 4 GW wind has to be enabled to connect to the grid. 700 MW wind capacity has to auctioned by 31 Aug 2026. Furthermore 676 MWh grid storage capacity must be installed.

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[9] MELLÉKLET a következőhöz: Javaslat A TANÁCS VÉGREHAJTÁSI HATÁROZATA a Magyarország helyreállítási és rezilienciaépítési terve értékelésének jóváhagyásáról szóló, 2022. december 15-i végrehajtási határozat módosításáról at: https://op.europa.eu/en/publication-detail/-/publication/9ae9a221-90e1-11f1-9262-01aa75ed71a1/language-hu

[10] https://www.palyazat.gov.hu/kozlemenyek/megjelent-az-okos-villamosenergia-fogyasztasmerok-beszerzesenek-es-telepitesenek-tamogatasa-cimu-rrf-gs-6-7-1-26-kodszamu-felhivas

[11] E.ON Dél-dunántúli Áramhálózati Zrt., E.ON Észak-dunántúli Áramhálózati Zrt., OPUS TITÁSZ Áramhálózati Zrt., ELMÜ Hálózati Kft., MVM ÉMÁSZ Áramhálózati Kft., MVM DÉMÁSZ Áramhálózati Kft.

[12] RRF-6.7.2-26 F component: Smart metering, development and digitalization of the power grid 304 431 167 527 Ft