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EXPRESS

Regional context assessment

Hajdú-Bihar County

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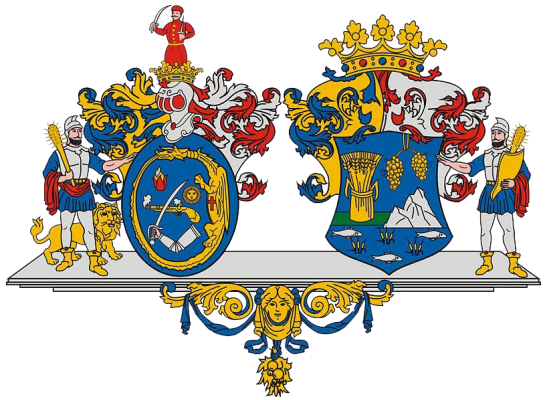

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Where we are?

Challenges

- necessity to increase the self-sufficiency of the county (62% of greenhouse gas emissions come from energy consumption emissions, with households and public buildings accounting for a significant share)
- applicable methods, new approaches, potential new structures and basically an overall guidance how to achieve such objectives at regional and local levels
- production and local use of renewable alternative energy should be promoted especially in disadvantaged areas

necessary to assess the extent to which the potential of the wider area is being exploited in the districts (solar, geothermal, biomass, etc.)

in which areas their use can be economically and environmentally sustainable

Current situation

- Adverse effects of climate change to a greater extent than the national average (droughts, weather extremes, inland water)

- Strong need to change: residential, public and commercial energy use, transport, agriculture, waste management

- Climate efforts are strongly supported by the Climate Strategy

Largest potential

The SW part of the county is the most favourable area: global irradiance can reach 1300 kWh/m2/year
Towards the north and east, this value decreases slightly, but even in the worst areas it reaches 1 250 kWh/m2/year

Optimal biomass potential is available in the area, mostly in agriculture by-products and to a lesser extent, from herbaceous energy crops

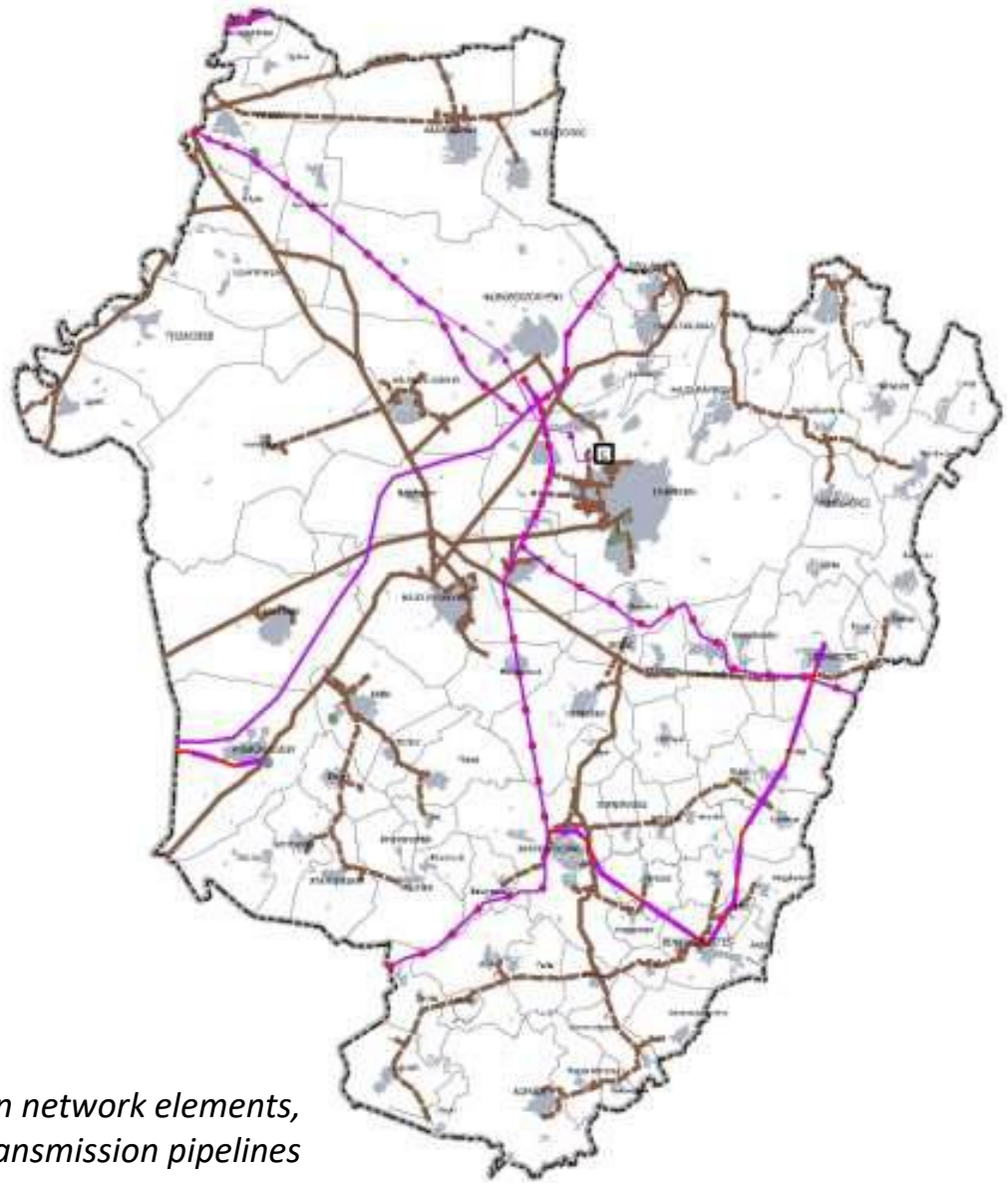
Significant geothermal potential: 111 registered operating hot water wells, of which 38 produce water warmer than 60 °C. A number of barren hydrocarbon wells in the county have been assessed as suitable for conversion to geothermal wells; there are 30 exploitable barren hydrocarbon wells in the county, with a probable water temperature of 90°C at depths of 1,400 to 1,600 m.

Current energy sector operational environment

- The power plant structure is **in transition**
- The energy density of RES and the production potential are **moving towards a dispersed structure** of smaller production units, i.e. towards decentralised energy production
- Power plant categories: in the Hungarian electricity system, MAVIR Hungarian Independent Transmission Operator Company differentiates between the following **power plant categories**
  - A fundamental distinction is made between small power plants below 50 MW and large power plants with a capacity of 50 MW and above
  - In the categories below 50 MW, it further distinguishes between small power plants with a capacity of 500 kW to 50 MW, 50 kW to 500 kW and below 50 kW
- The vast majority of the **electricity** demand in Hajdú-Bihar County is **generated outside** the county boundaries and is supplied to the county's consumers via high voltage grids
- **Heat** generation is characterised by individual heating systems, mostly based on **natural gas and solid biomass** (firewood)
- Natural gas is supplied through the gas pipeline network, mainly from imports, while 20% of the domestic demand can be supplied by Hungarian production
- The **hydrocarbon deposit** near Hajdúszoboszló (Gólyás) is located within the county, which has been fully exploited since its discovery, and due to its favourable geological structure, it is currently used as one of our gas reservoirs for the storage of imported gas
- Among the settlements of the county, district heating systems based on natural gas are in operation in Hajdúnánás, Hajdúböszörmény, Debrecen, Püspökladány and Berettyóújfalu
- The transport sector is dominated by **rail and road transport**
  - The energy demand for road transport is mainly covered from **imported oil**
  - The majority of vehicles are petrol and diesel powered, but the number of alternative propulsion vehicles – mainly **hybrids, plug-in hybrids, pure electric vehicles** – is quickly **increasing**
  - There are also a small number of vehicles running on LPG
  - **Rail** transport uses **electricity and diesel**, depending on whether the line is electrified or not

Current energy sector operational environment

- At present, a **power plant** is operating in Debrecen in the county, using natural gas as fuel
- Other important elements of the energy supply are the international and domestic **hydrocarbon transmission pipelines** crossing the county
- Almost all households in the county are connected to the **electricity system**
- Gas networks have been installed **in all the municipalities** in the region
- Natural gas transported on the pipeline system is released at the **gas transfer stations** of the transmission system

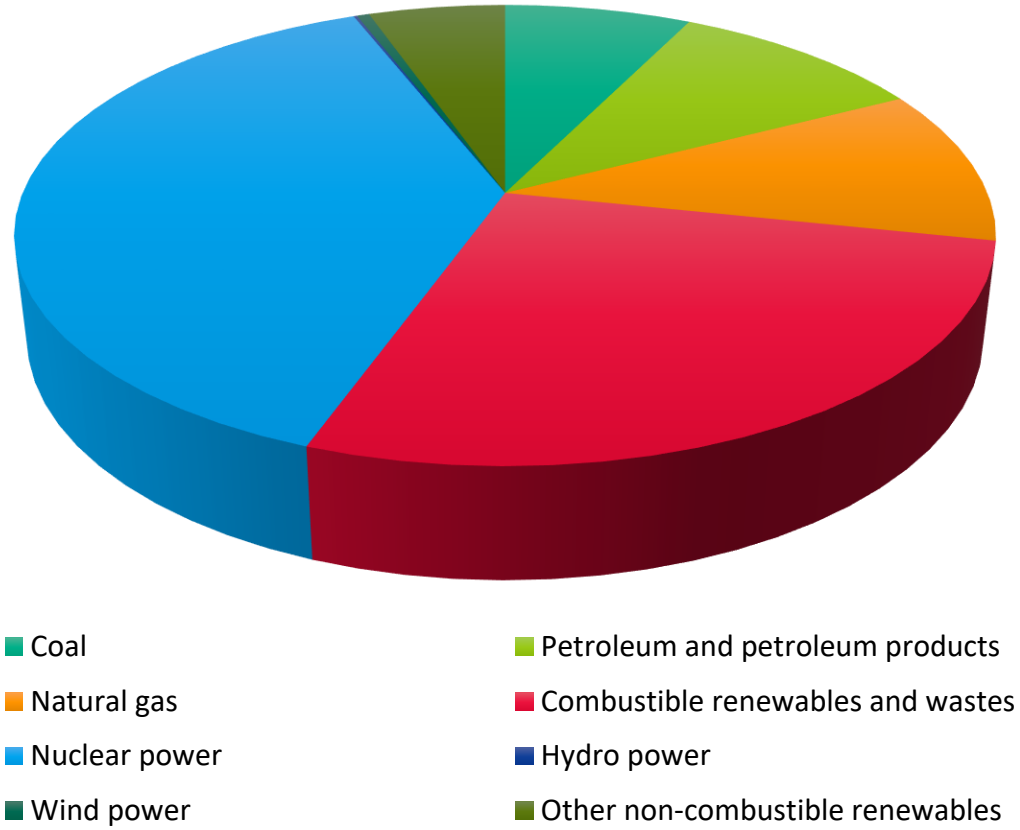


Major electricity transmission and distribution network elements, natural gas and oil transmission pipelines

Sources of energy - general

Production of primary energy in Hungary in calorific values (PJ), 2022

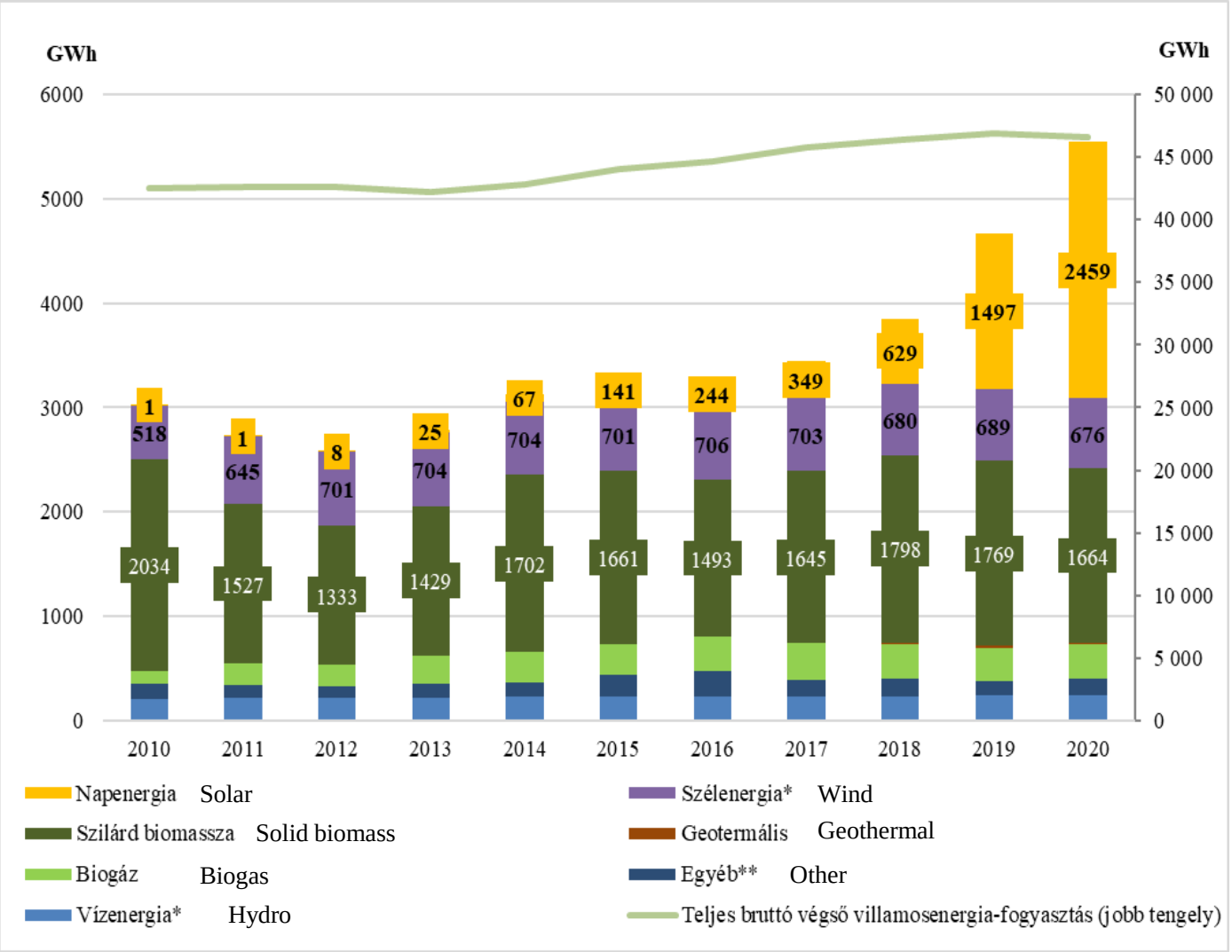
Total: 449,4 PJ in 2022



Sources of energy - renewable

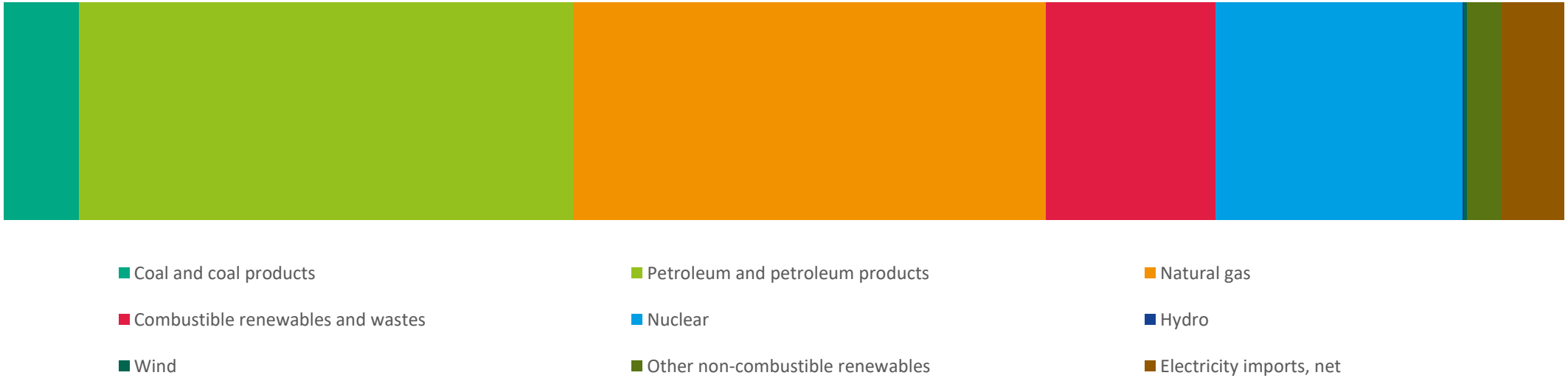
Gross electricity generation, Hungary

- 2020: total of 5,548 GWh of electricity was produced in Hungary using renewable energy sources (increase of 18.73% compared to 2019)
- Solar electricity generation increased significantly by more than 60% (44% of the renewable electricity generation)
- Electricity generation from biodegradable municipal waste increased by 21.9%
- Electricity generation from hydropower and biogas increased slightly (+0.13% and +0.91% respectively)
- Electricity generation from geothermal (–11.11%), wind (–1.89%) and solid biomass (–5.94%) decreased



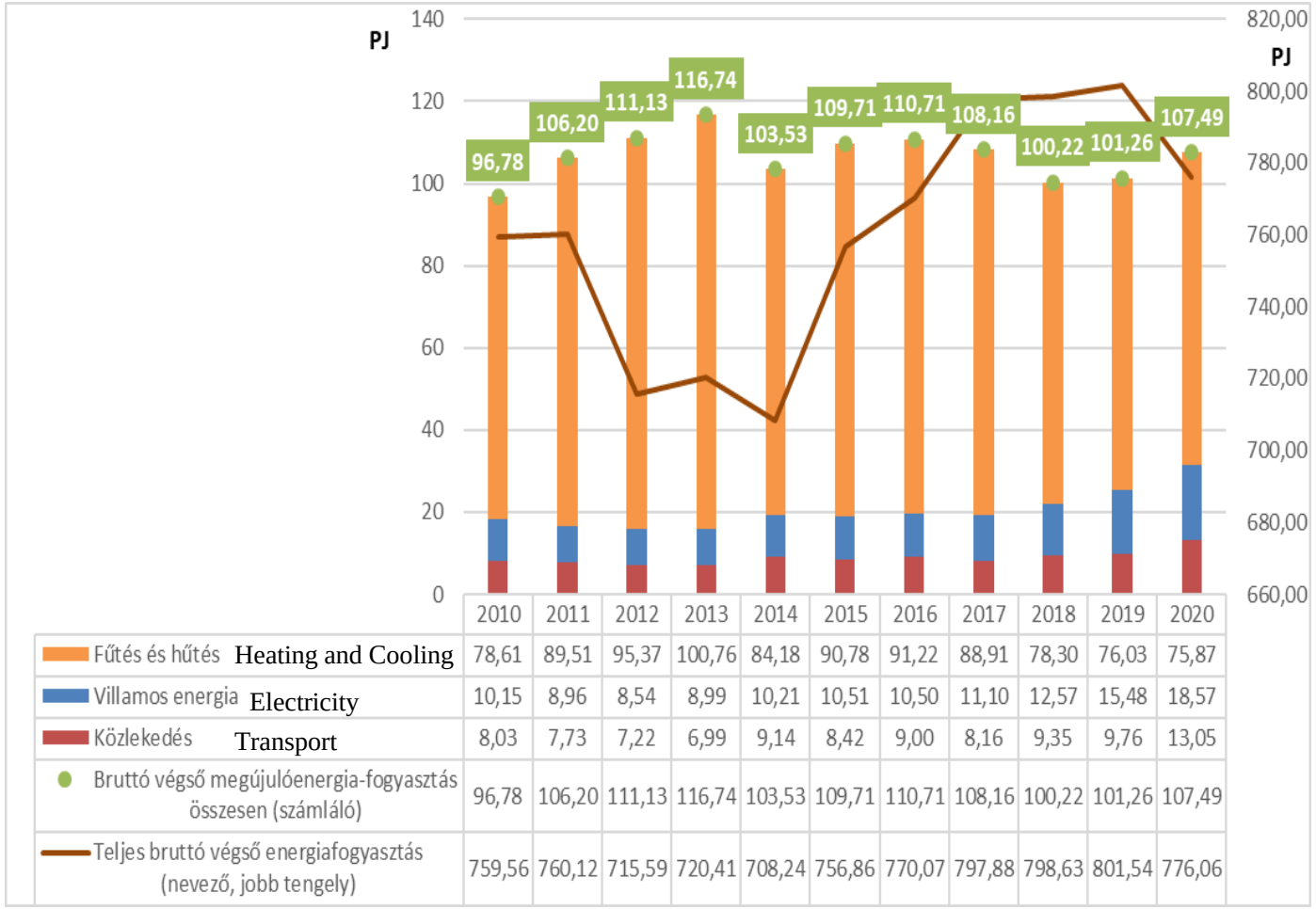
Sources of energy - consumption

Structure of primary energy consumption (%) in Hungary



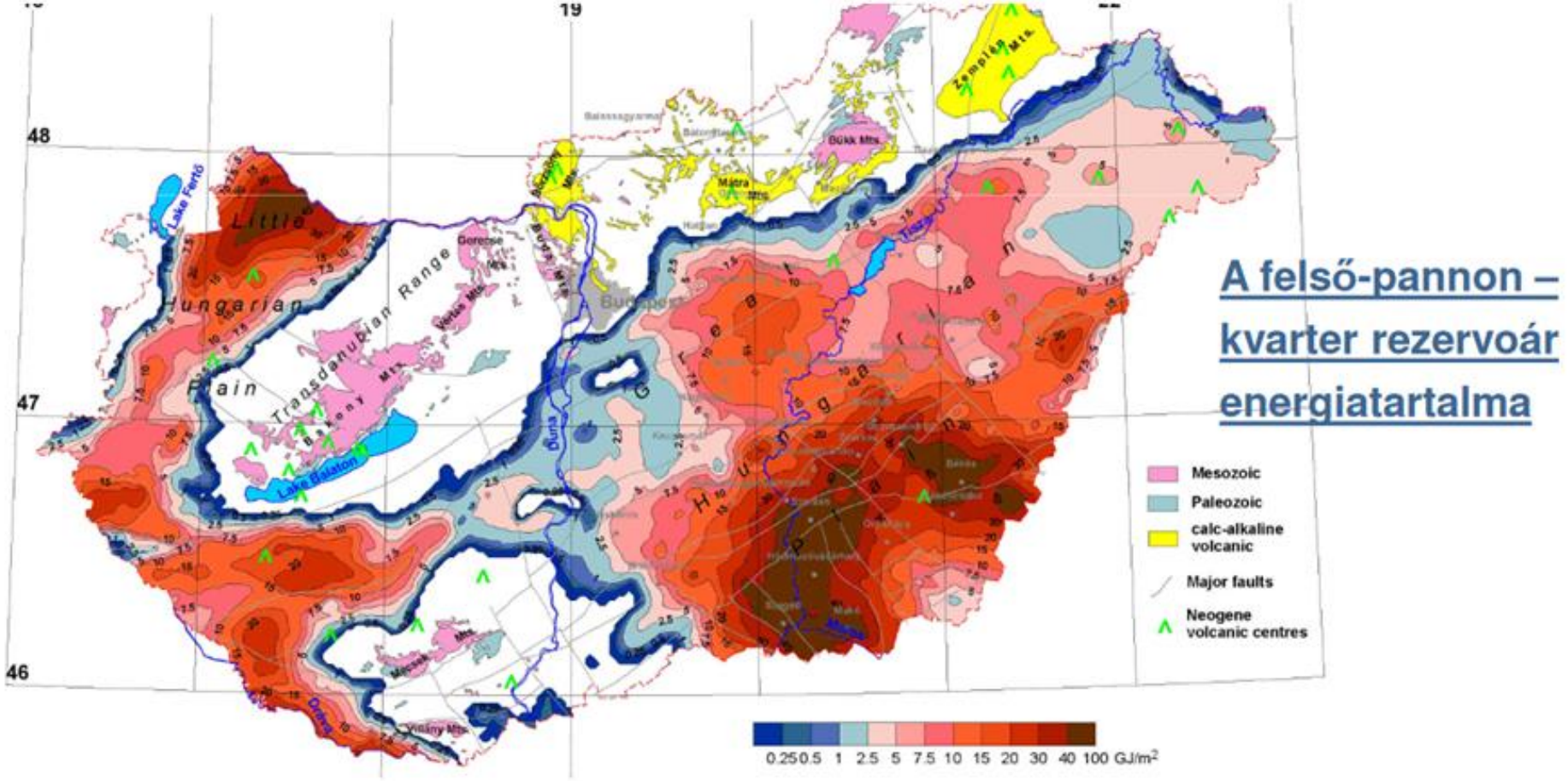
Sources of energy - consumption

- Total **gross final energy consumption** in Hungary from all domestic energy sources amounted to **776.06 PJ** in 2020
- The gross final consumption of energy from **renewable** energy sources was **107.49 PJ**, which represents a renewable share of 13.85% of the gross final energy consumption.
- The largest share of energy consumption from renewable energy sources continues to be in from **heating and cooling** sector (70.59% in 2020) (decreasing since 2016)
- At the same time, however, the share of renewable electricity is increasing, accounting for **17.27% of total renewable energy consumption in 2020**
- The share of renewable energy for transport is also increasing (**12.14% in 2020**).



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fűtés és hűtés Heating and Cooling	78,61	89,51	95,37	100,76	84,18	90,78	91,22	88,91	78,30	76,03	75,87
Villamos energia Electricity	10,15	8,96	8,54	8,99	10,21	10,51	10,50	11,10	12,57	15,48	18,57
Közlekedés Transport	8,03	7,73	7,22	6,99	9,14	8,42	9,00	8,16	9,35	9,76	13,05
Bruttó végső megújulóenergia-fogyasztás összesen (számláló)	96,78	106,20	111,13	116,74	103,53	109,71	110,71	108,16	100,22	101,26	107,49
Teljes bruttó végső energiafogyasztás (nevező, jobb tengely)	759,56	760,12	715,59	720,41	708,24	756,86	770,07	797,88	798,63	801,54	776,06

Sources of energy – geothermal asset



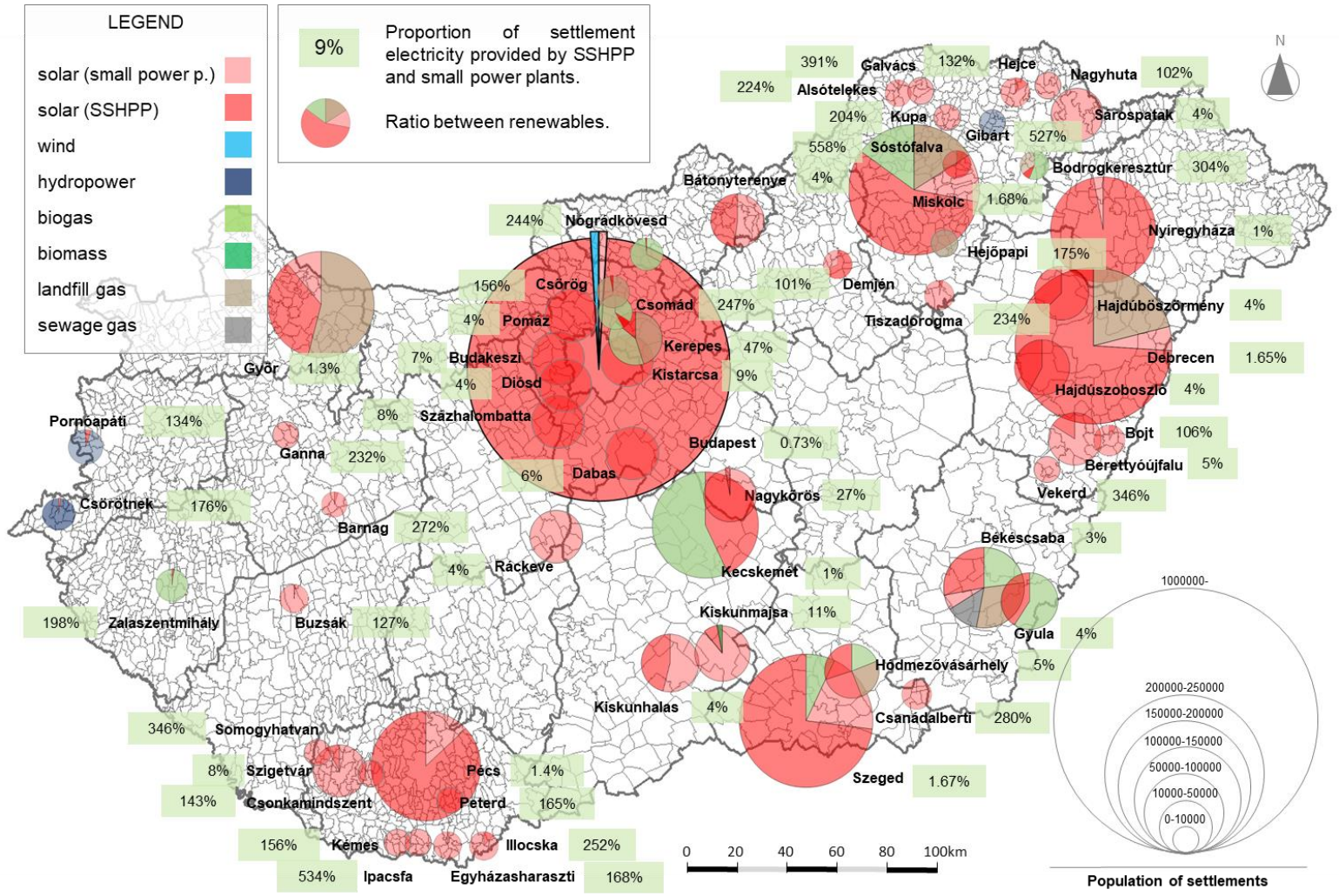
The Upper Pannonian-Quaternary reservoir of fractured sedimentary rocks has a maximum depth of ~2500 m. At this depth, the temperature is 100-120 °C. It accumulates significant geothermal energy over large parts of the country.

Level of energy self-sufficiency

- Data on the level of energy self-supply in settlements is available until 2017
- At that time, there were around 29,000 household-scale power plants (HPPs) in operation in the country, with a total installed capacity of 240 MW
  - 99.7% were solar power plants
  - If their estimated electricity generating capacity is taken into account, in 2017 there were four settlements in Hungary that generated more electricity from the HPPs within their own territory than their annual electricity consumption
  - Each of these four settlements is a village with a small population
  - In the category between 10,000 and 100,000 inhabitants, the highest renewable share produced by HPPs is 26%, while the highest share produced by settlements with more than 100,000 inhabitants is 1.26% - in Hajdú-Bihar county, there were no settlements in the top 20 in each of the above two categories
  - The share of electricity produced by the HPPs in Debrecen, the county seat, was 1.22% (Table 3).
- Among the settlements with the highest renewable share, a village in Hajdú-Bihar is also represented
  - Vekerd - where the solar power plant produces 346% of the local electricity consumption
  - Berettyóújfalu, Hajdúböszörmény and Hajdúszoboszló are also found with a renewable share between 4 and 2%
  - In Debrecen, 0.44% of the city's electricity consumption came from the production of these power plants

Level of energy self-sufficiency

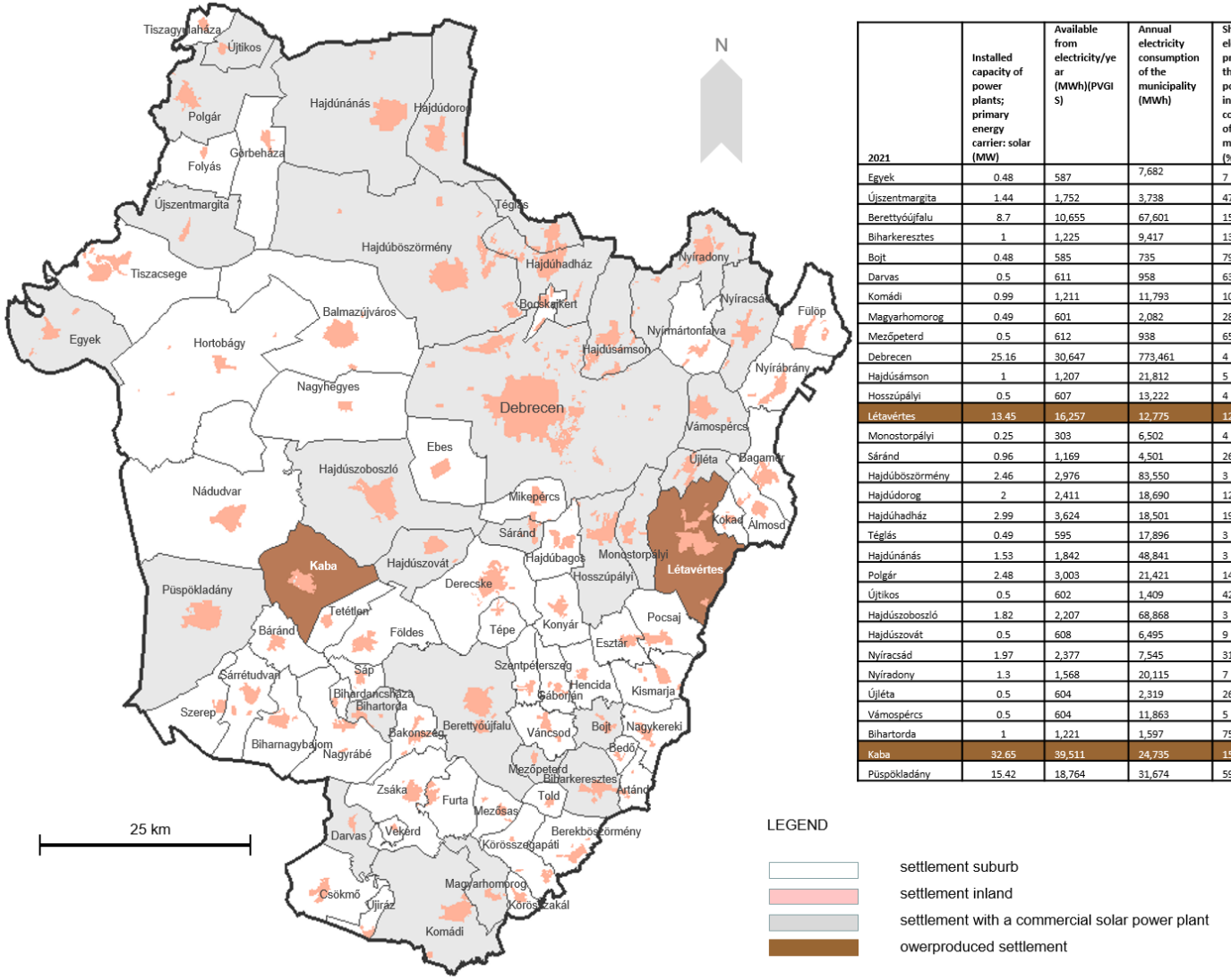
- Combined electricity generation capacity – 2017
  - 30 settlements in Hungary that were able to generate more electricity than their annual consumption within their territory, solely from renewable energy sources
  - Hajdú-Bihar county
    - Vekerd (346%)
    - Bojt (106%)
    - Berettyóújfalu, Hajdúböszörmény, Hajdúszoboszló were among the top 20 towns with the highest rates in the county, with 5% and 4% shares
    - Debrecen: 1.68%



The combined proportion of the electricity produced by local household power plants (HPPs) and small power plants below 0,5 MW – not subject to permitting, not HPPs – relative to the total electricity consumption of Hungarian settlements

Level of energy self-sufficiency

- Data on the installed capacity of commercial solar power plants available up to 2021
- Hajdú-Bihar: 31 municipalities have commercial solar power plants
- Kaba and Létavértes: electricity produced corresponds to 159% and 127% of the annual consumption (can therefore be considered self-sufficient)
- On five other settlements, this ratio ranges between 50 and 100%

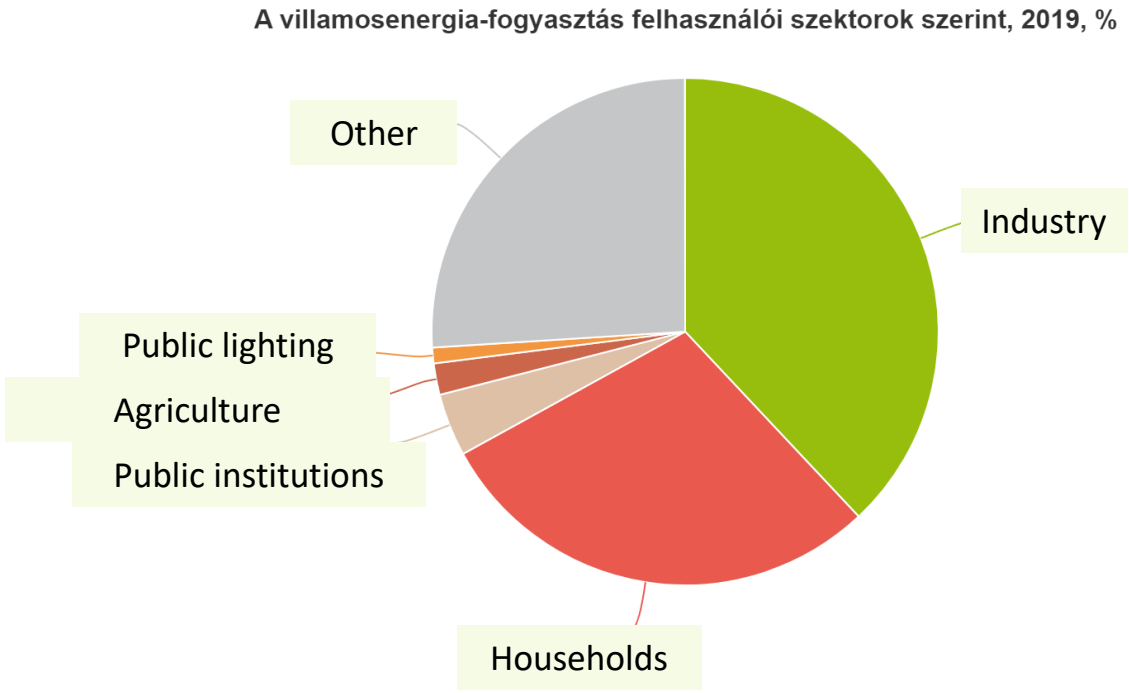


2021	Installed capacity of power plants; primary energy carrier: solar (MW)	Available from electricity/year (MWh)(PVGIS)	Annual electricity consumption of the municipality (MWh)	Share of electricity produced by thermal power plants in the consumption of the municipality (%)
Egyek	0.48	587	7,682	7
Újszentmargita	1.44	1,752	3,738	47
Berettyóújfalu	8.7	10,655	67,601	15
Biharkeresztes	1	1,225	9,417	13
Bojt	0.48	585	735	79
Darvas	0.5	611	958	63
Komádi	0.99	1,211	11,793	10
Magyarhomorog	0.49	601	2,082	28
Mezőpeterd	0.5	612	938	65
Debrecen	25.16	30,647	773,461	4
Hajdúsámson	1	1,207	21,812	5
Hosszúpályi	0.5	607	13,222	4
Létavértes	13.45	16,257	12,775	127
Monostorpályi	0.25	303	6,502	4
Sáránd	0.96	1,169	4,501	26
Hajdúböszörmény	2.46	2,976	83,550	3
Hajdúdorog	2	2,411	18,690	12
Hajdúhadház	2.99	3,624	18,501	19
Téglás	0.49	595	17,896	3
Hajdúnánás	1.53	1,842	48,841	3
Polgár	2.48	3,003	21,421	14
Újtikos	0.5	602	1,409	42
Hajdúszoboszló	1.82	2,207	68,868	3
Hajdúszovát	0.5	608	6,495	9
Nyíracsád	1.97	2,377	7,545	31
Nyíradony	1.3	1,568	20,115	7
Újléta	0.5	604	2,319	26
Vámospércs	0.5	604	11,863	5
Bihartorda	1	1,221	1,597	75
Kaba	32.65	39,511	24,735	159
Püspökladány	15.42	18,764	31,674	59

Total installed capacity of (municipal) commercial solar power plants, electricity production capacity and the proportion of the of energy generated relative to the settlement's consumption (2021)

Energy consumption - electricity

- The public electricity network covers **all municipalitie**s in Hungary
- At the end of 2019, the operators supplied a total of 5 million 667 thousand customers, 91% of which were household customers
- The increase in the total number of consumers has been driven by the connection of **new industrial and service** facilities
- The amount of electricity used has been increasing since 2013, including residential consumption since 2015
- In terms of total electricity consumption**, industry is the largest consumer**, with electricity consumption in the residential sector and other sectors, mainly market services, lagging somewhat behind



Energy consumption - electricity

Accounts	2022
Total volume of electricity supplied (thousand kWh)	1 589 550
Volume of electricity supplied to households (thousand kWh)	597 138
Electricity supplied for public utilities (thousand kWh)	65 784
Electricity supplied for industrial purposes (thousand kWh)	528 994
Electricity supplied for agricultural purposes (thousand kWh)	95 140
Electricity supplied for public lighting (thousand kWh)	16 938
Electricity supplied for other purposes (thousand kWh)	285 556
Total number of consumers using electricity (pieces)	289 461
Number of household consumers using electricity (pieces)	265 273
Consumers of public utilities (pieces)	2 897
Number of industrial consumers (pieces)	6 146
Number of agricultural consumers (pieces)	1 798
Number of other consumers (pieces)	13 347
Length of low-voltage network (kilometre)	4 044

Energy consumption - gas

Accounts	2022
Number of household gas consumers (pieces)	160 812
Number of central boilers in residential buildings (pieces)	1 498
Enterprises providing district heating (pieces)	6
Municipal consumers (pieces)	794
Other consumers (pieces)	8 485
Total consumers (pieces)	172 540
Household consumers using gas for heating (pieces)	160 727
Industrial consumers (pieces)	687
Agricultural consumers (pieces)	258
Length of pipe network on the 31th December (kilometre)	4 466
Volume of gas supplied to households (thousand m3)	188 879,6
Volume of gas supplied to central boilers in residential buildings (thousand m3)	5 519
Volume of gas supplied to enterprises providing district heating (thousand m3)	2 047
Volume of gas supplied to municipal consumers (thousand m3)	16 011
Volume of gas supplied to other consumers (thousand m3)	36 142,5
Total volume of gas supplied (thousand m3)	313 479,3
Volume of gas supplied to industrial consumers (thousand m3)	56 958,8
Volume of gas supplied to agricultural consumers (thousand m3)	7 921,4

District heating and hot water supply

Accounts	2022
Amount of hot water supplied to households (thousand m3)	959,3
Amount of hot water supplied to other consumers (thousand m3)	17,1
Amount of district heat supplied to household consumers (Gigajoule)	714 439
Total volume of district heat supplied to other consumers (Gigajoule)	544 936
Total volume of heat used for district heating (Gigajoule)	1 259 375
Total volume of hot water supplied (thousand m3)	976,4

Prospects & trends + main challenges

The current situation (2023)

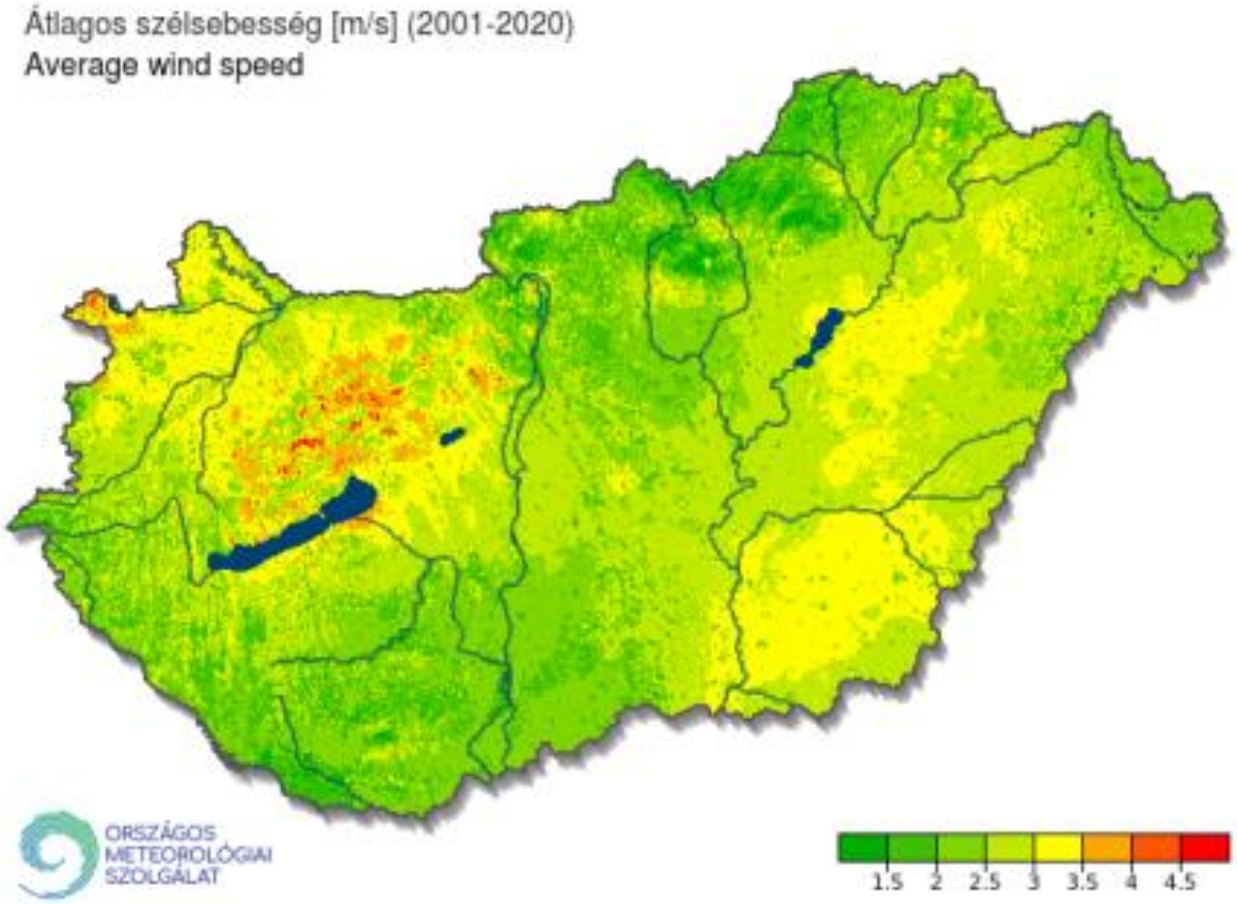
- Significant **commercial and residential solar power capacities** have been developed in Hajdú-Bihar
- **Geothermal energy** for heating – particularly in almost all the thermal bath complexes
  - Existing geothermal potential used to heat public buildings: **Létavértes, Kaba**, Balmazújváros, Derecske, **Földes**
- Hajdúböszörmény has an example of the use of **animal and plant biomass** from agriculture for energy purposes (though the county has an outstanding potential for biogas production from agricultural raw materials)
- Municipal **waste water gas and landfill gas** from municipal waste is only produced in **Debrecen**
- Solid biomass is used only in local heating systems, mainly for firewood heating, despite the availability of large forests as resources - there are no municipal heating systems or power plants in the county.
- Despite the medium wind energy potential in the county, there is **no wind-based electricity generation**, mainly due to regulatory constraints

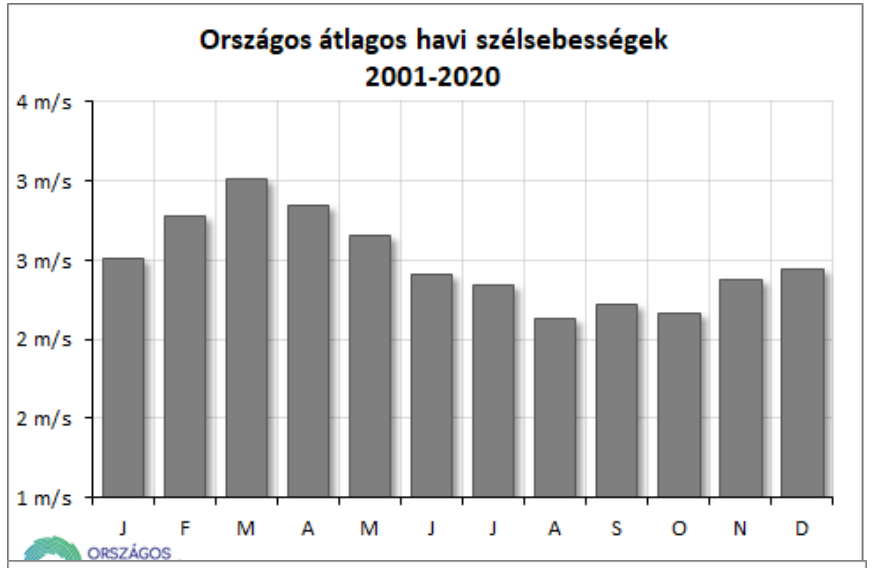
Prospects & trends + main challenges

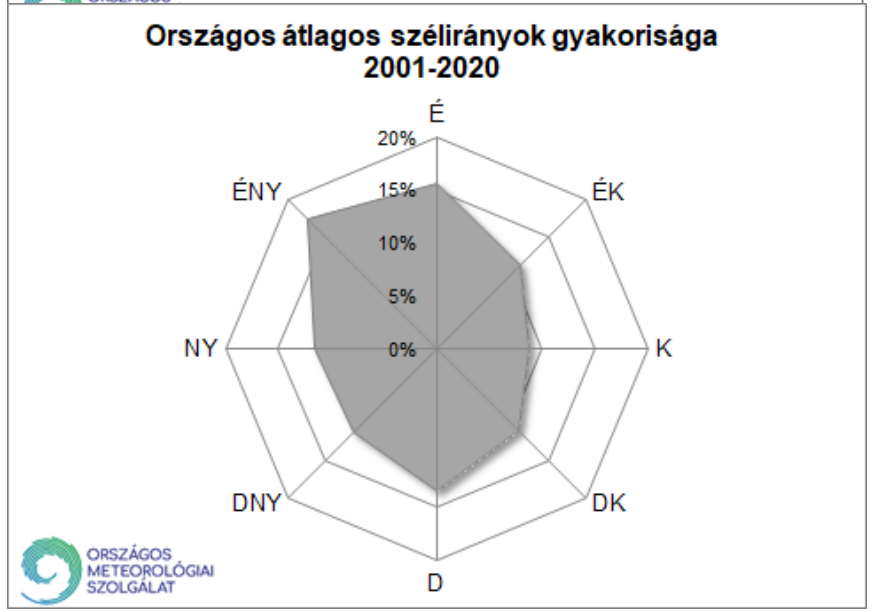
Renewable energy potential

- Good potential for solar energy, wind energy, solid biomass, biogas and geothermal resources
- **Solar energy**
  - climatic conditions of Hungary & available technologies: installed capacity of 1 KW can produce between 1000 and 1200 kWh of electricity per year
  - taking into account agro-economic, landscape, land use, resource management aspects, it is primarily the potential of the built environment that should be exploited
  - there is still significant potential in the built and urban environment for utilising solar energy
- Medium potential for **wind energy**
  - average wind speed is between 2 m/s and 3.5 m/s
  - wind speed has a characteristic annual cycle, with the windiest period being the first half of spring, while the lowest wind speeds are generally observed in late summer and early autumn
  - on average, there are 131 windy days (i.e. when the wind gusts reach or exceed 10 m/s) in Hungary, and 33 of these days are stormy (i.e. the number of days with gusts greater than 15 m/s)
  - specific characteristics of the county's territory can be exploited efficiently, mainly by using small wind turbines
  - naturally, the most favourable conditions are available outside of settlements in areas that are sparsely built up and are where the surface is only covered with low vegetation; however, despite the disturbed wind zones, there is also considerable potential in the built, urban environments
  - vertical axis wind turbines are best suited to exploit this potential, and can be installed on buildings, on electricity poles or free-standing

Prospects & trends + main challenges







Territorial variation, monthly course and frequency of direction of the national average wind speed from 2001 to 2020

Prospects & trends + main challenges

- The primary materials for **solid biomass** are available in different forms
  - NE is covered by forests planted in the Nyírség region - outstanding source of biomass
  - the arable land covering a large part of the county produces a significant amount of secondary crop raw material.
- **Biogas production** is based on three sources:
  - sewage gas from municipal sewage sludge
  - landfill gas from municipal landfills
  - in the largest quantities, biogas from livestock farms, animal manure, crop residues and food industry residues
- Hajdú-Bihar county has favourable **geothermal** potential
  - the available thermal water temperatures (max. 80-100°C) allow mainly direct heat utilisation (heating of buildings, district heating, supply of heat for agricultural and industrial processes)
  - however, heat-pump heating of individual buildings/building complexes can be achieved in any part of the county by using geothermal or ambient heat

Among renewable energy sources, **solar and geothermal potentials are outstanding**, but the most efficient renewable energy production can be achieved by hybrid systems meaning not only combining resources but also distributing and converting energy between consumption sectors.

Prospect & trends + main challenges

Technology

There is a wide range of technologies available for renewable energy production and energy storage. These include mature, new and experimental technologies. Mature technologies are now becoming less expensive and can operate on a market basis without subsidies.

Balanced supply, energy storage – energy security

The welcome increase in weather-dependent renewable energy sources, in favourable weather conditions, is feeding a significant amount of electricity into the grid, the distribution of which is becoming an increasing challenge for the transition system operator (MAVIR Hungarian Independent Transmission Operator Company). Balancing is currently achieved through significant imports of electricity, which increases the country's vulnerability. The problem can be solved by grid upgrading and by storing surplus energy in various forms. However, this would require significant investments by the Hungarian state and any market players involved.

Regulatory background

The key to achieving self-sufficiency is the regulatory framework and its long-term predictability. Predictability will encourage investments and widen the scope for their financing, for example through lending opportunities. However, the regulatory framework is a function of the physical conditions for energy security. The fossil energy industry, which is interested in maximising the profitability of its investments in fossil resources, is a brake on the expansion of renewables. The sector's lobbying capacity can also strongly influence political will.

Financing

If these conditions are in place, the financing opportunities will be expanded, the most important precondition for which in Hungary at present is the creation of conditions for energy security and a favourable regulatory environment.

Communal unity and commitment

The lack of unity and trust in energy communities can be an obstacle to the realisation of renewable energy self-sufficiency. This requires a predictable regulatory environment, proactive community leadership, a clear business plan, and technological and market knowledge of the energy economy.

Points of interest (development areas)

Further potential for renewable energy production in the county

- The **installed capacity of PPSs** continues to grow at a promising rate
  - A positive step forward is the possibility of building storage capacities for new applications (the energy produced can be used locally, putting less strain on the grid and ensuring a more balanced local energy supply)
- Under current legislation, the amount of PPS capacity that can be installed cannot exceed the electricity demand of the place of consumption
- Settlements undergoing **dynamic economic growth**, such as Debrecen, could be treated as special zones, allowing household producers to build additional capacities above their own needs, thus contributing to the supply of the region's increased electricity demand from green sources
- There is significant untapped renewable energy potential in the municipal environment
  - **solar, wind, geothermal energy**
- Solar energy, which is the most widely used renewable in Hungary, has further untapped potential for municipal production:
  - further deployment of classic installation systems (on ideally located roof surfaces),
  - utilisation of vertical wall surfaces, especially for multi-storey buildings,
  - the use of solar energy on the roofs of agricultural, industrial and commercial buildings (halls),
  - covering of car parks of commercial buildings with solar panels (multiple benefits: electricity generation, shading and therefore lower fuel consumption, protection against ice damage)

Points of interest (development areas)

- Huge **untapped potential for wind energy** in the county (large power plants)
  - but land use, landscape-related, environmental concerns (e.g. migratory birdlife)
  - solutions:
    - medium and small turbines, mainly with vertical axis;
    - favourable sites outside of settlements could be the already developed areas of agricultural and agro-industrial sites (so that turbines do not occupy valuable agricultural land, there is no additional “anthropogenic pollution” in the landscape, the sites are significant energy-consuming sites, and there is room for the installation of reservoir capacity);
    - on sections of the national road network with street lighting, electricity pylons can also act as vertical wind turbines (on some sections this could mean a wind farm with hundreds of turbines);
    - vertical turbines can also be effectively deployed in urban environments in disturbed wind zones; smaller turbines, no larger than a chimney, do not alter the urban landscape, but can generate significant electricity if installed in large numbers
- The **whole county is suitable for geothermal heat recovery by heat pumps**, and a number of technologies have been developed (ground collectors, ground source heat pumps, use of thermal water)
- In contrast to the use of thermal water, *geothermal heat recovery from small depths is easier to implement* due to its lower cost and simpler technology, and it can be combined with other renewable energy sources (solar, wind)
- Potential for harnessing ambient heat and storing surplus weather-dependent renewables in hydrogen from water decomposition

Points of interest (development areas)

Further increase of energy efficiency

- The continuation of building modernisation programmes (insulation, replacement of windows and doors, local use of renewables, energy storage),
- Construction of new buildings with “passive house” parameters,
- Design of building structures adapted to local climatic conditions (orientation, building structure, roofing),
- Design of green surfaces to reduce energy consumption, in particular for shading in summer (the temperature difference between directly irradiated and shaded surfaces – building, pavement, vehicle – can be as much as 20-30°C)

Creating a favourable legislative environment

- Creating conditions for wind energy use both outdoors and indoors,
- Ensuring the possibility of overproduction of energy beyond own needs,
- Creating a predictable regulatory environment,
- A cohesive community with motivated, committed leadership,
- Building community trust

Good practice 1

Létavértes – municipal district heating based on geothermal energy

- heating needs of about 10 buildings using geothermal energy
- significant reduction in monthly expenditure of up to 50%
- geothermal district heating for educational, cultural, office and other public service buildings
- the geothermal project, launched in 2019 and completed in 2020, includes a 1,300-metre production well with an outlet water temperature of 64°C and a 1,400-metre reinjection well with a return water temperature of 73°C
- the geothermal system currently provides heating for public buildings for the “Léta” part of town
- further developments include the extension of the system towards the “Vértes” part of the town of Létavértes
- in addition, Létavértes is home to one of the largest commercial solar power plants in the county, with an installed capacity of around 13.45 MW and a maximum capacity of over 16 GWh per year, which is 27% more than the annual electricity consumption of the town
- in the Derecske district, which includes Létavértes, the share of electricity generated by household-scale solar power plants is close to 7% of the district’s annual electricity consumption

Good practice 2

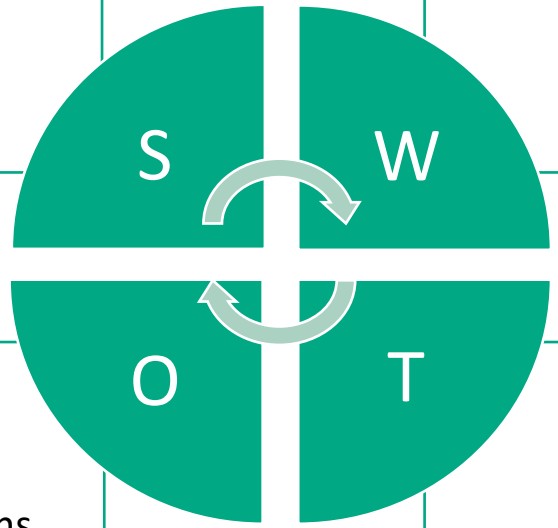
The biogas plant of Béke Mezőgazdasági Kft. of Hajdúböszörmény

- The plant has one of the largest stock of dairy cattle in the country: almost 2,000 animals are involved in intensive milk production at the company's farm while the pig farm produces manure from around 600 sows and their offspring
- The manure from the cattle and pig farms is used to produce biogas, 50-60% of which is methane
- Methane is burned in gas engines to produce electricity and heat
- The gas engine drives a 637 kW generator, which produces electricity sold on the open market through the grid
- The heat is used for the heating of the fermenters and the pig farm, where it also supplies utility hot water, and finally the residual heat and the exhaust heat from the gas engine at 400°C are used to power a dryer to evaporate the moisture from the final product of the fermenters
- The remaining dry matter is then used to replenish the soil

SWOT

- The region has good potential for the exploitation of solar, wind, solid biomass, biogas and geothermal resources

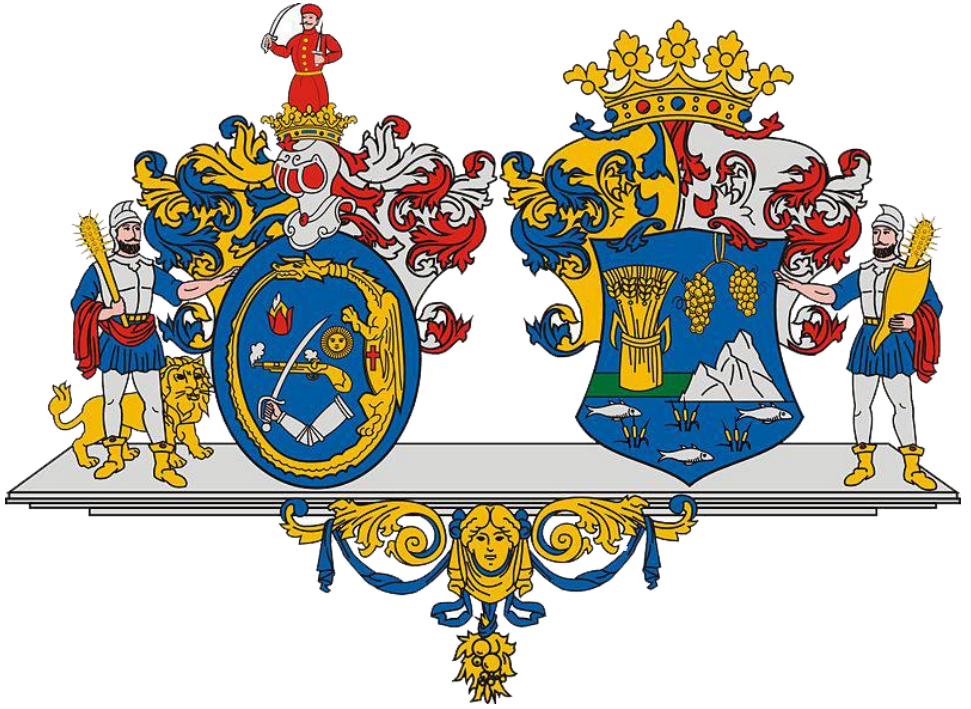
- Undiscovered and unexploited in detail renewable energy potential
- Energy dependancy
- Balanced supply, energy storage



- Increasing EU support for alternative for the use of alternative energy sources, innovative innovative solutions
- The county's geothermal energy potential of the potential of thermal energy exploitation of resources

- Lack of incentives
- Regulatory framework
- Lack of long-term collaboration and commitment

Thank you!



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