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A.T2.2 State of the art energy report

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1. EXECUTIVE SUMMARY

The Southern Great Plain (SGP) is one of the seven planning and statistical (NUTS2 level) regions in Hungary situated in the south – south-eastern part of the country. The region is constituted by three counties: Bács-Kiskun, Békés and Csongrád, and borders form the south and east by Serbia and Romania, respectively. The administrative centre of the SGP is the city of Szeged, which is also the seat town of Csongrád County. Respectively, the county seat towns of Békés and Bács-Kiskun Counties, are Békéscsaba and Kecskemét.

The region represents almost one fifth of the total area of Hungary. The population of the region based on the latest estimate was 1,244,000 people, which is approximately 12% of the total population of Hungary.

A majority of its area is a plain with an average elevation of below 200 m above the mean see level. The climate of the region is humid- and dry-continental with a gradually drying trend towards the east. The main rivers crossing the target area are the Duna (Danube), the Tisza, the Körös and also the Maros rivers.

Southern Great Plain is characterized as having the most parse settlement network of the whole country. However, due to historical reasons, the level of urbanization few cities is high.

The Southern Great Plain Region is characterized by mainly agricultural landscapes and rural area. It also plays a gateway role to the Balkans, since M5 and M43 motorways connect Serbia and Romania with Budapest and towards with Western Europe. Thus, agriculture, transportation and industrial related activities are widespread in this region. The region's share in the national GDP was 9.1 % in 2017.

In Hungary, the power transmission system is operated (and developed) by the Hungarian TSO (transmission system operator) called MAVIR (Hungarian Independent Transmission System Operator Company). MAVIR owns and operates the high voltage power grid, which is a single common transmission line network, with the total length of 4,800 km. In the Southern Great Plain, there are three cross-border transmission lines; two 400 kV lines connect Hungary with Romania and one 400 kV double circuited line with Serbia. The Hungarian electricity export mainly transacted through these lines towards Serbia.

The owner and operator of the domestic high-pressure transmission system is FGSZ Ltd, which provides natural gas to gas supplier companies, power plants and industrial consumers as well. In the Southern Great Plain region there are three underground natural gas storage facilities: Zsana (mobile gas capacity of 2 170 Mm^3), Kardoskút (mobile gas capacity of 280 Mm^3) and Szőreg safety storage (mobile gas capacity of 1 200 Mm^3 + 700 Mm^3), which total to more than 70% of the storage domestic capacity. The sole distributor in the Southern Great Plain region is ÉGÁZ-DÉGÁZ Ltd. In 2016, the complete length of the gas pipeline network in the target region was 14,511.6 km, and natural gas supply was available in 253 settlements.

The distribution of the Hungarian housing stock according to the type of heating is predominated by gas heating. The share of the district heat is around 17,3%. Only 11 settlements of the region are supplied with district heat, of which five town had geothermal district heat capacity (Szentes, Hódmezővásárhely, Makó, Csongrád and Szarvas). The share of district heating in housing stock is 9.49% (48,792 households), which meant the lowest value amongst the Hungarian NUTS 2 regions.

The Southern Great Plain region lies on the 4th Trans-European transport corridor which connects Western-Europe and the Balkans. In Budapest the corridor branches into two separate lines, one heading to Romania, and the other leading towards Montenegro through Serbia. The upcoming extensive railway

transport infrastructure development project regarding Budapest-Belgrade transport route is worth mentioning.

A total network of 5,218 km of roads is present at the target region. A total length of 182 km of it is motorway (M5, M43) which is an important transportation northwest-southeast oriented transit transportation route. Total length of primary roads is 299 km, while secondary roads are present in 860 km length. The vast majority (3,877 km) of the total length of the road network is ranked as a main road.

The region has no international airport. It is serviced by the two international airports of the country (Budapest, Debrecen). Only small public airports mainly used for private and recreational purposes, are present.

Regarding waterways the situation of the region is advantageous, the main two waterways (Duna and Tisza) present are almost suitable to use during whole year. On these waterways transaction of mainly international freight transport occur.

In 2016 the Hungarian primary energy production was 132 070 GWh, which is 44% of the gross inland consumption (298,949 GWh). Similarly to the situation of EU, Hungary is highly dependent on fossil fuels import, especially regarding crude oil and natural gas. It is important to note, that 48% of the final electricity consumption is based on import.

Regarding the Hungarian electricity generation, the main energy source is the nuclear fuel. Hungary currently has one nuclear power plant of 2 000 MW installed capacity in Paks, located in the next to the Southern Great Plain. In 2016 more than half of the amount of electricity was generated by nuclear power (more than 16,000 GWh). Expansion of the Paks nuclear power plant is projected. Presumably, the construction works will begin in 2020, and the optimistic forecast suggesting, that operations may commence already in 2026/2027.

The share of fossil fuels in the electricity fuel mix was 38.7%, whilst the renewable was 10.2% in total in 2016. The renewable-based electricity generation is dominated by the solid biofuel (4.7 %), and the share of wind (2,2 %) and biogas (1,1 %) were also notable of the total electricity production in 2016. Currently, the domestic wind power capacity is concentred in the northwester region of Hungary. Hydro, solar and renewable waste-based electricity production are also present in Hungary, but their shares are in the electricity production remained under 1 %.

Hungary has a significant geothermal capacity, generally the temperature of the water is not high enough to supply competitive source for electricity generation. The first geothermal power plant in Hungary which provides also electricity (2 MW) commenced the operation in 2017, however a further plant is under development close to the Southern Great Plain region.

2. INTRODUCTION

2.1. General description of the region

2.1.1 Geographical situation

The Southern Great Plain (SGP) is one of the planning and statistical (NUTS2 level) regions in Hungary situated in the south – south-eastern part of Hungary (Figure 1). It is part of the so-called Hungarian Great Plain and includes three counties: Bács-Kiskun, Békés and Csongrád. With its total area of 18,337 m^2, the SGP region the largest among the seven NUTS2 statistical regions. The neighbouring regions are the Central Region including the capital city, Budapest and Pest county, the Northern Great Plain, Southern Transdanubia and Central Transdanubia Regions to the west. The Southern Great Plain region is bordered by Romania and Serbia to the east and south, respectively.

The target region represents almost one fifth of the total area of Hungary. The population of the region based on the latest estimate was 1,244,000 people in 2016, which is approximately 12% of the total population of Hungary. The SGP is the 3rd largest region regarding the population. The administrative centre of the SGP is the city of Szeged, which is also the seat town of Csongrád County. Respectively, the county seat towns of Békés and Bács-Kiskun, are Békéscsaba and Kecskemét. While Hungary has a total number of municipalities of 3155, SGP includes 254 (8% of the total) municipalities.

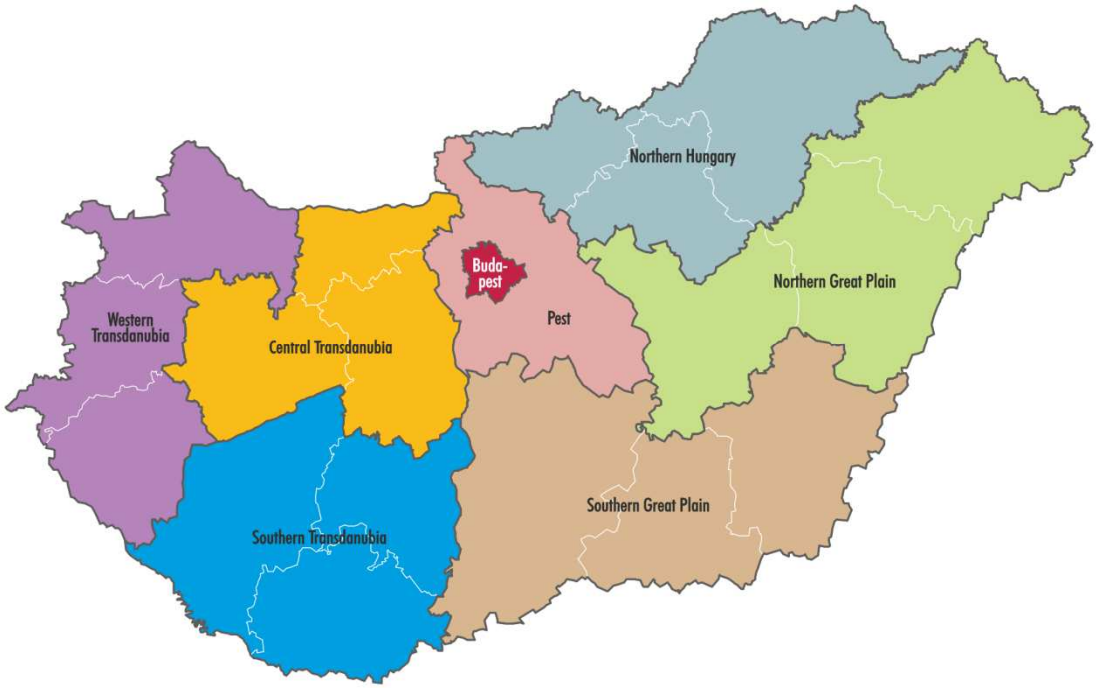


Figure 2.1. Geographical situation of Southern Great Plain (SGP) region

A majority of its area is a plain with an average elevation of below 200 m above the mean see level and also is rich at natural and landscape heritages. Much of the total area is suitable for agricultural utilization, 85% of its farming land is used for field crop production. The region also encompasses three national parks, accounting to 21% of the total area of national parks in Hungary. The main rivers of the target area are the Duna (Danube), the Tisza, the Körös and also the Maros rivers.

The climate of the region is humid- and dry-continental with a gradually drying trend towards the east. Basinal characteristics of the area strongly prevail; thus, winters are cooler, summers are warmer than the national average. The average annual temperature in the region is 10.5-11.0 °C, the highest in Hungary. Yearly precipitation rate is 500-600 mm, which is the lowest at national level. Sunny hours can be up to 2100 hours/year in the region, which is some 10-15% higher than those in the western and northern part of Hungary. Heating and cooling degree day values on both regional and national level, are given in Figure 2.2. and Figure 2.3., respectively.

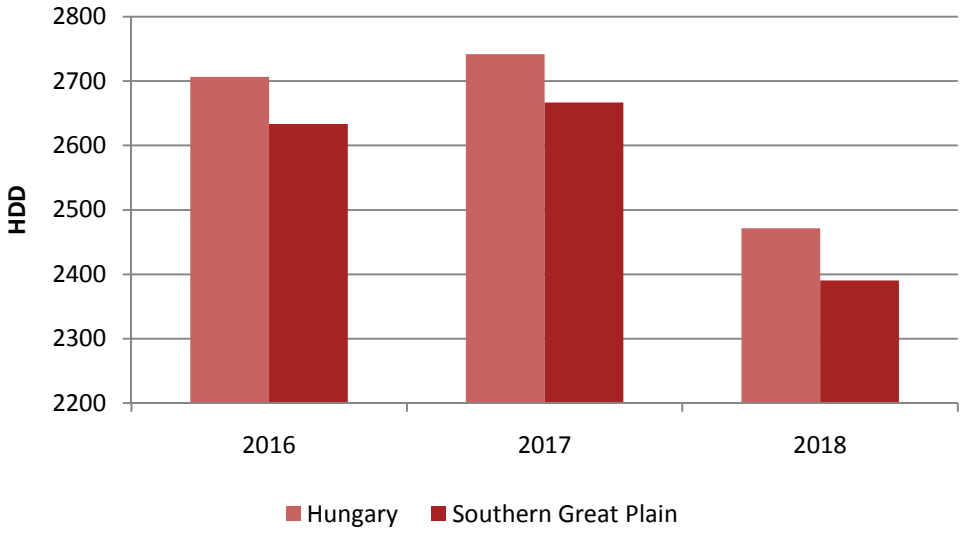


Figure 2.2. Heating degree days in Hungary and in the SGP region

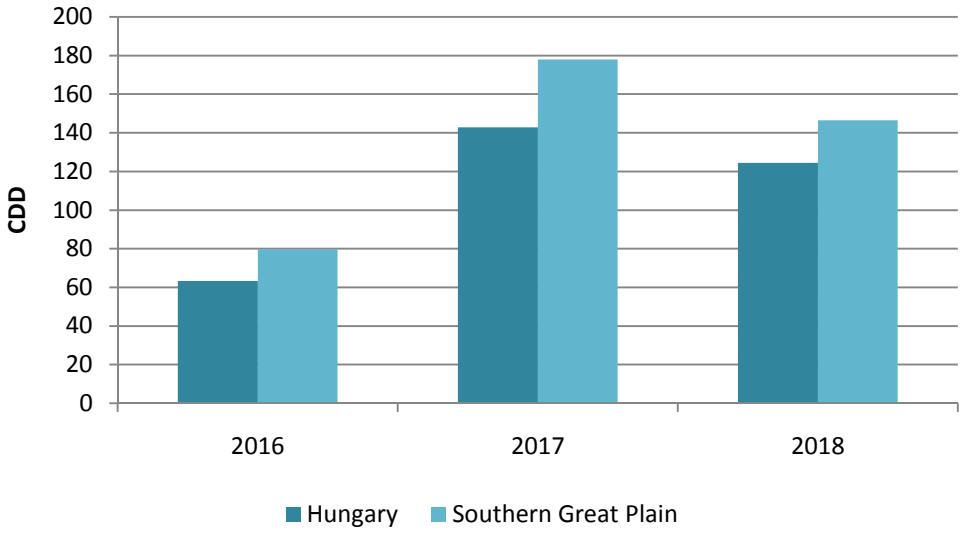


Figure 2.3. Cooling degree days in Hungary and in the SGP region

As a consequence of climatic characteristics of the region heating degree days are lower, while cooling degree days are higher than the national average.

2.1.2 Settlement structure

All three counties constituting the Southern Great Plain region can be characterized with most parse settlement network of the whole country. Whilst the average number of settlements per 10km^2 in Hungary is 34, this number in the region is 14. The average population density values at national and regional levels are 105 and 68 inhabitants/km^2, respectively. With a total number of 47 towns, the region is one of the most urbanized part of the country. Table 2.1. gives an overview on the settlement structure of Southern Great Plain Region.

	National	Regional
Area (km²)	93,022.56	18,337.39
Population (thousands)	9,778	1,244
Number of municipalities (total)	3,155	254
Municipalities with inhabitants (number)		254
> 1.000.000		0
500.000 to <= 1.000.000		0
100.000 to < 500.000		2
50.000 to < 100.000		1
10.000 to < 50.000		17
5.000 to < 10.000		24
1.000 to < 5.000		144
< 1.000		66

Table 2.1. Overview on settlement structure of Hungary and the Southern Great Plain Region

Examining the settlement stock of the SGP region, it can be stated, that more than half (57 %) of the total number of municipalities belong to the 1,000-5,000 population range category. It is significantly higher than the national average, which is 37%. Small towns and larger villages play a leading role in not only giving the majority of the settlements in the region but also in meaning the residence of a notable amount of people.

Municipalities with less than 1,000 inhabitants (26%) play a less significant role in the Southern Great Plain region, unlike the national average, which is more than 50%. Approximately, 9% and 7% of all the municipalities of the region belongs to the 5,000 to 10,000 and the 10,000 to 50,000 number of inhabitant's category, respectively. Only 1% of the municipalities have a population between 50,000 and 500,000.

Further characteristics of the settlement structure of the SGP region is the notable proportion of residents living in outlying areas, although a decrease could be identified during the past few years.

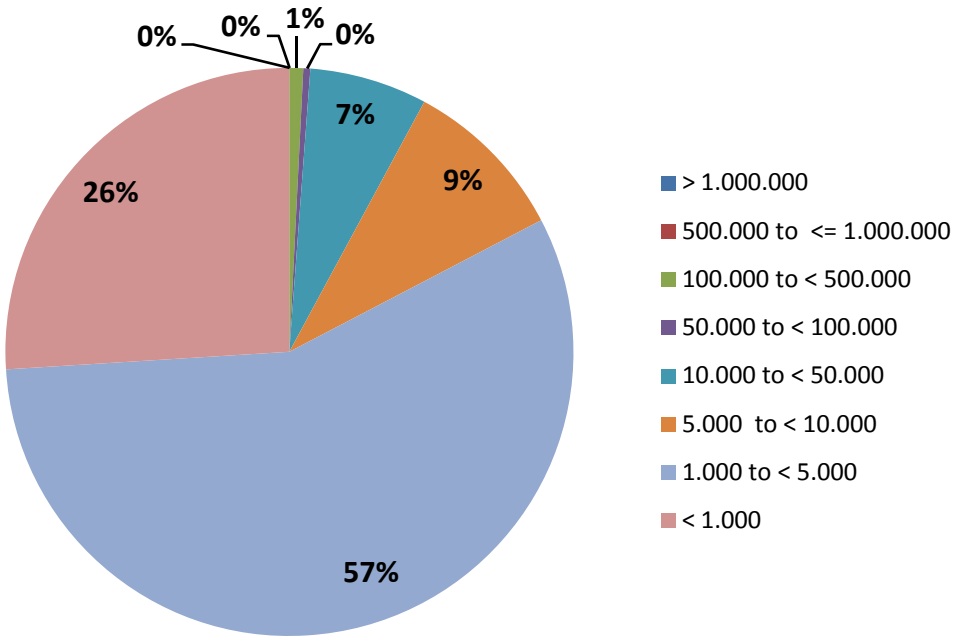


Figure 2.4. Municipalities with inhabitants

2.1.3 Demographic structure and development

Population:

An overview on population development both in national and regional level is given in Table 2.2. It can be concluded, that population development has a characteristic of a decreasing trend both in national and regional level between 2000 and 2016. Population decline is a long-term process lasting from 1980's until nowadays, however with a varying degree of decline rate.

Population development in thousands	National	Regional
2000	10,222	1,383
2005	10,098	1,355
2010	10,014	1,318
2015	9,865	1,271
2016	9,830	1,263

Table2.2. Overview in population development in national and regional level

As a consequence of both inland migration and immigration due to economic reasons, the degree of population decline in regional sense is significantly higher compared to the national value. Regarding the above indicated 16 years interval, decline rate was -3.9 % and -9.5%, respectively. Multiple bar and line charts showing the population development of Hungary and the target region is presented in Figure 2.5.

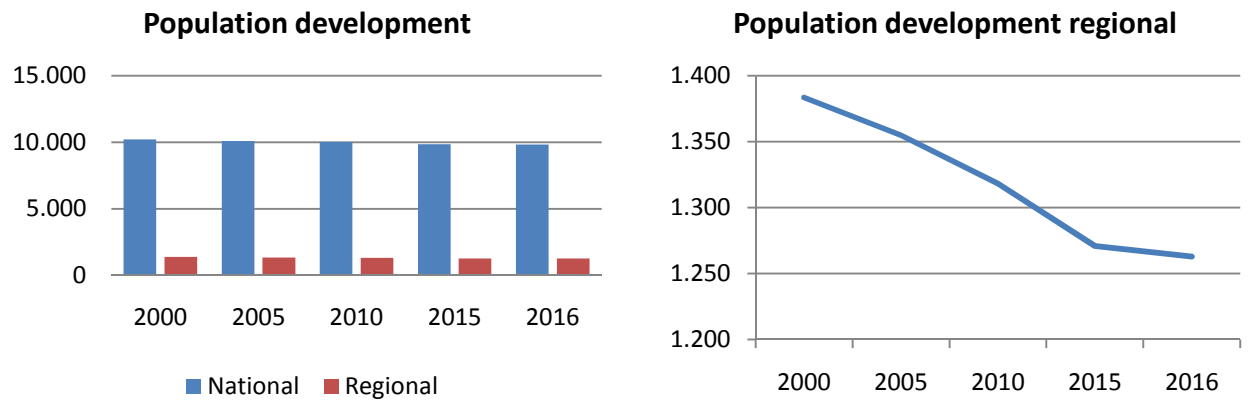


Figure2.5. Bar and line chart of population development characteristics in Hungary and in the target area

The population decline rate in regional aspect varied between 2-3% until 2015, since then moderation in decrease rate could be identified. Note, that the chart shows data of 5 years periods between 2000 and 2015, whilst the last period encompasses only 1 year.

Households:

Data presented in Table 3. provides and overview on total number of households both national and regional level. As numbers in Table 2.3 and charts in Figure 2.6. show, an increment in total number of households on both national and regional level can be identified with an average growth rate of 10% between 2000 and 2015.

Number of households	National	Regional
2000	3,740,300	512,400
2005	3,816,200	530,800
2010	4,014,500	542,200
2015	4,151,900	566,400
2016	4,149,000	563,400

Table 2.3. Number of households in national and regional level

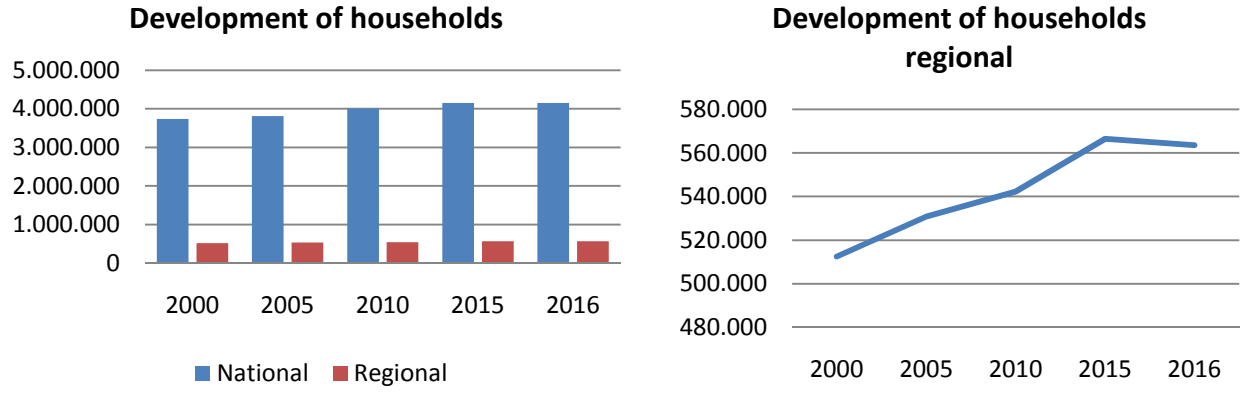


Figure 2.6. Development of households

However, by 2016 the development turned into a slowly decreasing trend. Decline in number of households were more significant in regional level (0.5%), than in national level (0.07%)

Average size of households in the Southern Great Plain Region have always been below the national average between 2000 and 2016 (Figure 2.7.). In both regional and national levels, the values are decreasing, in 2016 the average size of a household is 2.37 persons and 2.24 persons, respectively.

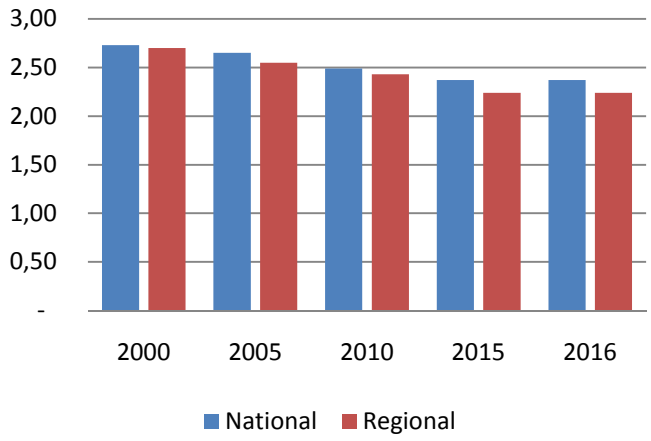


Figure 2.7. Average size of households

The decline rates between 2000 and 2015 were 13% (national) and 17% (regional), however there was no measurable change between 2015 and 2016 on neither national, nor regional level.

2.1.4 Regional economy

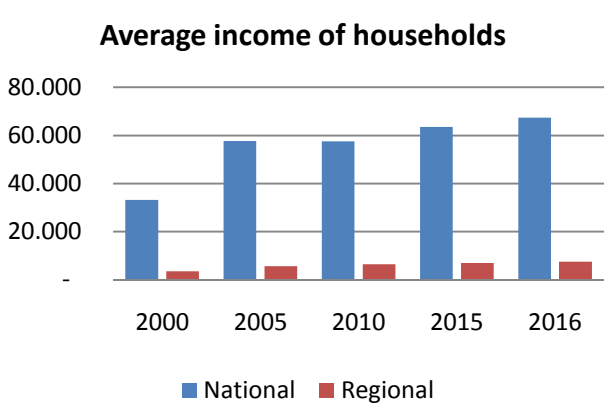
The regional economy is described here based on three parameters, which are the following:

- Average disposable income of households
- Gross domestic product (GDP)
- Gross value added (GVA) and number of employees
- In this section each of the parameters mentioned above are being detailed.

Average income of households

Average income of households has increased by slightly more than 200% between 2000 and 2016 both on national and regional level. Charts in Figure 2.8. show the rate and the overall trend of changes. The increase in the consumer price index in the same time span is 112.8 %. Thus, the real-income-growth adds up to around 87 % for regional households. Average income of households on a region level gives around 10-11% of the national values during the whole, above specified time span.

Statistical average income in the region was 13,420 EUR/household in 2016, which is 17% less, than the national average at the same year.



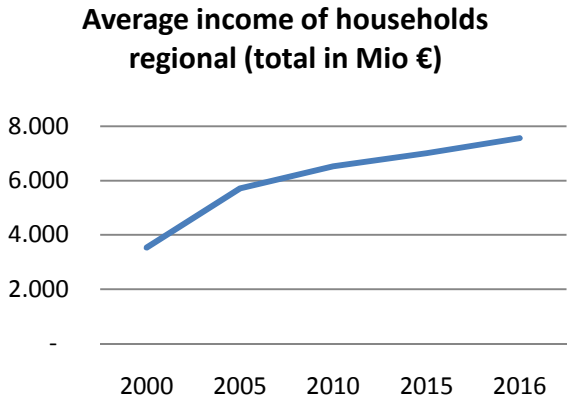


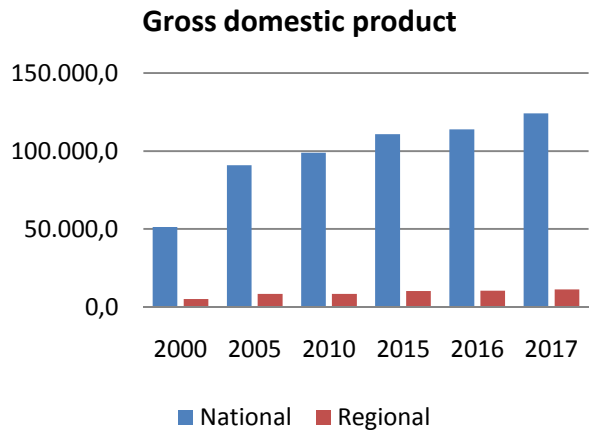
Figure 2.8. Average income of households

Gross domestic product (GDP)

GDP is a measure for the economic power of a territorial unit. The share of the regional economy in the national GDP was 9.1 % in 2017, while the average value with regard to the time span from 2000 to 2017 is 9.14 %. The maximum share (10.0 %) was measured in 2000, while the minimum value belongs to the year of 2010.

GDP growth with regard to the target region on the specified time span (2000-2017) was measured to be 218.3 %, while on national level it reached up to 241.6%. The GDP per capita is 9,050 EUR in the Southern Great Plain region, which is 28.6 % lower than it is on national level.

Rate of increase varied between intensive growth (2000-2005), stagnation (2005-2010) and moderate growth (2015-2017). The absolute GDP values are 11 200 EUR and 12,400 EUR at regional and national levels, respectively.



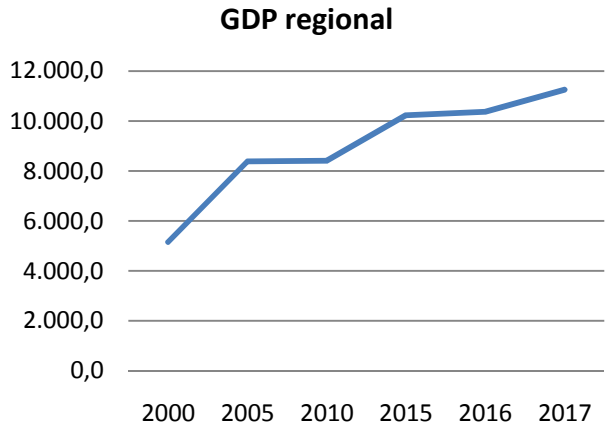


Figure 2.9.: Development of gross domestic product

Gross value added (GVA) and number of employees:

Gross value added (GVA) is an economic productivity metrics that measures the contribution of a corporate subsidiary, company or municipality to an economy, producer, sector or region. GVA thus adjusts gross domestic product (GDP) by the impact of subsidies and taxes (tariffs) on products. Fig.2.9 is giving a comparative overview on the GVA on national and regional level.

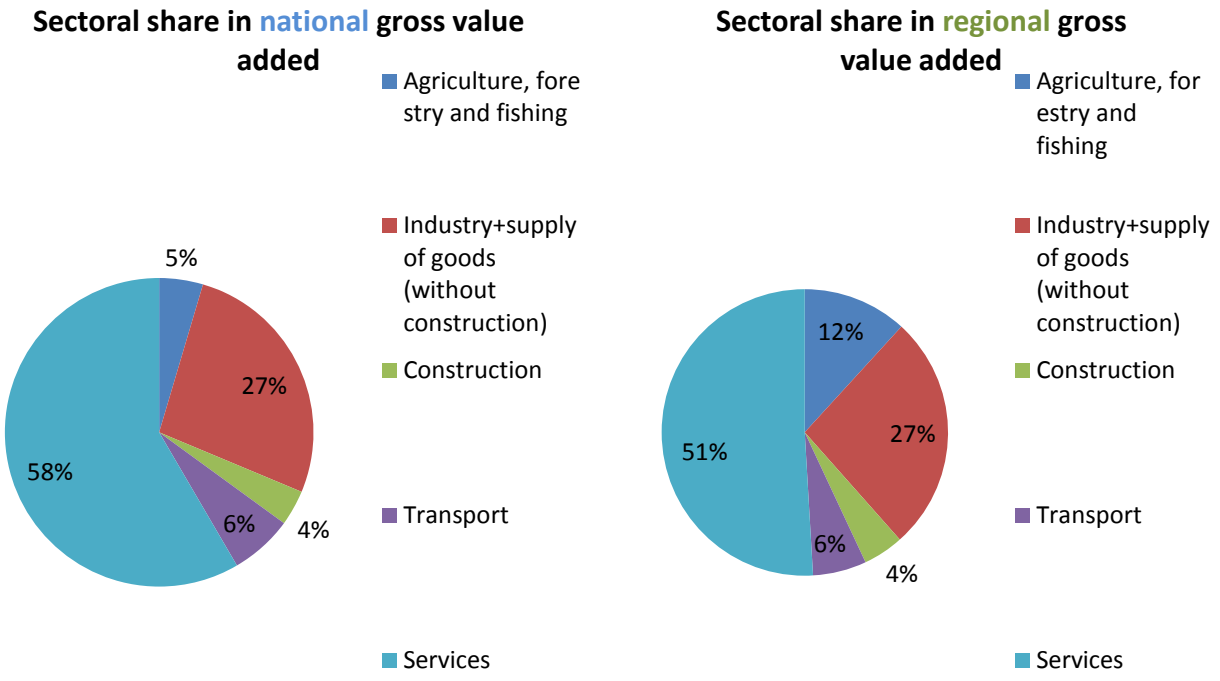


Figure 2.9. Sectora lshare in national and regional GVA

Transport, construction and industry together with supply of goods gives the same amount of share of total GVA in national and regional level. The values are 6 %, 4 % and 27 % respectively, of what with 27% the industry together with supply of goods is the highest.

In the Southern Great Plain region agriculture with its 12 % share of the total regional GVA plays an important role in local economy. In comparison, at national level agriculture is much less significant with its 5% share to the total national GVA. At both (national and regional) levels, services account for the highest proportion of the GVA, with the respective values of 58 % and 51 %.

The share of the regional gross value added by the region compared to the total national GVA is 9 %, the same as the proportion of persons employed in the Southern Great Plain region compared to the persons employed all over Hungary.

Figure 2.10. provides a comparative overview on sectoral share of employees at national and regional levels. Based on the diagrams both in Figure 9. and in Figure 10. it can be concluded, that the rate of employees by sector is showing a very similar pattern in the sectoral share in the GVA. In the region, as well as at national level, the service sector plays the major role in employment with its 58 %. Industry commits approximately one fourth of the total number of employees both at national and regional levels. The rest of the employees (17-18 %) are split between agriculture, construction and transport sectors almost equally (5-7 % each).

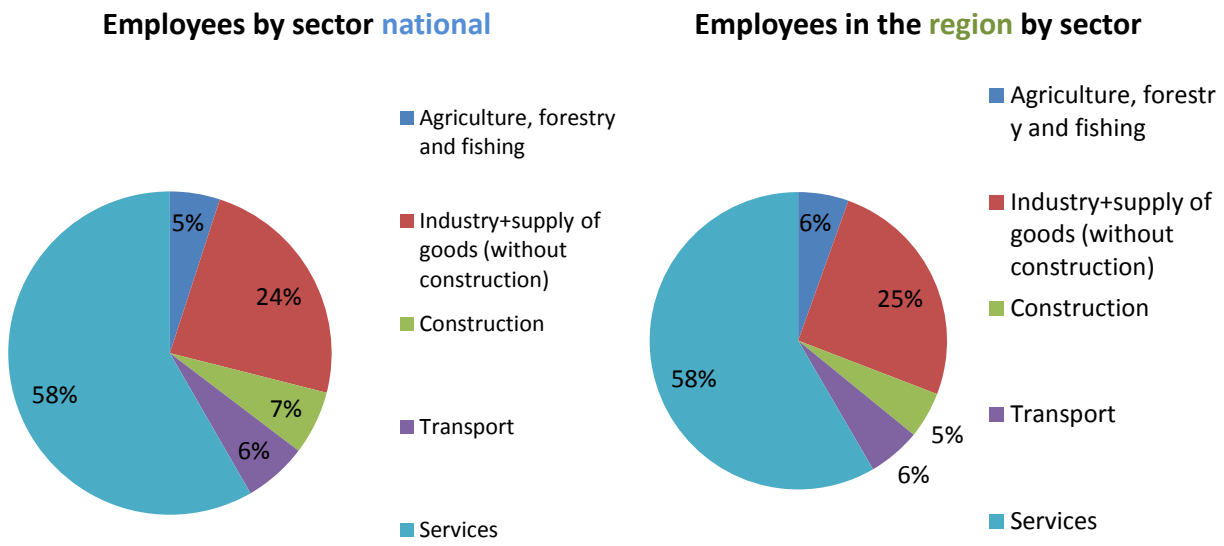


Figure 2.10. Employees by sector at national level and in the region

According to statistical data on number of employees by size of enterprises, almost 40 % of employees are engaged by large enterprises. Around 20-20 % of employees are working for micro and medium sized enterprises, while approximately 20 % of the employees are occupied by small enterprises.

On the other hand, enterprises acting in the economy are small organisations, almost 90 % of the total number of enterprises (34,000) are employing less than 10 employees. 8.5 % of the enterprises employ less than 50 people, and only 1.5 % of the enterprises are employing more, than 50 workers.

2.1.5 Particularities of the region

The Southern Great Plain region consists of three counties lying on the southern, south-eastern part of Hungary. Particularities of present settlement and demographic structure, economic structure and condition among others are influenced by geographical setting, long term nation-wide economic development etc.

The Southern Great Plain region have been an agriculturally developed area since historical times due to presence of almost limitless area suitable for growing crops and livestock breeding. As a consequence, most of the inhabitants lived and worked in farms, while only a few towns could develop, namely Szeged, Gyula, Békés, Kecskemét and Kalocsa. During the Ottoman occupation people fled to cities, making the 16-18. century a flourishing period of towns. After expelling the Turkish army an extensive resettlement campaign started, also in the target region and agriculture was still played a major role in economy.

After WWII economic structure changed radically, there was no place for individual farms and enterprises, production was forced, planned economic structure was introduced, towns became local industrial hotspots. Many of the farmers were forced to accommodate to the new environment by working in the factories, constructions etc. As a result, extensive inland migration took place, commuting was also very common.

After the 1990's the change of the regime reformed the economic, and demographic structure again. Privatisation of government/party owned companies, firms started, services started to develop, and inflow of capital took place at the same time. The overall economic development is coupled with relatively high inflation. Standard of living in the Southern Great Plain region is below Hungarian average, thus intensive international and inland migration is continuous. Economic environment is friendly for investors, skilled workforce, however is limited. Share of agriculture today is much less important than historical times, but still a significant factor.

In summary the Southern Great Plain region can characterised as a peripheral territory with a strong focus on agriculture. However, industry plays also a major role in economy. Overall decrease of population has been under process since 1980's. Due to historical factors level of urbanization is high. The city of Szeged is an economic, cultural, educational and industrial centre, the most important county seat town of the region. Tourism, mainly agro-tourism is common, and in a developing stage. There is a huge potential in renewables, especially in terms of geothermal, solar and biomass energy resources.

3. INFRASTRUCTURE

3.1. Energy related infrastructure

Electricity grid infrastructure

The scheme of the Hungarian electricity distribution and trading system is illustrated in Figure 3.1.

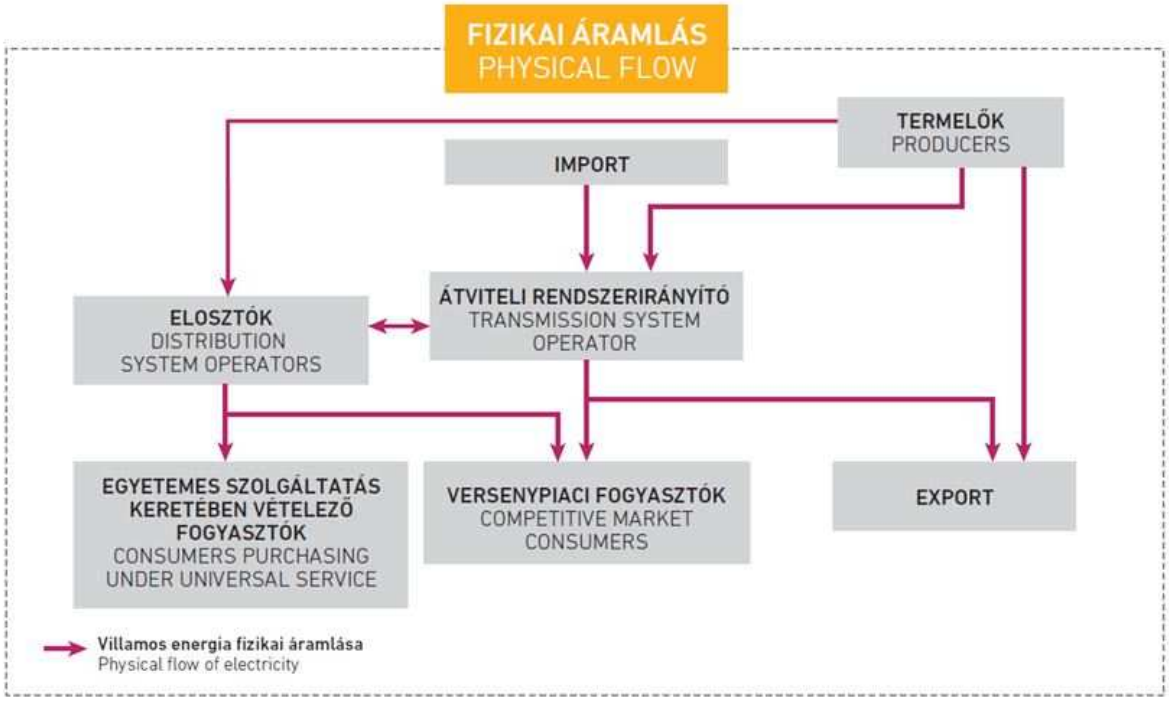


Figure 3.1. Scheme of the electricity distribution and trading system- (source: Dates of the Hungarian Electricity system 2017, MEKH)

In Hungary, the transmission system is operated (and developed) by the Hungarian TSO (transmission system operator) called MAVIR (Hungarian Independent Transmission System Operator Company). MAVIR owns and operates the high voltage power grid, which is a single common transmission line network, with the total length of 4,800 km.

The company also coordinates the electricity generation of the producers and synchronises the operation of the Hungarian electricity system with the neighbouring systems. The Hungarian electricity system is directly connected to all neighbouring countries with the exception of Slovenia. Extension of the transmission system towards Slovenia and Slovakia is in progress.

Main cross-border electricity flows are shown below, in Figure 3.2.

Figure 3.2. Cross-border flows at the time on the annual peak load in 2017 (MW) (source: Dates of the Hungarian Electricity system 2017, MEKH

The transmission system operates according to the independent transmission operator model and operates independently of the other economic operators.

The electricity market is dominated by national public companies. Six regional distribution system operator companies are present in Hungary: (NKM Áramhálózati Kft., E-ON Észak-dunántúli Áramhálózati Zrt., E-ON Dél-dunántúli Áramhálózati Zrt., É-ON Tiszántúli Áramhálózati Zrt., ELMŰ Hálózati Kft, ÉMÁSZ Hálózati Kft.). They are responsible for the operation of the electricity network (120 kV and below) and the supply for consumers. NKM Áramhálózati Kft. (former DÉMÁSZ) is currently the DSO in the entire Southern Great Plain region.

In Hungary the liberalization of the electricity and natural gas market was completed in 2008.Currently, the free choice of supplier applies for all of the consumers, so the consumer chooses their supplier. HUPX (Hungarian Power Exchange Company) is the operator of the organized Hungarian electricity market.

For most of the households and small consumers electricity is provided under universal service. Currently three universal service providers are present in the Hungarian electricity market, whilst the number of licences trader companies is over 160. The electricity market is dominated by national public companies.

The Hungarian transmission grid is actually „reconditioned" and properly covers the country, according to the internal demands. Despite of the good coverage of the country, due to the increase of the consumer's electricity demand, the possible developing of new power plants in the near future, and cooperation with

the surrounding countries it is expected, that development and expansion of the transmission network will be needed. In case of the Southern Great Plain Region, development of a new gas-fired power plant near Algyő with the power generation capacity of 400-800 MW is planned. This investment would involve the expanding of the electrical substation of Sándorfalva and a building a new 400 kV transmission line.

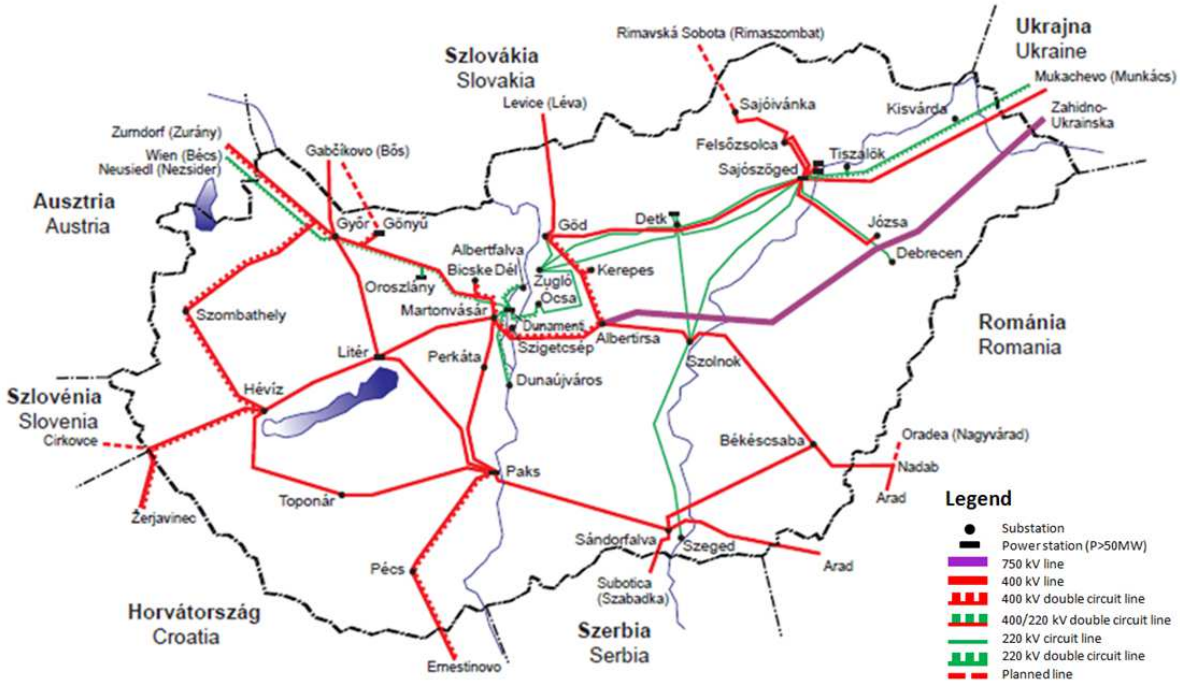


Figure 3.3. The Hungarian electricity grid (source: Dates of the Hungarian Electricity system 2017, MEKH)

In the Southern Great Plain three cross-border transmission lines are situated; two 400 kV lines connect Hungary with Romania and one 400 kV double circuited line with Serbia. The Hungarian electricity export mainly transacted through these lines towards Serbia.

From the 32 domestic transmission and distribution substations in Hungary, the following three are located in the Southern Great Plain region:

- Békéscsaba: 400/120 kV substation; insuring the Szolnok- Nadab (Romania) and Szolnok-Sándorfalva lines;
- Sándorfalva: 400/120 kV substation insuring the Békéscsaba, Paks, Szabadka (Serbia), Arad (Romania) and Szeged lines;
- Szeged 220/120/35/20 kV substation.

The total length of the low-voltage network in the Southern Great Plain Region is 16,539.1 km

Table 3.1. gives an overview about the number of consumers and sold electricity

	Number of consumers	Household consumer	Total amount	Sold to households
Hungary	5 553 592	5 125 969	36 898 GWh	10 773 GWh
Southern Great Plain	745 796	688 861	4 213 GWh	1 398 GWh

Table 3.1. Number of consumers and sold electricity in 2016 (source: Data of the Hungarian Electricity System 2016; MEKH and KSH yearbook)

As can be seen in Table 3.1, in the Southern Great Plain Region 33% of the total electricity (4,213 GWh) was sold to the household consumers. Thus, the average electricity consumption of the households in the region in 2016 was 1,874 kWh. These numbers are in line with the national data, which was 1,939 kWh in 2016. At national level 94% of the consumers of the electricity was supplied by universal service, and 73% of the total sold electricity was purchased in the free-market.

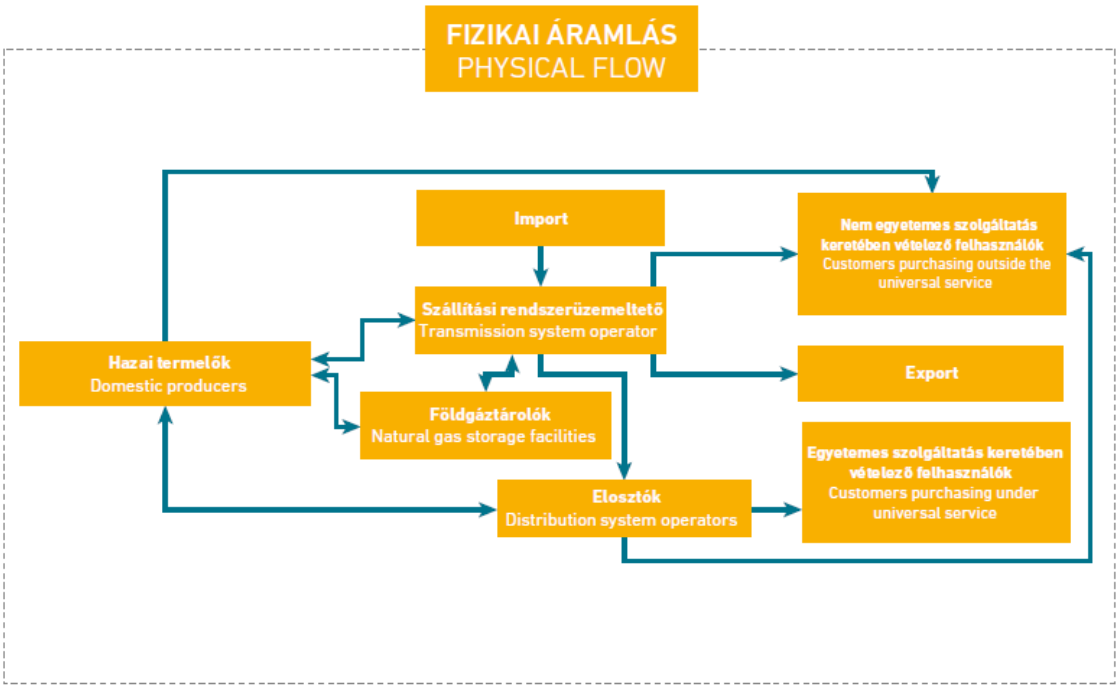
Regarding smart metering, the first initiative has commenced in 2012-ben, by a national scale pilot program, installing around 20 000 smart electricity meters in the area of competence of the six distribution system operators (app. 3 000 meters operate in the Southern Great Plain region). A particularity of this project is, that in Budapest smart gas, water and district heat meters were set up as well, creating a multi-utility smart metering system.

Gas grid infrastructure

The owner and operator of the domestic high-pressure transmission system is FGSZ Ltd, which provides natural gas to gas supplier companies, power plants and industrial consumers as well. FGSZ Ltd. operates a complete telemechanical and remote supervision system from the system operation centre in Siófok and in the 6 regional natural gas transmission plants.

MGT Ltd (Hungarian Gas Transit Ltd.) is the system operator of the 92 km long Hungarian-Slovak high-pressure interconnector gas pipeline (between Hungarian Vecsés and Slovakian Vel'ké Zlievce).

For corrosion protection purpose, cathode protection system is in operation throughout the entire steel



transmission pipeline system.

The simplified model of Hungarian natural gas distribution is summarized and illustrated in Figure 3.4.

Figure 3.4: Operation model of the domestic gas sector (source: Data of the Hungarian System 2016; MEKH)

The Hungarian integrated natural gas transmission system comprises:

- entry points - 5 cross-border, 14 domestic and 5 storage facility entry points;
- exit points - 5 cross-border, 400 gas delivery stations, 5 storage facility exit points;
- high-pressure natural gas pipeline system- total length of 5 874 km, operated generally at 63 bar (in specific cases up to 75 bar) pressure;
- 7 compressor stations;
- 17 (centre) pipeline nodes.

The storage facilities are located in Hajdúszoboszló, Kardoskút, Zsana, Pusztaederics and Algyő. From the five (four normal and one safety) underground natural gas storage facilities, three are situated in the Southern Great Plain region - Zsana (mobile gas capacity of 2 170 Mm^3), Kardoskút (mobile gas capacity of 280 Mm^3) and Szőreg safety storage (mobile gas capacity of 1 200 Mm^3 + 700 Mm^3), which total to more than 70% of the domestic capacity.

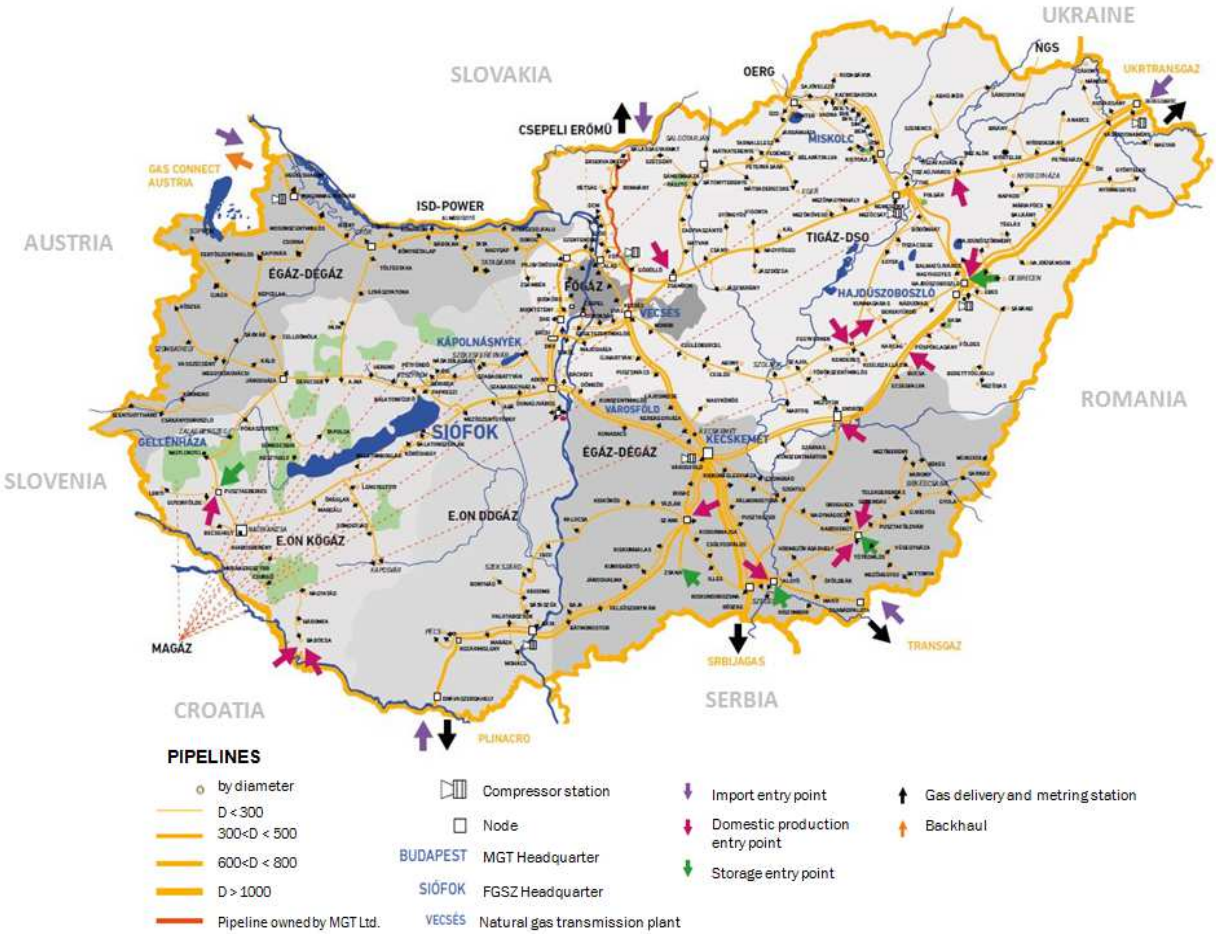


Figure 3.5: High-pressurenaturalgastransmissionpipelinesincludingthetargeregion (source: Data of the Hungarian Natural Gas System 2016; MEKH)

In 2016, ten domestic natural gas distributors had operating license in Hungary.

The sole distributor in the Southern Great Plain region is ÉGÁZ-DÉGÁZ Ltd. In 2016, the complete length of the gas pipeline network in the target region was 14,511.6 km, and natural gas supply was available in 253 settlements.

However, 93% of the regional natural gas consumers were households, 49% of the sold amount was provided to non-household consumers. The average natural consumption of the households in the region in 2016 was approximately 920 m^3, which is approximately 10% lower comparing to national level.

	Number of household consumers	Total supplied amount [thousand m^3]	Sold to households [thousand m^3]
Hungary	3 453 000	8 545 000	3 451 000
Southern Great Plain	456 503	821 726	419 885

Table 3.2. Number of consumers and amount of supplied gas in 2016 (source: Data of the Hungarian Natural Gas System 2016; MEKH and KSH yearbook)

3.1.3. District heat infrastructure

The distribution of the Hungarian housing stock according to the type of heating is predominated by gas heating. The share of the district heat is around 17,3%.

The simplified model of Hungarian district heat distribution is summarized and illustrated in Figure 3.6.

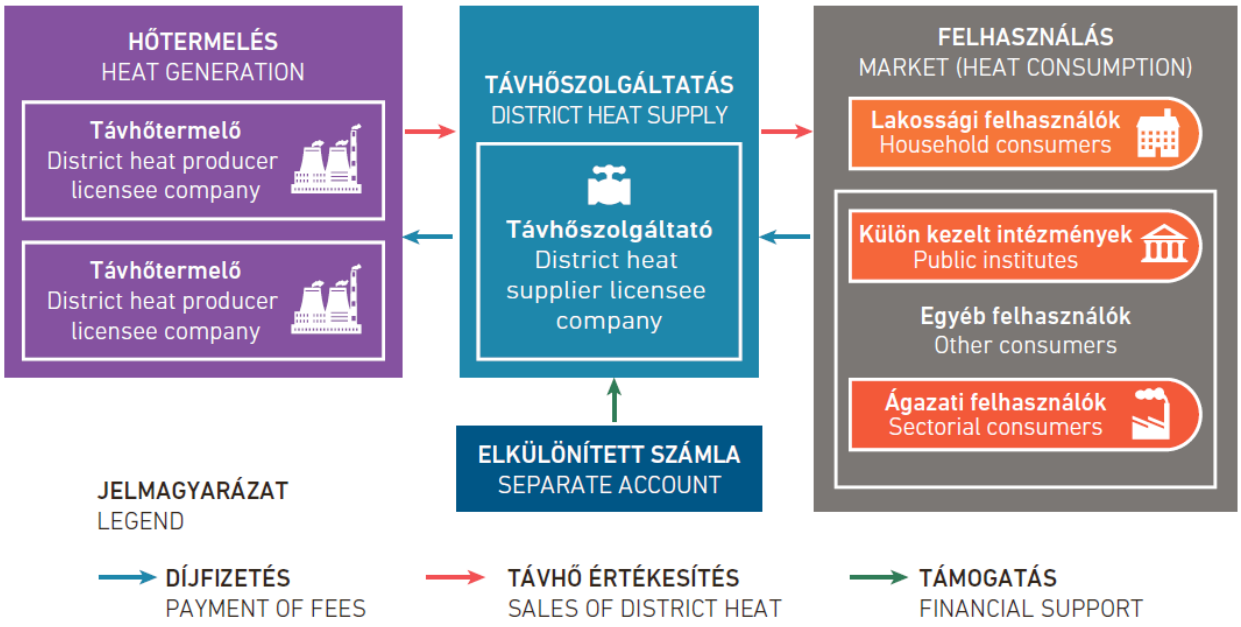


Figure 3.6. Model of the district heat supply (source: Data of the Hungarian District Heat Sector 2016; MEKH)

The main domestic infrastructure elements are listed below, in Table 3.3.

	2014	2015	2016
Number of supplier substations [pcs]	2,001	1,986	2,025
Number of consumer substations [pcs]	12,662	12,740	12,833
Number of heat transfer stations [pcs]	7,226	7,198	7,193
Route length of district heating pipeline [km]	1,909	1,915	1,870

Table 3.3. Key features of the national district heat infrastructure

In 2016, a total 165 facilities possessed district heat producing licensees in Hungary. Their net district heating capacity was 7,812 MW from which 998 MW was the capacity of the renewable energy source-based heat producing facilities.

The most relevant conventional technologies were hot water boilers (4,633 MW), back-pressure steam turbine (694 MW) and combined cycle production (449 MW). Regarding the renewable energy sources, biomass (817.7 MW) and thermal water (177.9 MW) were the main energy sources.

In 2016, the Hungarian district heat suppliers had a total of 677,077 consumers and its 97% were household fee payer.

	Supplied households	Total amount	Sold to households
Hungary	657,273	26,262,568 GJ	19,697,317 GJ
Southern Great Plain	48,792	1,823,400 GJ	1,402,404 GJ

Table 3.4. Amount of heat sold by district heat suppliers [GJ] (source: Data of the Hungarian District Heat Sector 2016; MEKH)

The number of the domestic district heating systems varied according to Figure3.7.

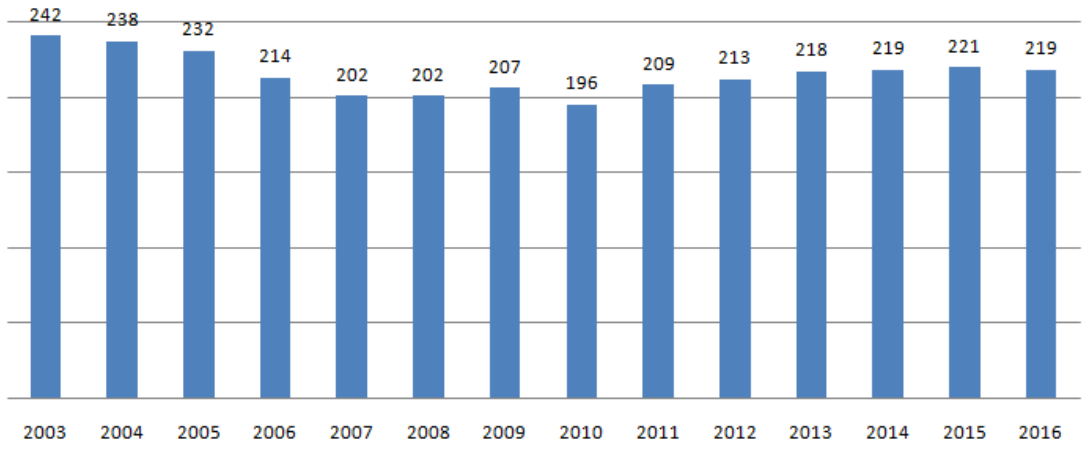


Figure 3.7. Changes in the number of district heating systems

Regarding the Southern Great Plain region, the district heating capacity in Bács-Kiskun and Békés County is generally poor. Only 11 settlements of the region are supplied with district heat, from which five town had geothermal district heat capacity – Szentes (13.7 MW), Hódmezővásárhely Makó Csongrád and Szarvas. The share of district heating in housing stock is 9.49% (48,792 households), which meant the lowest share value regarding the Hungarian NUTS 2 regions. App. 77 % of the regionally provided district heat was supplied to the households.

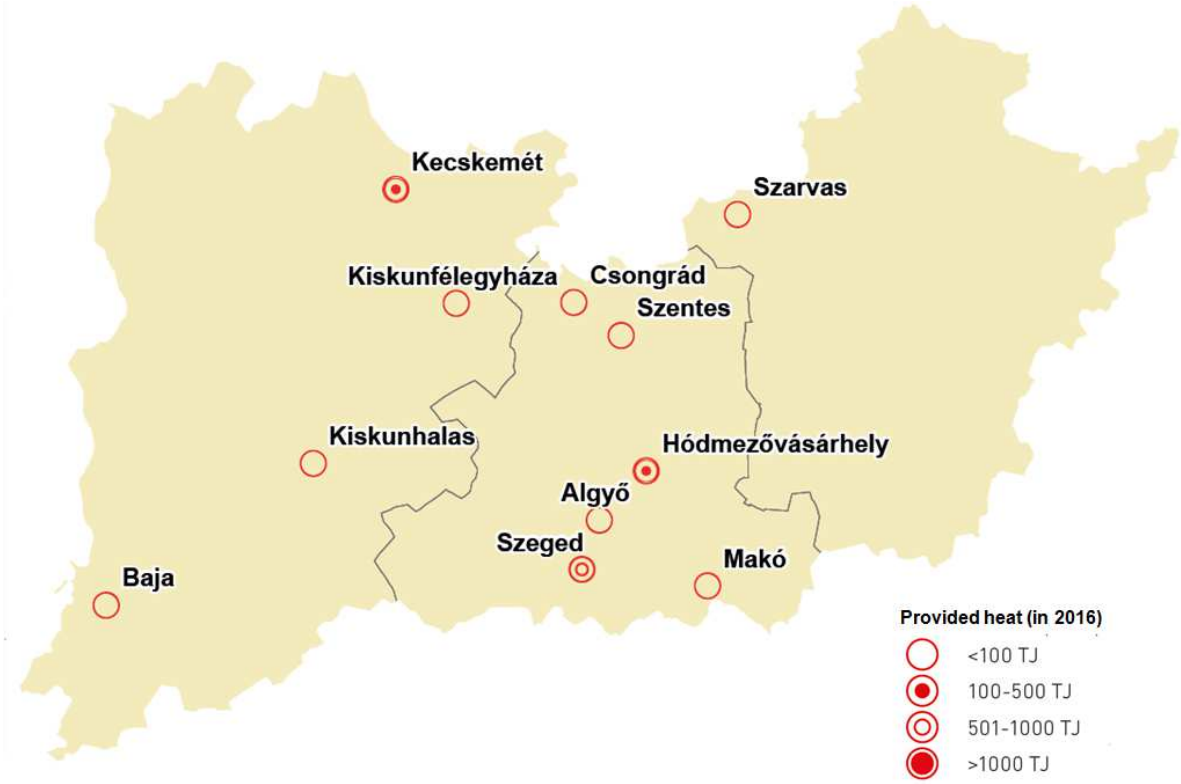


Figure 3.8. Settlements supplied with district heating in the target region (source: Data of the Hungarian District Heat Sector 2016; MEKH)

3.2 Mobility and transport related infrastructure

3.2.1 Rail network

Official railway transport map of the Southern Great Plain region is presented in Figure 3.9. Railway infrastructure is maintained by Hungarian State Railway company. The Southern Great Plain region lies on the Trans-European transport corridor. The 4th corridor cuts through the region, which joints Western-Europe and the Balkans. In Budapest the corridor branches into two separate lines, one targeting Romania, and the other leading towards Montenegro through Serbia.

The main railway lines are almost exclusively electrified (red colour on map), whilst branch lines are still non-electrified (magenta). As it is shown on the map, the region can be characterised with a relatively dense rail network. Thicker red and magenta colours represent the main lines, while the thinner lines stand for the branch lines. Railway lines drawn with double line are used only for freight transport, while dotted lines are railway network out of use at the moment.

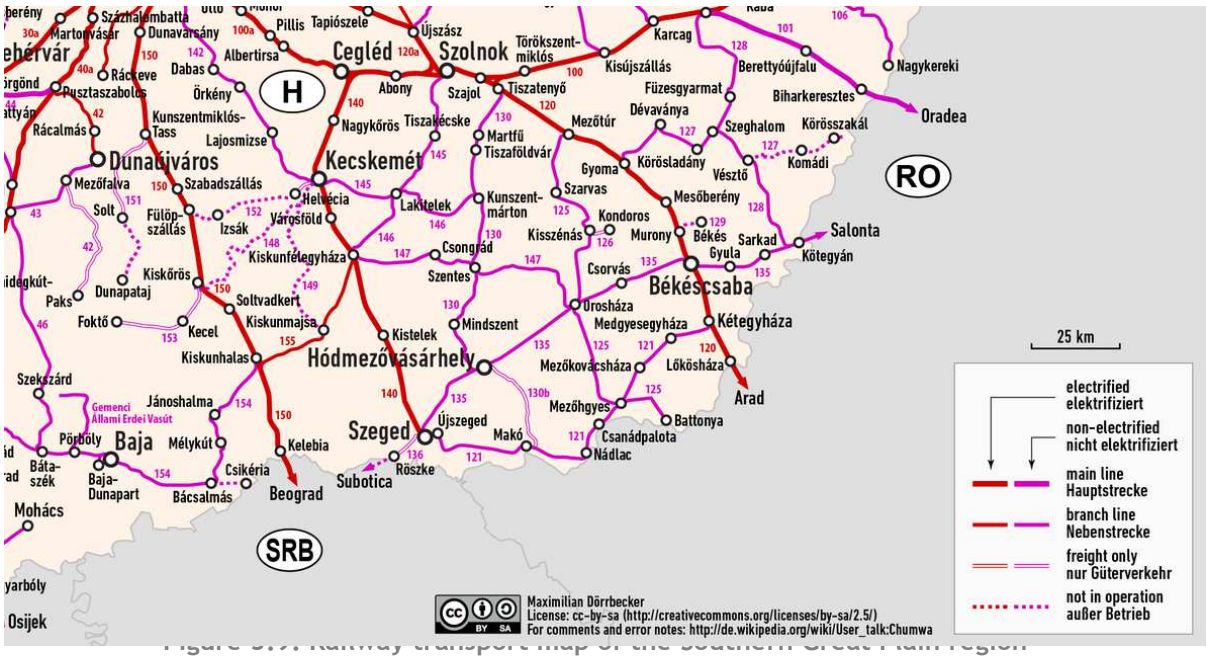


Figure 3.9: Railway transport map of the Southern Great Plain region

Condition of the trains and the tracks are unsatisfactory, standard of service is undeveloped compared to Transdanubia. Many of the branch lines are lossmaking due to low number of passengers. This phenomenon in not unique to the region, it is specific to most of the branch lines in Hungary. Inhabitants of the region rather use other means of transportation for commuting as a consequence of the above-mentioned factors.

Development projects targeting passenger railway infrastructure are carried out from time to time, however only short section of the infrastructure is affected at a time. It is important however to mention the upcoming extensive railway transport infrastructure development project regarding Budapest-Belgrade transport route. According to recent news on the project a new track will be built next to the existing one, between Budapest and Kelebia. The new line on the other hand will be used mainly for freight transport purposes.

3.2.2 Road network

Road network map of the Southern Great Plain region is shown in Figure. 3.10. A total length of 5,218 km-of roads is present at the target region. A total length of 182 km of it is motorway (M5, M43) which is an important transportation northwest-southeast striking transit transportation route. Total length of primary roads is 299 km, while secondary roads are present in 860 km length. The vast majority (3,877km) of the total length of the road network is ranked as a main road.

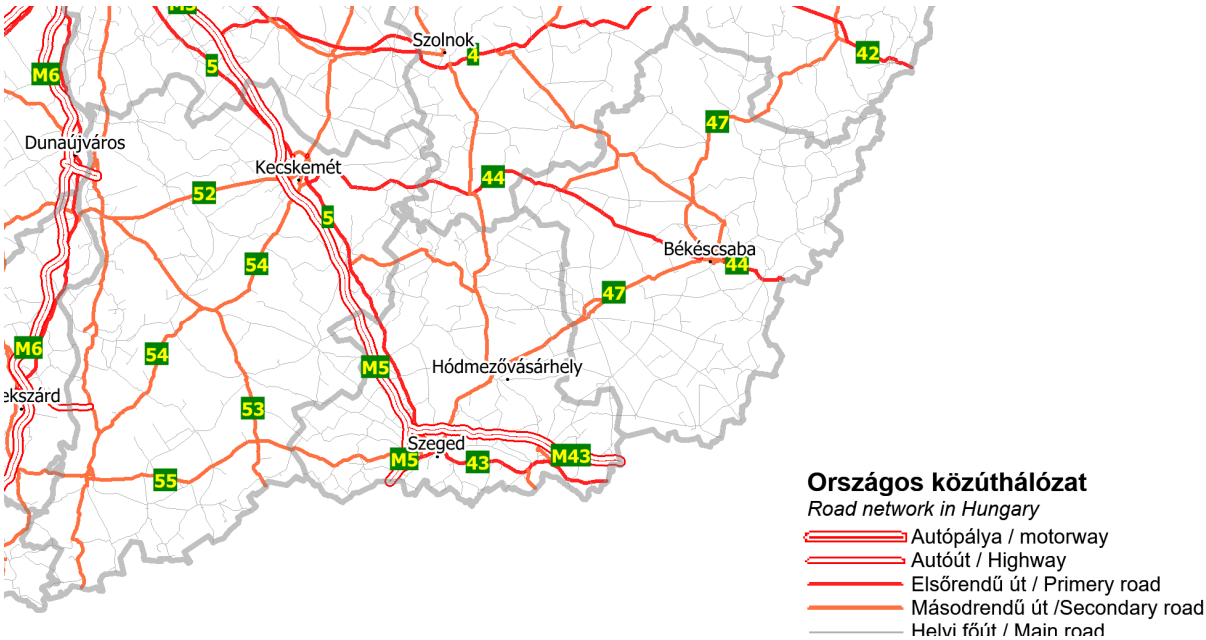


Figure 3.10. Road network map of the Southern Great Plain region

Despite, being one of the busiest transit routes in Hungary, the primary road transportation network infrastructure is undeveloped and insufficient quality. Quality of the road network infrastructure is below the national average regarding all road categories.

In contrary to the relatively developed state of the northwest-southeast oriented road network infrastructure, transversal transportation connections are poor in terms of both quality and quantity. Low number, unequal distribution and insufficient capacity of bridges on rivers (Danube, Tisza, Körös) further complicate east-west road connections.

However, extensive development projects are planned: construction of a new, east-west oriented motorway is planned in the future. The planned path of the new motorway will follow the road Nr. 4, which is not part of the target region, but most likely to have effects on distribution of passenger and freight transport traffic.

There is high inequality within the region in the distribution of road network infrastructure. While western part of the region can be part of trans European transport system, and can benefit from development projects, eastern part can only gain advantages due to railway infrastructure development projects.

3.2.3 Aviation and waterways infrastructure

However, the region has some minor airfields of different category, they do not have national importance. Locations and type of airfields in the Southern Great Plain region are shown in Figure 3.11.

Figure 3.11. Locations and type of airfields in the Southern Great Plain region

Airfields in the region are the following:

- Sport Airfield: Ballószög,
- Non-public airports: Békéscsaba, Kalocsa-Foktő, Kiskunfélegyháza, Szeged,
- Non-public aerodrome: Szentes
- Non-public airfield: Jakabszállás
- Non-public take-off and landing grounds: Matkópuszta, Kiskőrös, Baja, Szatymaz, Kákahalom
- Military: Kecskemét

The main inland waterway of the Southern Great Plain region is the river Danube, which plays a major role, as it is one of the routes of Trans-European Network (Corridor VII). Map and classification of waterways of Hungary and the Southern Great Plain region is presented in Figure 3.12.

In the region the whole section of the Danube suits to the requirements of the Danube Committee stated against water course-parameters, thus classified as a class VI. (of international importance) waterways.

Regarding the river Tisza, the section situated in the region is suitable to be used by large ships. According to the waterways classification standards of the United Nations corresponding committee, the last 17 km long section of the Tisza right before the state border, can be characterised as a class IV. category waterway, which is the best classification regarding the Tisza.

Waterways infrastructure in the region is however still an undeveloped and untapped sector of transportation. Implementation of development might only be available if multi-purpose utilization is planned.

3.12. Figure: Map and classification of waterways of Hungary and the Southern Great Plain region

Ports in the Southern Great Plain region are situated in the following settlements:

- On river Danube: Dunavecse, Harta, Foktő, Baja, Solt, Fajsz
- On river Tisza: Szeged
- On river Körös: Köröstarcsa
- With national and international importance: Baja, Szeged.

3.3 Particularities of regional infrastructure

As well as in Hungary, the regional electricity distribution and transmission system is “reconditioned”, its capacity able to satisfy the internal demands. The coordinator of the transmission system is MAVIR Ltd., who synchronises also the Hungarian network with the neighbouring systems.

The most significant, domestic high voltage lines of the region are Paks-Sándorfalva, Szolnok-Békéscsaba and Békéscsaba-Sándorfalva 400 kV lines. Regarding the cross-border electricity flows, the Southern Great Plain region has interest most of all in the electricity export towards Serbia (Subotica).

In the region the distribution system is operated by NMK Power Grid Ltd. Electricity generation infrastructure and capacity is assessed in chapter 5.1.

The gas pipeline network is well organised also on national and regional level and it is operated by FGSz Ltd. The region has notable role not only in the gas import, but also in gas storage, as three of the five

Hungarian gas storage facilities are situated in the region with 70% of the total domestic storage capacity. Currently the Hungarian hydrocarbon production is concentrated in the Southern Great Plain region.

The gas distributor company of the target region is ÉGÁZ-DÉGÁZ Ltd. The rate of households supplied with piped gas is relatively high, it is above 80% also in Hungary and in the region, from which app. 90 % utilize gas for heating purpose.

As already noted, the district heat availability in the Southern Great Plain region is the lowest amongst the Hungarian NUTS 2 regions, only 9,5 % of the housing stock is provided with district heat. On one hand it is the consequence of the slight number of relevant power plant. On the other hand, in most part of the region, the settlement structure -especially the rare settlement network and low population density – is unfavourable for installation and operation of reasonable district heating systems. A regional particularity is the increasing installed capacity of geothermal based heat generation.

As it was already mentioned in previous paragraphs, density of railway and road network of the Southern Great Plain region is satisfactory. Inhomogeneities in the network however occur, especially in road network infrastructure. Lying on a main national and international north-south striking transportation corridor, western part of the region is more developed and is in a preferable situation regarding development project. On the contrary, infrastructure at the eastern and south-eastern part of the region became outdated in the past few decades, there is a strong need in quality improvement of secondary roads, branch railway tracks and train carriages. Also, there is a high potential in decarbonization of branch railway infrastructure. East-west striking transportation routes are overloaded and unequally distributed; however, improvements are already planned (M4 Motorway).

The abovementioned particularities are mainly the consequences of the following process. Inland and international migration, urbanization changed the settlement structure of the region, population of small towns, villages are declining since 1980’s. Passenger number of branch railway tracks connecting small towns and villages with local economical hotspots decreased dramatically, either due to depopulation, and increase in car use. Declining income generates erosion of railway network infrastructure, thus as a self-generation process, popularity of railway transport system decreases further. At the same time increasing load on outdated road infrastructure leads to erosion of road infrastructure, as well.

Due to overall area of the country and the region itself, inland aviation infrastructure is not developed, there is no actual need for it. The two international airports of the country (Budapest, Debrecen) covers the whole area, the latter is also significant even in Eastern-Central European scale. Small, public airports are mainly used for private and recreational purposes.

Regarding waterways the situation of the region is advantageous, the main two waterways (Duna and Tisza) present are almost suitable to use during whole year. On the mentioned waterways transaction of mainly international freight transport occur. Water bodies apart from these are mainly used for touristic and recreational purposes.

4. TRANSPORT

4.1. Basic data and modal split

For modal split in passenger and freight transport, data are available only on national level, but not on regional level. For the regional perspective of road and rail transport data for Southern Great Plain region, not significant differences are supposed from the national ones. Air and waterway transport are not applicable, because of the geographical characterization of Hungary and lack of a respective infrastructure.

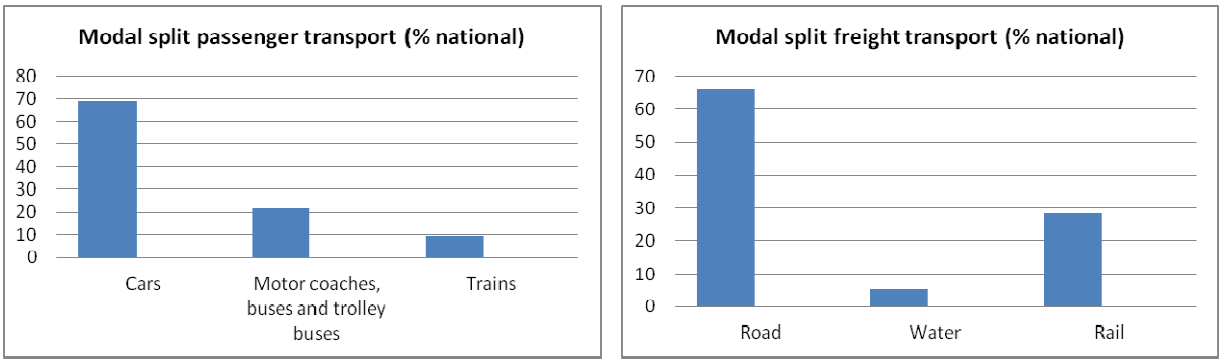


Figure 4.1. Modal split of passenger and freight transport on national level

Figure 4.1 provides an overview of the modal split of passenger and freight transport on national level. In case of the passenger transport, the main focus in passenger transport is on cars with an approximately 70% on national level. The public transportation can be divided into two sections. The share of passenger transport by motor coaches, buses and trolley buses is approximately 20%, whilst the passenger transport by train is approximately the half, 10%. Two-thirds of modal split of freight transport is road transport, whilst the water transport represents only a minor share (5%) of the freight transport. The remaining 28% share of freight is transported on rail.

4.2. Road transport

Data regarding motor vehicles by type (4.2.1) and passenger cars by fuel (4.2.2) is available on both national and regional level. Data regarding number of passenger and freight transport tonnes kilometres (4.2.3.) is available only on national level.

4.2.1 Motor vehicles by type and fuel

In total, the stock of motor vehicles in Southern Great Plain Region is 545,982. This is a share of 13,5 % of the total number of vehicles in Hungary. Regarding the general fuel usage in the motor vehicles (such as e.g. the use of electricity or natural gas for transporting goods, electric motorcycles etc.) there are, currently, no data available. Table 4.1 is giving an overview on the number of motor vehicles by type.

Motor vehicles by type	National	Regional
Passenger cars	3,313,206	410,046
Motorcycles	162,148	23,784
Lorries	460,845	65,031
Buses	18,482	1,999
Road tractors	68,117	12,462
Other motor vehicles	122,609	32,660
Total	4,145,408	545,982

Table 4.1. Motor vehicles by type in 2016

Figure 4.2 is illustrating the contents of Table 4.1.

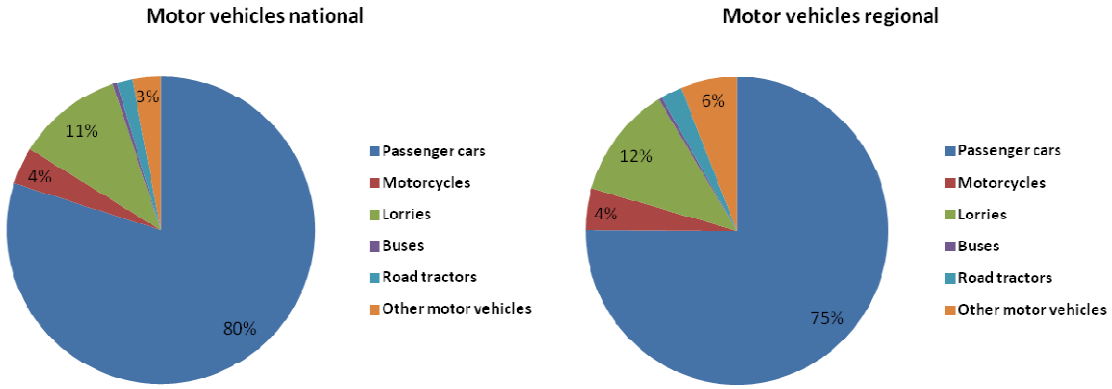


Figure 4.2. Share of the different motor vehicles by types in 2016

The distribution on regional level is similar to the one on national level, with the difference, that other motor vehicles (e.g. motorized work machinery used in agriculture and forestry) are more represented in rural regions than in the average national level.

4.2.2 Passenger cars by fuel, kilometre and fuel performance

The amount of passenger cars in the Southern Great Plain region is approximately 330,000, which is 12,2 % of the total fleet of passenger cars in the whole country. Regarding the passenger cars per capita on regional and national level, there are no differences between the two numbers; both of them are around 0.33. However, the distribution of cars by diesel and petrol fuel is equal in the total and regional level, based on the database it is supposed, that generally the more advanced technology (hybrid, electric, etc.) is less widespread on regional than regional level.

Table 4.2. is giving an overview on the passenger cars by fuel on national and regional level.

Passenger cars by fuel (number)	National	Regional	Average annual km/car	Average Consumption (l/100 km; or kWh/100 km)
Petrol	2,301,168	277,559	n/a	7.88
Petrol-flex fuel	n/a	n/a	n/a	n/a
Diesel	970,997	123,362	n/a	6.56
Electric	758	38	n/a	16.38
Liquefied petroleum gas	16	n/a	n/a	10.61
Natural gas	925	n/a	n/a	5.01
Petrol / Liquefied petroleum gas (bivalent)	n/a	n/a	n/a	n/a
Petrol / natural gas (bivalent)	n/a	n/a	n/a	n/a
Petrol / electric (hybrid)	5,139	670	n/a	4.80
Diesel / electric (hybrid)	n/a	n/a	n/a	5.30
Hydrogen / fuel cell	n/a	n/a	n/a	n/a
Alternative	41,041	n/a	n/a	n/a
Total	**3,320,044**	**401,629**	**n/a**	**n/a**

Table 1.2. Passenger cars by fuel (number)

Figure 4.3 illustrates the distribution of the passenger cars by fuel on regional level, based on the database shown in Table 4.2.

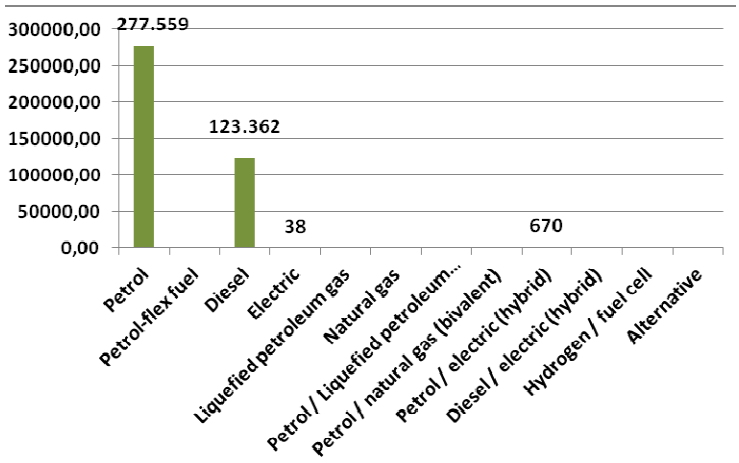


Figure 4.3. Passenger cars by fuel (number)

4.2.3 Passenger- and tonnes kilometres

Database related to passenger-, and tonnes kilometres is available only on national level, not on regional (Figure. 4.4).

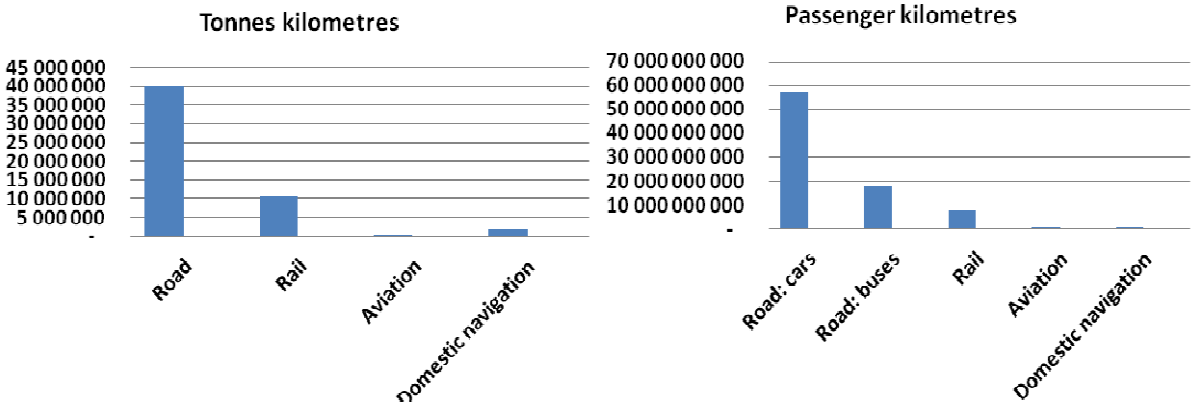


Figure 4.4. Amount of passenger kilometres and tonnes kilometres in 2016

Based on the figures, it can be seen, that on national level mostly cars are used for passenger transportation (approximately 70% of the total passenger kilometres). The cars are followed by the usage of buses and rails, whilst the aviation and domestic navigation are minor amount (0,01%) due to the geographical characterization of Hungary and lack of infrastructures. On regional level the same distribution is expected. In case of the tonnes kilometres, freight is transported mostly on road, and party on rail. Domestic navigation is approximately a share of 4%, whilst the aviation is negligible.

4.2.4. Particularities

The Southern Great Plain Region is characterized by mainly agricultural landscapes and rural area. It also plays a gateway role to the Balkans, since M5 and M43 motorways connect Serbia and Romania with Budapest and towards with Western Europe. Thus, agriculture, transportation and industrial related activities are widespread in this region.

4.3. Rail transport

4.3.1 Passenger and tonnes kilometres

Information related with passenger and tonnes kilometres is already discussed in the section 4.2.3.

4.3.2 Development of passenger and goods transports

Regarding to the development of transports of passenger and goods, data is available only on national level, but not on regional level. Figure 4.5. provides an overview of the development on national level.

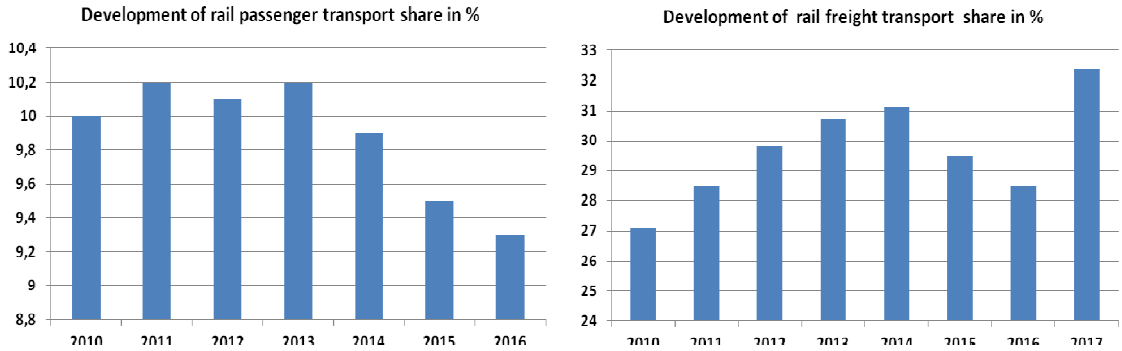


Figure. 4.5. Development of passenger and freight rail transport share

As the Figures 4.5 illustrates above, a decreasing tendency can be seen in both the share of rail passenger and freight transport between 2014 and 2016. In 2017 the share of rail freight transport increased significantly comparing the changes of the 2010 and 2016.

4.3.3 Particularities

Information related with passenger and tonnes kilometres is already discussed in the section 4.2.4.

4.4 Air and waterway transport

Air and waterway transport have significantly lower share in case of both passenger and freight transport in Hungary. Regarding domestic navigation the number of passenger kilometres was 11,800, 000 (0,01 %) share of the total passenger kilometres), whilst the volume of freight transport was 1,975,000 tkm (5.3 % share of the total freight transport kilometres) on national level. More information is already discussed in chapter 4.1. Three international airports are present in Hungary, and none of the three airports are located within the Southern Great Plain Region. Consequently, there is no air transport on regional level and the on national level is negligible as well.

5. ENERGY STATUS

5.1. Energy in the European and national context

In the following chapters the main parameters of the respective simplified energy balances are represented by graphs with the following abbreviations:

- PP: Primary production (blue bar)
- GC: Gross consumption (red bar)
- TI: Transformation input (green bar)
- TO: Transformation output (violet bar)
- FEC: Final energy consumption (light blue bar).

As shown in Figure 5.1, the following statement can be concluded:

- Both on national and regional level, the share of solid fossil fuels, crude oil and petroleum products, and electricity in final energy consumption is less comparing to the respective share in EU 28.
- On the other hand, in case of natural gas, the share of it in the final energy consumption is higher than the share in the EU28.
- The utilization of renewable energies is higher than in the in the EU28.

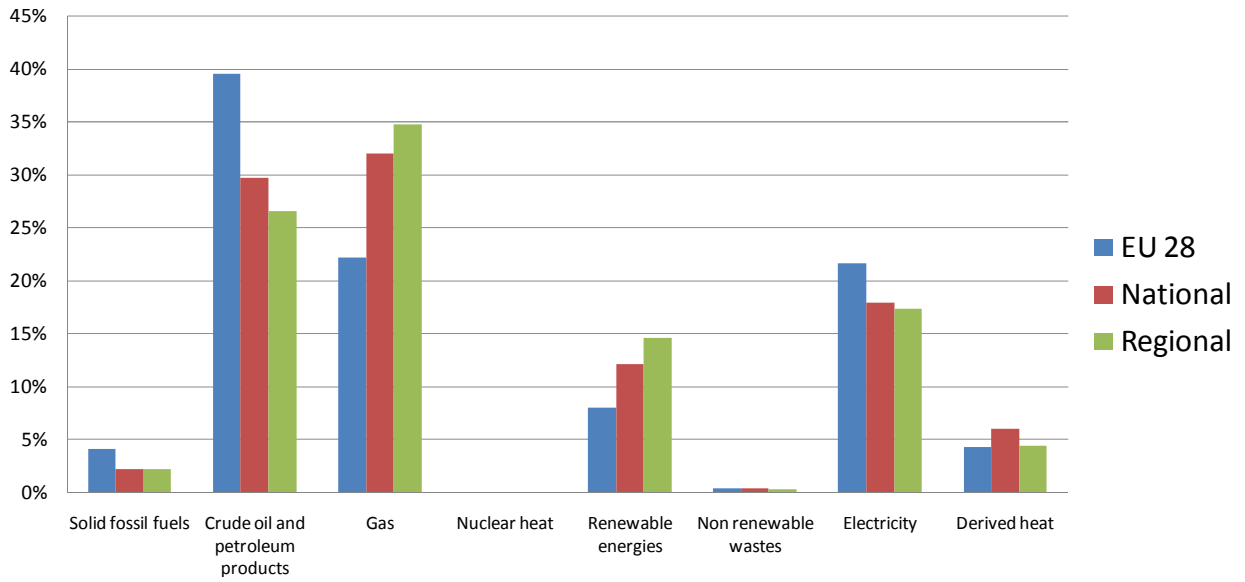


Figure 5.1. Comparison of shares in final energy consumption

5.1.1. Simplified energy balance of EU 28 (based on year 2016)

Figure 5.2 illustrates, that the fossil fuel import (crude oil, petroleum products, natural gas and solid fossil fuel) plays a crucial role in the energy economy of the EU.

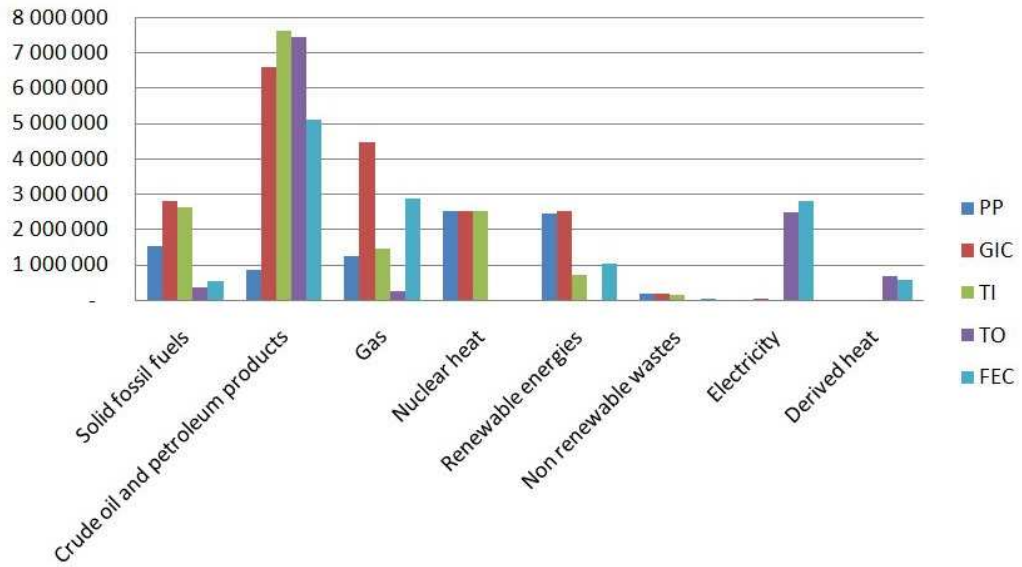


Figure 5.2: Simplified energy balance of the EU 28

5.1.2. Simplified national energy balance (based on year 2016)

In 2016 the Hungarian primary energy production was 132 070 GWh, which is 44% of the gross inland consumption (298 949 GWh). Similarly to the situation of EU, Hungary is highly dependent on fossil fuels import, especially regarding crude oil and natural gas.

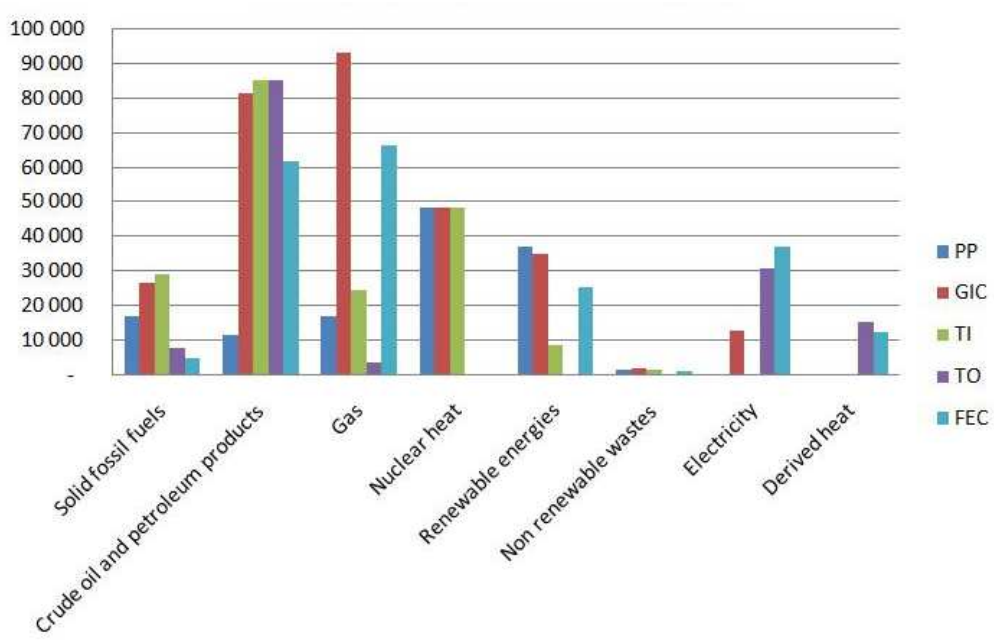


Figure 5.3. Simplified energy balance of Hungary in GWh

The utilization of natural gas and renewable energies are higher, meanwhile the crude oil consumption is lower than in the Union.

Approx. 16.2% of the gross inland consumption is supplied by nuclear heat, which provides approximately half of the generated electricity.

Regarding the residential shares in the final energy consumption of the different energy sources, it is shown, that households use the 50% of the gas, the 30% of the electricity and the 80%of the renewable energies.

5.1.3 National electricity fuel mix

Regarding the Hungarian electricity generation, the main energy source is the nuclear fuel. Hungary currently has one nuclear power plant of 2 000 MW installed capacity in Paks, located in the next to the Southern Great Plain. In 2016 more than half of the amount of electricity was generated by nuclear power (more than 16,000 GWh). Expansion of the Paks nuclear power plant is projected. Presumably, the construction works will begin in 2020, and the optimistic forecast suggesting, that operations may commence already in 2026/2027.

The share of fossil fuels in the electricity fuel mix was 38.7%, whilst the renewable was 10.2% in total in 2016.

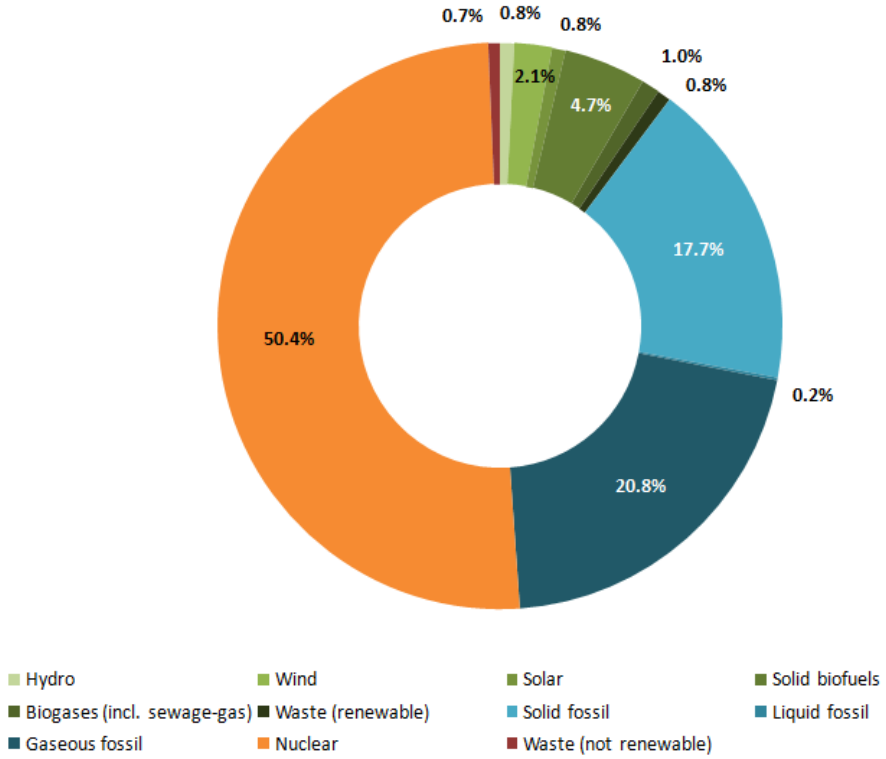


Figure 5.4. National electricity fuel mix

In respect of the fossil fuel-based electricity generation, also the solid and gaseous (mainly natural gas) fuels play a key role, with contribution of 5 760 GWh and 6 479 GWh in 2016, respectively. Importance of liquid fuel is minor, only less than 0,2% of the electricity generation was supplied on oil base.

However, the renewable-based electricity generation is dominated by the solid biofuel (4.7 %), the share of wind (2,2 %) and biogas (1,1 %) were also notable of the total electricity production in 2016. Currently, the domestic wind power capacity is concentred in the northwester region of Hungary. Hydro, solar and renewable waste based electricity production are also present in Hungary, but their shares are in the electricity production remained under 1 % .

However, Hungary has a significant geothermal capacity, generally the temperature of the water is not high enough to supply competitive source for electricity generation. The first geothermal power plant in Hungary which provides also electricity (2 MW) commenced the operation in 2017, however a further plant is under development close to the Southern Great Plain region.

It is important to note, that 48% of the final electricity consumption is based on import.

According to the report of the European Environmental Agency, the Hungarian specific CO_2 emission (CO_2 intensity) related to public electricity production was 260.4 g/kWh in 2016.

5.1.4 Time series of national final energy consumption

According to the relevant database, the final energy consumption has decreased by 10% between 1990 and 2016. This decreasing tendency is visualised in Figure 5.5. The energy consumption was falling until 2014 due to the economic crisis in 2009. Starting from 2015 the energy consumption started growing.

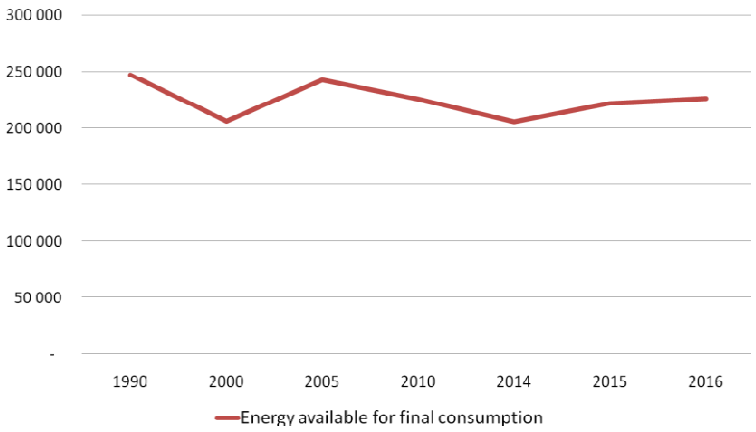


Figure 5.5. Development of FEC in GWh/year

Regarding the development of the renewable based energy consumption, a slight but constant increment can be observed (left graph of Figure 5.6), although the main part of final energy consumption is still covered by non-renewable energy sources (72.2 %).

Waste based energy generation commenced in 2005, and it provided 0.35 % of the final energy consumption in 2016. The right graph of Figure 5.6 to the right shows, that solid biomass plays key role in renewable sector. The total share of liquid biofuel and other renewable energy sources are less than 1.4% of the final consumption.

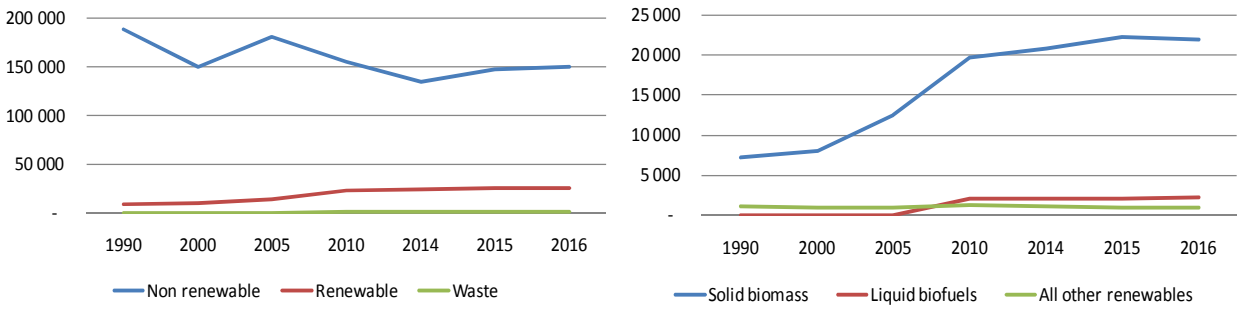


Figure 5.6- graph to the left: Energy available for national final consumption (GWh/year); graph to the right: Development of renewable energy in national final consumption (GWh/year)

Development of the efficiency in transformation processes and distribution losses are illustrated in the two graphs of Figure 5.7. In the period between 1990 and 2016, the efficiency of transformation has not changed significantly, while the distribution loss decreased, from 3.4 % to 2,6 % between 1990 and 2016. In the energy balance statistics, the transformation of nuclear heat to electricity is calculated with an efficiency of 33 %.

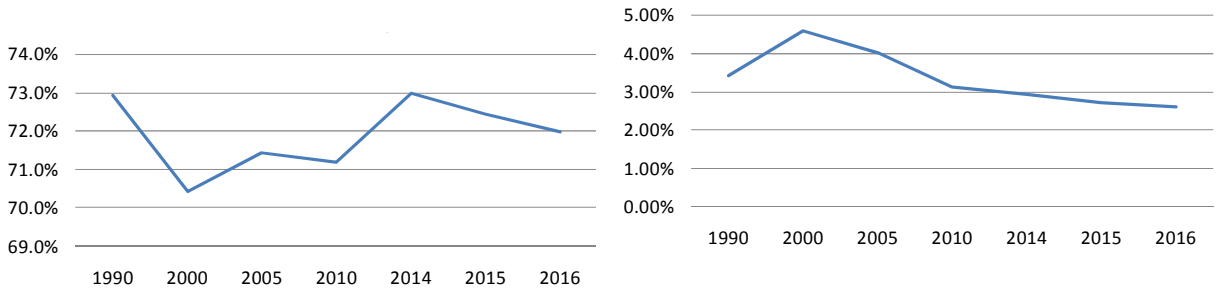


Figure 5.7 graph to left: Transformation efficiency; graph to the right: Distribution loss

5.1.5 Energy prices

In Hungary the average consumer end electricity and gas prices are lower than the European average.

Gas:

Wholesale prices level for natural gas was 15.9 €/MWh in 2016, whilst the consumer end price was 36.3 € cent/kWh for household consumers including 48% of taxes and levies and 32.9 € cent/kWh for non-household consumers, with a tax content of 40%. Starting from 2006, until 2011 a significant rising of the price can be seen, following a smaller decrease. The overall increase of the price was 185 %.

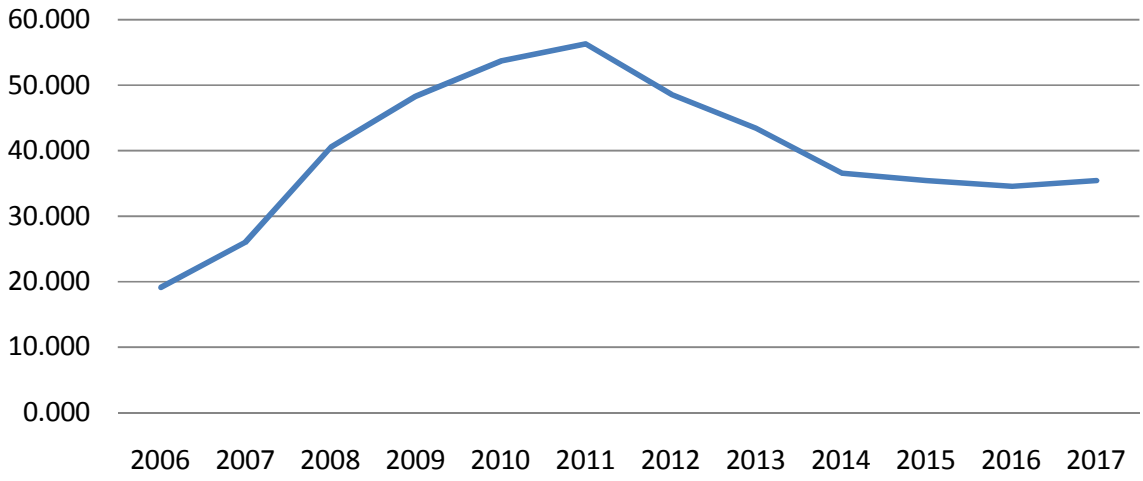


Figure 5.8. Average household gas prices (€/MWh)

Electricity:

Concerning electricity, the wholesale prices was 35.4 €/MWh in 2016, which is relatively high compared to other countries of the Central-Eastern European region, due to the significant rate of electricity import. In that year, the average consumer end price for household consumers was 11.60 € cent/kWh, whilst for non-household consumers was 8.21 € cent/kW. Their taxes and levies content were 59% and 41%, respectively. The average household electricity prices did not change as significantly as the gas prices, but a similar trend of the curve can be observed.

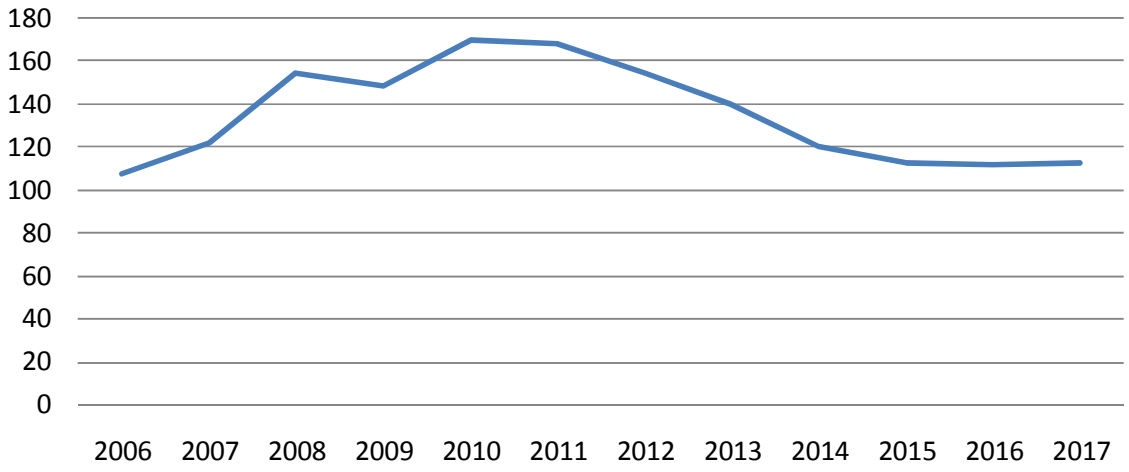


Figure 5.9. Average household electricity prices (€/MWh)

District heat:

In 2016 for the household consumers, the working and consumer end price was 3.02 € cent/kWh and 4.59 € cent/kWh, respectively. Regarding the non-household consumers, the working price was 4.06 € cent/kWh, whilst the consumer end price was 6.59 € cent/kWh.

Oil and petroleum products:

Table 5.1. giving an overview at the prices of the most common petroleum products.

	Net price	Customer end price (incl. taxes and levies)	Share of taxes and levies	Energy content
Petrol	4.71 € cent/kWh	11.25 € cent/kWh	58%	8.1 kWh/L
Diesel	4.4 € cent/kWh	9.93 € cent/kWh	56%	9.8 kWh/L
Heating oil	4.69 € cent/kWh	10.6 € cent/kWh	56%	9.8 kWh/L
LPG	5.23 € cent/kWh	8.56 € cent/kWh	39%	12.8 kWh/kg

Table 5.1. Prices of the most common petroleum products

Electricity injection tariffs

Regarding renewable energy-based electricity, the injection tariffs are bound to contract.

For the power plants, which bound the feed-in contract before 1 January 2017, the previous feed-in tariffs (FIT) scheme is available. In this previous FIT scheme (its Hungarian abbreviation is KÁT) the tariff rates varied according to various factors:

- the type of energy source;
- the installed capacity of the power plant unit (three different rates: up to 20 MW, 20-50 MW and above 50 MW);
- the intraday feed in period (peak, valley or deep valley);
- the period of the year (summer and winter time tariff differentiation);
- the area where plant is commissioned.

This FIT scheme is presented in detailed form in Table 5.2.

Capacity	P < 20 MW (in case of hydro, P < 5 MW)			20 MW < P < 50 MW			P > 50 MW (in case of hydro, P > 5 MW)		
Period	**peak**	**valley**	**deep-valley**	**peak**	**valley**	**deep-valley**	**peak**	**valley**	**deep-valley**
Hydro	92.02	82.37	33.62	-	-	-	57.25	36.64	36.64
Wind	92.02	82.37	33.62	92.02	82.37	33.62	57.25	36.64	36.64
PV*	82.37	82.37	82.37	73.62	65.90	26.87	57.25	36.64	36.64
Geothermal	92.02	82.37	33.62	73.62	65.90	26.87	57.25	36.64	36.64
Biofuels	92.02	82.37	33.62	73.62	65.90	26.87	57.25	36.64	36.64
Biogases	92.02	82.37	33.62	73.62	65.90	26.87	57.25	36.64	36.64
Waste**	86.32	59.49	31.04	86.32	59.49	31.04	86.32	59.49	31.04

*Solar photovoltaic, **: Renewable municipal waste

Table 5.2. Feed-in tariffs for power plant with FIT contract bound before 1 Jan 2017 [€/MWh]

The new scheme (abbreviated as METÁR), which came into force in 1 January 2017, is built on three pillars based on the power plant's installed capacity:

1. **Power plants with 50 kW - 500 kW installed capacity and demonstration plants**: feed-in tariffs are used (KÁT). The support is for a 5 and half - 25 years long period.
2. **Power plants with 500 kW – 1 MW (except for wind) output**: receive an administrative, market 'green' premium (Green Premium I) without any competitive bidding procedure. The power plants need to shell the produced electricity on the free market, but they can receive the difference (between market and feed-in tariff price) as a premium. The premium price support is for a 4 - 25 years long period.
3. **Power plants at least 1 MW installed capacity and all wind power**: Plants are obliged to participate in a tendering procedure in order to receive the green premium (Green Premium II). Similarly to the EU Guidelines, the demonstration projects are treated as exceptions. The premium price support is for a 5- 25 years long period.

The so-called "brown premium" paid for existing biomass power plants is helping biomass projects run with more certainty.

Household scale power plants (up to 50 kW output) can benefit from net metering. The electricity surplus injected to the grid is remunerated by the electricity supplier at the electricity retail price until the amount of consumed electricity is exceeds the injected quantity. Above that wholesale prices are applied.

	METÁR KÁT (P < 0.5 MW)			Price supported with Green Premium		
Period	**Peak**	**Valley**	**Deep-valley**	**Peak**	**Valley**	**Deep-valley**
Hydro	110.5	98.9	40.3	110.5	98.9	40.3
Wind	-	-	-	-	-	-
PV*	98.9	98.9	98.9	98.9	98.9	98.9
Geothermal	110.5	98.9	40.3	110.5	98.9	40.3
Biofuels	110.5	98.9	40.3	110.5	98.9	40.3
Biogases	110.5	98.9	40.3	110.5	98.9	40.3
Waste	110.5	98.9	40.3	110.5	98.9	40.3

*Solar photovoltaic,

Table 5.3. Feed-in tariffs and Green Premium supported prices for power plant with contract bound after 31 Dec 2016 [€/MWh]

Gas injection tariffs

In Hungary there is no injection tariff for gas.

Purchasing tariff of the gas is set by individual contracts

5.2. Regional energy demand

5.2.1 Regional energy demand by fuel and sector

Since energy balance statistics are not available on regional level, built in auto calculation feature of the corresponding data collection file have been utilized for estimation of regional energy demand. According to the calculation, total energy demand of the South Great Plain region is approximately 22.000 GWh. The share of the regional energy demand is only 10.5% of the total national final consumption.

The detailed regional energy demand is presented in Table 5.4.

Estimation of regional energy demand (GWh)	Total	Solid fossil fuels	Crude oil and petroleum products	Gas	Renew. energies	Non renew. wastes	Electricity	Derived heat

Final energy consumption	**22 024**	**475**	**5 851**	**7 646**	**3 208**	**66**	**3 804**	**970**
Agriculture, forestry and fishing	1 769	-	1 019	403	134	-	210	-
Industry (without construction), energy, water sewage etc	4 253	277	496	1 438	143	64	1422	413
Construction	306	5	196	59	5	-	37	4
Transport	4 437	-	4 108	47	183	-	99	-
Services	2 059	3	32	1 176	44	2	639	163
Residential	9 199	190	-	4 523	2 699	-	1398	390

Table 5.4. Regional energy demand

As well as on national level, the most significant energy source in the region is natural gas with a share of 35% in total energy demand. Among all the above listed sectors, residential consumption makes up the majority of the total consumption. However crude oil and petroleum products account for almost one third of the consumption (27%), followed by electricity with 17%.

The share of renewables (as primary energy sources) in the total energy demand is 14.5% and mainly located in the residential sector, due to the relevant amount of agricultural originated biomass. Proportion of renewable energy sources can be higher, if renewable energy sources used to generate electricity and district heat is also taken into consideration. The share of the different fuels in the final consumption of the region is visualized in figure 5.10.

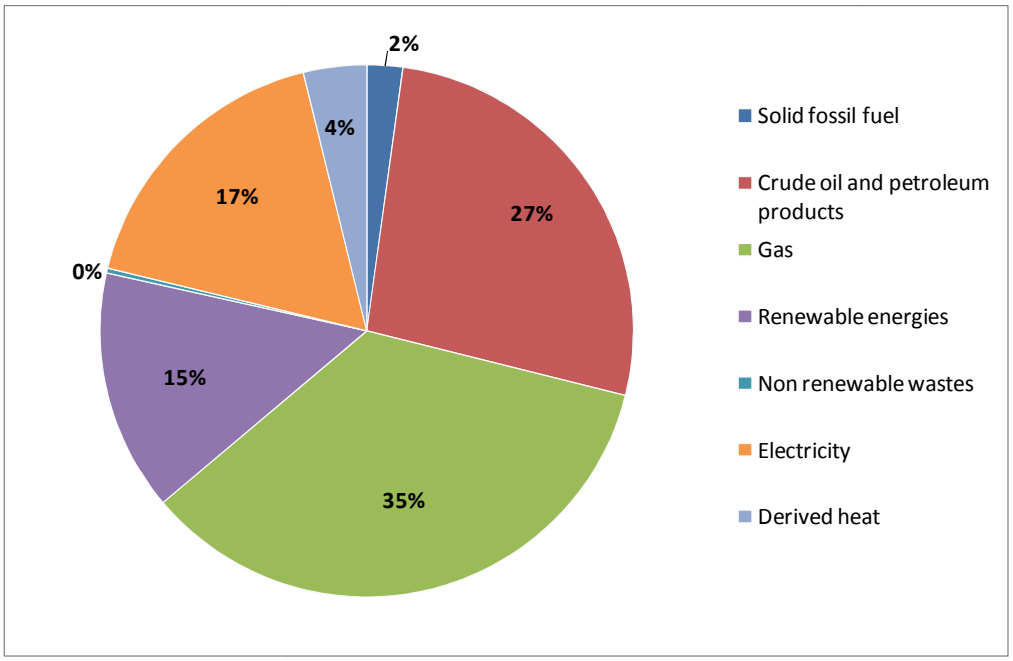


Figure 5.10. Final energy consumption by fuel

The graphic overview on the regional final consumption by sectors is given in Figure 5.11. As visualized in Figure 5.11, the highest proportion of energy consumption can be accounted for the residential use (42%), followed by the transportation (20%), and industry (19%), while services and agriculture make up 9% and 8% of the total energy consumption, respectively.

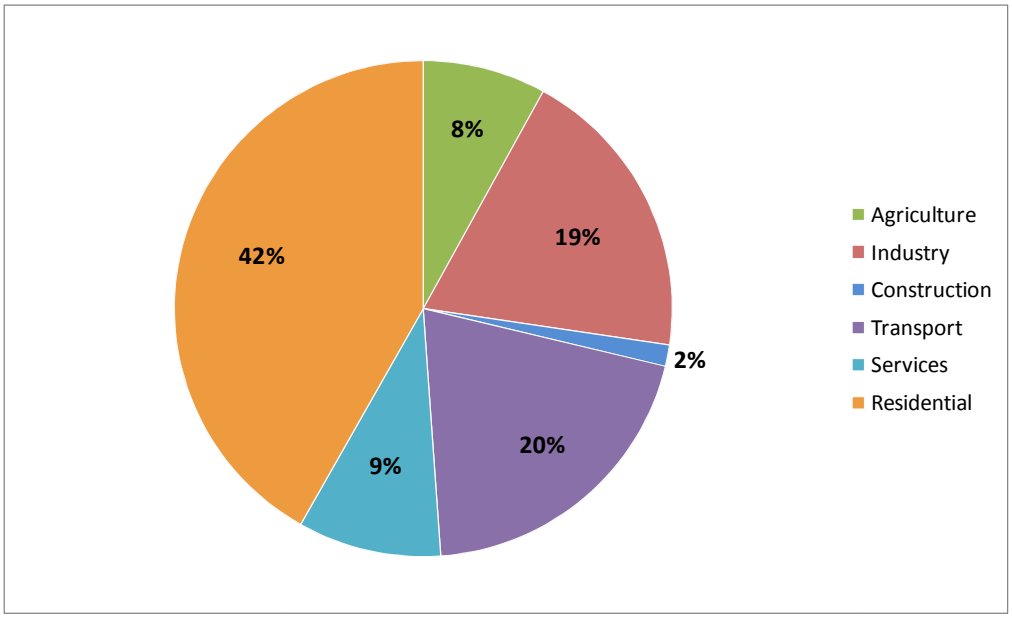


Figure 5.11. Share if sectors in the regional final energy consumption

The share of renewable and non-renewable energy in the different economic sectors is summarized in Figure 5.12.

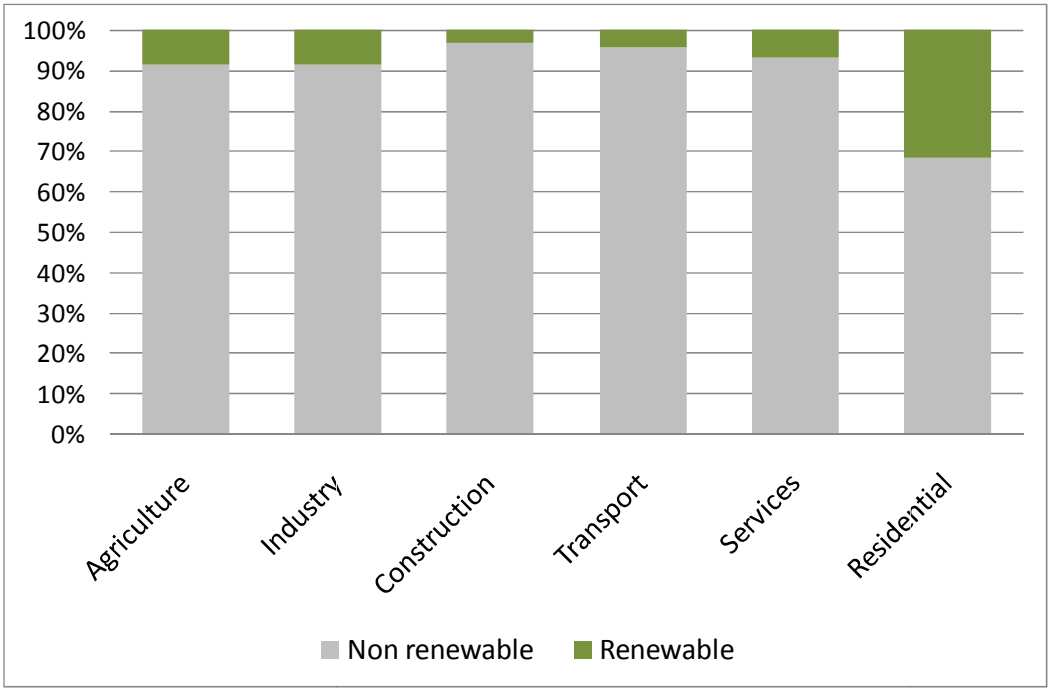


Figure 5.12. Share of renewables in total sectoral consumption

Regarding the overall final energy consumption 17% of the regional energy demand is produced in renewable base (including the renewable portion of electricity and district heat), however its share exceed 10% only in the residential sector (32%). According to Table 5.12., it is obvious, that there is a strong need of transition to renewable energy sources, especially in transportation and industry sectors, which are the second two most energy demanding sectors.

5.2.2. Regional particularities of energy demand and energy demand of the region

The regional energy demand is calculated, based on the use of key figures derived from general national/regional energy statistics.

Among all Hungarian NUTS2 regions, in the South Great Plain region share of households connected to district heat grid is the lowest.

As it is known from previous sections, urbanization rate in the Southern Great Plain region is the highest in Hungary, which makes the region more energy demanding.

Favourable situation regarding renewable and green energy sources (high solar radiation values and geothermal potential), however can be recognizable in share of renewables in residential sector.

5.3 Regional energy supply

Electricity

Thus, regarding the regional electricity production, information is available only on the power plants which feed electricity to the grid, assessments in the following chapters are based on these data.

In Hungary the electricity generating power plants are classified in four types with respect to their installed capacity:

I. **Large power plants**, with capacity of 50 MW or above;
II. **Small, licensed power plant,** under 50 MW installed capacity;
III. **Non –licensed power plant,** between 50 kW and0,5 MW;
IV. Non –licensed microgeneration power plants for households, under 50 kW (in the following abbreviated to **HMKE**).

Currently 12 large power plants operate in Hungary, but none of them is located in the Southern Great Plain region, thus the electricity generation capacity of the region is far below the regional demand (3 804 GWh/year). Currently the region's greatest power plant is MOL's gas-based facility in Algyő with 9.73 MW installed capacity commenced to operate in 2018.

However, the regional electricity generation could be characterized by the dominance of small, licensed power plants, providing approximately 2/3 of the total regional capacity in 2016, the importance of non-licensed generators is continuously increasing.

Data presented in Table 5.5. provides an overview on the number and capacity of the different class of power plants located in the region, and on their electricity generation in 2016.

	Number of facilities [pcs]	Installed capacity [MW] (Electricityonly)	Electricity generated in 2016 [MWh]
Small, licensed power plant	35	52.6	68,664
Non –licensed powerplant	33	11.1	10,950
HMKE	3,241	30.5	26,832
Total	**3,313**	**116.8**	**106,446**

Table 5.5. Number of power plants, their installed capacity and the electricity generation in the Southern Great Plain region (in 2016)

However gaseous fossil had the highest share in the regional electricity generation of 2016, the most installed capacity was related to photovoltaic technology (42.2%) This share has increased in the last three years due to the emerging popularity of non-licensed size renewable power plants. In respect of solar based electricity generation, the change in the FIT scheme (in 2017) was also a favourable circumstance, as several planned solar power investments committed themselves in the previous FIT scheme, accelerating the spread of photovoltaic technologies.

The share of the different energy sources in the entire regional electricity generation of 2016 is given in Figure 5.13.

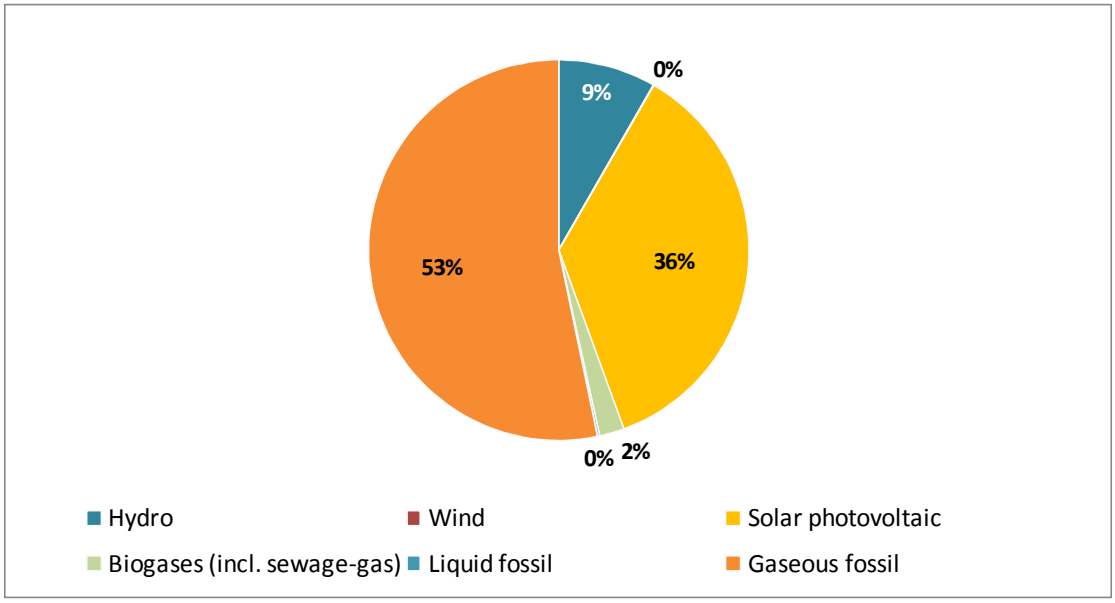


Figure 5.13. Electricity generated by regional producers in 2016

Regarding the licensed power plants, gaseous fossil based is the most significant electricity generation technology, its share was 58% of the licensed, installed capacity in 2016. Since that time further natural gas-based capacity has been installed, increasing the significance of fossil energy sources. Utilization of renewable energy sources is also notable in the region. In 2016, the 16 licensed biogas power plant generated 21% of the total regional electricity production. However currently nine photovoltaic power plants possess generation licence, solar capacity development has started just in the last five years. Despite

the rural characteristic of the region, the first licensed biomass-based power plant (of 8.34 MW) is only in installation phase. A regional particularity is the hydro power plant, installed in Békésszentandrás (in River Körös) with a capacity of 2 MW.

Increment in number and installed capacity characterizes the situation of non-licensed power plants. The current governmental „green subsidizations" focus on this category, especially on HMKEs. Between 2015 and 2018 the number of non-licensed generators doubled in the region, whilst the installed, non-licensed solar capacity increased by 166%.

In 2016, 95 % of the capacity of non-licensed, non-HMKE power plants was based on renewable energy – 73.4 % of solar energy, followed by biogas (21.2 %). In case of HMKE, excluding 2 natural gas units, the entire electricity generation capacity used renewables, almost exclusively solar energy (99.5% of the HMKE capacity is based on photovoltaic source). Utilization of wind energy is less important in the region – only seven, HMKE size units are installed.

The following major investments have taken plane in the region since 2016 regarding the electricity generation:

- a combined cycle gas plant with 9.73 MW electricity generation capacity was installed;
- a biomass power plant with a capacity of 8.34 MW is under development in Foktő;
- nine new licensed, photovoltaic based power plants were installed in the region, with a total capacity of 16.5 MW;
- two biogas-based electricity generation units have commenced to operate with 1.3 MW capacity;
- the number and installed capacity of non-licensed solar plants are continuously increasing. In 2017 the total capacity was 71.2 MW

District heat

Information is only available on district heat producers, therefore in the following chapters assessments are based on their data.

As it was mentioned above, the district heating capacity of the region, especially in Békés county is poor. In 2016, a total of 16 district heat producer facilities, with 20 heat generation units were operated in the region. Renewable based district heat was provided only by 7 units.

Table 5.6 is summarizing the key characteristics of the regional district heat generators.

	Number of units [pcs]*	**Installed thermal capacity [MW]** ***(District heat only)***	**District heat generated in 2016 [MWh]**
Geothermal	6	32.9	90 230
Solid biomass	1	2.5	11 370
Natural gas	13	472.9	404 900
Total	20 units (16 facilities)	508.3	506 500

**the biomass based and 3 of the geothermal facilities are complemented with fossil (gaseous) units, these are divided in order to distinguish the heat generation technologies*

Table 5.6. Number of heat generating units, their installed capacity and heat generation in the Southern Great Plain region (in 2016

However, the main source of the regional heat generation is natural gas - 80% of the provided district heat was produced on gaseous fossil base - in 2016, five towns- Szentes, Hódmezővásárhely, Makó, Csongrád and Szarvas - had geothermal district heat capacity, which supplied 18% of the generated district heat. Biomass based district heat was provided only in Baja. Co-generation of electricity and district heat occurs only in two facilities.

A graphic overview on the share of the regionally generated district heat by fuel is given in Figure 5.14.

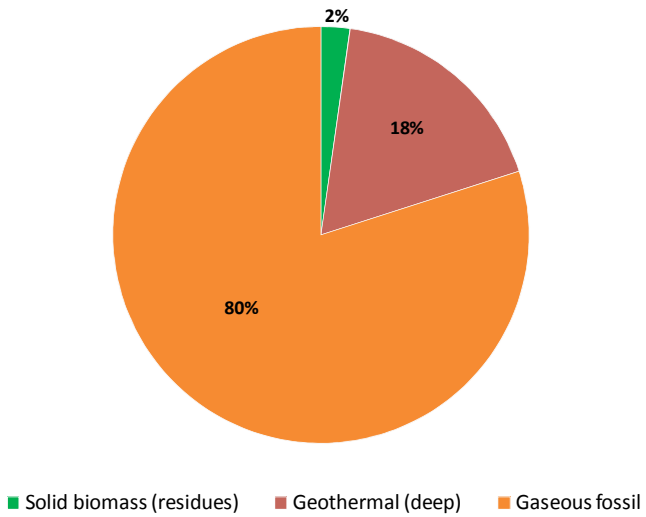


Figure 5.14. District heat generated by regional producers in 2016

Currently a large scale geothermal based district heat project is under development in the city of Szeged. According to the official plans, nine heating zones will be provided with geothermal heat by nine extraction and 18 recharging wells with a depth of 2 000 m. The projected, annual heat generation of the system projected to be around 450-500 thousand GJ/year.

Fuel generation

Detailed information on this issue is not available on regional level, nevertheless the Southern Great Plain region is also an important, if not the most significant area, regarding conventional hydrocarbon reservoir and production in Hungary, which makes petroleum products the cheapest and most reachable energy source.

5.3.2 Supply mix

The energy self-supply rate of the Southern Great Plain region is rather low. Whilst the covering rate regarding heat is approximately 52%, only 3% required electricity was produced within the region in 2016. However, we have to note, that a significant development has started since 2016, regarding the regional electricity supply, installing more than 70 MW further capacity.

The regional share of the renewable energy sources both in electricity and heat production, is higher than national average.

Detailed information on regional fuel supply is not available.

5.3.3. Energy storage

Due to the lack of significant altitude difference, there is no pumped-water energy storage facility installed in the region (nor in Hungary).

According to the data available only two energy storage (battery storage) facility were installed in the country - both of them operates in Budapest (out of the SGP region), with a total capacity of 10 MWh.

5.3.4. Regional key technologies for supply

The Southern Great Plain Region could be characterized by a low rate of self-supply, especially regarding electricity production. However, we have to note, that regional electricity supply has developed greatly since 2016, which was the basis period (year) for the assessments of this energy report.

As it was highlighted in the previous chapter on regional energy demand, there is a strong need of transition to renewable energy sources, however the 'renewable-potential' of the region is mostly unexploited and commenced to develop only in the last 5 years.

Regarding the renewable based energy production, the region could be characterized by the following specific features:

- Importance of photovoltaic electricity generation is increasing continuously, also on scale of licensed and non-licensed power plants. Before the new FIT scheme, installation of nine licensed PV power plants, with a total capacity of 16.5 MW had started.
- currently, the electricity generation from biogas is based on licensed power plants, but the regional structure offers further possibilities also by the installation of new licensed and non-licensed size power plants;
- geothermal based energy production is currently limited to district heat generation, however in the neighbouring counties geothermal power plant have already been installed;
- biomass potential is rather unexploited - currently, only one district heat generator utilizes this source of energy, and one licensed biomass power plant is under development;
- only one licensed hydro power plant operates with an installed capacity of 2 MW;
- due to meteorological specifics of the region, utilization of wind energy is present only on HMKE scale (with a total capacity of 60 kW).
-

The balancing of production, storage and distribution are currently an issue.

5.4 Regional demand-supply balance and development potential

5.4.1. Regional self-supply rate

Table 5.7. summarize the regional energy balance, which is calculated by comparing the total energy generation with the sectorial energy demand of the region. Thus, there is no detailed information available on regional fuel generation, the table includes only the sectorial electricity and heat balance.

Regional balance (MWh) regarding:	Electricity	Heat
Non-residential sectors (without transport)	- 2,200,883	- 74,164
Residential sector	- 1,291,399	116,943
Transport sector	7,440	-
Total	- 3 697 334	- 463,721

Table 5.7. Regional energy balance in MWh (based on data of 2016)

As it was mentioned in the previous chapters, there is no significant power plant (above 10 MW) in the region, which causes rather low electricity self-supply rate (approximately 3%). District heat generation is also characterized by operation of minor plants, located in settlements with higher population density, nevertheless the regional heat supply is able the cover a higher rate of the demands (52%). Covering rates by sector are shown in table 5.8.

Supply covers demand of…	Electricity	Heat
Non residentialsector	5 %	87 %
Residential sector	8 %	130 %
Transport	3 %	-
Total	3 %	52 %

Table 5.8. Regional demand covering rate of the own generation

The main Hungarian electricity producing facility (Paks nuclear power plant) is located on the border of the region, and due to the liable electricity distribution grid, the actual quality of electricity supply is appropriate. In the last three years several licensed fossil and renewable based power plants were installed. Furthermore, significant development could be observed regarding non-licensed renewable source utilizing plants.

5.4.2. Energy efficiency potential

Regarding the energy efficiency potential of the Southern Great Plain, the following possible development ways were identified:

1. General (not region specific) potentials:
    - Deep renovation of residential buildings
    - Deep renovation of building stock of municipalities
    - Intensification of electromobility, especially in public transport
    - Implementation of individually controllable residential heating systems for properties provided with district heating.
2. Region specific potentials:
    - Improve the utilization of geothermal potential, especially for district heating;
    - Augment utilization of residual biomass for electricity, heat production;

5.4.3. Resource potential

Regarding electricity, the main resource potential of the Southern Great Plain region is solar, geothermal and agricultural residual based biomass and biogas production. For heat generation, the excellent geothermal potential should be exploit. Since agriculture has a significant role in the economy of the region, agricultural residual based biomass and biogas production is a key potential also for renewable electricity, heat and biofuel generation.

The notable solar geothermal, residual biomass and biogas (including also sewage based and landfill gas) potential of the region offers an outstanding possibility to the development of an efficient and resilient regional energy management system with highly renewable energy mix and low carbon dioxide emission.

5.4.4. Technology potentials

As photovoltaic cells become less expensive and more available, their popularity is increasing in Hungary. Solar electricity production is an engaging tool for homeowner not only in area without electricity connection possibilities, but also for lower utility bills.

Intensification of renewable based electricity production demands installation of effective and economical electric storage system.

The government attempts to improve the spread of new electricity generation technologies by financial support through the current FIT scheme.

Industrial symbiosis.

Regarding the residential sector, the average condition of the regional owner-occupied housing stock is rather poor, due to the high median age. Bácsalmás micro-region - located in Bács-Kiskun county- has the oldest housing stock at national level, as approximately half of the residential properties were built before World War II.

6. CO_2 EMISSIONS

In 2016 the national CO_2 emission was around 44.2 Million tons, within that the share of the Southern Great Plain was 4.5 Million tons (10.2%). The contributions of the different sectors to the CO_2 emission on national and regional level are visualized in Figure 6.1.

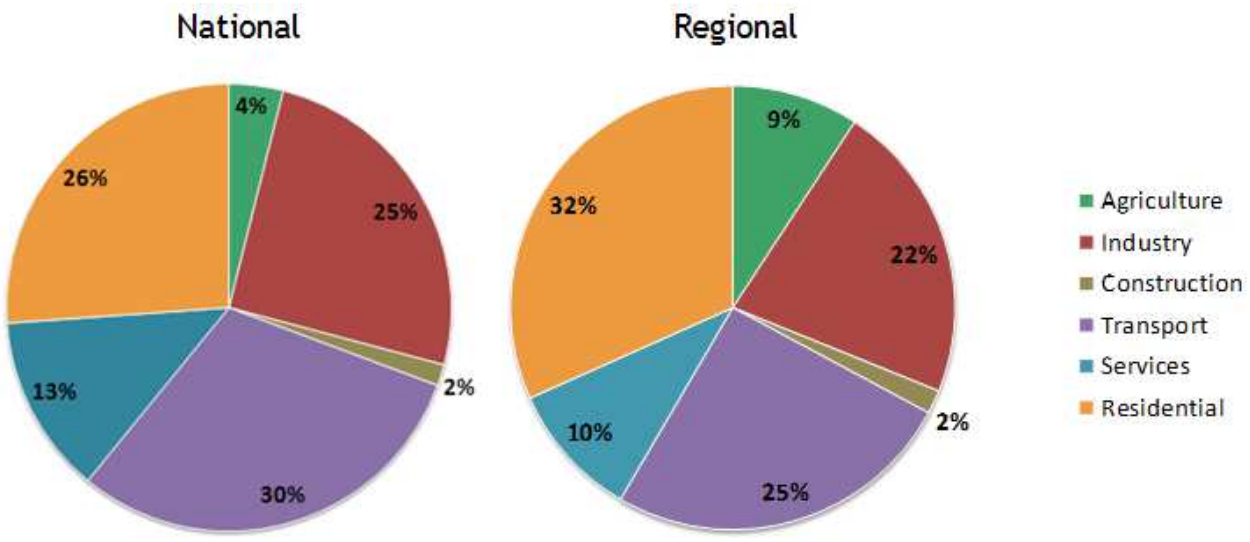


Figure 6.1. Share of sectors in regional CO_2 emissions from energy consumption

As it was mentioned in the previous chapters, the share of the residential sector in the regional final energy consumption is higher (42%) than that on national level (35%). Accordingly, the highest share of CO_2 emission is related to the residential sector, followed by transportation and industry. However, services and agriculture also have key importance in regional economics, due to their lower energy demand, they play minor role in carbon emission.

Table 6.1 is giving an overview on the value of energy consumption related CO_2 emission per capita on national and regional level.

CO_2 emission from energy consumption in tons per capita	National	Regional
Residential	1.18 tons	1.2 tons
Total	4.5 tons	3.6 tons

Table 6.1. CO2 emission value per capita (based on data of 2016)

Whilst CO_2 emission of the residential sector is similar on national and regional level, the total emission is lower in the region than the national average, due to the less energy demand of regional transport and industry.

7. KEY FIGURES AND BOTTOM LINE OF THE SITUATION

The Southern Great Plain region includes three counties –Bács-Kiskun, Békés and Csongrád – covered by 254 municipalities. The settlement structure of the region is dominated by large villages and small towns (with 1.000-5.000 inhabitants). The population of the region is decreasing (with the exception of the city of Kecskemét.)

The contribution of the regional economy in the national GDP is 9.17%; whilst in the national GDA is 9.11%. In the Southern Great Plain region agriculture with its 12% share of the total regional GVA plays an important role in economics. The regional share to the total number of employees in national level is 8.9%.

Due to the restricted access to regional data on transportation, only limited findings could be concluded. The region also acts as a gate of the Balkans and Romania, since M5 motorway connects Serbia and Romania with Budapest and towards with Western Europe. The regional railway and road network are adequate, but inhomogeneous. Due to decreasing number of branch railway tracks (connecting local economical centres and villages), further increases in car use is forecasted. As it was mentioned in chapter 4., in the period between 2014 and 2016 a decreasing tendency could be observed in both the share of rail passenger and freight transport, however in 2017 the share of rail freight transport increased significantly comparing the changes of the 2010 and 2016.

The Hungarian final energy consumption is highly dependent on energy import (fossil fuels, electricity), and it is dominated by gas and crude oil/petroleum products. The share of the renewable in the final energy consumption in national and regional level is 12.1 % and 14.6 %, respectively. Both in national and regional

level the major consumption is related to the residential sector (35 % and 42 %, respectively) followed by transport and industry.

The electricity generation capacity of the Southern Great Plain region is very low, in 2016 only 3% of the total demand was covered by own sources, however notable capacity development was observed in the last three years with a main focus on utilization of renewable sources by non-licensed power plant. However, the contribution of photovoltaic based capacity is predominant -42% of the total capacity in 2016, followed by gaseous fossil (33%) and biogas (23 %)- in the existing installed capacity mix, 53% of the electricity was produced by natural gas fuelled plants. The share of the renewables within regional electricity and the district heat generation was 46.5 % and 20.1 %, respectively.

In relation to the fuel generation of the target region, detailed information is no data available, nevertheless the Southern Great Plain region is the most significant area, regarding conventional hydrocarbon reservoir and production in Hungary. The notable agriculture sector of the region provides further biofuel production possibilities.

According to the available information the region does not have any energy storage capacity, excluding its remarkable natural gas storage facilities.

Regarding the regional energy consumption related CO_2 emission value per capita is 3.6 tons/year in total with high contribution of residential related emission (1.2 tons/year).

8. CONCLUSIONS

Similarly, to the national situation gaseous fossils are the main energy sources of the Southern Great Plain region.

The region has a low self-supply capacity regarding electricity generation, however its economic structure, meteorological characteristic provides excellent possibilities for renewable based generation. In relation of small size (non-licensed power plants) a favourable trend is in progress, increasing significantly the regional renewable electric energy production capacity, and providing the basis of a regional energy system, which – according to the European tendency - points into the direction of decentralized generation.

For district heating geothermal potential is also an underused energy source, with high development potential.