# Application of Renewable Energy Sources in Hungary in the Southern Transdanubia Region

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**Abstract** The European Union accepted its Europe 2020 strategy in March 2010. The strategy laid down the need to meet the 20/20/20 targets (reduce greenhouse gas emissions by 20%, increase energy efficiency by 20% and increase the renewable energy usage by 20%) in the field of energy policy. In addition to these goals, the Council expressed its long-term and grandiose intention to reduce the carbon dioxide emission by 80–95% in the European Union and other developed and industrialized countries by 2050.

Implementation of the EU commitment and the commitment determined by Hungary that exceeds the EU target requires establishment of hundreds of power plants using renewable energy sources in Hungary or conversion of power plants currently using fossil fuels into power plants using renewable energy sources. The Southern Transdanubia region is on the top in the context of both options. The town of Bóly has played a significant role in the Hungarian use of geothermal energy for public purpose district heating. The project which was started in 2003 brought only partial success, but the town continued the development. The second part finished in 2010, which makes it possible to not only fulfil the town's communal needs but can also heat the town's industrial park. Other towns in the region also use the opportunity in the region's high geothermal gradient for energy purposes. Other towns such as Bonyhád, Szentlőrinc and Szigetvár followed Bóly's positive example. Besides utilisation of the geothermal energy, solar power plants have shown up continuously in the past decade, not only with domestic but small plant nature. In 2013 the town of Sellye inaugurated the 0.5 MW capacity solar power park, which is capable to serve 250 family's electricity need in a year. This plant was the biggest in the country the day it was inaugurated. Two solar power parks were built in Szigetvár between 2013 and 2015 with 0.5 MW capacity each, which is capable to

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serve nearly 500 family's yearly electricity needs. The country's biggest capacity (10 MW) solar plant was finished in the spring of 2016 in Pécs, the centre of the region. This plant probably will reduce the countries carbon dioxide emission by 15.000 ton annually.

The application of the renewable energy sources is supported by tender sources from the European Union and the Hungarian government. The Operational Programme's 'Environment and Energy' fourth priority axis (increasing the use of renewable energy sources) has supported the application of the renewable energy sources in the 2007–2013 EU tendering period. In the framework of the fourth priority, 1624 tenders got support in total of nearly HUF 88 billion. The Operational Programme supported tenders to establish and extend solar cells, solar collectors, geothermal power plants, heat pumps, bioheating plants and hydroelectric power plants. In the Southern Transdanubia region, 262 projects supporting the use of renewable energy sources received subsidies between 2007 and 2015. More than 80% of these projects supported the use of solar cells and solar collectors. The power plant of Pécs using coal and then natural gas was converted to utilise biomass. This power plant has nearly 85 MW electricity capacity and serves the district heating needs of 150.000 citizens in the city of Pécs.

**Keywords** Europe 2020 strategy • Renewable energy sources • Southern Transdanubia region • Biomass • Geothermal energy • Solar power plant

## 1 Introduction

Energy policy has been an important strategic issue of nation-states after the 1950s. The unequal geographic location of fossil energy sources dominating power generation divided the world into energy importer and energy exporter countries. The use of energy sources has been and is still largely determined by environmental protection, technological development, political events and deepening of world economy. The development of IT systems and the expansion of transport options, which made transportation cheaper, created the opportunity to obtain the necessary energy sources from a distance, even from the other side of the world. The development of technology influenced the access to energy resources and opened the door to the use of renewable energy sources, and spreading environmental awareness facilitated the expansion thereof.

Hungary is an extremely poor state in terms of energy sources; the energy policy of the country and the structure of energy sources have been and are largely determined by the dependence on energy import. The country that belonged to the Soviet sphere of influence after World War II obtained major part of its energy import needs from the Soviet Union. The import channels established in connection to that (Friendship I and II oil pipelines, Brotherhood gas pipeline, unified electricity system of Comecon countries) still determine the energy procurement options of the country struggling with energy import dependence. Hungary, like other Central

European countries, tried to reduce its unilateral energy import dependence to Russia through several measures in the last 25 years, but these efforts have achieved only partial success. The country's dependence on Russian energy import has remained; thus, Hungary has a particular interest in reducing its energy import needs, regardless of the implementation of EU regulations. The best solution is to increase the use of renewable energy sources.

Implementation of the commitment to increase the use of renewable energy sources determined by Hungary, even transcending the EU target, requires the establishment of hundreds of power plants using renewable energy sources in Hungary or transformation of power plants currently using fossil resources into power plants using renewable energy sources. The Southern Transdanubia region is in the forefront with regard to both options in Hungary, through the example of which the endeavours made in Hungary in connection with the use of renewable energy sources can be presented.

## 2 The Role of Renewable Energy Sources in Energy Policy

### *2.1 EU Energy Policy Based on the Use of Renewable Energy Sources*

The European Council formulated the new EU energy policy plan on the summit held in Hampton Court in 2005, in favour of which the Council requested from the Commission to rethink the current issues of the European energy policy (Katona 2009). The Green Paper published in 2006 specified sustainability, competitiveness and creation of security of supply as the cornerstones of the EU's energy policy. The Green Paper wanted to achieve sustainability by using competitive renewable energy sources and by cutting back utilisation. It wanted to achieve competitiveness by investing in "clean" power production and in energy efficiency and by supporting innovation. Meanwhile it wanted to achieve security of supply by reducing dependence on import, by improving readiness for emergencies, by ensuring access to energy and by ensuring investments necessary due to increasing energy needs. The European Council adopted basic principles of the common energy policy of the European Union in 2007 in order to achieve the objectives set in the Green Paper, including the 20/20/20 targets. According to the decision, 20% decrease in greenhouse gas emissions, increase of renewable energy sources from 8.5 to 20% within the gross energy consumption and 20% improvement in energy efficiency must be achieved throughout the European Union until 2020.

To implement all these, the European Union adopted the Europe 2020 strategy in March 2010 that identifies three mutually reinforcing strategic directions. By determining intelligent, sustainable and inclusive growth directions, the European Union intends to create a more resource-efficient, more environmentally friendly and more competitive economy based on knowledge and innovation until 2020

(Szemlér 2011). The reasons for creation of the strategy were the growing dependence of the European Union on energy import, the risk of security of supply of the import as well as excessive dependence on fossil energy sources and inefficient use of resources further increasing the problems arising therefrom. Unified action of the EU member states became necessary in order for the European Union to act efficiently to reduce energy dependence and increase energy efficiency. The strategy set forth the necessity of achieving 20/20/20 targets in the field of energy policy. In addition to these objectives, the Council formulated its long-term and grandiose intention that the European Union and other developed, industrialized countries should reduce their carbon dioxide emissions by 80–95% until 2050.

Following the adoption of Europe 2020 strategy, the European Commission adopted the Energy 2020 strategy in November 2010. The strategy aiming to create competitive, sustainable and secure energy supply and energy consumption deals in details with realisation of the energy goals specified in the Europe 2020 strategy. The document states that the basis of the economy and of the development of the European Union is the energy used efficiently that is continuously and securely available to ensure that the European Union has to realise investments with a total investment cost of thousands of billions of euros until 2020, thereby creating diversification of existing energy resources and replacement of obsolete equipment in the energy industry (Gosztonyi 2014). The document draws the attention to that; however, currently nearly 45% of power generation of the EU comes from production using low carbon dioxide emission technologies, this is largely from nuclear power plants and to a lesser extent from the use of renewable energy sources, and it is expected that one third of the production capacity will have to be replaced due to wear and tear until 2020. This is an additional obstacle to achieve the objectives specified in the Europe 2020 strategy (Haffner 2011).

The European Council and the European Parliament determined the 20% target, which is set in the strategy at EU level, regarding the proportion of energy from renewable energy sources to varying degrees with regard to the member states because the starting value, renewable energy potentials and energy source mix of the member states were different. Accordingly, the country-specific objectives were determined differentially by taking the above factors and the economic performance of the country into account in Annex No. 1 of 2009/28/EC directive. In case of Hungary, 13% target has been determined that means 8.7% increase compared to the base value, namely, more than treble of the renewable energy generating capacity (Table 1).

## *2.2 Hungarian Energy Policy Supporting Renewable Energy Sources*

The Hungarian Parliament adopted the energy policy guidelines for 2008–2020 in 2008, in which—in line with the new evolving energy policy directives of the

**Table 1** Country-specific targets of Europe 2020 strategy

| Country | Proportion of energy from renewable energy sources in the total gross energy consumption in 2005 (%) | Target for proportion of energy from renewable energy sources in the total gross energy consumption in 2020 (%) | Current value (2014) (%) | Expected growth in 15 years (%) |
|---|---|---|---|---|
| EU-28 | – | 20 | 16 | – |
| Belgium | 2.2 | 13 | 8 | 10.8 |
| Bulgaria | 9.4 | 16 | 18 | 6.6 |
| Czech Republic | 6.1 | 13 | 13.4 | 6.9 |
| Denmark | 17.0 | 30 | 29.2 | 13 |
| Germany | 5.8 | 18 | 13.8 | 12.2 |
| Estonia | 18.0 | 25 | 26.5 | 7 |
| Ireland | 3.1 | 16 | 8.6 | 12.9 |
| Greece | 6.9 | 18 | 15.3 | 11.1 |
| Spain | 8.7 | 20 | 16.2 | 11.3 |
| France | 10.3 | 23 | 14.3 | 12.7 |
| Italy | 5.2 | 17 | 17.1 | 11.8 |
| Cyprus | 2.9 | 13 | 9 | 10.1 |
| Latvia | 32.6 | 40 | 38.7 | 7.4 |
| Lithuania | 15.0 | 23 | 23.9 | 8 |
| Luxembourg | 0.9 | 11 | 4.5 | 10.1 |
| Hungary | 4.3 | 13 | 9.5 | 8.7 |
| Malta | 0.0 | 10 | 4.7 | 10 |
| Netherlands | 2.4 | 14 | 5.5 | 11.6 |
| Austria | 23.3 | 34 | 33.1 | 10.7 |
| Poland | 7.2 | 15 | 11.4 | 7.8 |
| Portugal | 20.5 | 31 | 27 | 10.5 |
| Romania | 17.8 | 24 | 24.9 | 6.2 |
| Slovenia | 16.0 | 25 | 21.9 | 9 |
| Slovakia | 6.7 | 14 | 11.6 | 7.3 |
| Finland | 28.5 | 38 | 38.7 | 9.5 |
| Sweden | 39.8 | 49 | 52.6 | 9.2 |
| United Kingdom | 1.3 | 15 | 7 | 13.7 |

Source: Edited by the author based on Annex No. 1 of 2009/28/EC directive

European Union—security of supply, competitiveness and sustainability are determined as long-term energy objectives of the country. In addition to increasing the proportion of renewable energy sources and energy from waste to achieve the objectives, it aimed to reduce specific energy consumption and gradually introduce environmentally friendly and nature-friendly technologies. By adopting the guideline, the Parliament also called upon the government to develop a strategy to use renewable energy sources.

The ‘National Energy Strategy 2030’ developed on the basis of the guideline, adopted in 2011, specified insurance of long-term sustainability, security and economic competitiveness as primary objective of the Hungarian energy policy. The government intends to guarantee security of supply, to enforce environmental considerations and depending on the options of the country, and to stand up for solving global problems through implementation of the strategy. The strategy determines five priority endeavours that the government considers necessary to achieve the set goals. These are increasing energy saving and energy efficiency, increasing the proportion of renewable energy, preserving the current capacity of nuclear power and using Hungarian coal and lignite assets in power generation in an environmentally friendly way. The strategy intends to achieve the termination of the electricity import balance of the country until 2030 by this ‘nuclear-coal-green’ scenario based on these three pillars. On the one hand, the energy strategy contains specific proposals for the decision-makers and players of the energy sector until 2030, which determines the direction of the 5-year action plans, and on the other hand, it contains long-term visions until 2050, like the EU strategy. The document identifies the establishment of biogas and biomass power plants and utilisation of geothermal energy as priority in order to achieve the proportion not reaching the EU target. Besides, it forecasts the growth of solar-based heat power and electricity and utilisation of wind power after 2020, envisaging a total of 20% renewable energy proportion among the primary sources of energy by the end of this period (Haffner 2015).

The strategy does not detail the outline of growth rate of renewable energy sources; furthermore it does not determine specific measures that should be taken to this end. These were introduced in the National Renewable Energy Action Plan in accordance with the provisions of Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources. The government made a commitment of 14.65% differentiated by sectors in the action plan, exceeding the 13% EU regulation, with respect to the ratio of renewable energy sources in 2020, and an intensive government policy supporting the use of renewable energy sources particularly is necessary to achieve that. Hungary has less than 5 years to implement these objectives (Olajos et al. 2011) (Fig. 1).

The above diagram shows that the proportion of renewable energy sources in the total gross energy consumption increased by 5% all in all between 2005 and 2014 in Hungary. It should be highlighted that this value has not increased, but it decreased by 0.1% since 2012. Increased support of the use of renewable energy sources will be needed to this, which can be ensured by the government by expanding the support and feed-in tariff system related to production of renewable energy sources, encouraging the production of renewable energy sources, and by using EU and national development funds in a way of supporting the use of renewable energy sources as much as possible (Mezősi 2014). In line with Europe 2020 strategy, promotion of renewable energy sources gets high priority in the course of using the EU development funds for 2014–2020. It ensures EUR 995 million funding for power generating companies to replace fossil fuels with renewable energy sources

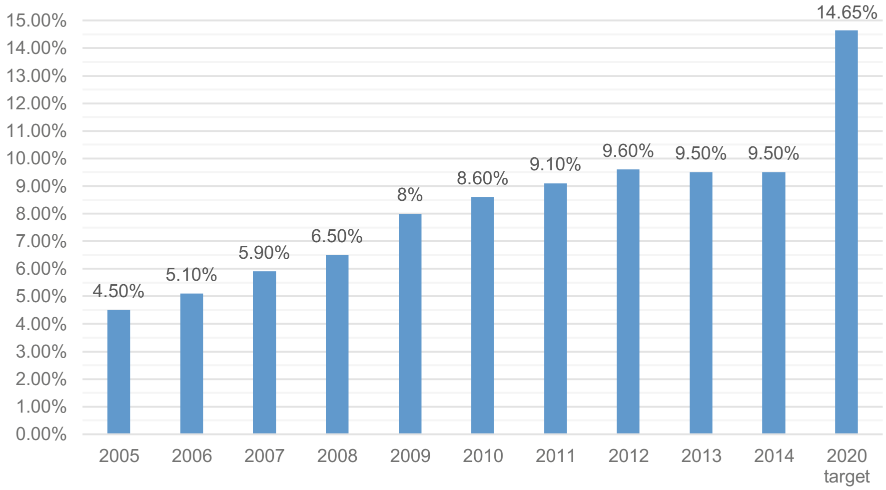


**Fig. 1** Proportion of energy from renewable energy sources in the total gross energy consumption. Source: Edited by the author based on Eurostat data

and to establish new power generating capacities using renewable energy sources. In addition to that, it ensures EUR 208 million funding for generating companies and approximately EUR 250 million funding for local governments to cover their own energy needs from renewable energy sources. The funding sources exceeding the previous funding level by orders of magnitude may serve as a basis to meet the targets for renewable energy ratio (Haffner and Schaub 2015).

## *2.3 Use of Renewable Energy Sources in the Southern Transdanubia Region*

The Southern Transdanubia region is in the forefront in utilisation of renewable energy sources in Hungary. From the 27 small-scale power plants subject to licence (capacity between 0.5 and 50 MW) operating in the Southern Transdanubia, 2 partly and 12 fully generate electricity and in many cases combined heat energy by using renewable energy sources (biomass and biogas). Among 22 district heat production licensee companies generating heat energy only, 4 companies use solely and 3 companies use partly renewable energy sources (biomass, geothermal energy). In case of the unlicensed nondomestic small-scale power plants (capacity between 0.05 and 0.5 MW) and the household-sized small-scale power plants (capacity under 0.05 MW), only 5 from 1344 power plants use fossil energy sources, while major part of the domestic power plants (98.4%) use solar power. 99.2% of household-scale power plants using renewable energy sources has been established since 2008. The development funds ensured by the European Union and by the

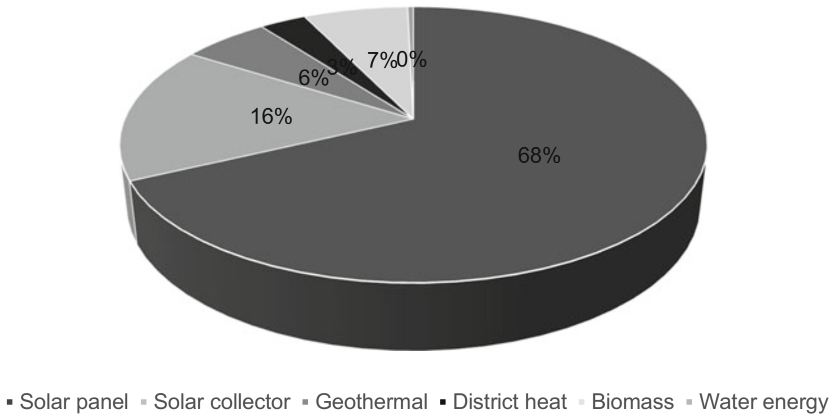


**Fig. 2** Distribution of investments in the Southern Transdanubia funded from the Environment and Energy Operative Programme between 2007 and 2013. Source: Edited by the author based on the data of palyazat.gov.hu

Government of Hungary played a defined role in that. The Environment and Energy Operative Programme (EEOP) supported increasing the use of renewable energy sources during the EU tendering cycle between 2007 and 2013. One thousand six hundred twenty-four applications received funding close to a total of EUR 284 million at the national level. From that, 262 projects supporting the use of renewable energy sources received funding in the Southern Transdanubia region. Utilisation of renewable energy sources in the Southern Transdanubia region is presented through the most significant ones from among the funded projects (Fig. 2).

### 2.3.1 Geothermal Energy Utilisation

Geothermal energy means the internal heat in the Earth's crust, the extraction of which requires a carrier medium. Advantage of geothermal energy is that unlike other renewable energy sources, it is available continuously not intermittently, although it is limited and its amount and temperature decreases over time. Hungary has highly favourable geothermal conditions that are a great opportunity for geothermal energy utilisation. The geothermal gradient is 45 °C/km in the country that is more than one and a half times the average 20–30 °C/km on the Earth. Accordingly, the country has significant, an estimated 343.000 PJ exploitable geothermal energy reserves. The most commonly used utilisation method of geothermal energy is the direct heat utilisation, which allows utilisation for municipal and industrial heating purposes and electricity generation in addition to utilisation for therapeutic and touristic purposes and in agricultural and industrial production (Gőőz 2015). Geothermal energy with less than 30 °C temperature available up to 400 m depth may be utilised through heat pumps. The heat pump collects the geothermal energy, the heat degree of which is directly not recoverable, and converts it into heat that can be utilised for heating. The warmer fluid, which is in the low- and medium-temperature range between 30 and 140 °C, can be used for heat production and for combined heat and power production above 100 °C (Fischer et al. 2009).

More than 150 geothermal wells has been explored in the Southern Transdanubia region primarily in the course of oil and uranium search then in the last decades consciously for the purpose of energy recovery, significant part of which is not utilised. Most striking form of utilisation of geothermal energy in the region is utilisation for therapeutic and touristic purposes, while utilisation of geothermal energy for heating purpose in district heating system is realised in Bóly and Szentlőrinc, but besides this examples of utilisation of geothermal energy for agricultural purpose and through heat pumps can be found in many areas of the region. The pioneer of utilisation of geothermal energy in Hungary is the city of Bóly. In the small city of less than 2000 inhabitants, the heat source found during uranium ore search in 1983 has been utilised. The settlement started the planning process necessary for exploitation of the well in 1996. The studies prepared promised extremely favourable utilisation opportunities; however the first drilling took place only in 2003 within the framework of the EU's SAPARD programme. The SAPARD programme supported the agricultural and rural development of ten Central and Eastern European countries joining the European Union prior to the accession. Drilling of a 1500 m deep thermal well, establishment of a power line system supplying consumers and thermal stations belonging thereto and implementation of automatic control were planned under the project. However, the project was partially unsuccessful; thermal water was not found until a depth of 1800 m. The exploration of Sarmatian limestone aquifer between 650 and 750 m found low temperature, 40.2 °C water during drilling that ensured the underfloor heating of many cultural institutions from 2005. In lack of reinjection wells, the inefficient system was a significant burden on the operation of the municipal wastewater treatment plant; furthermore it resulted in significant additional costs (mining tax, water resource contribution). Despite the negative experiences, the city decided not to eradicate the system but to develop it. They started implementation of second phase of the thermal project using European Union fund. Water source with higher temperature and higher yield (72–80 °C, 60.0 $m^3$/h) was found during the new drilling. A reinjection well has been developed under the application that made the system more cost-efficient and environmentally friendly. The city started the third phase of the thermal project in 2010 in order to exploit the well with 20% overcapacity compared to the planned capacity, in the framework of which heating of the production halls located in the industrial park of the town was ensured by using additional yield of the well. Besides, the geothermal heating system was built in all the institutions of the local government under the third phase. The local government of Bóly implemented three phases of the investment with a total cost of HUF 627 million, and approximately HUF 9.5 million (in 2011) is spent on the annual operating cost thereof. Thus the town saves approximately more than 650.000 $m^3$ (in 2011) natural gas, the cost saving of which exceeds EUR 2 million (in 2011). In addition to that, the town saves approximately 1373 tons $CO_2$ emission annually by replacing the natural gas for heating purpose entirely, which means hundreds of thousands of euros worth of tradable $CO_2$ quotas savings at the national level (Pálné Schreiner 2013).

In addition to the geothermal energy utilisation in Bóly, the system established in another small town of the region, in Szentlőrinc, is also noteworthy. Szentlőrinc is an agrarian small town in Baranya county with nearly 6500 people, where the possibility of utilisation of geothermal energy emerged at the beginning of the 1990s. Many studies have been prepared regarding the exploitation of hot water under the town and regarding its use in the district heat supply of the town. However, test wells were made just to a depth of 800 m, while the desired hot water is located at a depth of 1500 m, and the town could not realise the cost of exploration thereof from its own resources. Consequently, the exploitation of geothermal energy in Szentlőrinc was awaited for plenty of 20 years. PannErgy Plc. listed on Budapest Stock Exchange deals with implementation of heat and electric power generation projects in several parts of the country using the opportunity arising from utilisation of domestic geothermal energy. Szentlőrinc Geotermia Ltd. established by the company and the local government of the town started the research in the town in 2009, in the course of which they found temperature 83 °C hot water that could be utilised in the existing district heating system. The geothermal heating system ensuring the district heating supply of 590 households and several local government institutions was established within the framework of approximately HUF 1.3 billion project, 34% of which was ensured by the funding won in the Environment and Energy Operative Programme tender. Thus they serve the district heating and hot water needs of significant part of the town at significantly lower fees than earlier by 100% renewable energy sources instead of the previously used coal, then oil fuel, and finally natural gas. It shall be emphasised that similarly to Bóly, the thermal water brought to the surface by pumping, having temperature 60–75 °C even after use, is injected back thus ensuring that the system can be used in an economical and environmentally friendly way for a long time (Haffner 2013).

### 2.3.2 Biomass Utilisation

Biomass means the total weight of all living and recently dead bodies on land and in water, products of microbiological industries and all organic origin products and waste generated after transformation. Biomass can be divided into three groups based on its consistency and energy utilisation. Solid biomass can be used for heat and electricity production, liquid biomass (biofuel) can be used as propellant, while biogas can be used as propellant and also for heat and electricity production. Hungary's natural conditions are favourable for the use of biomass for energy purposes; this resource has the greatest potential for energy in the country (Pintér 2015). Total biomass reserves of the country are some 350 million tons, and the theoretical biomass energy potential is 417 PJ in Hungary (Lukács 2010). Due to the variety of available technologies, biomass can be used for energy purposes in diverse ways. It is important to highlight that use of biomass can only be considered utilisation of renewable energy source while retaining certain criteria (use of locally produced biomass, use of covering local needs, production within the framework of sustainable management) (Somogyvári 2007). The gaseous form of biomass, the biogas, has approximately two-thirds of caloric value of natural gas that can be used to generate electricity and heat energy and combined heat and power during utilisation for energy purposes. Biogas can be produced by anaerobic fermentation of organic matter, during management of municipal wastewater, among others, by using sewage sludge generated at a sewage treatment plant. Approximately 0.2–0.4 $m^3$ biogas can be recovered 1 kg of dry material. Biogas can be used by loading it into the natural gas network or by burning it directly in the gas engine. Approximately 1.8 kWh tradable electricity and 5.5 MJ heat energy can be produced by using 1 $m^3$ biogas (Bai 2005). There are numerous examples of utilisation of solid biomass and biogas for energy purposes in the Southern Transdanubia region.

Research began in 1950s in Hungary on the energy recovery of wastewater generated by livestock. Daily 4–5 tons of manure generated on a pig farm were used for the research conducted on the site of Pécsi Állami Gazdaság, which was sufficient for the production of daily 200 $m^3$ biogas. During the research conducted with semi-dry method, biogas has been produced successfully, which ensured the electricity and heat energy needs of the site. Agricultural biogas production and utilisation spread gradually in the country until the 1980s, when significant part of the country's natural gas network was completed, which reduced the importance of biogas production. After accession to the European Union, the opportunities provided by EU development funds for rural development purposes brought a significant upswing in biogas utilisation. Within the framework of New Hungary Rural Development Programme, opportunities opened for establishing biogas plant with 40–70% EU fund intensity. Biogas plants utilising agricultural by-products were established in the Southern Transdanubia, in Kaposvár, Kaposszekcső, Bicsérd and in Bonyhád under the fund.

Kaposszekcső is an agricultural town with approximately 1500 inhabitants, located on the border of Baranya and Tolna counties. The first biogas power plant of the Southern Transdanubia that produces electricity as well was established by HUF 1.23 billion investment in the town's industrial park in 2010. Manure and slurry generated on the town's livestock farms are used in three fermentation units of the plant with a total capacity of 7500 $m^3$. The rated electricity generation capacity of the plant is 0.84 MW. In addition to the biogas plant, a bioethanol factory also operates on the site, and the by-products generated during its production are also utilised by the biogas plant, the waste heat of which is used by the bioethanol factory during its production. The bioethanol factory produces an average of 12.000 $m^3$ bioethanol per year by using approximately 30.000 tons of corn, which is sold as fuel additive (Pálné Schreiner 2013).

### 2.3.3 Solar Energy Utilisation

Energy from the Sun reaches the Earth's surface through the Earth's atmosphere in the form of heat and light. The energy of solar radiation reaching the surface is constantly changing due to the Earth's rotation around its axis and its movement in elliptical orbit around the Sun, the Earth's axial tilt as well as to the change in weather conditions. As a result, the energy reaching the Earth's surface is changing between 200 and 100 W/m$^2$ (Sljivav and Topic 2014; Sljivac 2015). Hours of sunshine vary between 1740 and 2080 in Hungary; most of the radiation reaches the country in the southern areas of Transztisza, while the hours of sunshine exceed 2000 in the Southern Transdanubia and in the Alföld as well (Fig. 3).

Solar energy also can be utilised in a passive way by conscious design, choosing appropriate building materials and good orientation and by making use of other environmental conditions. In case of energy (active) utilisation, we distinguish between utilisation with solar collector and solar panel. Solar collectors are used to produce hot water for usage and heating; thus, these tools usually allow only local utilisation of heat energy only. Solar panels converts the energy of solar radiation into electricity, which can be used either for local purposes through battery storage and prompt use or by loading it into the power line system. Utilisation of solar energy has the highest specific investment cost and consequently long, 10–30-year payback period, yet it is one of the most common and popular methods of application of renewable energy sources (Bobok-Tóth 2010; Szabó et al. 2010).

The majority of new power plants established in the Southern Transdanubia region, using renewable energy sources, utilises solar energy. In addition to 1313

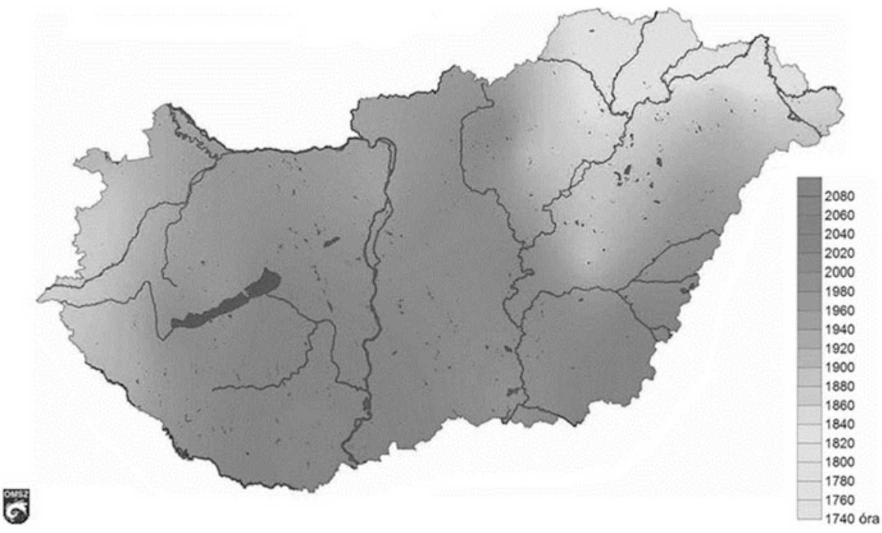


**Fig. 3** Hours of sunshine in Hungary. Source: National Meteorology Office

(in 2014) household-sized small power plants (under 0.05 MW capacity) that are producing essentially for their own use, 10 (in 2014) solar power parks producing for network with a capacity primarily around 0.5 MW (however, consciously kept under that due to easier approval process) can also be found in the region. Such power plant with nearly 0.5 MW rated power can be found in Sellye and Szigetvár as well. Sellye is a small town with nearly 3000 inhabitants, centre of the poorest area of the Southern Transdanubia, the Ormánság. The solar power park in Sellye was handed over n 2012, which was the largest solar power plant of the country at the time. 3500 $m^2$ solar field surface was created on a 2.5 ha land, which has 0.49 MW rated electricity generating capacity. The average 800.000 kWh of energy generated per year ensures the annual electricity needs of approximately 250 households. The investment was realised from nearly EUR 1.5 million with 50% funding from the European Union and the Government of Hungary. Expected payback period of the investment with respect to the part above the funding is more than 10 years, and it is more than 25 years with regard to the total investment cost. Two solar power plants each with a rated power of 0.49 MW were established under similar parameters in Szigetvár in 2013, which is able to ensure the electricity needs of further nearly 500 households in the region.

The largest solar power park in the Southern Transdanubia and in the country as well has been handed over in the spring of 2016 in the centre of the Southern Transdanubia region and of Baranya county, in Pécs. The rated power of the solar power park built at the cost of more than EUR 15 million is 10 MW, which can ensure the needs of almost 5000 households. The investment was realised with funding from the European Union and the government of Hungary, which funded 85% of the costs. The solar power park is established on the previous ash lagoon of the power plant in Pécs presented above. Forty thousand solar panels have been installed on the 10 ha of land, in eight modules each with a capacity of 1.25 MW. The energy generated is loaded into the national power grid through the power plant in Pécs.

## 3 Conclusion

Increasing the proportion of renewable energy sources in the gross energy generation is a much more diverse and important goal than achieving the objectives set in the strategy. Hungary and countries of the European Union are poor countries in terms of energy sources; thus, they can ensure their energy needs solely by large-scale use of import. That means special security of supply risk for the countries of the European Union that is a current and growing problem due to the global political events of the past half-decade (Arabic spring, Russian-Ukrainian conflict). Less than 5 years before the deadline set for meeting the energy objectives of Europe 2020 strategy, both Hungary and many member states of the European Union must take serious measures in order to be able to fulfil the objectives. The projects realised in the Southern Transdanubia region, using renewable energy


**Fig. 4** Power plants presented, using renewable energy sources in the Southern Transdanubia. Source: Edited by the author

sources, can be good examples for implementation of further developments in terms of utilisation of biomass, solar energy and geothermal energy (Fig. 4).

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