WP 3 Hungary

Inventory of demo projects

Author: ECH - Energy Centre Hungary

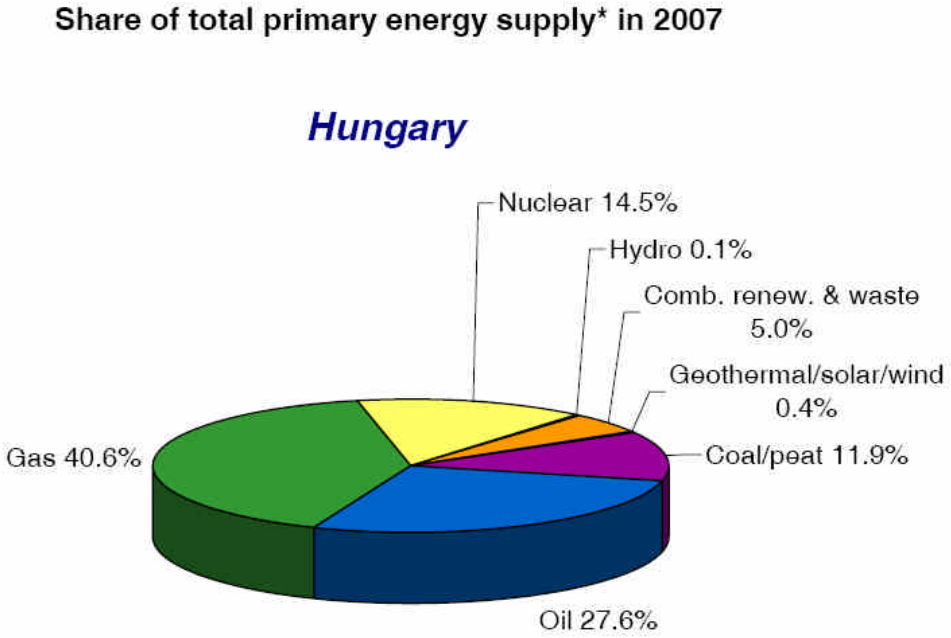
1. General information

1.1 Basic data

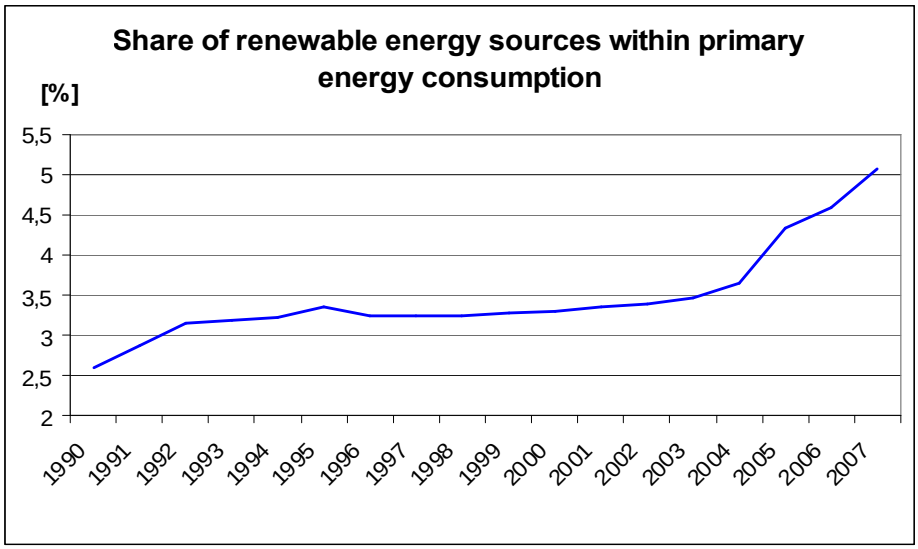
Area: 93 033 km^2
Population: 10.06 million
Population density: 108 inhabitants/km^2
Regions:
No.1: Central Hungary (Közép-Magyarország, HU11)
No.2: Central Transdanubia (Közép-Dunántúl, HU21)
No.3: Western Transdanubian Region (Nyugat-Dunántúl, HU22)
No.4: Southern Transdanubian Region (Dél-Dunántúl, HU23)
No.5: Northern Hungarian Region (Észak-Magyarország, HU31)
No.6: Northern Great Plain Region (Észak-Alföld, HU32)
No.7: Southern Great Plain Region (Dél-Alföld, HU33)

1.2 Energy indicators

Gross inland consumption: 1125 PJ
Total production of primary energy: 427 PJ (thereof renewable energy: 13.9 %)
Primary production of renewable energy and waste: 59.4 PJ (thereof biomass and waste: 88.7%)
Final energy consumption[2]: 706 PJ
RES shares of final energy consumption: 4.8 %
Share of RES within electricity consumption: 3.9 %
Net energy imports: 62 %
CO2 emissions per capita: 5.36 tonnes

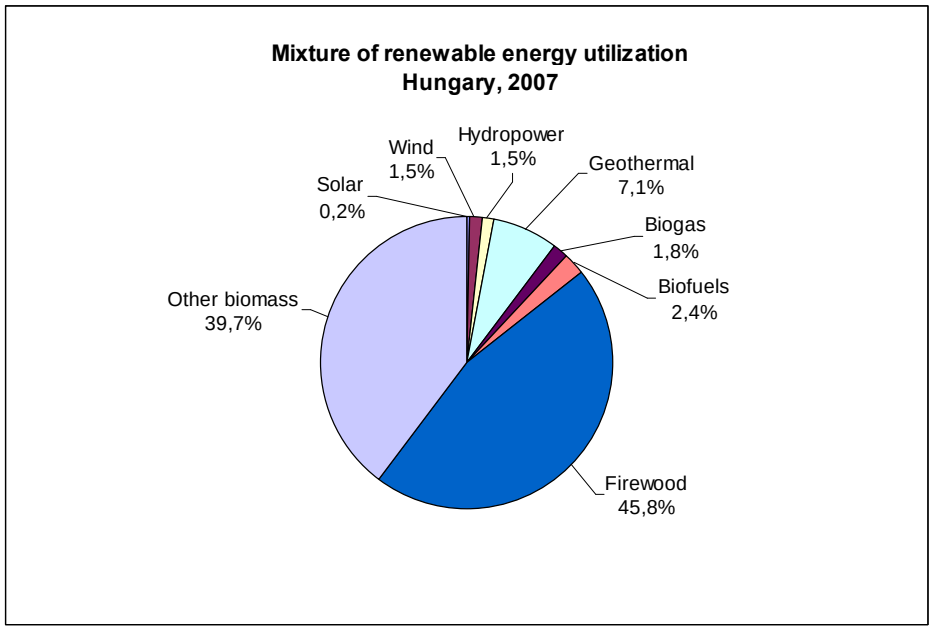


Source:IEA



Share of Renewable Energy Sources within Primary Energy Consumption
(Source: Energy Centre)

The share of renewable energy sources has considerably grown in recent years in Hungarian energy supply. While in 2000 they accounted for 3.3% in primary energy use, in 2005 they represented 4.3% and in 2007 they had a share of 5.1%.



Mixture of Renewable Energy Utilization in Hungary, 2007
(Source: Energy Centre)

In Hungary the most important renewable energy source is biomass, accounting for nearly 90% of all renewable energies in 2006. Biomass is followed by geothermal energy, renewable waste and hydro power but these sources significantly fall behind biomass use.

2. Current status of renewable energy

2.1 Biomass

Calculations for the Hungarian biomass potential are one of the most disputed issues among the estimates for Hungarian renewables' potential. Estimates widely differ and there are also problems with statistical classification. Based on the estimates for Hungarian biomass potential, 8-15% share (100-190 PJ) within the total national energy use can be achieved between 2015 and 2020.

	low value	top value
Institutions	PJ/year	
Hungarian Academi of Science, Renewable Energy Subcommittee (2005-2006)	203	328
Energy Club (2006)	58	223
European Environment Agency (2006)	145,5	
Ministry of Agriculture and Rural Development	260	
min and max values:	58	328

Biomass accounts for the largest share of Hungary's renewable energy consumption. It has accounted for about 87% of the energy generated from renewable energy sources.

In 2008 the electricity generated from biomass was accounted for 4.5% of the total electricity which was 1818GWh.

In renewable-based heat production, similarly to green power generation, biomass has the highest volume (~32PJ) and share accounting for 98.7%.

The total biomass production (heat+electricity) was 50,64 PJ in 2008. It is expected to reach 84PJ by 2020. If we also include biogas and biomethan than the value will be even higher, 93.54 PJ.

Forestry wastes and sawmill byproducts are currently burnt in furnaces to provide heat or briquetted for retail sale. Hungary mostly uses firewood for heat and electricity production. Nearly 40 percent of the roundwood production is used for energy purposes.
Electricity production from renewable energy sources was given a boost after 2003 by the conversion of existing power plant capacities into biomass-fired (Pécs Power Plant – 49 MW, Kazincbarcika Power Plant – 30 MW, Ajka Power Plant – 20 MW) and a switch in coal-fired power stations to the co-burning of coal with firewood and other agricultural crops. With a few exceptions, however, these technologies have a very low efficiency.

Energy plantations can yield between 23-38PJ/year, which is more than double of energy from forest yields per hectar. Only about 10 - 20 percent of the main agricultural products could be used for energy. This proportion amounts to approximately 40 - 80 PJ/year. In addition, about 40 - 60 percent of agricultural by-products can be used for energy production, which is approximately 90 - 185 PJ. In total and with other resources included, the agricultural energy potential for Hungary is between 58 - 328 PJ based on different estimations.

2.2 Wind

Hungary located in the Carpathian basin, which is unfavourable for wind potential but the most significant potential is located in the north-western region of the country. Potential is 532.8 PJ/year according to the Hungarian Academy of Science.
In Hungary the first wind turbine was built in the year 2000 and the installed capacity has reached about 100MW in 2008 and 177MW in 2009. Currently, just about 1.5% of Hungarian energy comes from wind. Hungary has 32 wind farms installed ranging from 250 kW to 50 MW in capacity.

The current 330 MW cap on wind energy connection to the grid is placed by the Transmission System Operator should be significantly increased by 2020 and might be able to reach 920MW. Companies who are willing to connect to the electricity grid must undergo a tendering process. (calls for bids to establish wind power capacities). The Hungarian Energy Office gave permission for 330MW in 2006 and an additional 410MW is currently under evaluation.

2.3 Geothermal

Hungary has some of the largest potential of geothermal energy in Eastern Europe. The best sites can be found in the southern transdanubian and the great plain regions. Generally, the identified resources are low to medium enthalpy, 50 °C to 200 °C, and more suitable for heat supply than electricity production. Because of this condition the main focus of the utilization is heat production and balneology. There is no electricity production as of now. The main consumers of geothermal heat are in the agriculture industry for the heating of greenhouses, spas and pools. The residential and industrial demands have led to over 2,000 wells currently in operation supplying over 7,940 TJ per year to Hungary.

Geothermal installations in Hungary have been estimated as having a total capacity of 694.2 MW used only for heat generation. Proportion of geothermal energy utilization in the energy balance of Hungary, despite the significant proven resources, is low (0.16%)

2.4 Photovoltaic/ solar thermal energy

Hungary lies in the middle of a basin, on a relatively flat surface surrounded mainly by mountains, and has favourable solar conditions compared to other European countries. The number of the annual sunny hours is 1,900-2,200, and the average annual total of the incident sunshine is 1300 kWh/m2. Hungary has 1838 PJ theoretical potential and 4-10 PJ actual potential. The current use is about 0,1 PJ which means around 70,000m2 surface area. The most common collector used in Hungary is the flat-plate collector; however, demand for flat-plate, vacuum, and unglazed collectors has been strongly increasing.

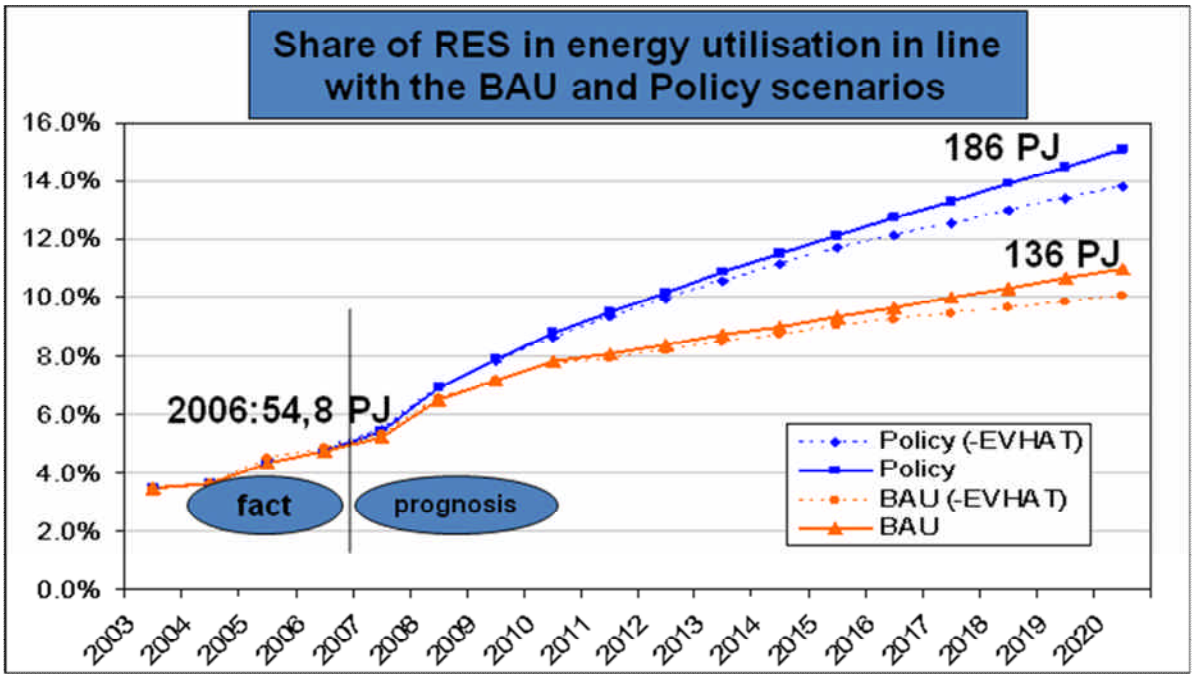
There is no database available on the installed solar capacity, therefore only estimates can be made. 300-500 kWp is estimated for PV capacity. The largest system is over 100 kWp, but the most common capacity is 10 kWp. About 3/4th of the applications are independent and used for electricity generation at highway emergency phones, meteorological stations, safety equipments, public lighting, farm houses, electric fence, etc..
Despite not having many applications using solar power itself, Hungary has a manufacturing plant that is a subsidiary of a solar PV company. Solar Thin Films, Inc is a United States based company with its machinery manufacturing subsidiary, Kraft Electronikai Srt., based in Budapest, Hungary.

Although the domestic natural endowments are very favorable, solar energy utilization is still less than 0.01%. The Hungarian government is planning to have 20,000 roof with solar collector by 2010.

2.5 Hydropower

Hungary is one of the less mountainous countries in central Europe, and therefore has only limited hydroelectric potential. Currently there are 32 hydropower plants in Hungary with a total 55MW installed capacity. Hydroelectric plants in Hungary generally produce approximately 0.18 billion kWh each year, which is about 0.5 percent of the total electricity produced. 90% of this electricity is coming from four larger plants.

Hungary has little potential for further water power development with the exception of small and micro sized power plants. The small scale plants have 10MW actual potential which equals to 60 GWh/year electricity production. Hydropower stations (equaliser energy storage plant) built on the larger rivers would be a good solution to compliment electricity generation from wind farms. In this way the electricity grid instability problems could be avoided. However due to political and historical reasons large scale hydropower stations is unlikely to be built.



In the framework of the "Renewable Energy Strategy: Strategy for the Increased Utilization of Renewable Energy in Hungary 2007-2020" two scenarios were established to set target figures, calculated as the share of renewable consumption to gross final energy consumption. The vital difference between the base case (BAU – Business As Usual scenario) and the strategic scenario (Policy scenario) is that the BAU scenario is based on existing or planned measures whereas the Policy scenario takes into account other measures aimed at encouraging the utilization of renewable energy sources. Both scenarios were developed for two cases: if the measures for the improvement of energy efficiency succeed (BAU, Policy) or if they fail (BAU EVHAT, Policy EVHAT).

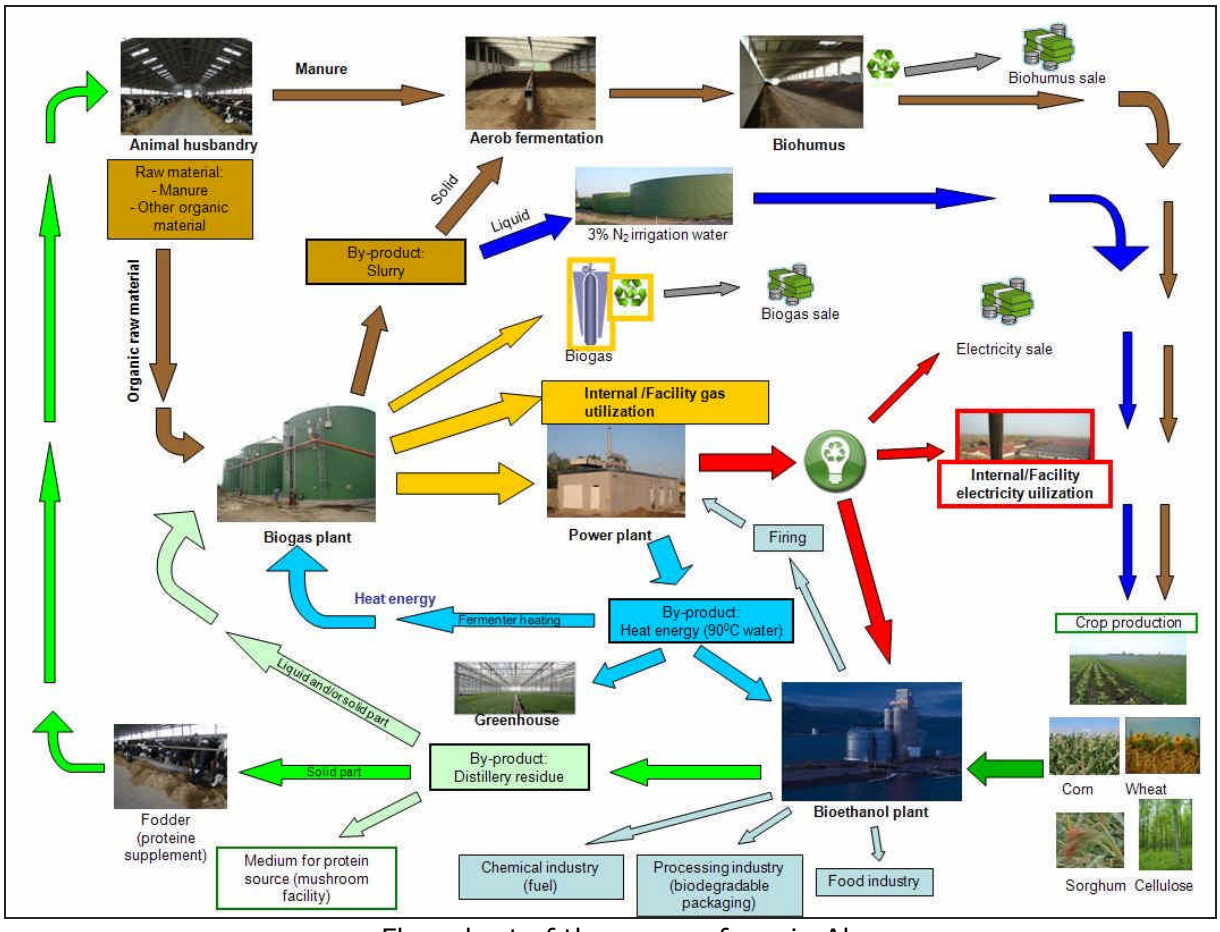
The BAU scenario leads to a share of renewable energy sources of 11% by 2020 if the necessary energy saving measures are implemented. If such measures fail the share is expected to reach 10%. If the proposed measures are realized the strategic (Policy) scenario leads to a share of renewables of 15% by 2020. Without the implementation of the energy saving measures a share of 13,8 % is anticipated provided the share of biofuels goes up to 5,75% by 2010 and 10% by 2020. According to the BAU scenario renewable energy use increases from 55 PJ in 2006 to 136 PJ or to 186 PJ in the Policy scenario. Within the total use consumption for heat production slightly falls while green power generation and the share of biofuels increase.

3. Demo projects

3.1 Energy farm in Abony

Abony is located 85 km from Budapest and has about 15.000 residents. It is surrounded by farmland where arable farming, wine and fruit production is typical. The energy farm project is a complex system where beside biogas energy production, bioethanol is also produced. The energy farm embraces the biorefinery concept: dedicated crops and residues are processed into energy carriers through various, interlinked conversion platforms. This creates closed loops in by-product and waste utilisation among the farm components, minimizing environmental emissions and fossil energy inputs.

The farm operates 3000 ha of cropland, producing mainly feed for a dairy operation (2000 heads of cattle). The manure is processed in anaerobic digesters (AD) to biogas, which is then combusted in a 640 kW CHP plant. Power is fed to the electricity grid, heat is used internally, to maintain AD temperature and for the future (not yet built) distillation process, as well as in greenhouse production. Distiller's grain -residue from ethanol production- will be used as fodder in the dairy-farm to augment the cow's protein diet. The accelerated composter closes the loop, where all remaining residues are treated and processed into a valuable market commodity. The process results in significant production cost cuts, through energy savings, rationalisation of production and carbon emission offsets.



Flow chart of the energy farm in Abony

The inputs are 50.000 tonnes manure, residues and 15.000 tones sorghum and corn annually. Using these materials 640kW electricity and 900-1000kW heat is produced. Due to the innovative and complex technology no residues are generated and landfilled, moreover 13.000t/year CO_2 is saved. This investment creates 90-115 new workplaces in the area. The 15 thousand tones capacity bioethanol plant is planned to be built in 2010.

The energy farm concept is being multiplied in Hungary, a clear sign of success. The economic viability of the whole operation increases as there are variable output options for an input mix that is vulnerable to external price drivers.

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3.2 Biosolar village heating system in Pornóapáti

Biomass plant in Pornóapáti

The small village -with 384 residents- can be found near the Austrian border. The biosolar heating plant in Pornóapáti was built in 2005 and it provides heat for public buildings (729 GJ of heating and 88 GJ of DHW), for 104 households (6402 GJ of heating and 894 GJ of DHW) and for enterprises (760 GJ of heating and 20 GJ of DHW) through the local small scale district heating system. Currently, the annual heat demand is entirely covered by the 2 biomass boiler with nominal capacity of 2*600kW. With the help of an Austrian construction company the widely and successfully utilized Austrian biomass fired village district heating system was mimicked and applied firstly in Hungary.

The necessary row material (wood chips) is collected from a local wood processing company as well as from the local woods. 400 t/year wood residues from the local wood processing company and 654 t/year wood chips from the local forests is utilized.

The heating plant is planned to include a 465m^2 solar collector system, which would entirely cover the heat demand of domestic hot water (DHW) production. If it is built the operation of biomass boilers would be needed only for the heating season and the solar collector would satisfy the DHW needs during summer. At the first stage of the realization, only the installation of the biomass heating plant and the establishment of the local district heating system were possible. However, the heating plant and its surroundings was arranged so that it could be supplemented with the 465m^2 solar collector system. It can only be realized in the near future

and it would require national or EU support. After the investment is finished 1 168 tones CO_2 saving will be reached annually.

Positive outcomes:
- The project was able to highly improve the togetherness of the local community.
- The competitiveness of the region has improved.
- The external opinion of the region has improved.

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3.3 Biogas plant for CHP production, Pilze-Nagy Kft. mushroom producing facility

Pilze-Nagy Ltd. was formed in January 1997 by the transformation of a registered (in 1991) oyster mushroom cultivation and trade private enterprise. The company's headquarter is located 5km from Kecskemét on a 10 hectares area. During the twenty years of continuous work the family business has grown and established diversified activities. The main activities are closely linked, which are as follows: raw materials of oyster mushroom, oyster mushroom cultivation, commercial marketing of fresh oyster mushrooms, and the biogas production for electricity and heat generation.

The purpose of this project is to utilize the organic waste generated during mushroom production (exhausted soil) in an environmentally friendly way. Before the installation of the biogas plant, a research and development program had been performed to develop the methodology for the utilization of such raw materials. In the facility, 3430 tones/year organic waste arises during the cultivation of mushrooms. Besides this, pig manure and cannery waste are fed into the 2000 m^3 anaerob fermenter. 1 050 000 Nm^3/year biogas is produced. It is fed into the CHP plant that produces 1 750 MWh/year electricity and 6 850 GJ/year heat. The electricity is fed into the electricity network. Thanks to the biogas plant, 1 820 tones/year CO_2 reduction can be reached. Significant part of the heat could be utilized for heating (and perhaps cooling) the mushroom producing tents and the buildings of the facility. For this purpose, only some hundred meters long district heating pipeline should be installed that would connect the CHP plant and the boiler room. The expected payback time of the heat utilization would be about three years. The possibility of the installation of district heating pipeline and reconstruction of heating system is currently under consideration and it will be

supposedly realized in the near future. The utilization and sale of the produced energy highly increase the incomes and competitiveness of the company.

The Pilze-Nagy Ltd. has carried out a pioneering development by building a biogas plant using residues generated during mushroom production and this fully complies with their original goals: more economical and environmentally friendly disposal of waste. While the use of heat generated during power generation is highly improves the economics of the mushroom, they are using environmentally-friendly technology to guarantee sustainable development.

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3.4 Biogas Plant for CHP production, Csenger-Tej Kft. Cattle farm

Source: http://www.inwatech.com

The biogas plant in Csengersima produces electrical energy from dairy farm's (cattle breeding farm) by-products, like liquid manure, cow dung, maize silage, cornhusk and wastewater from milkhouse. The quantity of the substrates is about 26 000 tons and it results in 1 800 000 m^3 annual biogas production. The mezophilic fermentors were made of, stainless steel modular components.Unique mixing technology facilitates outstanding efficiency and biogas yield This biogas is burned in a CHP plant which has 536 kW nominal capacity. The generated electricity covers the electricity need of the farm and the additional energy is fed into the 22 kV electrical grid. The gas motor's waste heat (via a heating system) provides enough energy for the fermenters to keep the substrates and the biology on the right temperature (38°C for mesofil bacterias). Thanks to the biogas plant, 2 900 tones/year CO_2 mitigation can be reached.

Raw material source: 11 000 t/a cow liquid manure, 9 000 t/a cow dung, 3 000 t/a mais silage, 400t/a glycerin

The supported price (feed in tariff system) of the electrical energy will help for the company to increase its incomes, because the price of their main product, the milk, is very low.

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3.5 Pannonhalma

The Abbey of Pannonhalma is one of the most precious, sacred places in Hungary which is part of the World Heritage. It plays a significant role in the Hungarian education and culture. The Abbey hosts about 80-90.000 guests annually. For this reason the installed renewable technologies function as demonstration project for the wide public. The purpose of the project was to make the energy system more efficient and environmental friendly. Therefore in 2009, a wood chip boiler and a CHP (Combined Heat and Power) unit were installed and the old boilers, entirely fed with natural gas, were removed.

The new biomass boiler is fed with residues from the monastery's agriculture and forestry territories and from nearby areas. 955 tonnes/year vine stem, lavender stem residues from the arboretum is collected and supplies heat for the Abbey's heating and DHW (Domestic Hot Water) system. The capacity of the biomass boiler covers 60% of the peak heat demand (including both heating and DHW demand) of the Abbey. In this way it supplies 80% of the annual heat demand of the local buildings.

Beside the biomass boiler, a natural gas based CHP unit was installed to provide heat and electricity for local purposes. The CHP unit can cover about 10% of the peak heat demand (including both heating and DHW demand) and 40% of the peak electric demand of the Abbey. This means that the CHP unit supplies about 30% of the annual heat demand and 76% of the annual electric demand of the local buildings. The generated electricity is not fed into the public electric grid, it is entirely used for supplying local demands.

Heat demands are always higher than the capacity of the CHP unit. In winter the CHP unit provides heat for DHW and partly for heating purposes. The remaining part of the heat demand is covered by the biomass and gas boilers. The biomass boiler satisfies the base load of the system, the gas boiler is activated only in winter peak periods. If the local electric demand is low then the CHP unit operates at a lower capacity producing less heat. In this case the biomass and gas boilers operate at a higher capacity covering the remaining heat demands. In summer, the CHP unit can entirely satisfy the heat demand of the DHW production therefore the biomass and gas boilers are switched off all during the summer season.

557 tonnes/year CO_2 savings is reached by the biomass boiler and 455 tonnes/year by the CHP unit.

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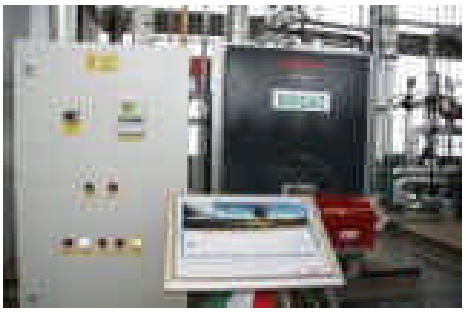
3.6 Miskolc district heating, landfill gas utilization



Source: http://www.miho.hu/

In 2006, the landfill in Miskolc was recultivated with EU support. Simultaneously the possibility for flaring the continuously generating landfill gas had been developed. The district heat supplier company, MIHŐ,has decided that instead of flaring the gas without utilization they will utilize the gas to satisfy the heat and domestic hot water needs of a building estate 1.5 km far from the landfill, which had been satisfied with boilers fed by natural gas previously. A landfill gas fired gas engine was installed in the heating plant and in one of the boilers the burner was replaced for using biogas. Due to this investment a great proportion of the heat is generated using co-generation, which is both energetically and economically favourable.

250 m^3/h gas can be exploited continuously trough the 84 built gas wells from the recultivated landfill site. An additional 67 wells are drilled in 2009. The biogas is fed into a boiler that provides heat and domestic hot water for the building estate. In winter the whole amount of biogas is utilized but in summer time there is less need for heat energy therefore the extra gas had to be flared. To be able to fully utilize the landfill gas a CHP gas motor was installed in the second phase (in 2010) to generate heat and electricity. The motor has 500 kW nominal capacity and the generated electricity is fed into the grid.

The social status, prestige, and consequently the market position of district heating has significantly decreased in the recent years in Hungary. This is due to the relative high price of district heating compared to other energy sources and also to the inadequate service levels. For strengthening the market position, the district heating company should increase the level of service and the efficiency of technical development.

With this investment 3 872 t /year CO_2 emission savings is reached annually. The expected emission savings during the whole life cycle of the project is 58 073 t CO_2.

The project will have the following positive effects in Miskolc DH:

- cost reduction due to the competitive disadvantage of the heat loss,
- improvement in public perception of district heating,
- long-term retention of existing consumers,
- new consumers latch on to the district heating system,
- operational cost reduction by having new consumers.

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3.7 NÁD-BRIKETT, agro-briquette production

Prior to the project, a complex technology was developed by the contribution of experts and professional companies for the utilization of secondary solid biomass developing in agriculture and reed farming. After the preparations, an agro-briquette production facility was installed with the capacity of 0.7 tonnes/hours in Nagyiván. The realized project serves as a pilot project aiming to spread the developed technology for agro-briquette production. The used raw material is corn straw and reed from the local agricultural area.

Briquettes are manufactured in hydraulic, piston and spiral processes. Their most typical general characteristics: they are made from natural raw material, do not contain foreign binding agents, have low moister content (approx 10%). Their heating value is 17-19 MJ/kg.

An unutilized industrial building was renovated and made suitable for the installation of the needed equipments. The facility operates 6 000 hours/year and produces 4 200 tonnes agro-briquette annually. The produced bio-briquette is sold mostly for residential (about 30-40%) and public consumers (40-50%).

During operation they can reach 3 562 t/year CO_2 emission savings annually. Expected emission savings during the whole life cycle (20 years) of the project is 71 240 t CO2.

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3.8 Complex bioenergy project at Beszterc

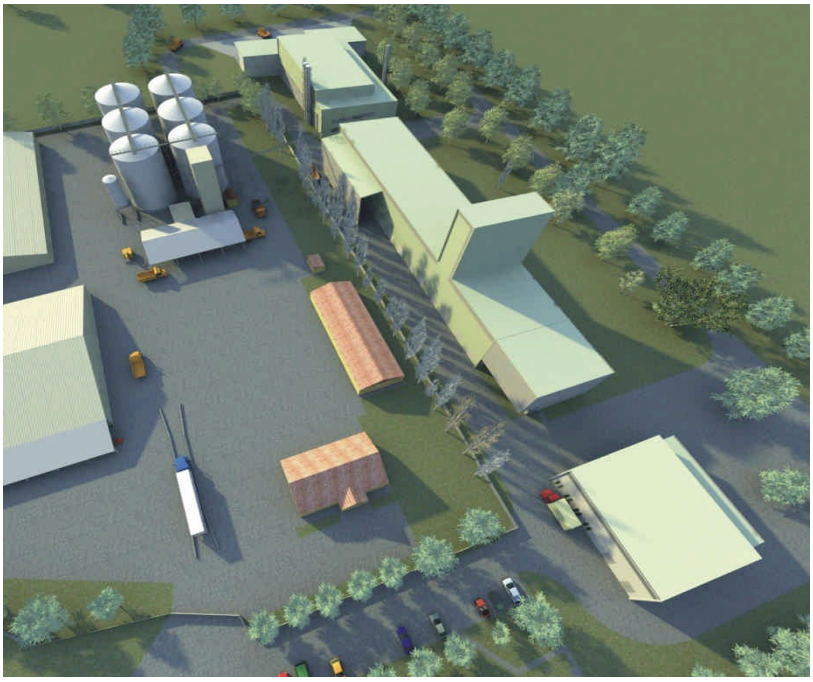
The central element of the investment is a biomass-fired power plant with 3 MW thermal and 12 Mwelectric capacity, for which the fuel is provided by a facility that is also producing 4000t biobriquette annually. The raw material will be so far unutilised by-products (remaining logs after felling, boughs from pruning, straw, etc.) coming from the nearby areas. The briquette project is still under development but it have been design to ensure that the higher quality materials biobrikettet is sold, while the law quality materials are used within the plant. The power plant boilers were selected accordingly and the minimum energy need is sought to achieve.

The group's objective includes the construction of a bioethanol plant, for which the biomass-fired power plant will provide the heat and electricity. Due to such innovative co-operation high efficiency can be achieved, while the ethanol plant is supplied fully from renewable energy sources. Through this complex project the EU bio-ethanol targets can be reached and leasds to greater carbon savings. The necesarry raw material - the corn - for the bioethanol is provided by 60 growers belonging to the Szuro-trade group.

As the first invest of the complex a bacterial fertilizer plant was built in 2009. This plant is connected to the power plant as a consumer of the produced heat and electricity; and to the bioethanol plant as a facility which reduces that adverse environmental impacts of corn production. By using the manufactured bacterial fertilizer the fertilizer need can be reduced by 30%. Taking the product's whole life-cycle into account 70% GHG reduction can be achieved during bioethanol production.

In the second phase the biobriquette plant will be built in 2010, and with the third phase – bioethanol plant- the whole project will be finished. As a result of this complex investment a demo project is created, where by-products from nearby areas are utilized efficiently and the

following products are produced with "quasi 0" fossil fuel use: bioethanol, electricity (that can be fed to the grid), biobriquette, bacterial fertilizer, high nutritional value feed raw material.



Left: the existing plant, Right (from the bottom): fertilizer plant, bioethanol plant, power plant with the briquetting machine

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