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Legal, social, economic and ecological applicability of different RES in Hungary

Public acceptance and environmental conditions - an overview in 2009

A Master Thesis submitted for the degree of
"Master of Science"

supervised by
Prof. Dr. Miklós Nemenyi

László Pongrácz
0727684

Vienna, 2009

Affidavit

I, **LÁSZLÓ PONGRÁCZ** hereby declare

1. that I am the sole author of the present Master Thesis, "**LEGAL, SOCIAL, ECONOMIC AND ECOLOGICAL APPLICABILITY OF DIFFERENT RES IN HUNGARY,** PUBLIC ACCEPTANCE AND ENVIRONMENTAL CONDITIONS - AN OVERVIEW IN 2009", 55 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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Abstract

A growing number of industrial consumers and households in Hungary switched to natural gas during the period of low prices of the 90s. However, because the high import – and fossile – energy carrier dependency, security issues mean nowadays a great challange. On the other hand, according to European legal engagements and national targets energy supplies from renewable sources should be essential components of the energy strategy of Hungary in the future.

Based on the most authentic, relevant and up-to date information sources this work tries to give a Hungarian overview of RES utilization in different fields. The thesis reflects on legal-, ecologic-, business-, scientific- and social questions. At last a SWOT analyses presents the most important influential factors and characters of the Hungarian renewable energy sector.

The share of renewable – solar, thermal, wind, hydro, biomass and geothermal based – energy is gaining in Hungary but the increase is really small concerning the potential of the different renewable resources. While there is huge ecological potential of RES in Hungary we cannot see a wide range of RES applications, unfortunately. The existing equipments are usually large scale units. In this context diversification and decentralisation should be a top issue in the next years. The economic crisis and the subsequent recession have a great negative effect on investment from both business and the public, at least in Hungary. Without different types of subsidies and a decentralised, harmonised and technology-specific RES policy it is just an utopia to reach the ambition target of renewable energy resource utilization in Hungary.

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1. Introduction

The world is facing two major global challenges: *climate changes* and the economic viability of available traditional *energy source* in the near future. These challenges are really global and all countries, including Hungary, have to face them and look for and implement solutions (*IEA, 2001*; *LÁNG, 2003; IPCC, 2004; VARGA-HASZONITS AND VARGA, 2004*).

The framework for renewable energy producers is determinded by national and EU legislation. Strategies and targets based on these. In December 2008, at the meeting of the European Council the leaders of member states decided about the future of the EU's energy and climate package and approved the new Renewable Energy Directives. According to this, for Hungary it is compulsory to reach 13% proportion of renewables in total energy use by 2020.

All in all, the use of renewable energy is increasing year by year in many countries not only in Europe but all over the world. In the last years renewable energy has come of age. According to *TWIDELL AND WEIR* (2006): 'it makes good sense, good government and good business'. Energy supplies from renewable (such as solar, thermal, photovoltaic, wind, hydro, biomass/biofuels, wave, tidal and geothermal) sources will be essential components of every nation's energy strategy; not least because of concerns for the *environment* and for *sustainability*. Moreover, a diversified mix of energy sources and so decentralisation will increase *security* of supply.

However, when seeing alongside in Hungary's energy supply, the so called renewable – solar, thermal, wind, hydro, biomass and geothermal based – energy is only slowly gaining. Therefore, the aim of this work is to find out at least some of the reasons. Looking after the possible answers of this main point I tried to collect and review authentic information of the most appropriate sources dealing with utilization of RES in different levels. So, this work would like to:

- introduce the present state of renewable energy use in Hungary,
- compare it to the potentials,
- present the current legislative and market environment, and
- analyse the public acceptance and social effects of using RES.

Within the European Union's 'Energy and Climate Package' Hungary's target for renewables as mentioned before is 13%. The Hungarian government adopted the 'Strategy for Increase in Renewable Energy Use 2008-2020' in September 2008.

This should play a key role in reaching the target. However, the economic crisis and the subsequent recession have a great effect on the market of renewables, too. The limited access to credit have a negative effect on investment from both business and the public. In such cases scientific institutions got less support and the public acceptance probably decreases, as well.

For having a quite clear overview which is free of any rhetoric phrases of some politics I studied the present legal-, ecologic-, business-, scientific- and social situation related to utilization of renewable energy resources in Hungary. A SWOT analyses should help to clarify the different factors. The result should be a kind of ‘status report’ that is worth to read I suppose by sponsors, possible investors, officials, business stuffs, students and even decision makers, too.

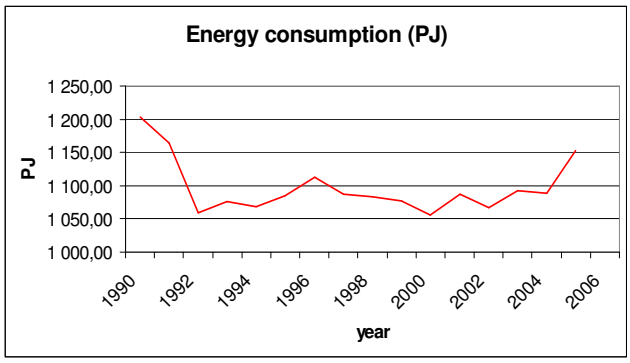
2. Energy – Hungary: background and facts

2.1. Energy mix of Hungary

To understand the Hungarian situation of energy production and utilization, some basic facts should be known that can be see on *Figure 1*, too:

- the total demand of energy in the country is about 1100-1200 PJ/year,
- the import dependency on fossile energy resources is relatively high, approximately 70%.

Due to these facts it is a fundamental question how the dependency can be decreased, and where from the country will recieve its energy.



Coal (included lignite)	25%
Oil	86%
Natural gas	81%
Electricity	17%
Total	~70%

(Source list[1])

Figure 1. Energy comsumption of Hungary and import dependency

Primary Energy Supply

Natural gas and oil dominate primary energy supply in Hungary (*Table 1*). However, the share of oil, as well as the share of solid fuels, has declined significantly since 1990 as these fuels have been gradually replaced by natural gas. Natural gas supply has increased by 31% over the period 1990-2004, demonstrating a percentage share in 2004 far above the EU-27 average (24%). The total consumption of energy has remained fairly constant in recent years. Only a 4% of primary energy supply concerns renewable sources in 2004 (below EU-27 average of 6%).

Domestic Production

Nuclear energy is the most important domestic source of energy, as *Table 1* presents it clearly. Hungary also produces small quantities of gas, solid fuels (hard coal) and oil. The share of renewable sources in domestic production was 10% in 2004, with total produced renewable energy showing a remarkable increase of 85% since 1990. In contrast, domestic production of all other energy types has

significantly declined since 1990, leading to a decreasing of total domestic energy production. The domestic primer energy production was 426.7 PJ in 2007, while the amount of import reached 697.3 PJ (KHEM, 2008; Source list[2]).

Table 1. Energy mix of Hungary in 2004

Mtoe	Primary energy supply	Domestic production	Imports	Final energy consumption	Electricity generation (TWh)
Solid fuels	3.4	2.2	1.1	0.7	8.2
Oil	6.3	1.6	4.9	4.5	0.8
Gas	11.7	2.4	9.3	7.5	11.8
Nuclear	3.1	3.1			11.9
Electricity			0.6	2.7	
RES	1.0	1.0		0.7	1.0
Other	0.7			1.2	
Total	26.2	10.2	15.9	17.4	33.7

(Source[3]; EU, 2007)

Imports

Hungary's import dependency is slightly above the EU-27 average. Natural gas represents the majority of imported energy sources, the use of which has been increasing in recent years. Hungary is also a crude oil importer, with declining imported quantities since 1990. The Russian Federation is the main source of imported gas and oil for Hungary. Total imported energy has fluctuated over the period 1990-2004.

Electricity Generation

Electricity generation in Hungary is largely based on nuclear energy, natural gas and coal. Gas and nuclear power provided each about 35% of generated electricity in 2004. The share of oil has been declining since 1999, as it has been gradually replaced by natural gas. The use of renewable energy sources (predominantly biomass) exhibited a dramatic increase in 2004 (an almost 6-fold increase) though is still only responsible for a very small percentage of the electricity generated.

Final Energy Consumption

Figure 2 presents the way energy is consumed in Hungary. Industrial and agricultural demand has decreased significantly, while transport demand has increased by 28% since 1990. Oil and gas contribute mostly to final consumption. *Figure 3* shows the intensity of the main sectors in Hungary while *Figure 4* presents the final energy intensity of some countries.

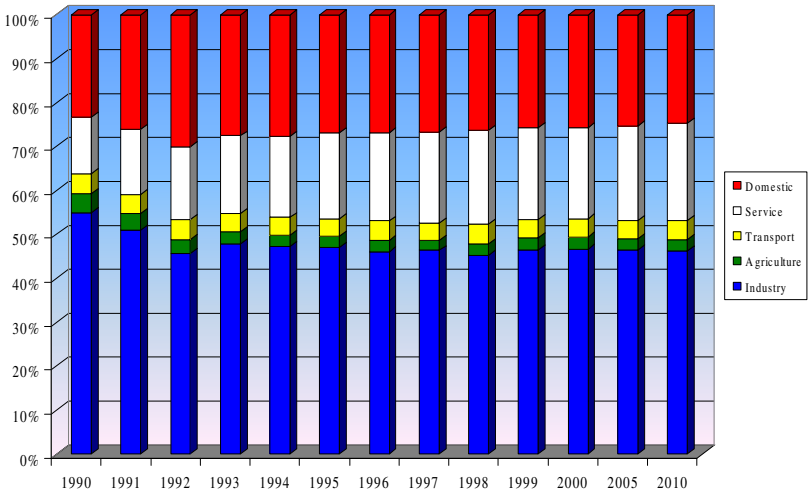


Figure 2. Energy comsumption in Hungary by sectors (plan)

(Source[4]; KHEM, 2008)

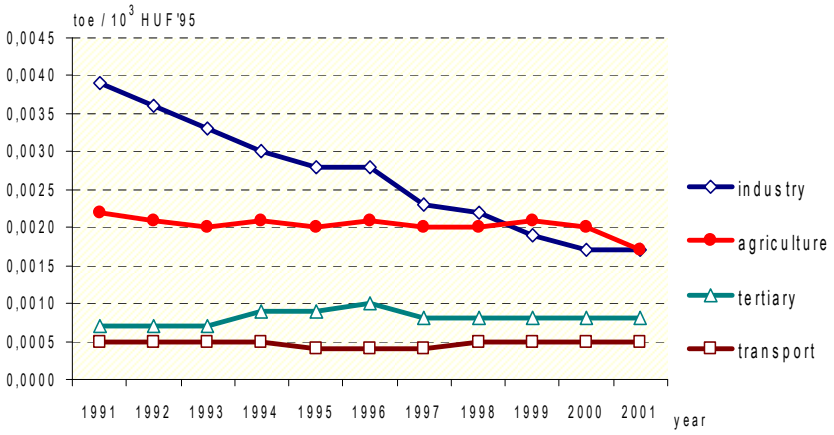


Figure 3. Final intensity of the main sectors in Hungary

(Source[5])

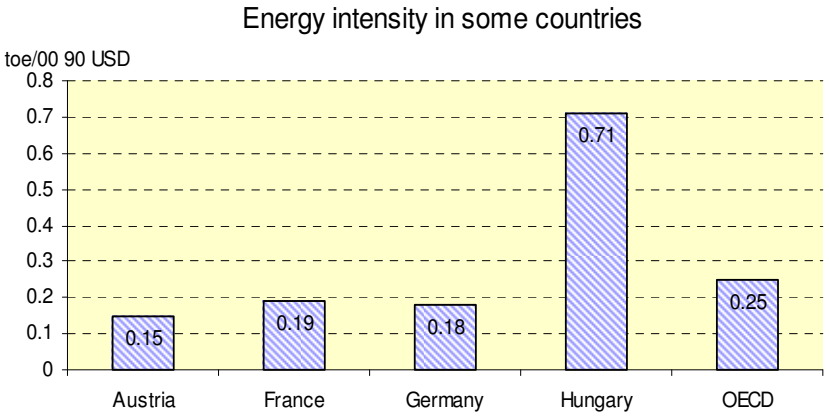


Figure 4. Energy intensity in some countries

(Source[7])

2.2. Energy policy of Hungary

Hungary has one of the most one-sided and vulnerable energy systems in the EU. Almost half of the primary energy supply (48.6%) consists of natural gas, a share comparable only to that of the Netherlands' (*Figure 5)*. What is more, in contrast to the leading gas consumer countries of the EU, Hungary has no significant indigenous production, imports nearly 81% of its demand exclusively from Russia through the Russian-Ukrainian pipeline network (*Figure 6)*. Transit volumes to Serbia and Bosnia-Herzegovina are irrevelevant in the light of its own needs. There are no spare capacities in the system as the Hungarian networks, pipelines and storages have reached their limits. Budapest has also failed to build up strategic storages and a critical number of bottlenecks has accumulated in the gas industry during the previous decade (*CSETE*, *2002*).

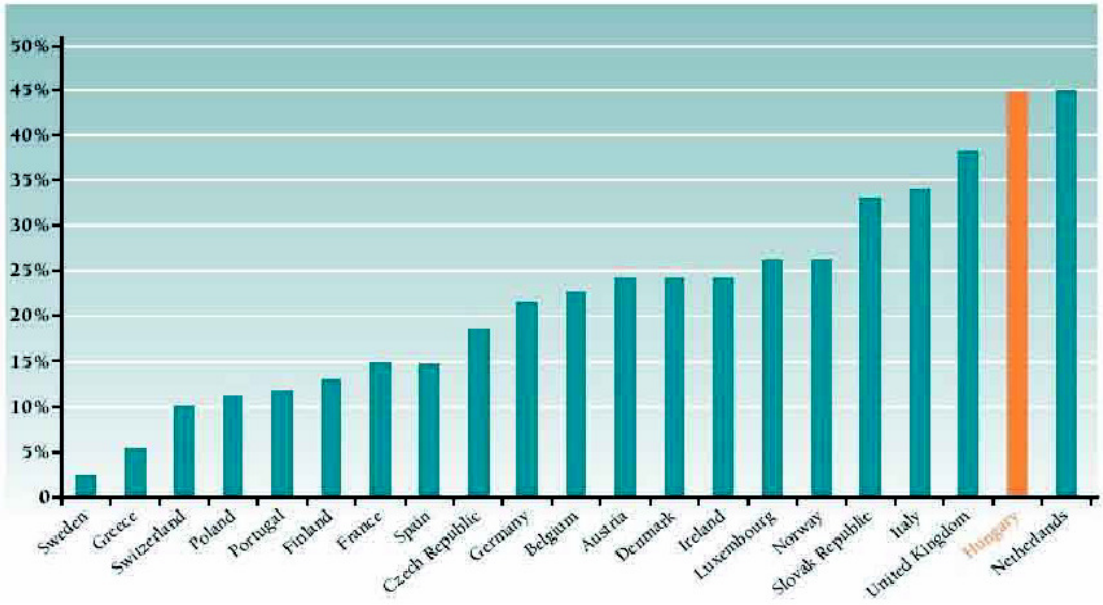


Figure 5. Share of natural gas in the primary energy consumption of some European countries

(Source[7])

Diversification of the supplies is rather a conservative topic on the political agenda. *BÍRÓ (2000*), *IEA (2000), DEÁK* (2006) and many others published detailed papers of the Hungarian energy policy of the last decades.

At the beginning of the '90s, the conservative *Antall-cabinet* (1990-1994) decided to build the HAG pipeline and connect the Hungarian network with the Baumgarten hub in Austria, instead of increasing the capacity of the existing eastern direction from the Ukrainian border. Actually, Hungary imports the same Russian gas through the HAG network.

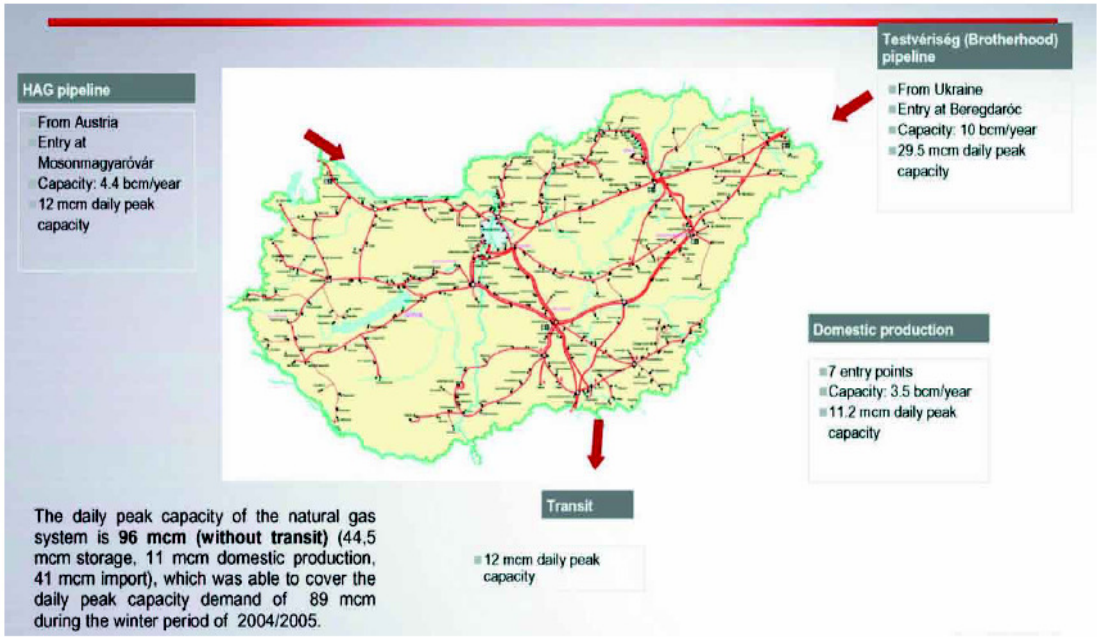


Figure 6. The high-pressure gas pipeline system in Hungary

(Source[8])

The *Horn-government* (1994-1998) succeeded in the management of the NATO enlargement debate without any long-lasting damage of the bilateral relations. Better representation of some Russia-oriented business lobbies in the Hungarian establishment also improved economic relations. However, it was the Horn-cabinet that did not allow Gazprom into the distribution network, raising artifical hindrances to the privatization. Continuing the work of the previous conservative government, smaller volumes of gas were contracted with Ruhrgas and GdF, presummably at 30% higher prices than Russian imports. This is still a symbolic example of false and expensive diversification efforts in Central-Eastern Europe. Anyway, all these issues did not trigger significant political debates and remained mostly at the expert level.

The *Orbán-government* (1998-2002) limited itself only to 'searching for diversification opportunities' without any financial or political support of a particular project. At the same time, energy security was rather perceived as a fight against Russian takeover of the industry. The attitude towards Russia is one of the most significant issues in the Hungarian foreign policy. So, the conservative Fidesz-government brought a kind of 'iceage' to the bilateral relationship and pursued a hostile policy towards Russia even when other Central-European and Western capitals had made a fresh start with Putin.

The *social-liberal coalition* under prime minister Péter Medgyessy (2002-2004) understandably pursued a reconciliatory policy. However, when Ferenc Gyurcsány

came to power in 2004, the social-liberal government went further and demonstratively developed its relationship with Putin, somewhat ignoring the cooling political climate around Russia. Even if these black-and-white domestic policy patterns also determined the attitude towards Russian energy supplies, energy has not become a major issue in these foreign policy debates. Issues related to Russia are usually discussed in the context of its historical role and general political and business trends, but energy supplies have remained an underrepresented topic in this regard.

2.3. International market

The gas crisis has shown the low level of network interconnectivity in Central and Eastern Europe. Each country has their own national development policy without any consideration of their neighbors' planning. The Eastern European energy markets consist of a set of very segmented national markets with strictly limited cross-border capacities. These countries are not only unable to help each other in case of disruptions, but cross border energy trade is also impossible. Establishing a substantial level of interconnectivity between these markets would result in lower energy prices, improved efficiency and a higher level of security (*KPMG, 2008*).

In the Visegrad countries energy networks are mostly East-West oriented. Strengthening the South-North connections became a major issue at the Visegrad level. Hence, Czeh Republic and Poland signed an agreement to connect their natural gas grid in the near future.

The Blue Stream 2 project is a possible extension of the Russian-Turkish sub-sea pipeline to the Central-European markets. At first sight, it clearly challenged the EU supported Nabucco-pipeline and understandably raised some questions about the Hungarian position in this question. Hungary seemed to continue trusting Russian supplies, amid the widespread fears of the 'Russian energy weapon' in Central European countries. At first sight, Budapest seemed to sail against the European wind and strengthen its ties with Moscow, presumably for its own benefit rather than that of the EU.

The Nabucco-project has been planned for 30 years. Searching desperately for a cheap and profitable way for Hungarian diversification, a connection between Turkey and the European markets seems to be the only possible way. It was definitely the notion of security that prompted the Hungarian government to move this project from the deadlock. Two basic questions had to be answered: who is going to fill the pipeline and who has the funds to build it (*DEÁK, 2006*).

STERN (2006) reported that one of the diversification projects should be an LNG terminal in the North Adriatic Sea. LNG became a favorable issue all over the world and especially in the Central European countries desperately in search for any gas imports other than Russian. However, it must be clear that the consumer's enthusiasm is not shared by the producers. Thus, LNG could be a good option for physical diversification but gas from the Adriatic will definitely cost much more than Russian gas. Floating the idea of expensive gas in the Hungarian political discourse would be unpopular.

2.4. Conclusions

The Hungarian governments have been preferring natural gas consumption since the mid-80s. A growing number of industrial consumers and households switched to gas during the period of low prices of the 90s. Natural gas was thought to be cheap and comfortable fuel and governmental price subventions only reinforced this belief. However, for some years the 'safety of gas supply' became the top priority issue in the industry, overshadowing external 'gas supply security' considerations. All this prompted the Hungarian government to rethink its previous policy and raise domestic gas prices in order to cover at least the most necessary maintenance costs.

There are some major risks concerning future market development. First of all, in Hungary there is no gas-gas competition on the market, because of lack of supply diversification. An other possible risk is the luck of proper infrastructure. When transmission network and storage facilities have not enough spare capacity there is a need for infrastructure development what would support both the market development and the safety of supply. Gas prices and infrastructure tariffs should cover the investment costs and return on capital to encourage further capacity development. This would result higher safety of supply and diversification. The next question is the market regulation. When there is dominant energy supplier possessing assets in various field (eg : electricity distribution, gas distribution, wholesale, trading, storage, transport) this create strong vertical and horizontal integration on the market, which would further delay and slow down market development, because there is a risk of control all elements of the gas/electricity supply chain and it would have negative impact on the gas/electricity retail market. That is why it is crucial to prevent any discrimination of competitors on the free market by the mean of regulation. Last but not least, there is a political risk, too. High crude oil prices result high gas prices, which should be reflected in the

residential and non-residential gas prices. These increases challenge the governments in power. Today in some areas of Europe, residential clients pay less for natural gas than the biggest industrial or power plant clients. If the end users' gas prices do not reflect and do not cover the actual costs of the gas supply in the public sector it slows down the free market development and increases the risk of safety of supply. Also to encourage further infrastructure investments, stabile and predictable tariffs and regulation is needed.

3. Legal and investment environment

3.1. Legislation, directives and strategies

Both Hungarian and European legislation set the general conditions for utilizing renewable energy through strategies and binding targets.

European regulation

One of the main influential factor of using renewable energy resources in Hungary was the European Directive 2001/77/EC (Promotion of electricity produced from renewable energy sources in the internal electricity market). However, this deals mainly with power generation.

Figure 7 shows the latest EU decision of the target of renewables by 2020 for each country. The share of renewables in electric energy production should be 3.6% till 2010. The share of biofuels in fuel use should be 5.75% till 2010, 8% till 2015 and 8-10% till 2020. The ratio of renewable sources in final energy consumption should be 13% in Hungary by 2020.

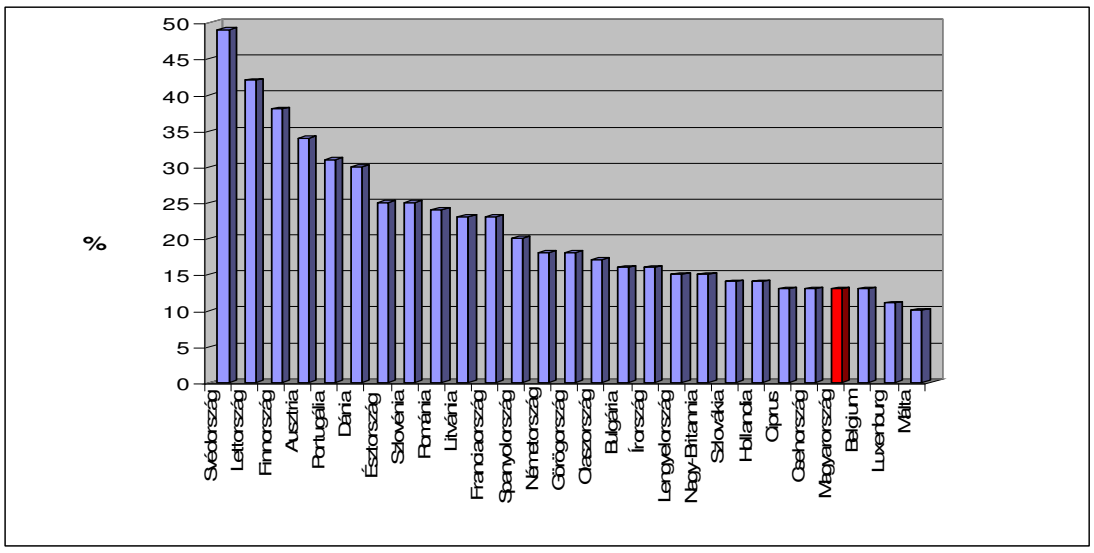


Figure 7. The target level of total RES for the European countries in 2020

(Source[9])

Looking over these targets and the present indicators of utilisation of renewable energy sources, we can conclude that Hungary is in unique situation among EU member states. The reason is not only the quite low value of the national target. Hungary is the only country among the member states where the lowest (!) new electricity target has been already surpassed in 2005 (*TÓTH, 2008*). *Figure 8* presents this.

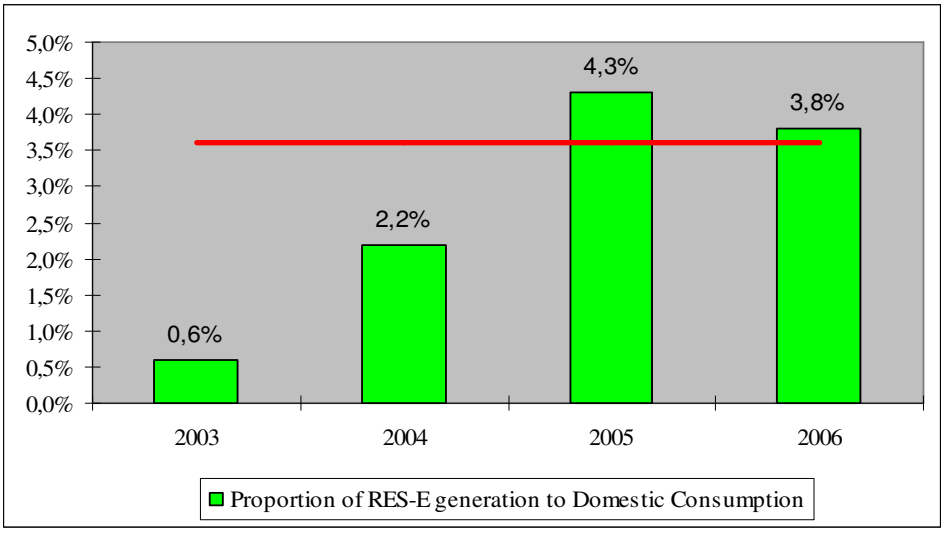


Figure 8. Proportion of RES-E in Hungary

(Source[10])

There are some other European important directives. 2002/91/EC deals vwith the energy performance of buildings that is a frequented topic nowadays in Hungary. The biofuel regulation can be read in the directive 2003/30/EC and 2004/8/EC contains some basic thing of cogeneration. The new renewable energy directive was discussed at the European Council meeting in December 2008. Directives 2003/30/EC and 2001/77/EC was amended and repealed by 2008/0016 (COD) on the promotion of the use of energy of renewable sources.

National legislation

Numerous national strategies, action plans and projects have been prepared on energy production and use in Hungary. Some of them targeting climate change as main issue (like VAHAVA: Change-Impact-Response – *LÁNG, 2003*) or usual deals with energy efficiency and renewable energy recources.

In April 2008 the Hungarian Parliment supported Resolution No. 40/2008 (IV.17.) on the new energy policy for the period from 2008-2020. The three main goals are: security of supply, competitiveness and sustainability. These include achieving and sustaining a balanced resource structure. The diversification of imported resources, the expoitation of national natural gas resources, the preparation of investment in a new nuclear power plant and of course the harmonisation of the energy and climate policy goals. This energy policy mentiones that a renewable energy strategy needs prepared.

In September 2008 the Government adopted the ‚Strategy for the Increase in Renewable Energy Use 2008-2020' proposed by the Ministry for Transport, Telecommunication and Energy (*KHEM, 2008*). The document lays out the advantages of renewables in comparison with traditional energy sources. State subsidy is needed to give renewables for the desired increase. According to the strategy the proportion of renewable utilization reaches 186.4 PJ by 2020. This is approximatly 15% of the overall energy use. In accordance with the European Union Climate and Energy Package, the document sets specific goals for the ratio of renewables in generating electricity, heat and transport sector (*Table 2, Figure 9*).

Table 2. Goals of the Hungarian renewable energy strategy by 2020

Renewable sourse for:	(PJ)
Electricity production	79.7
Heat production	87.1
Biofuels	19.6
Total	186.4

(Source[4])

Even if the above mentioned strategy, there is no separate renewable energy law in Hungary. Energy production based on renewables is regulated by a number of different laws. The law on electric energy (VET - Act on Electricity CX/2001) is the one which lays the principles of subsidizing renewable-based electricity generation. The many times amended electric energy law of 2001 introduced a preferential feed-in system for electricity generated from renewable energy sources, waste and cogeneration. The 2005 amendment to VET changed the framing of Renewable energy. The new text differentiates between renewables dependent and independent on weather conditions. The first group consists of solar and wind energy while the second contains geothermal, hydro and biomass. In order that the grid can be operated in a safe manner the VET obliges energy producers to give a time schedule and renewable energy producers were granted an exemption from this rule. The new law also set the obligatory feed-in tariff for renewable-based electricity that was 23 HUF/kWh (9,2 cent/kWh). This price has increased according to the previous year's inflation. Act No. LXXXVI of 2007 has maintatned the Hungarian Energy Office's right to set the amount of energy subject to obligatory feed-in in respect to specific investments, meaning individual discretion in each case. It also has the right to set the time scale of obligatory feed-in up until the end of the payback period. The office issues an annual certificate of origin for energy producers producing from renewables or heat from waste producers. Since January

2008 the transmission system operator (MAVIR) buy the electricity subject to obligatory feed-in (*TÓTH, 2008*).

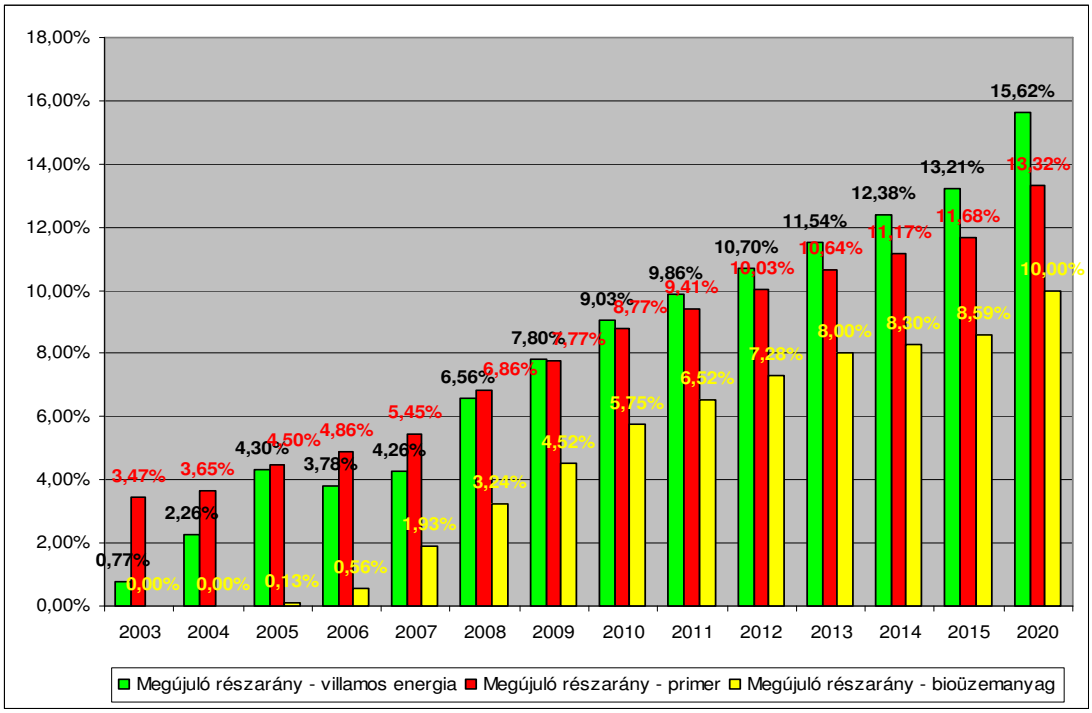


Figure 9. Expected share of RES in Hungary between 2003 and 2020 (RES-E, RES - primer, RES - biofuel)

(Source[4])

Current legislative regulation is especially diversified in the case of geothermal energy utilisation that is regulated by the mining act (No. XLVIII of 1993). If the exploition affects ground water the act on water management (No. LVII on water management) also has to be applied.

Other important side of legislation are the laws on conservation and on forests relevant to biomass, the revenue taxes law concerning the differentiated taxing of biofuels and the law on district hetaing. A list of different regulations can be read in the Appendix.

Vision for 2050

The EU's agenda for 2020 has set out the essential first steps in the transition to a high-efficiency, low-carbon energy system. However, the European countries need to develop a vision for 2050 and a policy agenda for 2030. According to the 2nd Strategic Energy Review (*Source[21]*) in the framework of the Strategic Energy Technology Plan (*COM 2007, 723 –*) the Commission will prepare a Roadmap towards a 2050 Energy Policy, in dialogue with member state officials, academics

and industry experts. The above mentioned high efficiency, low-carbon energy system need to be promoted not only in Europe but worldwide.

3.2. Subsidies

In the current circumstances most renewable energy technologies would not be able to compete with traditional production without subsidies. However, it is also important to note that the utilisation of fossil energy sources is also heavily subsidised by the state. To invite reasonable amount of investment, a stable, predictable subsidy policy and regulatory environment is needed. There are three main different subsidy possibilities at the moment in Hungary: investment subsidies for businesses and households, production subsidies (feed-in tariffs) and the so called 'hidden' subsidies for biofuels. Some other sources are available, too.

A total investment of about 2300 billion HUF is needed to achieve the development targets set out in the renewable energy strategy (186 PJ renewable use by 2020). The demand for support related to this amounts to around 410-420 billion HUF, half of which (220-250 billion HUF) is covered by EU and other programmes running up until 2015. The rest will be covered by similar EU programmes starting in 2013 (*KHEM, 2008*).

Investment

Enterprises, budgetary organisations and institutions, and non-profit organisations can apply for support for renewable energy investments in the framework of the European Union Cohesion and Structural Funds based Environment and Energy Operative Programme (KEOP) of the New Hungary Development Plan (UMFP) between 2007 and 2013. According to the targets in the KEOP the Hungarian state will subsidise 41 PJ of renewable energy production till 2013. This KEOP source can be spent on any renewable technology except for geothermic electricity generation and wind power plants connected to the grid. Altogether 4916 M Euro is available in the KEOP (*KHEM, 2008*).

Housholders (individuals, housing associations) have had the opportunity to apply for subsidies for energy efficiency and renewable energy investments in the framework of the National Energy Saving Programme (NEP). This programme startied 2000 and the budget available is quit small, and varies form year to year. *Table 3* presents the amount of investments realised with the help of the NEP between 2000 and 2007.

Table 3. Renewable energy investments realised with the help of the NEP

Year	Investment (billion HUF)
2000	538
2001	1322
2002	839
2003	1343
2004	289,5
2005	-
2006	518
2007	929

(Source[5])

Production

The system opeator (MAVIR) takes the green electiricity form producers at an advantageous and obligation feed-in tariff (so called KÁT balance circle) and the cost being passed on to electricity consumers who pay for this as a part of the overall price of electricity. *Figure 10* shows the sum of subsidy paid within the framework of feed-in obligation by categories and the changes of the specific subsidy on the basis of the first six months of the years 2006-2008. The calculated amount of subsidy connected with the electricity in the so called KÁT balance circle was 42.9 billion HUF in the first half of 2009. 27% of the total sum of the subsidy – 11.47 billion HUF – is pertaining to the electricity generated from renewable energy sources. 0.5 billion HUF was paid because of electricity generated from waste. The rest (30.9 billion HUF) of this subsidy „sponsored" electricity out of co-generation. The renewable category increased by 38% that means 3.2 billion HUF between 2008 and 2009 *(MEH, 2009)*.

There is no subsidy for renewable based heat generation in Hungary. This is a great obstacle to geothermal industry and the small, decentralised, biomass based district heating systems which have an otherwise reasonable good potential.

Hidden subsidies for biofuels

Since the 2006 amendments to the revenue tax law, fuels can only enjoy a reduced level of taxation if they contain a certain prescribed extent of some biological component. In the case of petrol (from 1 July 2007) and diesel fuel (from 1 January 2008) the refunding of revenue taxes has been replaced by a differentiated taxaton system.

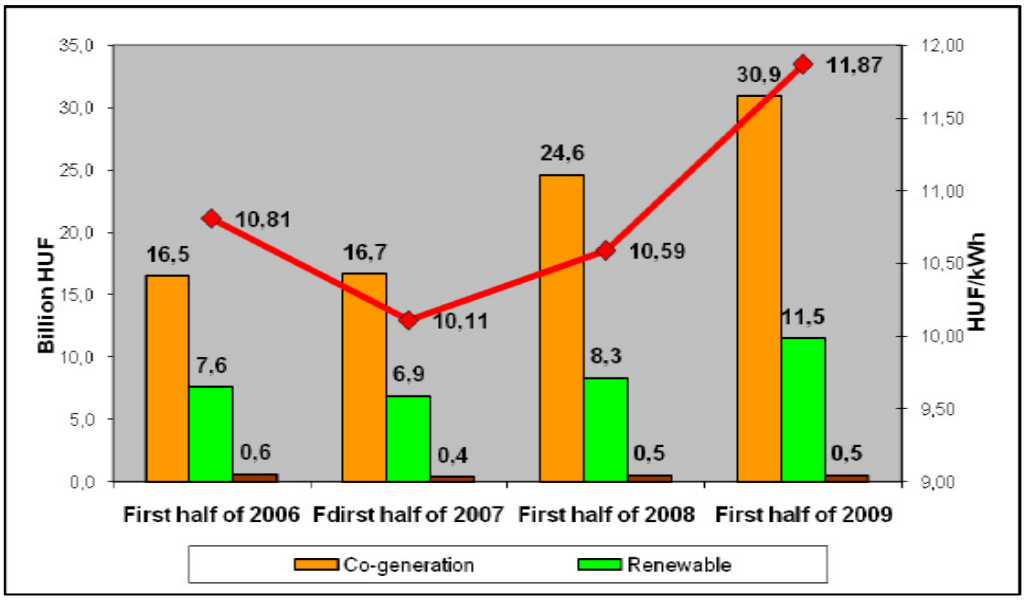


Figure 10. The subsidy paid within the framework of feed-in obligation by categories and the changes of the specific subsidy on the basis of the first six months in years 2006-2008 (left side: billion HUF; right side: HUF/kWh)

(Source[6])

Other sources avalible to support renewables

Through the New Hungary Rural Development Startegic Plan (ÚMVST), the European Agricultural and Rural Development Fund (EMVA) can provide support along three different strategic axis: fluid biomass, solid biomass and biogas.

The normative land based subsidies can be granted for fast growing arboreal energy plantations form 2008. It is handled by the Ministry of Agriculture and Rural Development (*KHEM, 2008*).

Most of the funding of research into renewable is done in the framework of EU community porgrammes like the 7th Framework Programme or the Intelligent Energy Europe programme. The National Research and Technoligy Office (NKTH) deals with national resources. It has been supporting several projects on renewable via its programmes named after Jedlik Ányos, Asboth Oszkár and Pázmány Péter. The Jedlik Ányos Programme has supported the consortium led by the Hungarian oil company called MOL. The Science, Technology and Innovation Policy Strategy and the related Action Plan passed by the Hungarian govermment also provides an opportunity to support projects on energy saving and alternative energy resource technologies (*KHEM, 2008*).

3.3. Conclusions

Regulations on renewables change abruptly in Hungary. Due to the many modifications they are often contradictory and unpredictable. Unfortunately, there is

a lack of a comrehensive approach in this field nowadays. A separate renewable energy law could give chance for this sector. In order to reach the compulsory target, a predictable and stable legal environment is necessary. The lack of this clear situation frightens off possible investors.

In the current circumstances most renewable energy technologies would not be able to compete with traditional production without subsidies. Enterprises, budgetary organisations and institutions, non-profit organisations and households can apply for support for renewable energy investments but the budget is seems to be sometimes low or the application process is extremely difficult. Because the small amount of different types of subsidies not only the large scale investment but also households and medium size applications are really rare, therefore decentralisation and so high energy supply security (mainly on rural areas) remain just an utopia. It is somehow similar to the conclusions of *PANZER ET AL. (2009)*: “Introducing a harmonised RES policy can only be favourable if it is designed technology-specific and, that a common European power market exists”.

4. RES: need or chance?

4.1. European target

According to the directive ‘renewable energy resources‘ shall mean renewable non-fossil energy sources like wind, solar, geothermal, wave, tidal, hydropower, biomass, landfill gas, sewage treatment plant gas and biogas. Since Hungary is a landlocked country, wave and tidal power as renewable source are not available. The European Comission proposed a national target of a renewable energy share of 13% by 2020 for Hungary that was adopted along the new renewable energy directive (2008/0016 (COD). On page 11 *Figure 7* showed that Hungary got a very low value. This is the third less among the European countries.

4.2. Potencials of RES in Hungary

Several authors have published different calculations on the potentials of renewable energy sources in Hungary. *NEMÉNYI ET AL. (2008)* deel with solar, wind, hydropower, biomass, biogas/landfill gas and geothermal sources, and the pump storage power plant. *Figure 11* presents its amount and ratios that based mainly on the calculation of Ministry of Economy and Transport and Hungarian Academi of Science (*MTA, 2006*.).

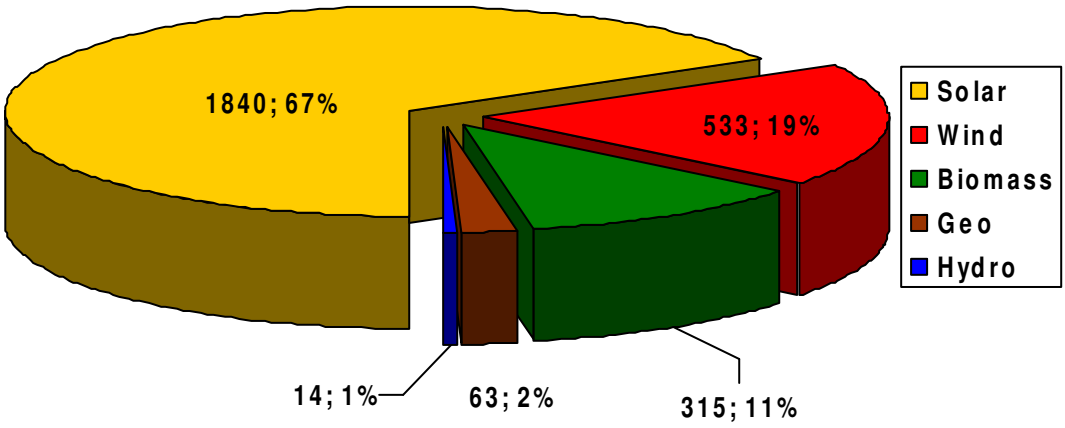


Figure 11. Potentials of renewable energy sources in Hungary (PJ;%)

(Source[11])

Solar energy

Hungary is situated in the temperate climate zone, which means it has four seasons with different cloud cover, hence different amount of sunshine arriving to the

surface. The country has great potential for the use of solar energy, as the number of sunny hours in Hungary is between 1,950-2,150 per year at an intensity of 1,200 kWh/m^2 per year (*Figure 12 and 13*). This amount of solar energy can provide a supply of hot water at 30-70°C from early spring until the end of the autumn, covering 60-70% of hot water need of a house/family. All in all, the theoretical solar energy potential in Hungary is well above the total amount of energy used in the country (*Figure 1 and 11)*. According to *KABOLDY (2004)* the estimated potential of solar energy in Hungary is 13,393,800 MWh/year or 47,835,000 GJ/year. Nowadays 0,1 PJ is utilized and about 4-10 PJ can be utilized in practice.

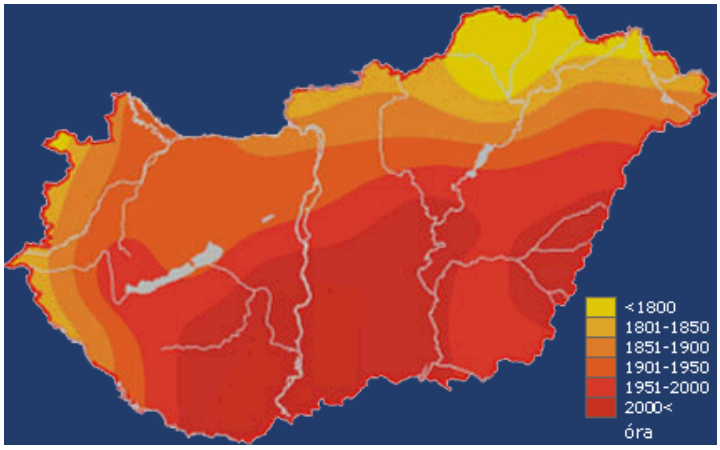


Figure 12. Number of sunny hours in Hungary

(Source[12])

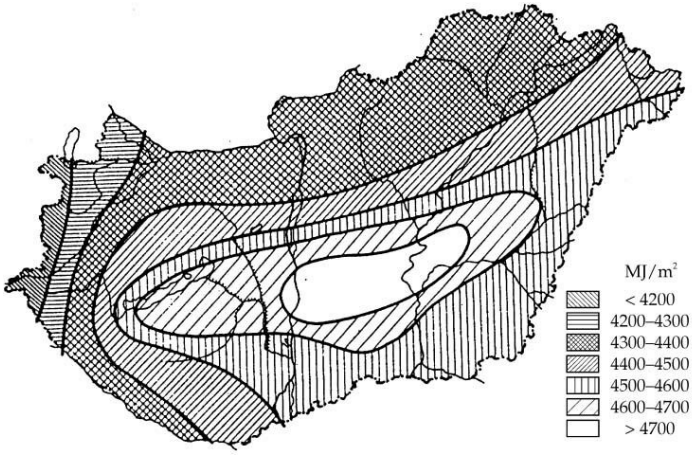


Figure 13. Average solar radiation in Hungary

(Source[13])

Wind energy and pumped storage power plant

The total theoretical ***wind energy*** potential in Hungary is about 533 PJ/year (*Figure 7*). However, according to the Hungarian Energy Office, by 2010 originally 330 MW of total wind energy capacity could be installed, mostly in North-West Hungary (*Figure 14*). This amount is well below the potential (*KIRCSI AND TÓTH, 2006*).

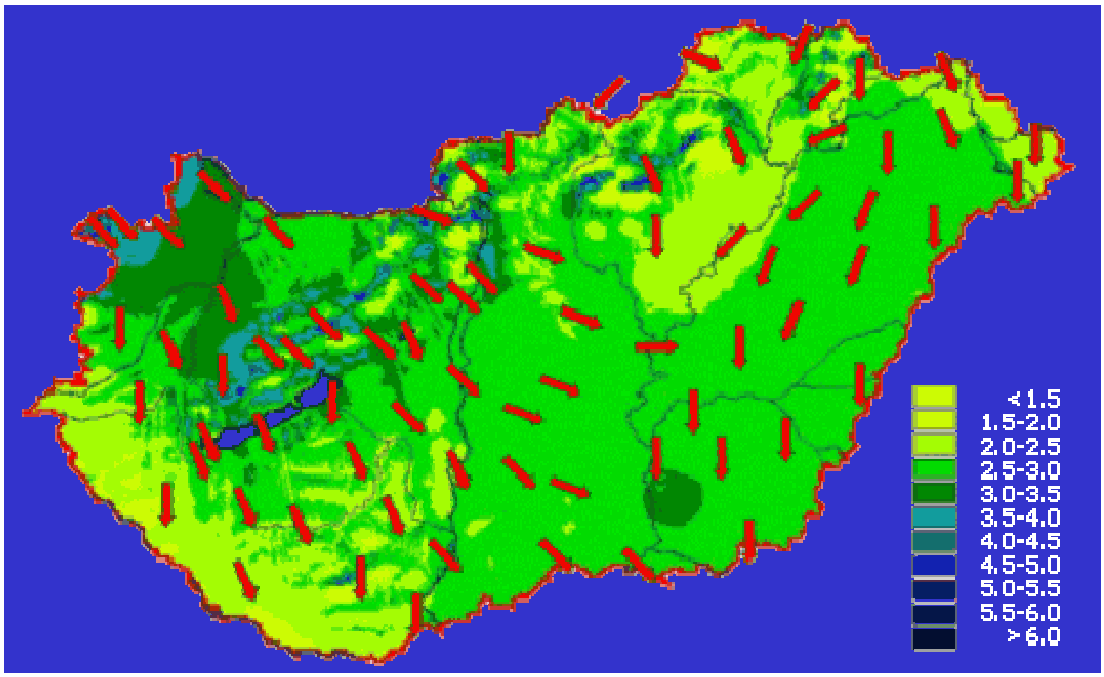


Figure 14. Wind directions and annual average wind speed in Hungary [m/s]

(Source[14])

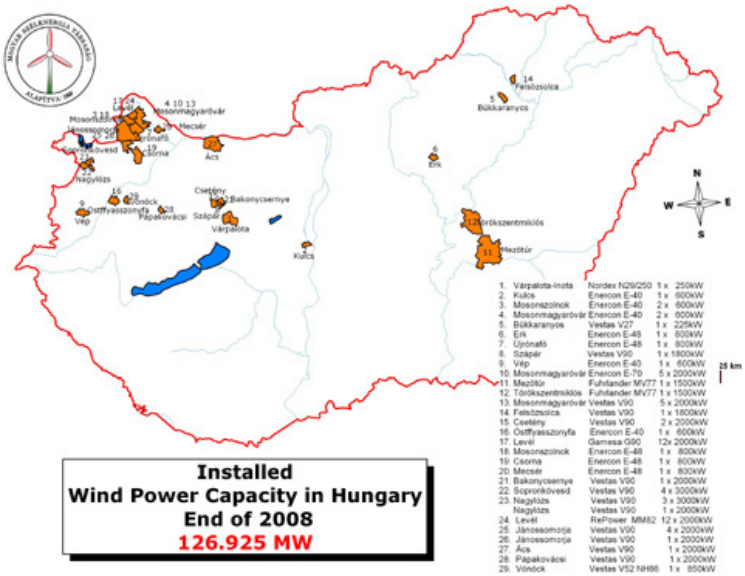


Figure 15. Wind energy utilization in Hungary (till the end of 2008)

(Source[15])

By 2006 December total of 39 wind power plant was already working in Hungary with 60.875 MW capacity. In 2008 February another 23 MW were installed in Sopron region. Till the end of 2008 there was 127 MW installed capacity (*Figure 15*) and nowadays there are more than 80 wind power plants with 177 MW capacity in Hungary *(Source[6])*. Good news that the 330 MW quota is increased by 410 MW in August 2009 (KHEM resolution 33/2009 (VI.30.) on the conditions of tender invitation for the establishment of wind power plant capacity).

Pumped storage power plants are normally not mentioned as a renewable energy source. However, it is important to mention it in spite of the fact that the pumped storage station does not generate renewable energy. It plays very important role in energy storage and system regulation. One of the main issue, why wind energy electricity generation has to be regulated is the fact that the Hungarian grid is not sufficient for the intake of the irregular large amount of generated electricity. For this reason experts are trying to install a system regulating pumped storage power plant in Hungary with no success so far. In most cases the opposition of the plant are environmentalist groups, sometimes even without sufficient background knowledge about the need for such power plant (*KIRCSI AND TÓTH, 2006*).

Biomass

Biomass utilization is mentioned as a good tool to reduce greenhouse gas emission because it is a so called 'carbon neutral' technology. Because of the climatic and other environmental conditions, Hungary has good possibilities for biomass utilization. However, limiting factors are the area for growing biomass and yields. According to *Figure 11* the total biomass potential of the country is about 315 PJ. The proportion of utilized biomass in 2004 can be seen on *Figure 16*.

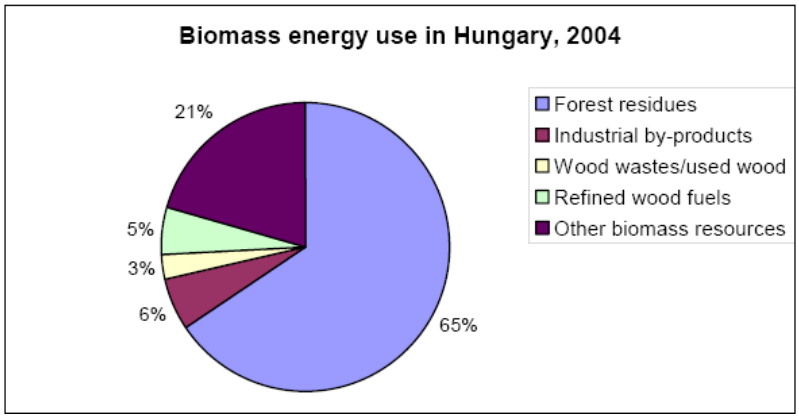


Figure 16. The structure of utilized biomass in Hungary (2004)

(Source[5])

The extent of biomass utilization in different regions is extremely different ranging from almost 0% to more than 75% (*BAI, 2002*). Biomass for energetic reasons can be divided into three categories:

- primary biomass, which includes natural vegetations (forests, arable land, etc),
- secondary biomass is related to the main and by products of animal husbandry,
- tertiary biomass consists of wastes from the different fields of industry (food, settlements, etc.)

For ***heating*** we can use conventional wood, short rotation forestry plants, miscanthus, cereal and maise, energy grass, old/used wood (like furniture etc.) and oil plants as row materials of solid biomass (*HOFBAUER, 2008*). Big part of the biomass used in Hungary is in the form of wood log combustion. This is the most traditional way of biomass combustion for residential heating and the fuel for these appliances is well defined since many centuries.

Biofuel production (like biodiesel and bioethanol) for the transport sector is an important part of utilization of biomass as well. All biofuels reduce the volume of life-cycle carbon compared to fossil fuels. Utilization of biodiesel is quite a fresh topic (*Figure 17*) but it seems an advantageous source of energy in terms of environmental, health, social and economic aspects (*NEMÉNYI ET AL., 2008*).

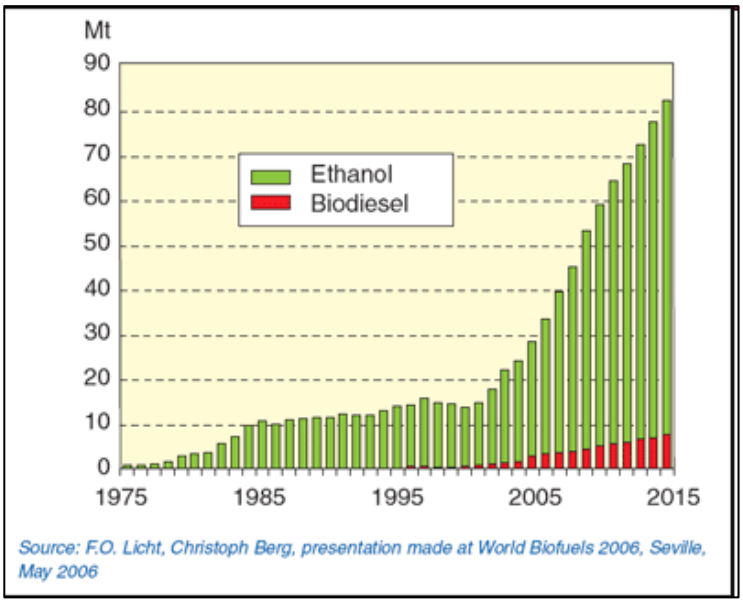


Figure 17. Trend of the world biofuel production (1975-2015)

However, the situation nowadays is not so favorable for this even if the appropriate environmental conditions for plant growing. Biofuels share expressed in energy content in the fuel market in Hungary shall be 5.75% by end 2010 (*KHEM, 2008*). Really a new field is biofuel from algae. According to NEMÉNYI ET AL. (*2008*), algae can yield theoretically between 9,000 to 185,000 L of oil per ha, depending on the specific strain. That is enormous productivity as compared with agricultural based biofuels.

The ***biogas technology*** combines environmental protection with the use of renewable energies according to the most up to date technology. Biogas is generated by natural digestion process of organic materials under absence of oxygen. Depending on the quality of the input material of biogas plant, several bacteria can generate different gas yields from the substrate. The anaerobic biogas process is altogether the best available utilization of organic substances. Biogas represents a valuable renewable energy source, ready to be converted into electricity in cogeneration plants. Assuming a calorific value of 35.8 MJ/m3 (standardized cubic meter) for methane, equivalent to 1.3 liter of light oil, biogas contains an average calorific value of 23 MJ/m3. This total energy content will be converted in cogeneration plant approximately 1/3 into electricity and 2/3 into thermal energy of about 90ºC. Approximately 12 to 20% of the thermal energy will be used in the biogas plant to control the temperature of the digesters and for the pasteurisation of all the incoming material in accordance with the EU-regulation (EU-V 1774/02). Biogas is expected to grow in importance most in the coming years. While in 2005 only 10% of potential was used, large-scale supply of inputs such as liquid manure, sewage sludge and slaughterhouse waste provide excellent opportunities for further development. Share of total electricity production in 2006 was 0.08%. The main resources for biogas are the liquid manure (14–15 million tonnes per year), the slaughterhouse waste (300,000 tonnes per year), and the sewage sludge (*KACZ, 2008*).

There is only one existing ***landfill gas*** burning plant in Hungary (in Budapest) that produces heat and electricity. Heat is distributed in the city and electricity (112.5 GWh) is bought by the electricity distribution company.

In Budapest there is 1200 t of solid waste daily and yearly 23 million m^3 (4.6 million t) communal waste in the settlements in the country. Yearly growing of waste in Hungary is 2-3% (62% is residential, the rest is institutional.) To handle this growing amount of waste and reduce the cost of transport, 5 new (regional) burning power plant is in planning phase (Inota, Orosháza, Tatabánya, Beremend, Pécs). However,

households waste is renewable only if collection is selective! *Figure 18* presents the places in Hungary where selective collection of household waste has already organised. The efficiency of the burning could be as high as 82%!

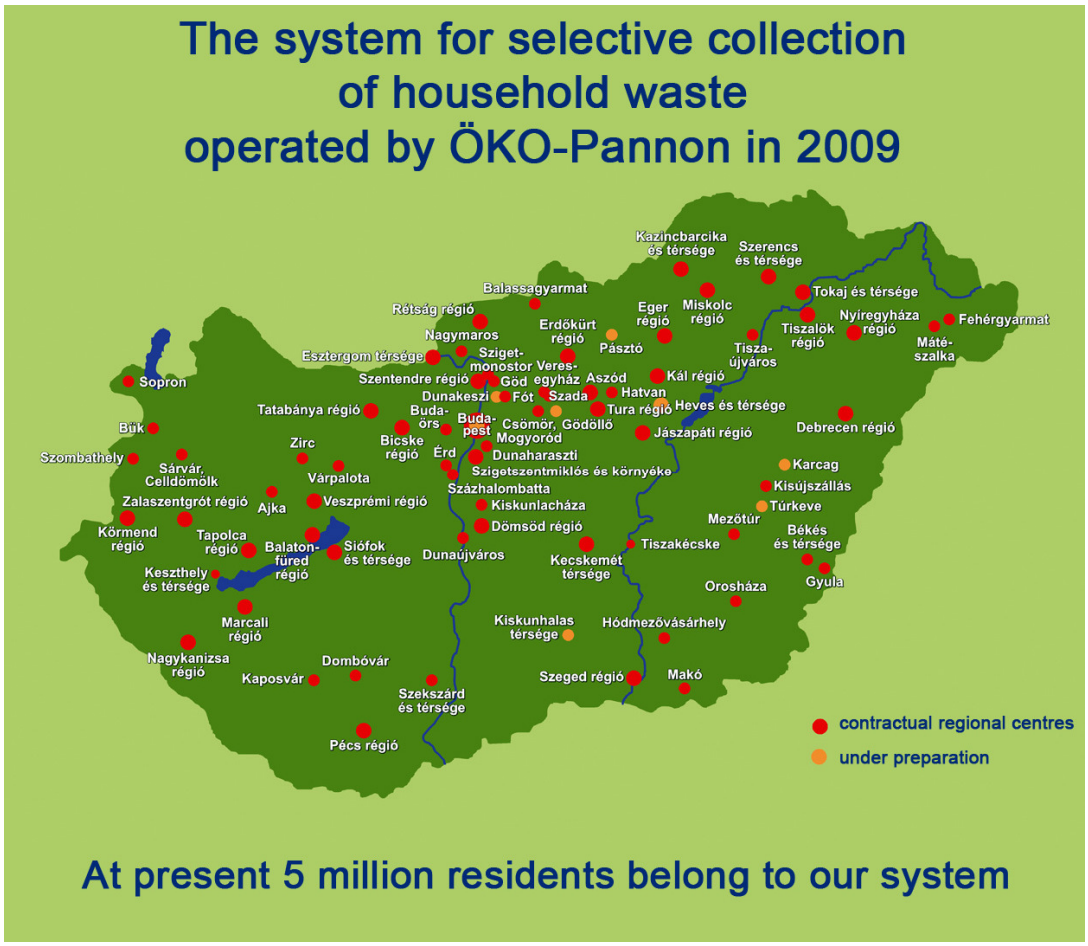


Figure 18. Selective collection of household waste in Hungary (2006)

(Source[17])

Hydropower

Because of the unfortunate misunderstanding with Slovakia on the Danube, utilization of hydro energy is a kind of nightmare in Hungary nowadays. The main factors affecting hydro power potential in a given place are the geographical and climatic conditions. Hungary is basicly flat area and the annual rainfall is 600 mm in general. This means quite unfavorable situation.

However, several authors have published different calculations on the potentials of hydro power energy sources in Hungary. The first known reliable estimation in the Carpathian Basin was made by *VICZIÁN* in 1905 and the result was 1,700,000 HP (horse power), that is approximately 1250 MW. *ROHRINGER (1917)* reported that 28,000 HP out of this amount was used. *MOSONYI ET AL. (1997)* calculated annually and totally 7,600 GWh (discharge line potential) in 1948. 2,000 GWh out of that was technologically feasiable and only 1,000 GWh was economically interesting. (Because of the technological developement, in the 70's only the planned Nagymaros plant could be 1,000 MW.) According to *BLASKOVICS (1998)* nowadays approximately 5,000 GWh would be technologically feasiable and the so called technical-economical potential is about 3,400 GWh (*KOZÁK, 2002*).

All in all, among other renewable energy sources hydroenergy is not the leading one in Hungary. The 37 plant in 2001 was totally 50 MW and produced 200 GWh electricity (*KOZÁK, 2002*). The three most important plants out of the existing hydro power plants in Hungary are the Kisköre, Tiszalök and Kesznyéten plant. The rest of the Hungarian plants are small hydro power plant. Besides the Nagymaros plant Hungary and Ukraine were planning the construction of a 440 MW hydro power station to be located on the Tisza River on the territory of both countries. Formerly there was a plan to build hydropower plant to the Drava River, but at the moment due to ecological issues it seems to be cancelled.

Geothermal energy

The geothermal gradient in Hungary is 5-7℃/100m. The World average for this gradient is ~3℃/100m (*PATAY*, 2007). As an average temperature of the water in different depth in the country is at 1000 m - 60 ℃, and at 2000 m - 120℃. Therefore, Hungary in most textbooks and publications is referred as one of the great geothermal powers (*MILICS AND NEMÉNYI, 2008*). *Figure 19* shows the spatial distribution of geothermal wells in Hungary. In spite of the great potentials about 3.6 PJ is utilized and 10-50 PJ is estimated to be available by geothermal utilization

(*MTA, 2006*). Because geothermal energy utilization does not mean only thermal wells, for geothermal energy utilization only 5% of the country is suitable.

Geothermal energy can be utilized for both energy needs: electricity generation as well as heat production. So far there is no electricity generation power plant in Hungary, however pilot projects were established by MOL in order to investigate the possibility to build a power plant on geothermal base.

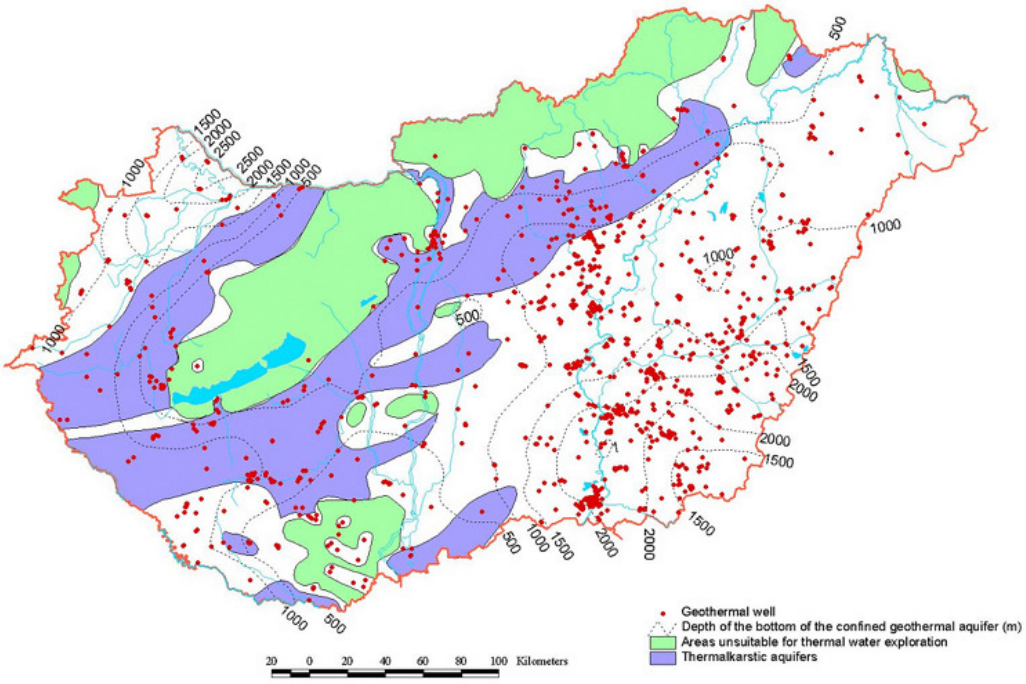


Figure 19. Spatial distribution of geothermal wells in Hungary

(Source[17])

4.3. Conclusions

The theoretical potential of renewable energy sources in Hungary is much higher than the energy need of the country. From this viewpoint the latest national target is not only absolutely, but also relatively low. Based on the favourable potentials, renewable energy production is increasing in Hungary. However, the increase is quite slow. The share of renewable out of the primer energy production is somehow 50-60 PJ/year that is approximately 4-5% at the moment.

The present regulations are favouring the solid biomass combustion and so during the last few years there was a remarkable increase in – usually – large scale biomass utilization. This situation could be interesting for the farmers and agricultural companies. The biogas (and landfill gas) technology belongs to this field,

too that has a kind of natural protection effect. The number of wind turbines is growing as well and this trend probably will continue because of the new 410 MW free quota. However, the investors come usually abroad. The solar technology is mainly used in the private sector which is strongly depend on the subsidy policy. Hungary is a flat country that means unfavourable conditions for building hydropower plants. Another reason of the low hydropower energy production is the conflict with Slovakia because of the Gabcikovo hydropower plant and it's so called 'C' variant. There are numerous wells in Hungary producing warm/hot water but these sources are usually used for thermal reasons. Hungarians are really proud of this thermal bath source but the Gabcikovo-misunderstanding has a negative social effect, too. 2/3 of the utilized renewable energies are used in heat generation while 1/3 is for electric energy production and 1.5% is utilized as biofuel.

5. Social aspects of utilization of RES

Besides environmental, diversification and security etc. aspects utilization of renewable energy sources have numerous social aspects as well. The propogation and representative activity of civil organisations, the scientific results of research groups, the well educated students of courses delaing with renewables, and of course media can influence the general opinion and knowledge of people, therefore thoroughout public acceptance these all influence the success of the sector.

5.1. Civil organisations

In Hungary there are specialised civil organisations working for different part of the renewable sector. Most of the organisations deal with one special kind of renewable source. Some of them work for the whole assortment of the sector (from the producers thorough processors till end-users). Theses organisation were founded mainly by enterprises and private persons. *Table 4* try to summarise the most relevant and active professional associations, its fields and the contact of the organisation, too.

Table 4. Civil organisations deal with renewables in Hungary in 2009

Name of organisation	field	contact
Magyar Megújuló Energia Szövetség/MMESZ	renewables (in general)	www.mmesz.hu
Biomassza Termékpálya Szövetség/BITESZ	biomass	www.bitesz.hu
Magyar Biomassza Társaság	biomass	www.mbmt.hu
Magyar Biogáz Egyesület	biogas	www.biogas.hu
Magyar Pellet Szövetség	pellet	www.pannonpellet.hu
Magyar Bioetanol Szövetség	bioethanol	www.etanol.info.hu
Magyar Szélenergia Társaság	wind	www.mszet.hu
Magyar Geotermális Egyesület	geothermal	www.mgte.hu
Magyar Termálenergia Társaság	geothermal	www.termalenergia.hu
Magyar Napenergia Társaság	solar	http://fft.gau.hu

There are a few Hungarian organisations deals with environmental protection, sustainability, and so renewable energy sources like Energia Klub, KÖVET, Magyar Természetvédők Egyesülete, Klímabarát Települések Szövetsége, Független Ökológiai Központ, Levegő Munkacsoport, Védegylet etc. These organisations works all over the country and have a strong connection with local or regional associations. Local representatives of international organisations also can be found in Hungary (WWF, Greenpeace etc.)

In Hungary there are so called clusters, too. Members of clusters are civil organisations, enterprises, research and education institutions, and sometimes communities and private persons. While the civil organizations are active all over the country, clusters work usually in a region.

5.2. Scientific centres

A scientific center of a university/collage or an institution has really a range of tools to influience the status of renewables in a country. By leading research results these centers have a strong pulling effect on industry that needs planty of well-educated experts as well. A great amount of research into renewable energy resources is being undertaken at Hungarian universities and other institutions that summarised in *Table 5*.

Table 5. Research centers in Hungary deal with renewables

Name of the centre	Place	Fild/activity
Univesity of West Hungary Faculty of Agricultural and Food Sciences	Mosonmagyaróvár	biofuels, biomass
Univesity of West Hungary Faculty of Foresty and Wood Sciences	Sopron	biomass energy crops
Széchenyi István University Department of Environmental Engineering	Győr	wind and solar energy
Szent István University Faculty of Mechanical Engineering	Gödöllő	innovative biomass production
Szent István University Department of Physics and Process Management	Gödöllő	photovoltaic and solar thermal energy use
Ministry of Agricultural and Rural Developement Institute of Agricultural Engineering	Gödöllő	biomass combustion
University of Szeged Regional Knowledge Centre for Environmental and Nanotechnology	Szeged	biogas, hydrogen and bioethanol production efficiency and geothermal energy
University of Debrecen Centre for Agricultural Sciences	Debrecen	biomass, biogas, solar energy (photovoltaic).
University of Debrecen Department of Meteorology	Debrecen	wind
Institute for Physics and Matrials Sciences	Budapest	solar panel technology
University of Miskolc Department of Natural Gas Engineering	Miskolc	biogas

However, education is still quite conservative related to renewables. Even today it is usual in energetics education for the main emphasis to be on fossile fuels and nuclear energy.

Some of the above mentioned universities organise courses such as in Mosonmagyaróvár, at the University of West Hungary in cooperation with the Technical University of Vienna (MSc course Renewable Energy in Central and eastern Europe), in Sopron at the Németh László Academy in cooperation with Szent István University (Expert in Alternative Energy - postgraduate course), or at the University of Debrecen (Renewable Energy Expert - postgraduate course).

5.3. Public acceptance

At first glance, Europeans appear to be quite familiar with new energy technologies. Over half claim to have heard of nuclear fusion (58%) and hydrogen energy and cars (53%), and more than 2 in 5 respondents have heard of geothermal energy (44%), ocean energy (43%) and fuel cells (41%). However, every fifth EU citizen (19%) admits that he has not heard of any of these technologies. Countries where citizens have better knowledge than in the EU on average are as follows: Germany, France, Finland, Luxembourg and Sweden. Citizens of Spain, Italy, Latvia, Lithuania, Hungary and Cyprus are significantly less aware of these technologies. The share of those not having heard of any of these renewable energy possibilities reaching 40% in Cyprus.

In most countries, respondents mention guaranteeing low prices and a continuous supply of energy most frequently. Southern European countries – Greece (68%), Portugal (66%), Cyprus (63%) and Malta (63%) in particular – rank low energy prices as a priority for national energy policy. In five Northern European countries – Denmark, the Netherlands, Sweden, Finland and the United Kingdom – the share of mentions concerning prices is not in the two highest scores. The half of citizens in Estonia and Finland (52%) consider guaranteeing continuous energy supply as a national priority. This could be related to both countries being dependent on gas imports from Russia and to the recent incidence of disruption in gas supply from Russia through Ukraine to Europe. It is remarkable that Danish (58%), French (45%) and Swedish (43%) citizens consider protecting the environment as one of the two highest priorities of their national government in terms of energy policy. In these countries, respondents mention environmental issues more often than Europeans on average *(Source[19]).*

LITVINE AND WÜSTENHAGEN (2009) made a large-scale survey of residential green electricity customers in Switzerland. They concluded that customer demand for green electricity can be greatly enhanced if market appropriately communicate the environmental benefits and provide convenient opportunities for action. *ZORIC AND HROVATIN* (*2009*) got similar results in Slovenia.

The *EUROPEAN SOCIAL SURVEY* reported data of the personal and social well-being of European citizens. Environmental protection is more important than freedom or personal well-being for Hungarians. However, this is a theoretical result because in practise environmental protection is usually the least important, both from social and personal view *(Source[19]).*

FORSENSE LTD. made a representative survay in Hungary in August 2008. The subject was related with sustainable developement, environmental protection and way of living. 46% of the respondents have already heard something of sustainable developement. The ratio is higher among man (54%) and peopel junger than 35 years, while lower among women (34%). Anyhow, knowledge of sustainability and renewable energy utilization shows higher stronger correlation with the education level of respondents. People with MSc or Bsc degree presented 74%, technicians produced 48% and 35% of the least educated group hava had information of sustainability and renewables. People who are able to harmonise sustainability and their life style could mention some examples of their everyday activity. *Table 6* presents the results. It is remarkable that utilization of renewable enrgy sources can't be found among the answers. *Table 7* shows the answers ‚Why not...'.

Table 6. Ranking of some activities related to sustainability and environmental protection

Activity	place
Selective waste collection	1
Prefer energy sparing products	2
Recycle as much as possible	3
Don't us (or less) car	4
Produce compost in the garden	5
Select the cleaning chemicals	6
Select the wrapping matherial	7
Use less paper	8
Prefer long-lasting products	9
Have bio or reform food	10

(Source[20])

Table 7. Ranking of some reasons "Why not…"

Reasons for ‚Why not...'	place
No possibilities	1
Too expansive	2
No information how to do	3
One single person is too less	4
Don't want to change his/her lifestyle	5
Allready done	6
Don't care	7
No time	8
Not important	9

(Source[20])

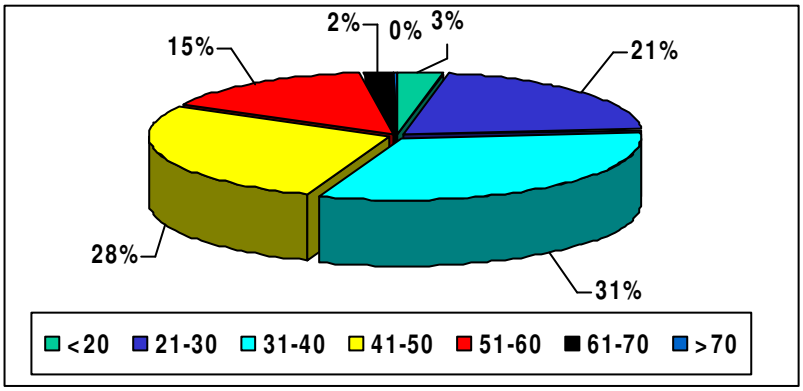
Because of the Russian-Ukrainian misunderstanding and the new action of Nabucco pipeline, energy security would have been an interesting issue again. Hence, *FORSENSE LTD.* asked 1000 people of energy security in July 2009. 90% of the respondents conceived of the unfortunate situation of Hungary in a gas crisis. Almost half of the respondents (45%) thought that the Hungarian government has no real tools for handling a kind of bad situation.

Another survey was made by *FORSENSE LTD.* in April 2009. The topic was: utilization of renewable energy sources in Hungary. More than 50% of the respondents answered that building new power plants is a crucial question for the future. 2/3 of the respondents would prefer wind and sun based power plants. Less than 50% mentioned the geothermal and the hydropower plants as a good tool for energy production. 20% would prefer a new nuclear power plant. This group consists of mainly elder people, or with low income or luck of higher education. However, 56 out of 100 respondents are for of renovation (and enlarge) the Hungarian nuclear power plant in Paks.

There are different opinions and knowledge of the effect of utilization of biofuels in traffic. *KOVÁCS ET AL.* (2006) made a representative survay that is referred by *NEMÉNYI ET AL.* (2008). The authors asked more than 400 people about their opinion. The question was as follows:

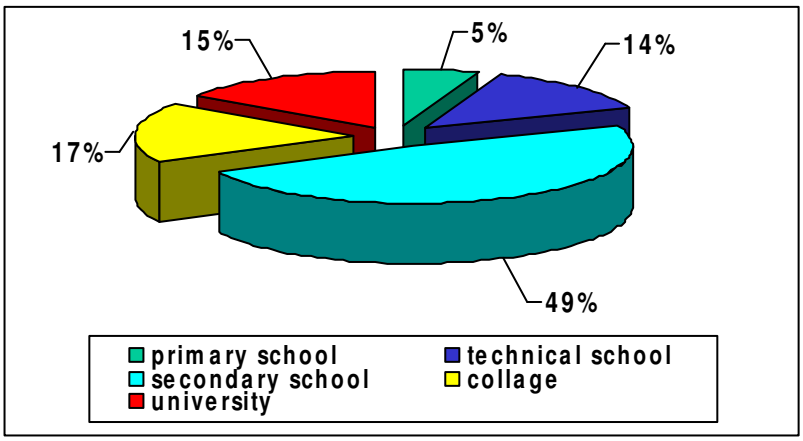
Would you use biodiesel – even if it would cost more than fossile diesel?

Share of the respondents by genderwas: 36% female and 64% male. People who gave answer by age and education can be seen on *Figure 20 and 21*. In total 54% of the respondents would not pay extra for biodiesel, 36% would not mind to pay 15% extra and 10% would pay even 30% extra on biodiesel compared to normal (fossile) diesel (*Figure 22*).



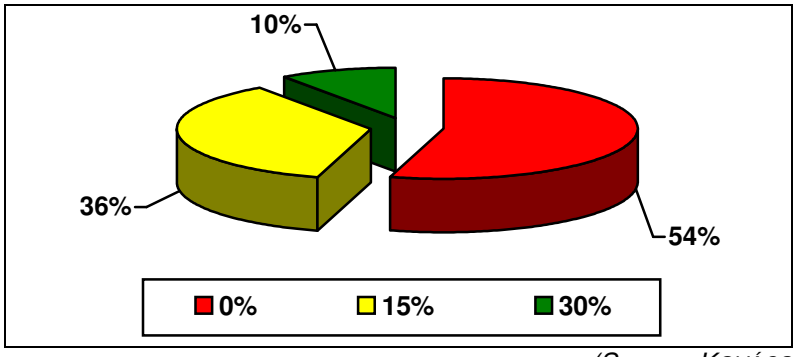
(Source: KOVÁCS ET AL,. 2006)

Figure 20. Age distribution of respondents



(Source: KOVÁCS ET AL,. 2006)

Figure 21. Education distribution of respondents



(Source: KOVÁCS ET AL,. 2006)

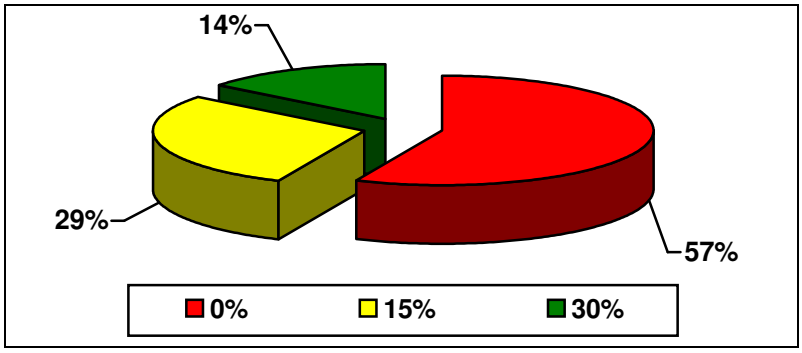
Figure 22. Distribution of total respondents (Would you pay more…)

Investigated the answers by educational level, the result was as follows:

- at college level 57% of the respondents would not pay more, however 29% would not mind to pay 15% and 14% would not mind to pay even 30% extra on biofuel (*Figure 23*),
- at university educational level only 36% of the respondents would not pay more, however 48% would not mind to pay 15% and 16% would not mind to pay even 30% extra on biofuel (*Figure 24*).

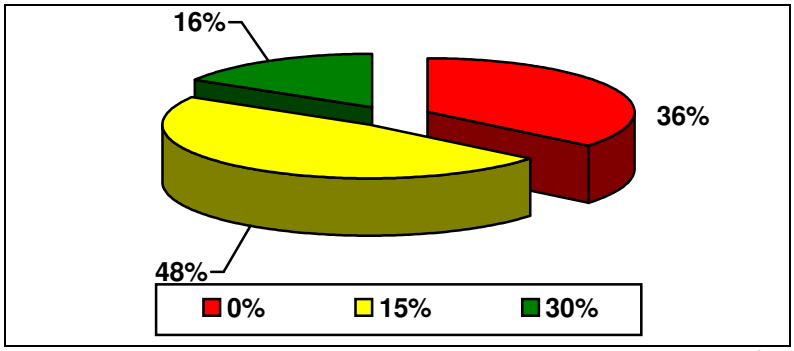
Furthermore, it is really remarkable that:

- 82,5% of the questioned people said the expenses for the biodiesel extra price should be paid by those who use regular diesel and oil,
- 90% of the questioned people think: it is important to highlight that the biodiesel was produced by Hungary.



(Source: KOVÁCS ET AL,. 2006)

Figure 23. Distribution of college educational level respondents



(Source: KOVÁCS ET AL,. 2006)

Figure 24. Distribution of university educational level respondents

Besides homepage of the above mentioned civil organisations (*Table 4*) there are magazins as well dealing with renewables. However, there was only one specialized magazin focusing on renewable energy sources called *BIOENERGIA* but because financial crisis there is no more new issu of this magazin. Some other magazins announce RES related articles, like *Környezetvédelem*, *Ma & Holnap Magazin*, *Magyar Ipari és KörnyezetvédelemImi Magazin* etc. *Mezőhír* is one of the most important agricultural magazin with a heading of RES (related mainly to agricultural). Newaspapers also announce articles of some interesting stories of utilization renewable energy sources.

There are regional, national and international exhibitions and expos. Some of the relevant events ar as follows: *RenEXPO, ÖKOTECH, ENERG EXPO*.

5.4. Conclusions

There are many factors that can influence people related to renewables and new technologies. Media seems to be one of the most important factors. Civil organizations, universities and research centers have a great effect, too. On the other hand, prices and its explanations (mainly thorough media) plays also a major rule. Nevertheless, security and diversification of energy supply is not a main issue for people, at least till service is available. Rest of the people think that the one who pays the higher expenses of renewable energy resources should be someone else, mainly the consumer of conventional products/services.

6. Future trends in utilization of RES in Hungary

The Hungarian renewable energy market is still in its starter stage beacuse the present ratio of RES is approximately 4-5% and ~55 PJ/year (*Source*[5]). It is difficult to prognosticate the future. Nevertheless, there are different scenarios untill 2030. A SWOT analysis can help to understand the present infancy and the scenarios or possible trends of the sector.

6.1. Scenarios

IPCC published its SRES (Special Report on Emission Scenarios) in *2000* according to the climate change. These scenarios are grouped into four scenario families (A1, A2, B1, and B2) that explore alternative development pathways, covering a wide range of demographic, economic, and technological driving forces and resulting GHG emissions.

According to the European and national legislation different scenarios were created in Hungary, too focusing mainly on the proportion of renewable energy resources utilisation, and of course regarding climate change and greenhouse gas emission.

Based on the calculation of the Ministry of Economy and Transport (*GKM, 2008*) there are two main possibilities:

- BAU – just a very few luck new installation of renewable energy resource utilization units,
- Policy – new and ambitious actions for increase the share of renewable energy resources.

According to the BAU calculation the 136 PJ renewable energy means 11% while based on the Policy calculation the 186 PJ will be equal with 14.9% of energy need of Hungary in 2020 (1248 PJ/annum).

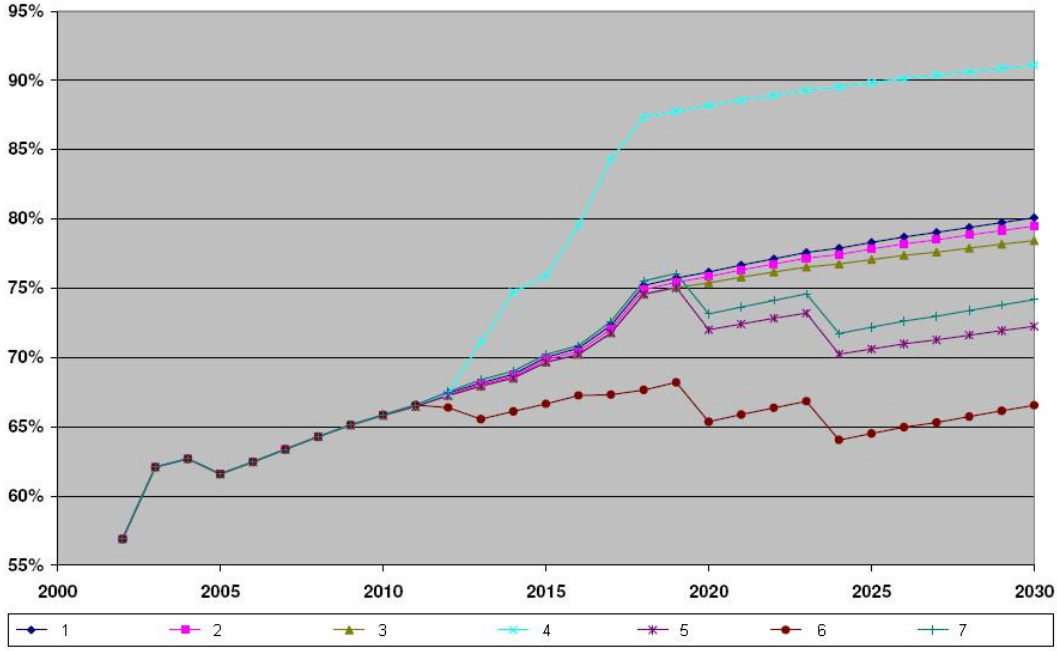
GÁCS ET AL,. (2006) published a comprehensive study of the new Hungarian energy policy for the 2005-2030 period. Some of the basic influential factors or hypothesis were as follows: the economy will increase by 3-5 % annually, importance of the third sector will increase, the importance of the export orientated production will increase and the input material and energy will decrease, energy consumption per GDP will decrease, employment rate will increase by 0.5-1% annually, natural gas consumption will increase and new electric energy producer capacity will enter into the market. Prices of oil, natural gas, coal and nuclear energy were also fixed: 56 USD/barrel, 250 USD/1000m^3, 800 HUF/GJ* and 200 HUF/GJ*, respectively (*1 EURO = 250 HUF). Because of the global economic crises, we can say that the rest

of the basic data have already changed and the trend is clearly negative. Hence, *Table 8* presents the 7 different scenarios in Hungary according to the above mentioned study of *GÁCS ET AL,. (2006*). Some of the scenarios are quite similar to the present situation and there are scenarios seems to be unlikely. *Figure 25* presents the dependency of import predicted by the different scenarios, *Figure 26* shows the CO_2 emission and *Figure 27* presents the share of import of total fossil energy consumption predicted by the different scenarios.

Table 8. Energy scenarios for the future in Hungary (till 2030)

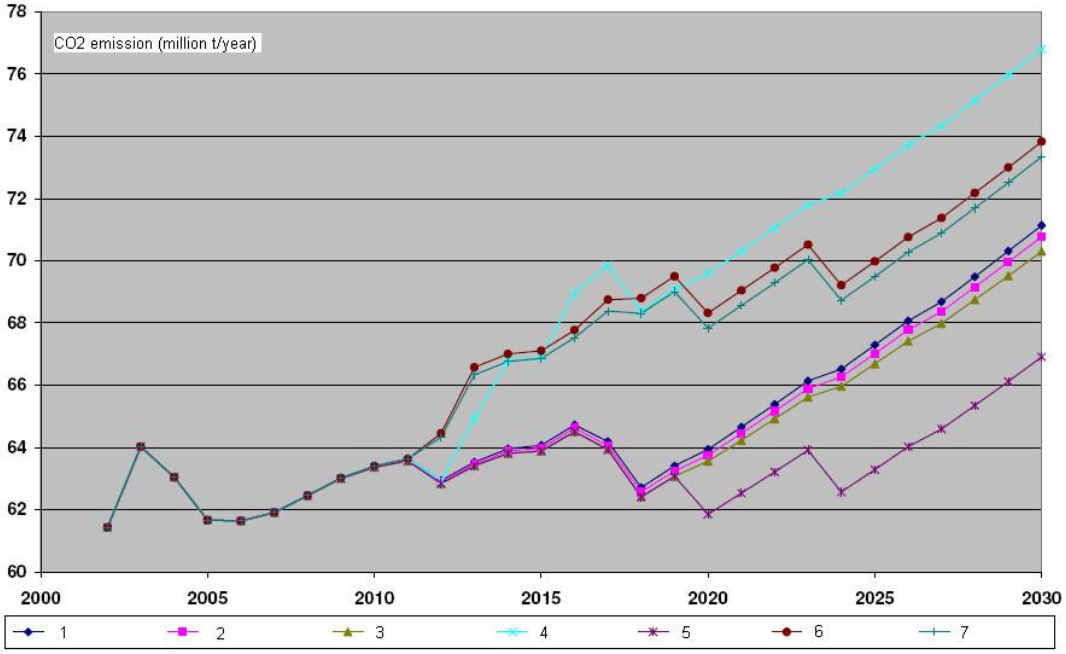
No.	Name of the scenario	Characteristics of the scenario
1	natural gas based variant	renewable energy: 500 MW (5 MW biomass, 10 MW wind energy annual increase), natural gas increase to 7200 MW performance
2	renewable 1	1000 MW (270 MW biomass, 730 MW wind), natural gas performance expectations: 7000 MW
3	renewable 2	1500 MW (505 MW biomass, 890 MW wind, 105 MW small hydro power), natural gas performance expectations: 6650 MW
4	without Paks nuclear power plant variant	very similar to natural gas based variant (1), the differences are: Paks nuclear power plant is in use until 2012-2016, following this date natural gas power plants are installed, the needed capacity is around 9800 MW.
5	low CO_2 emission variant	renewable energy: 1500 MW, new nuclear power plant: 1200 MW (+440 MW already installed), natural gas capacity: 5100 MW
6	lignite and nuclear power plant variant (the large power plant variation)	renewable resources: 500 MW, 4X500 MW lignite block (between 2012-2018), natural gas capacity: 3500 MW, new nuclear power plant: 1200 MW (+440 MW already installed)
7	coal and nuclear power plant variant	same as above mentioned, the difference is: instead of lignite import coal is used

(Source: GÁCS ET AL,. 2006)



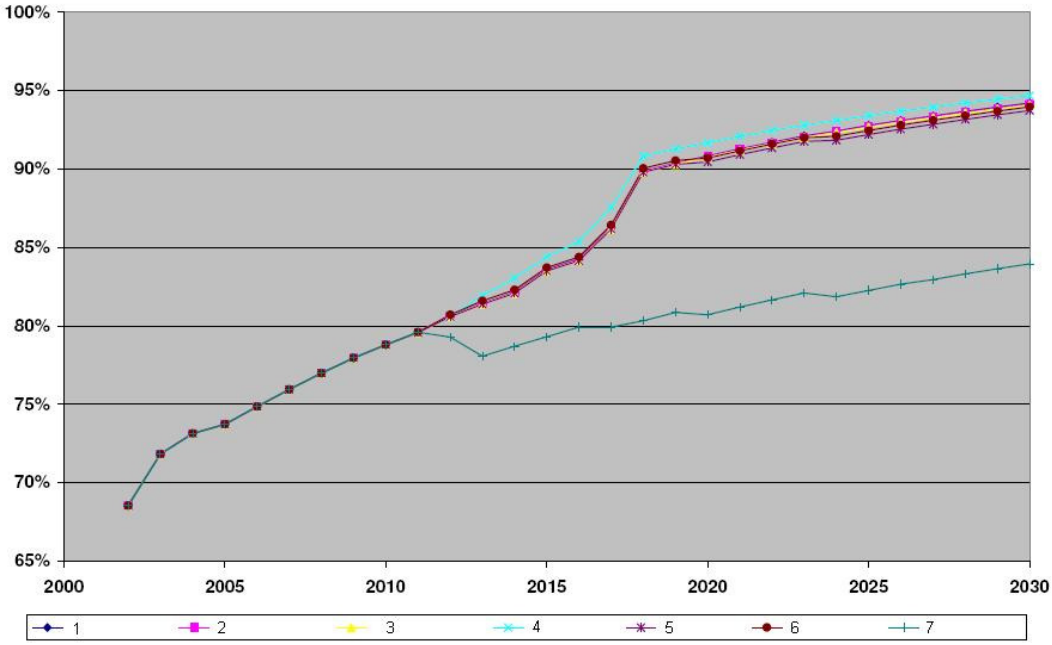
(Source: GÁCS ET AL,. 2006)

Figure 25. Dependency of import predicted by the different scenarios



(Source: GÁCS ET AL,. 2006)

Figure 26. CO_2 emission predicted by the different scenarios



(Source: GÁCS ET AL,. 2006)

Figure 27. Share of import of total fossil energy consumption predicted by the different scenarios

According to *Figure 25* the import dependency will be around 75% till the end of the period. However, Scenario No. 4 and 6 differ significantly from this data. Without Paks nuclear power plant we should use natural gas that results import dependency of 90% (Scenario 4). In case of lignite utilization and a new nuclear power plant (Scenario 6) the import dependency will probably decrease till 65%. Scenario 4 will result the highest CO_2 emission (*Figure 26*). The share of import of total fossil energy consumption predicted by the different scenarios will be around 95% but Scenario 7 will reduce this till 85%.

6.2. Market overview

By using a SWOT analyses it is easier to take into account the different influential factors. Moreover, calculations for officials, enterprices, banks etc. will be not only theoretical but more practical.

A lot of scinetists, authorities and other organisations made different analyses. *Table 9* shows the most up-to-date and comprehensive summary of the Hungarian renewable energy sector.

Strengths

According to the estimation of the Hungarian Academy of Science the theoretical renewable energy potential is approximately 2500 PJ/year in Hungary (MTA, 2006). The technically viable potential is much less than this, but Hungary is in a really advantageous situation for solar, wind, geothermal and biomass based energy production (Chapter 4).

Hungary is traditionally an agrarian country, which may partly explain the over-concentration on biomass. Farmers concerned about their traditional food markets would probably be happy to produce raw materials for biofuels for the electricity, heat and transport sector if they are given the right incentives. There is agricultural capacity and knowledge as well availbale to meet this need.

A great amount of research into renewables is being undertaken at Hungarian universitises.

There are courses deal with renevables at different universities (Chapter 5).

Table 9. SWOT analyses of the Hungarian renewable sector

Strengths	**Weaknesses**
1. outstanding renewable potential 2. tradition of agricultural production 3. well respected university research centres 4. postgraduate courses	1. unpredictable investment environment 2. quota system 3. inflexible Hungarian electricity system 4. little subsidy for research and development 5. conservative education 6. lack of experties 7. low consumer demand
Opportunities	**Threats**
1. European Innovation and Technology Institute 2. EU presidency	1. political risk 2. regulatory risk 3. climate change 4. sustainability **5.** economic crisis

(Source: ENERGIA KLUB, 2008)

Weaknesses

The Hungarian Energy Office (MEH) makes a decision practically in each individual case how long it guarantees the advantageaous feed-in tariff. Because of the feed-in tariff changes in legislation it is really difficult for an investor to calculate the income.

A special feature of the Hungarian system is that the Hungarian Energy Office (MEH) also uses a quota system for renewable based electricity production. This is unprecedented.

The rest of the electricity production in Hungary is based on traditional power plants built in the last century, from which output can only be slowly adjusted. However, some of the old-fashioned power plants use biomass (food) as fuel but the output regulation still makes difficulties. Natural gas based power plants are in planning stage and a pumped storage power plant is also planned. If the electricity system is not modernised, it will be a barrier to any significant increase in renewables.

National experties and research centers would be able to achive seruious results in many filds related to renewables only with adequate support. Without a national support system the European funds will not be able to generate a reasonable increase.

Even today it is still usual for the main emphasis to be on fossil fuels and nuclear energy in education. Renewables are usually dealt with in an erratic way in engineering and technology further education. This would be a main issue in the basic education, as well.

Based on the previous point, the Hungarian renewable energy sector will soon be facing the serious lack of experties. Not only higher education, but technical education also needs modernising.

Altough Hungarian citizens hear more and more about sustainable developement and renewable energy resources but public shows in general a low demand for green energy. Reasons are multi faced but probably the subsidised energy price of recent times prevent people from becoming energy-conscious consumers. So far, there is no opportunity to choose a green electricity service provider.

Opportunities

The EU's research and development center started its operation in 2009 in Budapest. The first programmes deals with renewable energy sources and climate change. Although the institute belongs to the EU it will surely have an impact on the Hungarian research and development policies.

In the first half of 2011 Hungary will hold the EU presidency. According to the statements of the Hungarian Ministry for Foreing Affairs the EU's energy and climate policies will be priorities during this period. The presidency might help put an emphasis on these issues in the Hungarian political context as well.

Threats

There is a lack of political commitment to renewable energy production in Hungary. The strong fossile and nuclear lobby makes it difficult for renewables to enlarge. Renewables mainly play supporting roles in the energy policy scenarios.

Regulations on renewables change so often and moody. Due to the many modifications they are often contradictory. Unfortunately, there is a lack of a comrehensive approach. A separate renewable energy law could give chance for the sector but this need a political unity.

The increase of warmer and drier periods and extreme weather patterns make more unpredictable the utilization of some renewable energy resources in the future. Hydroenergy applications and biomass utilization are fields those are more often influenced by the harmful climate processes.

Sustaining Hungary's characteristic towards biomass production for different reasons may raise the questions weather the necessary raw materials can be produced in a sustainable way, and weather excessive energy production will/would be in conflict with food and feed production.

The worldwide credit crunch and the subsequent recession have a significant effect on the market of renewables, too. The limited access to credit have a negative impact on investment from both business and the public.

6.3. Concluisons

Even if the different scenarios and scientific calculations the worldwide economic crisis modified the whole sector. It is really remarkable that most of the scenarios deal with large scale solutions. However, diversification should mean something else, too.

On the other hand, there is no doubt about the increase of renewable energy utilization in Hungary but the speed seems to be too low and the mix of renewables is dis-proportionate. However, taking into account the internal and external influential factors those are helpful or harmful to achieving a higher rate of renewable resource utilization there are numerous strengths and some of the weaknesses could be eliminated quite easy by simple methods. There are huge

reserves in private applications not only concerning green energy utilization but for ‘sponsoring’ the economy. The most important factors or ‘keywords’ are: education and information – research and technology.

7. Summary

The Hungarian governments have been preferring natural gas consumption since the mid-80s. Natural gas was thought to be cheap and comfortable fuel. The governmental price subventions reinforced this belief, too. However, for some years the ‘safety of gas supply’ became top priority issue because the so called ‘gas crisis‘. This prompted the Hungarian government to rethink its previous policy and raise domestic gas prices in order to cover at least the most necessary maintenance costs.

While the high natural gas dependency of Hungary, world is facing the economic viability of available traditional fossil energy sources, and a global climate change. Therefore, diversification and so energy supplies from renewable sources (such as solar, wind, hydro, biomass, geothermal, wave and tidal) will be slowly significant components of some nation’s energy strategy because security of supply, and so environmental and sustainability reasons. Concerning these subjects there are numerous European legal engagements and national targets as well. Hence, the ‘Energy and Climate Package’ approved by the European Union mentions as low as 13% by 2020 like Hungary’s target for renewable share in final energy consumption. However, potentials are even higher than the total energy need of the country. The structure of RES utilization is also one-sided and the yearly gain is quite low.

Based on the above mentioned facts, the aim of this work was to find out at least some of the reasons. Looking after the possible answers of this unfavourable situation I tried to collect and review authentic information of the most appropriate sources dealing with utilization of RES in different sectors. Concerning this I summarize the current legislative and market environment, then the present state of renewable energy use in Hungary compared with the potentials, and at last I cite a few scenarios and analysis of the public acceptance and social effects of using RES.

The share of renewables out of the primer energy production is nowadays somehow 50-60 PJ/year that is approximately 4-5%. 2/3 of the utilized renewable energies are used in heat generation while 1/3 is for electric energy production and 1.5% is utilized as biofuel. Hungary has huge potential for sustainable production of biomass drawing on its 5 million hectares of productive farmland and 3 million hectares of forest land. This situation could be interesting for the farmers and agricultural (forestry) companies. The biogas (and landfill gas) technology belongs to this field,

too that has a kind of natural protection effect. The present regulations are favouring the solid biomass combustion and so during the last few years there was a remarkable increase in biomass utilization. Biomass used for electricity generation is mostly wood co-fired in old-fashioned coal-fired power stations that have been adapted for this purpose. The wind energy sector is also really interesting in Hungary that developing rapidly. In 2009 the installed capacity reached 177 MW compared with 128 MW in 2008 (or 60 MW in 2006). The latest decision of the Hungarian Energy Office to open a new amount of quota for 410 MW creates a favourable situation for possible investors in this field. The geothermal sector also bears great possibility. There are numerous wells in Hungary producing warm/hot water but these sources are usually used for thermal reasons. The total potential is one of the highest rates within the Central and Eastern European region. While Hungary crossed by many rivers but it is a relatively flat country and thus quite low available hydro resources. Another reason of the low hydropower energy production is the conflict with Slovakia because of the Gabcikovo hydropower plant and it's so called 'C' variant. However, small scale hydropower plants are supported by the government and some small projects have entered into the market recently. The solar technology is mainly used in the private sector which is strongly depend on the subsidy policy.

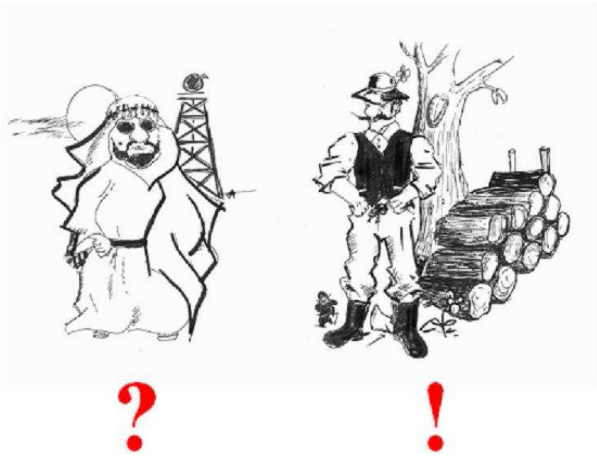
Due to the many modifications regulations on renewables in Hungary are often contradictory and unpredictable. Unfortunately, there is a lack of a comrehensive approach in this field nowadays. The unclear situation frightens off possible investors. In order to reach the compulsory target, a predictable and stable legal environment is necessary. A separate renewable energy law could give chance for the sector.

Most renewable energy technologies would not be able to compete with traditional production without subsidies. Hence, enterprises, budgetary organisations and institutions, non-profit organisations and households can apply for support for renewable energy investments. However, the budget is usually too small or the application process is extremely difficult. Because the small amount of different types of subsidies not only the large scale investment but also households and medium size applications are really rare, therefore decentralisation and so high energy supply security is unrealistic nowadays in Hungary.

While the worldwide economic crisis, different scenarios and scientific calculations were made. Most of the scenarios in Hungary deal with large scale solutions. However, diversification should mean something else, too (ie. decentralization). So,

security and diversification of energy supply (and so decentralization) is not a main issue for people, at least till service is available. Rest of the people think that the one who pay the higher expenses of renewable energy resources should be someone else. In this context media is one of the most important factor. Prices and its explanations (mainly thorough media) plays a major rule and so civil organizations, universities and research centers have a great effect, too.

All in all, there is no doubt about the increase of renewable energy utilization in Hungary but the speed seems to be too low and the mix of renewables is dis-proportionate. However, taking into account the internal and external influential factors those are helpful or harmful to achieving a higher rate of renewable resource utilization there are numerous strengths. Some of the weaknesses could be eliminated quite easy by simple methods. There are huge reserves in private applications not only concerning green energy utilization but for 'sponsoring' industry. However, without a harmonised and technology-specific RES policy it is just an utopia to think that the 13% target by 2020 will be reached. While based on the enormous RES potential of Hungary for creating a prosperous, sustainable and decentralised system, the most important factors or 'keywords' are: education and information – research and technology.



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[20] www.forsense.hu
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Current and referred legislation list

EU Directives

2001/77/EC – on electricity production from renewable energy sources
2002/91/EC – on the energy performance of buildings
2003/30/EC – on biofuels
2004/8/EC – on cogeneration
2008/0016 (COD) – on the promotion of the use of energy of renewable sources

National acts

Act XL of 2008 (and Act XLII of 2003) on natural gas supply
Act LXXXVI of 2007 on modified tariffs of feed-in obligation
Act XXVI of 2006 on security storage of natural gas
Act LIV of 2006 on forest and forest protection
Act LXXIX of 2005 on electricity
Act XVIII of 2005 on district heating service
Act XV of 2005 on trading of units of GHG emission
Act LXXXIX of 2003 on environmental burden fee
Act LXXXVIII of 2003 on energy tax
Act CX of 2001 on electric energy (VET)
Act CXVI of 1996 on nuclear energy
Act LVII of 1995 on water and ground water management
Act XLVIII of 1993 on mining

Resolutions and decrees

Resolution No. 33/2009 (VI.30.)	on the conditions of tender invitation for the establishment of wind power plant capacity
Resolution No. 40/2008 (IV.17.)	on the new energy policy for the period from 2008-2020

KHEM decree No. 44/2008 (XII.31.)	on the tariff calculation method and on the package of goods to be rendered by the universal supplier
KHEM decree No. 6/2008 (VI.18.)	on some data services related to the control, operation and use of electric energy system
KHEM decree No. 2/2008. (V.30.)	on the amendment of the GKM decree 96/2003 (XII.18) on the determination of natural gas public utility charges and the GKM decree 70/2003 (X.28) on the determination of charges for system use of natural gas

GKM decree No. 78/2005 (X.7)	on rules of pricing and obligatory taking over of RES-E (amending decree No 56/2002 (XII. 29)

A detailed list can be seen in Appendix.

APPENDIX

The most important legal rules affecting the scope of activities of the Hungarian Energy Office (MEH)

Governmental decrees

Govermental decree No 238/2008.(IX.29.)	on the Amendment of the Govermental decree 289/2007. (X.31.) on the state subsidy of residential piped gas and district heat consumption
Governmental decree No 60/2008(III.26.)	on the Amendment on obligatory off-take and purchase price of electricity generated from waste or from renewable energy sources, or by CHPG
Governmental decree No 389/2007. (XII. 23.)	on obligatory off-take and purchase price of electricity generated from waste or from renewable energy sources, or by CHPG
Governmental decree No 382/2007. (XII. 23.)	on authority licensing procedures for construction of electricity facilities
Governmental decree No 289/2007. (X. 31.)	on the state subsidy of residential piped gas and district heat consumption
Governmental decree No 285/2007. (X. 29.)	on measures to be taken in case of serious failure in the electricity system and in case of emergency in the electricity supply
Governmental decree No 273/2007. (X. 19.)	on the implementation of some provisions in the Act No LXXXVI (2007) on electricity
Governmental decree No 49/2006.(III.10.)	on the amendment act of the Natural Gas Supply of the Governmental decree No.112/2003. (29.07) on eligible consumers
Governmental decree No 269/2003 (XII.24.)	on the Amendment of Certain Governmental Decrees Determining Competences in Nature and Environmental Protection and Water Management
Governmental decree No 187/2003. (XI. 5.)	on Cross-border Transportation of Natural Gas
Governmental decree No 118/2003. (VIII. 8.)	on Determination of Regulations relating the Specific Value and its Calculations of Mineral Raw Materials and Geothermic Energy
Governmental decree No 113/2003. (VII. 29.)	on Management and Appropriation of Energy Management Allowances
Governmental decree No 110/2003. (VII. 24.)	on Organisation, Tasks and Scope of the Hungarian Technical Security Office
Governmental decree No 189/1998. (XI. 23.)	on Central Heating and Supply of Hot Water

Decrees of the Minister of Economy and Transportation (GKM)

GKM decree No 119/2007. (XII. 29.)	on the electricity network charges
GKM decree No 117/2007. (XII. 29.)	on the financial and technical terms and conditions of connection to the public utility electricity network
GKM decree No 116/2007. (XII. 29.)	on the discount in purchase of electricity by persons employed in the electricity sector
GKM decree No 110/2007. (XII. 23.)	on the calculation method f the electricity and consumable heat amounts in high efficiency CHPG
GKM decree No 109/2007. (XII. 23.)	on distribution of electricity under off-take obligation by the TSO and on calculation of such distribution fees
GKM decree No 82/2007. (IX.22.)	on the Amendment of the GKM Decree 96/2003 (XII.18) on the Determination of Natural Gas Public Utility Charges

GKM decree No 56/2007. (VI.1.)	on the Amendment of Certain Ministerial Decrees regarding Official Gas Prices
GKM decree No 27/2007. (III.2.)	on the Amendment of Certain Ministerial Decrees regarding Official Gas Prices
GKM decree No 74/2006. (X.31.)	on the Connection Fees to be Taken for Development of Connecting Natural Gas Network
GKM decree No 44/2006. (VI.30.)	on the Amendment of Certain Ministerial Decrees regarding Official Energy Prices
GKM decree No 107/2005. (XII.19.)	on the Amendment of the GKM Decree 70/2003 (X.28) on the Determination of Charges for System Use of Natural Gas
GKM decree No 105/2005. (XII.19.)	on the Framework of the price regulation of natural gas
GKM decree No 77/2005. (I.10.)	on the amendment of ministerial decrees governing administrative charges of natural gas
GKM decree No 5/2005. (I.21.)	Decree of the Ministry of Economy and Transport no. 5/2005 GKM on the medium-term regulation of the officially regulated price of electricity distribution and feed-in, system operation and ancillary services.
GKM decree No 46/2004. (IV.16.)	on the Circle of Data Subject to Supply Obligation in the Procedure of Price Supervision with Regard to the Administrative Prices of Natural Gas
GKM decree No 11/2004. (II.13.)	on the Technical and Security Specifications of Gas Connection Pipelines and Customer Equipment
GKM decree No 96/2003. (XII.18.)	on Determination of Public Utility Fees of Natural Gas
GKM decree No 86/2003. (XII. 16.)	on the Data Service Order of Certain Enterprises in Natural Gas Industry
GKM decree No 81/2003. (XII.10.)	on customers having priority in accessing natural gas storage, transmission and distribution pipelines
GKM decree No 70/2003. (X.28.)	on the Determination of System-Use Fees of Natural Gas
GKM decree No 55/2003. (IX.4.)	on Energy Efficiency Requirements regarding Neon Tube Caps
GKM decree No 51/2003. (VIII.14.)	on Acknowledged Costs regarding the In-payments into the Energy Management Allowances
GKM decree No 10/2003. (III.4.)	on Determination of the Authority licensing Rights for Preparatory Works and Property Rights
GKM decree No 44/2002. (XII.28.)	on the Lowest Volume of Energy Reserves and the Order of Storage of Energy Carriers of Power Plants with 50 MW Power and Above

Source: http://www.khem.gov.hu/en