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Liquid Biofuels Sustainable Development Analysis

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Abstract

The ecological footprint of Hungary is close to the European average and we expect further growth. The projects of the Széchenyi 2020 program and the Hungarian Multinational Oil and Gas Company (MOL) promote the development of the green economy provide significant subsidies. The depletion of petroleum-derived fuel and environmental concern has promoted to look over the biofuel as an alternative fuel source. However, the production of biofuels is an expensive process. The rapid spread of biofuels created an agricultural expansion, contributing to rising water demands; however, that was already a serious international problem. The competition for agricultural areas has an impact of price increment because the excessive rate of energy crops can replace not only the same kinds of food crops but other (for example fodder) varieties. In our evaluation, the third generation of biofuels seems the ultimate solution for us in the following 25-30 years' period.

Keywords: biofuel, environment, sustainable development

Introduction

Global climate change is possibly the most prevalent issue that reaches frequently even the average citizen through the media and the involved foundations. A few

emphasized areas are the relationship between emission and global warming, how biofuels deplete the ozone layer less than fossil fuels and what interrelations are between biofuels and the evolving unbalanced ecosystems. There is an enormous pollution caused by the use of fuels. On the other hand, there are sulfur and nitrogen oxides leaking into the atmosphere, which are directly responsible for the increase of the number of respiratory illnesses, acid rain, soil and freshwater acidification, and metropolitan smog (Popp et al., 2016).

It is a common practice everywhere to use the "well-to-wheel" approach. This means that carbon dioxide emissions are monitored in the total life cycle, thus we are able to measure the actual effectiveness (Chudy-Laskowska, 2020). The first-generation biofuels emit 35-50% less greenhouse gas than conventional fuels in the total life cycle (www.olade.org). According to the EC yearly report of 2017, in the case of the widespread of second-generation biofuels, a 90% GHG saving is possible. In most developed economies, increasing fuel consumption is largely responsible for greenhouse gas emissions, consequently, for the greenhouse effect (Késmárki-Gally, 2008; Karácsony, 2013). The greenhouse effect is a naturally occurring process that aids in heating the Earth's surface and atmosphere. It results from the fact that certain atmospheric gases, such as carbon dioxide, water vapor, and methane, are able to change the energy balance of the planet by absorbing long-wave radiation emitted from the Earth's surface. (Farndon, 2018)

Eurostat estimates that in the European Union 28% of CO_2 emissions are related to the transport sector, of which 84% is for road transport. In the 1990-1998 period, the carbon dioxide emissions grew by 18% in the EU, while between 1990 and 2020 this rate was already 40%. Under the Kyoto Protocol, Hungary undertook a reduction of 6% in greenhouse gases compared to the average of the 1985-1987 period. That time, the Hungarian emission was 111 million tons of carbon dioxide equivalent, while in 2020 this figure was only 97.2 million tons carbon equivalent. Biofuels are still not the cheapest way to reduce the amount of greenhouse gases; however, in the medium-term they seem to be the only option that is possible to make a significant reduction of GHG emissions in the transport sector (Sipos et al.,

2007). As comparison between CO_2 emissions of gasoline and bioethanol, gasoline produces about 2.44 CO_2 kg/l, while ethanol releases 1.94 kg/l, which means it reduces CO_2 emissions by 21%. In case of ethanol, the carbon dioxide and other greenhouse gases' reduction is also influenced by several factors: for instance the production effectiveness of the technology, the environmentally friendly production process, utilization of by-products, the energy supply of the refinery, and one of the most important: the quantity and source of energy consumed during production (Magda, 2014).

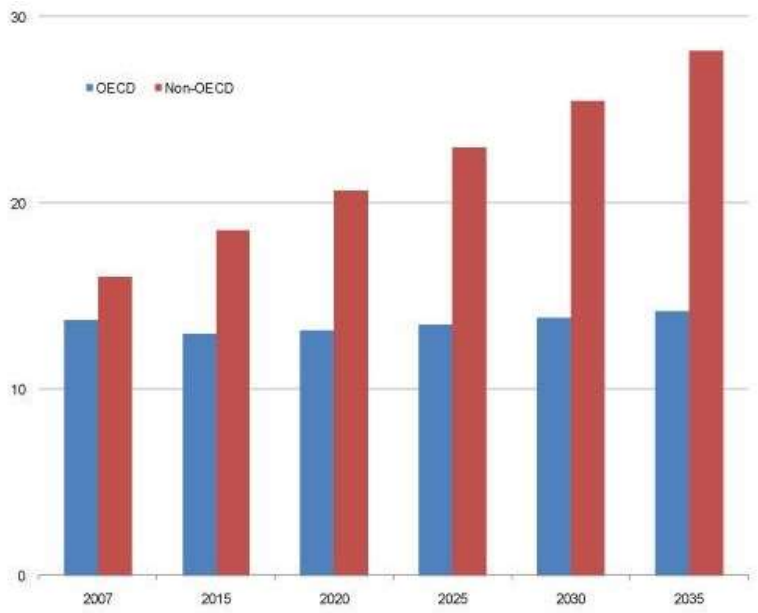

Figure 1. World energy-related CO_2 emissions, 2007-2035
Source: EIA, 2020

Most of the greenhouse gases are produced by burning coal; it generates 80% more CO_2 than the utilization of gas and 20% more CO_2 than utilization of oil - for producing the same amount of energy. The first indicator of CO_2 emissions growth can be placed in time at the beginning of the industrial revolution. Measurements show (for example, an examination of the Antarctic ice), that in the past 160,000 years the concentration of atmospheric CO_2 was nearly constant, then in the early 1800s it began to increase rapidly. Today, the initial value is 25% higher (www.ipcc.ch) Currently, the developed countries are responsible for 50% of CO_2

emissions, while half of the emission is caused by the United States solely. Unfortunately, in developing countries, mainly China and India, the industrialization will result in an extreme increase in CO_2 emissions in the future, and they even might take over the leading role from the USA by 2020.

Beyond these issues, we also have to mention other, less well-known but the same important factors of environmental effects. The rapid spread of biofuels created an agricultural expansion, contributing to rising water demands; however, that was already a serious international problem.

Researchers estimate that the demand for water will be 40% higher than the supply in many regions within 20 years. (www.mckinsey.com) This means that worldwide about one of three people will receive half the amount of water than it would be sufficient for their basic needs. The lack of water can cause a decrease in sanitation, epidemic threat, decreasing life expectancy, the decline in general health.

Literature Review

Sustainable development has become one of today's key issues. According to the UN Sustainable Development Framework, there must be four dimensions differentiated, these are environmental, economic, social, and institutional. The environmental aspect concerns the condition of water, land, atmosphere, other natural resources, and waste. The economical one investigates micro and macro economical interrelations and international affairs. The social dimension consists of demographic, health, education etc. indicatives. The last, institutional part includes the organs and their information flow, regulations, and legal background.

Biofuel, any fuel that is derived from biomass—that is, plant or algae material or animal waste. Since such feedstock material can be replenished readily, biofuel is considered to be a source of renewable energy, unlike fossil fuels such as petroleum, coal, and natural gas (Selin, 2018).

The depletion of petroleum-derived fuel and environmental concern has promoted to look over the biofuel as an alternative fuel source (Popp et al., 2018). But a

complete substitution of petroleum-derived fuels by biofuel is impossible from the production capacity and engine compatibility point of view. (Hassan, 2013).

Biofuels also supply environmental benefits but, depending on how they are manufactured, can also have serious environmental drawbacks (Lehmann, 2018). The crop types, agricultural practices, land and labor costs, plant sizes, processing technologies and government policies in different regions considerably vary ethanol production costs and prices by region (Demirbas, 2011).

However, the process of conversion, or chemical transformation, could be very expensive. and not worth-while to use for an economical large-scale commercial supply of biofuels. Hence, there is still a need for much research to be done for an effective, economical and efficient conversion process (Nigam-Singh, 2011).

In energy generating the alternative energy sources made up 7.2% of the Hungarian electricity production (IEA 2020). Consumers of the alternative energy sources prioritized biomass, geothermal- and solar energy (Table 1.). Hungary`s gross energy consumption in 2017 was 3000 ktons, consisting of 80% biomass usage (Hernandez et al. 2017).

	Consumption			Domestic facilities	Availability	Investment	Payback time	Barriers to use
	Electricity	Heat production	Fuel					
Biomass / Biogas	X	X	X	Favourable agricultural conditions, few energy forest	It depends on agricultural production and is therefore seasonal	Processing plant, operating units	Very soon	It can be detrimental to food production

Wind energy	X			Northwest Hungary is favourable,	Weather dependent	Construction & Network Integration, Land Use	7-8 years	Integration into a centralized electricity grid is problematic
Geothermic energy	X	X		Excellent conditions, especially in the Danube-Tisza Intermediary	Anytime	Installation, relatively high cost	Electricity: 5-8 years, heat generation: 2 years	Relatively high capital requirements
Solar energy	X	X		Favourable conditions: number of sunny hours per year: 1900-2300 hours / year	Weather dependent	Installation, relatively high cost	Photovoltaic application: 12-17 years, solar thermal energy: 6 years	Costly installation, long-term return on investment
Hydropower	X			Adverse hydrographic situation	Area and hydrographic dependent	Power plant construction, network integration (very high capital	8-15 years	Nature conservation problems, unfavourable conditions

						requirements)		

Table 1. Comparing renewable energy sources, self made.
Source: energiaklub.hu, 2019

Another challenging aspect of biofuel production is how it is changing the structure of food production and how it leads to a changing structure and volume of agricultural and food trade in different regions (Vásáry et al, 2013)

Methodology

In our research we conducted primary and secondary analysis, using regional science research methodology tools. In the frame of cluster analysis, we asked different questions about the energy structure of the country for each age group. There are great differences between age groups because younger generations see bioenergy sources of the future, meanwhile, middle-aged people are considering liquid biofuels power and older people traditional hydrocarbon-based technology to be a reliable source of energy.

The Q method can be useful for exploring individual opinions and differences of opinion, as well as for describing different opinion groups (Coogan, J., Herrington, N., 2011.). The advantage of a focus group is that we get to know each other's opinions independently, so we do not have to worry that the opinions of lower-level executives in the organizational hierarchy are not as pronounced when they are different from those of higher-level executives. The Q method uses correlations and so-called inverse factor analysis. In this method, factor formation is not done through statements, as is customary in social statistical procedures, but through individual Q-orders (filled-in Q-tables for each respondent) to create groups of individuals. Thus, I also determine the correlations between persons' Q-orderings in pairs. A factor, that is to say, an opinion group that will be based on that person who filled out the above table in a similar way and can, therefore, be considered as an opinion group.

Findings and Discussion

Studies on international agricultural markets estimated that new cultivable land will be required to satisfy future demand for food and feed. Increased productivity is expected on current arable land as well – the so-called "intensification" – due to the fast growth of the food and feed demand. Biofuels produced from crops will add extra demand for crops like wheat, sunflower, corn, and rapeseed. This will increase prices for these products (as well as for land) and lead to two impacts: intensification of agricultural production and conversion of forests and grasslands to arable land.

This process is called land use change/ indirect land use change, as the official description says "Indirect land use change (ILUC) occurs when land formerly used for a food crop is turned over to the production of biofuels. As a result, cultivation of the displaced food crop is often transferred to a location where land prices and the costs associated with agriculture are lower – this can be on grasslands and forested land. This is of concern because the deforestation and cultivation of virgin or semi-virgin land releases high levels of carbon previously held in soil and plants into the atmosphere. Subsequent use of nitrogen fertilizers on poorer soils would also lead to emissions of N2O from the soil." (ec.europa.eu)

In the EU, the growing demand for ethanol production is satisfied by involving abandoned lands in the plantation of inputs. The European Commission also deals with this issue. In order to reduce greenhouse gas emissions, the exclusion of biofuels cannot be an option because currently there is a target for biofuel production, that must be fulfilled by EU member countries. We can neither expect that nothing happens in the case of indirect land-use, because it would be hardly acceptable politically.

The utilization of tillable agrarian fields for biomass and conversion of forests into other agricultural lands have multiple negative influences, just to mention a few: global increase in food prices, creating unbalance in ecosystems, etc.

Table 2 and 3. demonstrate the different types of land use and the land use matrix.

Table 2. Types of land-use

Category	Comment
Forest	Follows the definition used by FRA 2005 (FAO 2006a). Includes all types of forests, but not tree formations under non-forest land use, such as agroforestry systems, urban parks, etc. Data can be drawn directly from FRA 2005.
Woodland/Grassland	Woodland and grasslands refer to land that have a vegetation cover other than forests, but that are generally not under intensive land use. The most common land use in this category would be different forms of pasture. FAOSTAT was used to obtain statistics for this category, under the assumption that the FAOSTAT category "Permanent pasture" is equivalent.
Agricultural crops	Refers to all areas where temporary or permanent agricultural crops are grown. FAOSTAT was used to obtain statistics, using the category "Arable and permanent crops".
Urban area	Should generally refer to all types of built-up areas including infrastructure. However, the data source (Láng, 2008) refers only to cities as such, and focuses on cities with more than 100,000 inhabitants.
Other land / water	Includes everything not covered by the above categories, e.g. deserts, polar areas, unvegetated and uninhabited land, wetlands that do not fall under above categories and inland water. No authoritative global data source for area trends was found for the components of this category.

Source: Designed by authors' own compilation

Table 3. Land-use change matrix

FROM/TO	Forest	Woodland	Agricultural crops	Urban area	Other
Forest	X				
Woodland		x			
Agricultural crops			x		
Urban area				x	
Other					x

Source: Designed by authors

Economical dimension of sustainable development

The production of biofuels is an expensive process. Calculations stipulate that in case of biodiesel an $80 / barrel and in case of bioethanol a $100-120 / barrel is a sustainable price level. The long-term oil price expectations remain below the sevalues. By comparison, the bioethanol produced by sugar cane in Brazil is sustainable even on the $45-50 / barrel price level. The technology of first-generation biofuel production – whether biodiesel or bioethanol –is a developed, mature technology, which means that there is no longer expected a significant cost reduction.

The competition for agricultural areas has an impact of price increment because the excessive rate of energy crops can replace not only the same kinds of food crops but other (for example fodder) varieties. The direct effect of this phenomenon is a significant price increase in the food industry.

The OECD-FAO Agricultural Outlook 2007-2018 emphasized the sensitive biofuel issue in connection with the food industry as well. The energy crop cultivation is responsible for the demand increment of grain and oilseed prices. The consequence is the price increase, which is proven with the most basic possible theorem of economics: the Marshallian Cross. The food prices are forecasted to

grow with 20-50% by 2018. Another misconception of common thinking is that people believe that the biofuel industry has a huge labour need that creates jobs and might have a serious impact on the country. We do not have Hungarian estimations, but it is likely that the large, mechanized agricultural production of single crops does not have large number of live-work requirements. The few largest biofuel refineries with sometimes foreign (Norwegian, American, etc.) investors create work possibility for only a few thousand citizens and it is common that they are not searching for top engineers and scientists, but cleaners and back-office workers, who they will not provide continuous training. In Hungary, the excise tax exemption for bio component does not exist since July 2017; it was replaced by a 4.4% rate of blending obligation. Anyone who fails to comply with this obligation must pay a higher excise tax of 8 € /litre. In addition, the Environment and Energy Operational Program supports the establishment of ethanol plants with 2.7 billion HUF, while the establishment of biodiesel plants is not supported.

Business environment in Hungary

The support functions of the state were already discussed when the regulations and the incentive taxation system were defined. As it became clear previously, the extent of state involvement cannot be extended above the mentioned factors in the issue of renewables, thus this section is intended to focus on the private investment environment.

The question is whether this environment is attractive enough to gather private investors into renewable energy business, so this industry could be able to grow besides the low level of state engagement.

In order to tell, if the Hungarian environment is optimal for investment in renewable energy, the key elements of the country's competitiveness must be investigated.

An ideal starting point for the analysis of the environment for investment might be the different indices of competitiveness. The World Competitiveness Yearbook compiles its yearly edition on the basis of 329 different indicative measures of the participating countries.

The measures examine all the sectors; thus, the final score reveals the complex status of the subject country; economic and political indicators, but the environment and the everyday life contribute to the final order creation of the competition. The World Competitiveness Yearbook 2020 found Singapore, Hong Kong, and the USA the three most competitive countries, while the rank of Hungary was 42 (in 2019 we were the 45th), just behind Italy and Peru.

Obviously, this ranking is not enough to describe the Hungarian business environment, but still, it gives a basic picture regarding the opinion of experts about Hungary. For example, if my company wanted to acquire market share, I would definitely check this compilation just to have basic approach towards the country.

The also acknowledged World Economic Forum (WEF) published their yearly competitiveness report called The Global Competitiveness Report 2017-2018. They also claim to base their opinion about several sources.

Based on the study, the five most inhibiting factors of the business and investment environment in Hungary are the following:

1. Tax rates
2. Tax regulations
3. Access to financing
4. Corruption
5. Political instability

Three factors were chosen, which are directly related to the liquid biofuel production in Hungary. To understand the business potential of private investments in renewable energy sector, we need to go through the connected factors one by one.

Tax rates and tax regulations

It may sound banal hearing again, but the Hungarian regulations of taxation are too complicated, the rates are too high, and due to the false regulations, the tax burden if distributed unevenly in the different levels of society. This cloudy tax system and the high tax rates have a direct impact on the competitiveness of a country, and seriously deteriorate the investment environment – according to the survey created by the European Commission, called "Taxation trends in the European Union". The document stipulated that in comparison to the EU, the tax rates regarding work and consumption are very high, while the tax rates regarding property and wealth are low. The Commission's survey shows that Hungary is characterized by high indirect taxes (VAT, excise duties and consumption taxes) compared to the GDP, and social security rates are high as well. However, direct tax rates (personal and corporate) are relatively low compared to the GDP.

Access to financing

"Access to finance is an essential driver for economic growth in developing and transition economies. It is also important in developed economies, where it stimulates markedly the social inclusion of certain groups of the population. Access to finance empowers people, gives them the opportunity to have an account, to save and invest, to insure their homes or to take a loan and – in many cases – to break the chains of poverty." (UNEP, 2020)

As regards the difficulty of access to financial resources, it is not typical only in Hungary; the scarcity in resources is spread worldwide due to the recession. Above this fact, we have to mention the vulnerability of the national currency, and the high market interest rate. As Figure 2 clearly demonstrates, the Hungarian currency HUF seems very vulnerable. This is obviously not optimal regarding the business environment, as the hectic and unpredictable exchange rates influence the purchase of households and business market actors negatively.

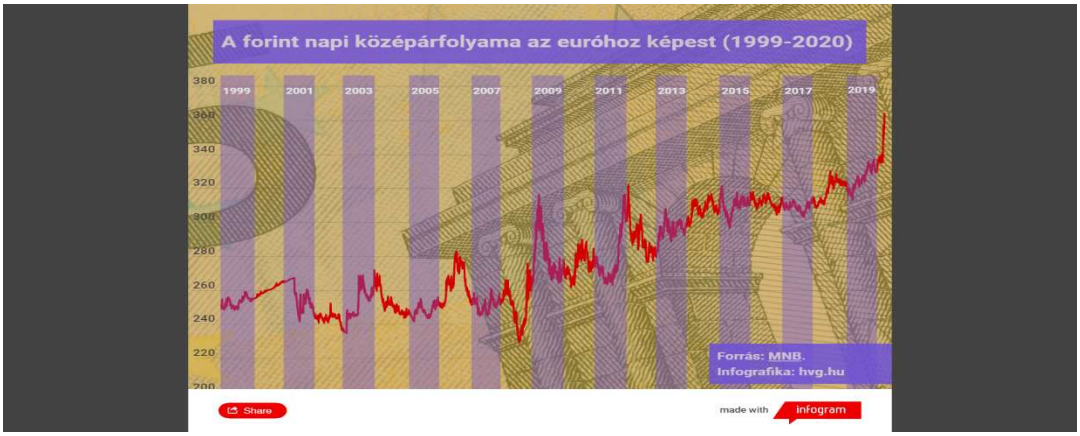

Figure 2. The HUF/EUR exchange rate between 1999 and 2020

Source: MNB http://www.exchange-rates.org/

Corruption

We have to admit that corruption does not belong closely to the economic dimension; therefore this factor will not be discussed in detail. However, it is also a very serious problem and does contribute to the weak competitiveness and investment environment of Hungary.

Political instability

Finally, nor the previous factor, neither political instability is measurable; but still, it really can pull back the number of investments, as if the financial / regulation / legal background is variable, carrying out a business plan is hardly possible.

Social dimension of sustainable development

Social sustainability concerns the quality of life, which includes health indicators, living standards, social cohesion, and integration. These factors depend highly on the environmental and economic dimensions; thus, the social dimension will be demonstrated on the basis of the previous two sections.

Biofuels represent in developed countries a solution for two problems: climate and oil. By time we had to realize that first generation biofuels are not solution to either, it even contributes to a third global problem: the current food crisis. Meanwhile the danger is that they allow rich-country governments to avoid difficult but urgent decisions about how to reduce consumption of oil, while offering new avenues to continue expensive support to agriculture at the cost of taxpayers. In the meantime, the most serious costs of these policies – deepening poverty and hunger, environmental degradation, and accelerating climate change – are being 'dumped' on developing countries.

For poor countries that tend to have comparative advantages in the production of feedstock, biofuels may offer some genuine development opportunities, but the potential economic, social, and environmental costs are severe. Oxfam report says that about 5.6 million square kilometres of land will be used for biofuel production, which means that approximately 60 million people are going to face the fact, that instead of food, fuel "grows" on their land.

On the Hungarian market neither food scarcity, nor water scarcity is a threatening option, because of the large resources of both raw materials and water supplies.

Conclusion

The primary aim with this research was to demonstrate and analyze the Hungarian possibilities regarding liquid biofuels. Now that we have looked through the concerning issues, we are ready to declare, that the World – including Hungary – is trying to stick with them, as a solution for the global problems – decreasing fossil stocks, growing energy consumption and high energy dependency - described in the Problem definition chapter. By now, it is clear that there are many opinions for and against biofuels; after we learned the environmental, economic and social dimensions of its production and utilization, this is quite understandable.

As it was stated by Hill in 2016, biofuels "to be a viable alternative, a biofuel should provide a net energy gain, have environmental benefits, be economically competitive, and be producible in large quantities without reducing food supplies".

Obviously, these are very high standards, but in our opinion we cannot lower our expectations, as we are not searching for a short or medium term solution, but for quite the long term. According to these conditions we are going to evaluate the generations of biofuels.

Except the net energy gain, first generation biofuels do not comply any of these conditions. As recent studies showed, first generation biofuels do not have environmental benefit on the life cycle compared to fossil fuel neither. As for the economic competitiveness, South American countries already produce first generation biofuels with developed, mature procedures, thus profitability is possible. However, in terms of world scale the production of first-generation biofuels is not profitable. For the question, if it reduces food supplies, the answer is trivial; the raw material of first generation is all edible products, so yes, the production does require and does reduce food supplies.

The second generation of biofuels is a much more developed and environmentally friendly solution. The first question is, if it has a positive net energy balance; the answer is yes: the energy outcome is higher than the energy input, thus the net energy ratio is positive. The question of environmental benefits is much more complex. As we learned from the study, the raw material of this type of fuel is biomass, what stands of biodegradable residue products from agriculture, forestry, and waste. Unfortunately, the utilization of these resources is not optimal, as the balance tilts to forestry products, and CO_2 emissions created by deforestation is very high. If the shares of resources could change so that biodegradable residues, by-products, and waste could be the main source, second generation could be environmentally sustainable. The production of second-generation biofuels should be much more efficient and developed; with technological developments, this generation of biofuels can become profitable. Additionally, the food supplies are not involved in the process, they are not used as raw materials, and thus the

production is not reducing the global food supplies. In our opinion, development of second-generation biofuels could be a step forward, which we must take in order to avoid the presently known negative effects of first generation biofuels. It is not negligible, that the rightful bad judgment of biofuels is created by the previous generation, but has a negative effect on this generation as well, as an average person cannot distinguish properly – the moral is against this, what makes international regulations harder to make.

Finally, the third generation of biofuels seems the ultimate solution for us in the following 25-30 years' period. The fuel production by the raw material of algae is highly net energy positive, does not pollute the environment, does not need large lands and is much more efficient than the previously mentioned alternatives. However, based on the present technologies, it is not economically sustainable, as the production costs are higher than the others – this will be the challenge of the future; but the experimental lab and reactor in Százhalombatta is a promising start in the research and development. Additionally, cultured algae do not reduce food supplies, thus the four conditional evaluation of Hill is complete, third generation can be a viable alternative of fossil fuels.

The secondary aim of the study was to call the readers' attention: what if a complex energy matrix is possible using only renewable energy. The study stipulated that the Hungarian energy potential vary from the actually exploited energy types on a very high extent. The European Commission and the Hungarian government are on the right way only in one particular sector: the transport. In the present infrastructure and technology, the substitution of fossil transportation fuels can be solved by partly second and partly third generation biofuels based on the previously mentioned factors. A coherent and sustainable solution is possible for all the other sectors, supplied by other renewable energy forms.

Multiple utilization ways of hydro power plants are already known, and we also know that the capacity of Hungary allows the establishment for more than 12 sustainable plants. The integration of energy generation and the irrigation of

cultivated land – where possible - has been successfully used in other Western-European countries.

We were also able to learn, that the domestic capacity for windmills is very high based on the windy field resources; if the financial support and regulations (for example oblige MVM to buy electricity on market prices, and without limitations) were given, the energy matrix could be completed this way, too.

Last, but not least: the complex possibilities of solar and hydrogen power – our vision for this matter. As we could see on the Hungarian solar map, there are huge possibilities in establishing solar collector fields. For maximizing the energy output, we would suggest creating mixed hydrogen power plants and solar power plants in the sunniest areas of Hungary. The purpose of this would be that as the study have discussed, both need sun, and we also learned, that the greatest drawback of the hydrogen power is the possibilities of storage: it is complicated, expensive etc. The solar collector could maintain both hydrogen and solar power plants – with all the surrounding buildings and needs – while hydrogen power plant could directly improve the energy matrix by contributing through daytime. Obviously, this type of mixture is not available on the less sunny parts of Hungary.

This vision of complex, localized energy matrix is still very expensive, thus needs a coherent systematic, modern view of regulations, taxation and a new approach to the governmental support in order to attract investments. As for the regulations for the transport sector, not only blending of biofuels should be compulsory, but the government should force oil suppliers to buy bio-component from second and third generation production sources. Obviously, due to the present prices it is not possible; however integrated governmental support could create a bridge over this gap – energy tax allowance on these types of biofuels could be a good start.

The final conclusion of this study is that the Hungarian energy matrix needs to be widened by renewable energy sources. The new energy matrix should be localized instead of centralized, based on the comparative advantages of the certain parts of Hungary. Still, second and third generation biofuels are sustainable and

appropriate for the transport – on a centralized production, because of the high-volume plants – however, the other energy consuming sectors should be supplied by other, more environmentally friendly solutions. Additionally, due to the expensiveness of these energy sources, new governmental regulations and aid are indispensable for attracting the investors.

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