

Bioenergy as the Solution of Energy Crisis in Ukraine

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Global energy demand is growing rapidly. This demand is mostly met by fossil fuels. Energy demand is expected to double or perhaps triple during this century. Thus, security of energy supply is a global issue. A large proportion of known conventional oil and gas reserves are concentrated in politically unstable regions, and increasing the diversity in energy sources is important for many nations to secure a reliable and constant supply of energy. In this context, bioenergy can play a pivotal role. Some of the main reasons for the people shifting their interest to biofuels were the exhaustion of fuel resources, rising prices of oil, natural gas and to a lesser extent coal, emission of the greenhouse gases and interest like rural development. Biofuels are the best way of reducing the emission of the greenhouse gases. They can also be looked upon as a way of energy security which stands as an alternative of fossil fuels that are limited in availability. Today, the use of biofuels has expanded throughout the globe. Bioenergy is now a key option in energy policies.

There are three main types of modern bioenergy products: bioethanol, biodiesel and biogas.

Bioethanol fuel is mainly produced by the sugar fermentation process, although it can also be manufactured by the chemical process of reacting ethylene with steam. The main sources of sugar required to produce ethanol come from fuel or energy crops (corn, maize and wheat crops, waste straw, willow and poplar trees, sawdust, sorghum plants). There is also ongoing research and development into the use of municipal solid wastes to produce ethanol fuel.

Biodiesel is a renewable fuel made from farm products such as vegetable or animal oils, fats, or recycled cooking greases. Almost all biodiesels are derived from soybean oil; however sunflower oil, rapeseed oil, recycled vegetable oils, and animal fats can also be used. The advantages of biodiesel: potentially biodiesel offers significant CO₂ savings as it greatly reduces emissions. Biodiesel also has the advantage of being readily available and does not require any changes to the current refueling infrastructure in order to be implemented on a wider scale. The disadvantages of biodiesel: the main issue with biodiesel is that cultivating crops for its production can upset or destroy natural habitats. It is also feared that it is causing an imbalance in developing countries that are growing the crops rather than producing sustainable food. It's also difficult to quantify the CO₂ produced by biodiesel. It is questionable therefore as to whether biodiesel is really a long-term environmental solution.

Biogas typically refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. Biogas originates from biogenic material and is a type of biofuel. One type of biogas is produced by anaerobic digestion or fermentation of biodegradable materials such as biomass, manure or sewage, municipal waste, green waste and energy crops. This type of biogas comprises primarily methane and carbon dioxide. The other principal type of biogas is wood gas which is created by gasification of wood or other biomass. This type of biogas is comprised primarily of nitrogen, hydrogen, and carbon monoxide, with trace amounts of methane. Biogas can be compressed, much like natural gas, and used to power motor vehicles.

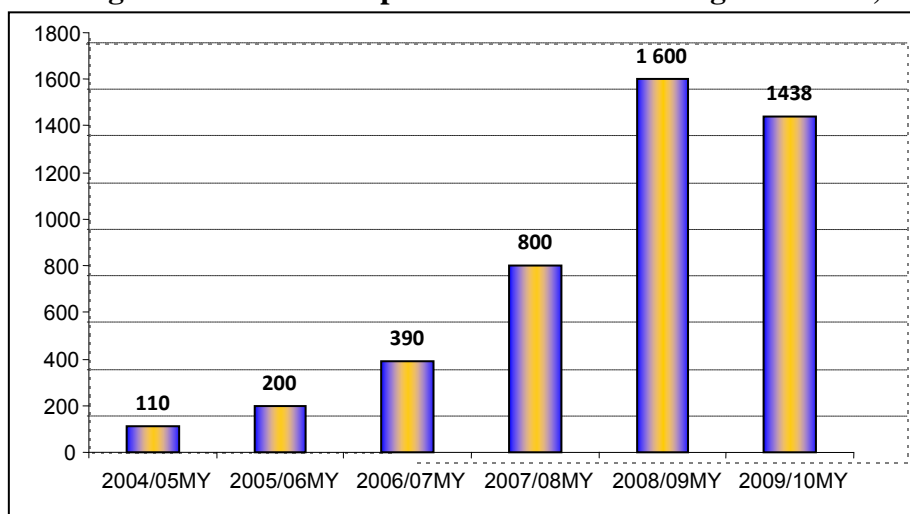
Bioenergy is commonly used in European countries. The European Commission has proposed a mandatory target: 20 % of all European energy should come from renewables (that's all renewable sources: wind, solar, wave, etc. as well as bioenergy) by 2020. At the moment, renewables account for 6.7 % of European energy consumption. Two thirds of this comes from biomass. The European Commission is also keen to promote biofuels — fuel for transport — as diversification is particularly important in transport because of its dependence on oil. The Commission has therefore proposed that biofuels make up 10 % of road transport fuel by 2020, providing they can be certified as sustainable. Data from 2007 show that biofuel makes up 2.6 % of road transport fuel in the EU.

In this paper we will focus on bioenergy use in Ukraine and accent on biodiesel production in Ukraine and its perspectives. Energy safety is an important compound of national and economic safety of each country. Ukraine is a country with a lack of domestic energy sources and rather high dependence on imported energy carriers. This fact encourages the search of alternative energy sources. According to official data, by the end of 2008 own extraction of natural gas amounted to 19,8 bln. cubic meters, extraction of crude oil reached 3,1 million tons and 59,3 million tons of coal were produced but this extraction of fossil fuels covered only small amount of energy consumption in the country. Ukrainian consumption every year equals 200 million tons o.e. of fuel and power resources, Ukraine itself covers its energy demand only for 53 %, it imports 75 % of the necessary amount of natural gas and 85 % of crude oil and oil products. The problem of dependence on imported energy carriers should be solved by introduction of modern energy saving technologies and by production of cheap alternative energy carriers (biodiesel, bioethanol, biogas, solar and wind energy). That is why successful development of bioenergy is of vital importance for Ukraine.

Ukraine has rather big potential of bioenergy production. Main energy crop that is used for biodiesel production is rapeseed. Rapeseed is a large winter or spring annual oil crop. Rapeseed plants grow from three to five feet tall and have yellow flowers. Rapeseed is primarily grown for its oil and meal. It contains more than 40% of oil.

Areas under rapeseed amounted 1,6 mln ha in 2008, it occupied 5% of all sown area in Ukraine (see Fig.1).

Fig. 1. Areas under rapeseed in Ukraine during 2004-2009, thous. ha

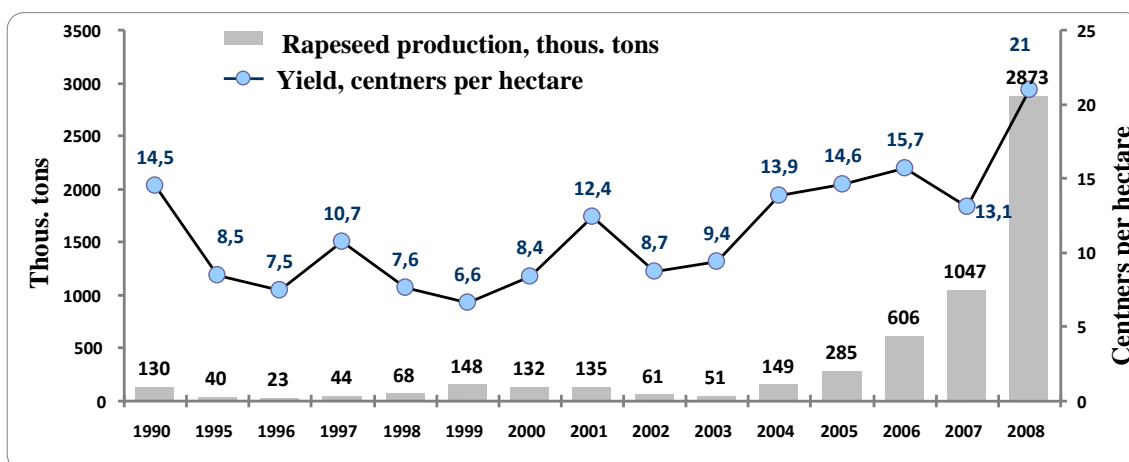


Source: State Statistics Committee of Ukraine (SSCU)

On the Fig. 1 we can see how areas under rapeseed rocketed during 2004-2009. Enhancing of areas under this crop is caused by the growing demand for it as the raw material for food and processing industry.

On the Fig. 2 we can see how rapeseed production in Ukraine changed during the period from 1990 to 2008 and how it was influenced by the rapeseed yield.

Fig. 2 Dynamics of rapeseed production in Ukraine during 1990-2008 years



Source: SSCU

During last 18 years rapeseed production in Ukraine raised dramatically and in 2008 it equaled 2873 thous. tons that is more than twice as many as in 2007. Particular growing of rapeseed production was observed during the last 5-6 years together with the growing interest to renewable energy and biofuel. Increase in rapeseed production was possible due to gradual rise in rapeseed yield and to enhancing areas under this crop.

Ukraine doesn't use all rapeseed for own consumption. Ukrainian consumption in 2008 amounted to 513 thous. tons that constitutes near 18 % of rapeseed production. The rest of the rapeseed goes to external markets. We can see volumes of rapeseed production and export by years in the Table 1.

Table 1. Production and export of rapeseed in Ukraine

Year	Rapeseed produced, thous. tons	Exported rapeseed, thous. tons	Share of export in the total production, %
2006	605	470	77,69
2007	1050	910	86,67
2008	2900	2387	82,31

Source: SSCU

Analyzing this data table we can see that Ukrainian export of rapeseed increased more than 4 % in 2008 compared to 2006.

From the information mentioned above we can conclude that Ukraine has good background for biodiesel production and doesn't use own potential completely.

National University of Life and Environmental Sciences of Ukraine (NUBiP) is one of the initiators of the development of biofuel production in Ukraine. It founded its own experimental biodiesel plant in 2008. In this article we will estimate the effectiveness of biodiesel production in Ukraine on example of this plant. Hereafter we can see main characteristics of the plant.

Table 2. Main characteristics of experimental biodiesel plant of NUBiP

Characteristics	Units	Value
Production of biodiesel	tons per year	1000
Production of oilcake	tons per year	2000
Cost of the project	UAH	3 200 000 (approx. 418 300,65 USD)
Payback period of the project	year	3

Source: data from the plant

Manufacturing process at the plant foresees the following stages of biodiesel production from the rapeseed.

First steps of biodiesel production correspond to traditional stages of plant oils production food and technical usage. Byproducts are used as raw materials in different industries. At the first stage during the biomass growing and harvesting it is necessary to use resource-saving technologies in order to decrease losses during the harvesting.

Rapeseed should have humidity around 5 – 7%, part of trash – not more than 1%, erucic acid content less than 2%, acid number not more than 3. Failure to comply with these requirements can cause decrease in oil quality. On the next stage we press the rapeseed and obtain oil. Produced oilcake contains fats (6-12%) and proteins (30 – 32%), thus it is a nutritious fodder for animals.

Important steps of biodiesel production process are processes of oil filtration and neutralization (before its esterification). Esterification is one of the core stages of biodiesel production. Esterification with the alkaline catalyst in reactors with the mixing device is the simplest and widespread process of biodiesel production. Under the influence of catalyst the oil is esterificated by methanol into methyl esters with the glycerine release.

During the stage of biodiesel purification all contaminations are removed with the help of washout and filtration, excessive methanol is removed by distillation and then it can be re-used. For water removal additional operations are conducted.

Biodiesel can be mixed with petroleum diesel in any ratio. In Ukraine it is common to mix such a fuel in the ratio from 10% to 40% depending on the season. It can be used in diesel engines without any modification.

Thus, the economic aspect of biodiesel production from rapeseed is of a core importance. So, let's make necessary calculations to estimate effectiveness of biodiesel production at NUBiP biodiesel plant:

- 1) We calculate costs for production of 1 ton of biodiesel (see Table 3);
- 2) We estimate incomes from the realization of by-products of biodiesel production (see Table 4);
- 3) We compare price of 1 ton of biodiesel and 1 ton petroleum diesel.

Table 3. Costs for production of 1 ton of biodiesel at NUBiP biodiesel plant

Expenditures	Quantity	Price	Cost, UAH
Rapeseed	3,2 MT	1300,00 UAH (approx. 170 USD) (prime cost)	4160,00 (approx. 544 USD)
Yield	3 MT/ha	-	-
Remuneration (with premiums)	21,67 man-hours	7,6 UAH/hour (approx. 1 USD/ hour)	228,26 (approx. 30 USD)
Methylate	156 kg	4800 UAH per ton (approx. 627 USD)	748,80 (approx. 98 USD)
Electric power	503,7 kilowatt	0,72 UAH/kilowatt (approx. 9,41 USD/ per 100 kilowatt)	362,74 (approx. 47 USD)
Amortization	-	-	501,60 (approx. 66 USD)
Summ	-	-	6001,40 (approx. 785 USD)
General administrative costs (10%)	-	-	600,14 (approx. 79 USD)
Total	-	-	6601,54 (approx. 863 USD)

Source: data from the plant

So plant produces biodiesel for University's consumption but we also have by-products (oilcake, glycerol) which we realize on market. The incomes from by-products realization are the following:

Table 4. Incomes from by-products of biodiesel production

Item	Quantity	Price	Cost
Oilcake	2,13 MT	1400 UAH/ MT (approx. 183 USD/ MT)	2982 UAH (approx. 390 USD)
Glycerol	210 liters	2600 UAH/ MT (approx. 340 USD/ MT)	546 UAH (approx. 71 USD)
Total	-	-	3528 UAH (approx. 461 USD)

Source: data from the plant

And now we can calculate how much is self-cost of 1 ton of biodiesel: $6601,54\text{UAH} - 3528\text{UAH} = 3073,54\text{UAH}$ (approx. $863\text{USD} - 461\text{USD} = 402\text{USD}$). Whereas price of 1 ton mineral diesel oil equals 5100UAH (approx. 667USD) we have our biodiesel at price $3073,54\text{UAH}$ (approx. 402USD) per ton and we save money.

Further development of the biofuel industry in Ukraine is mainly determined by the state regulation. There are several state programmes that foresee increase of the level of ecological and energy security of Ukraine, decrease of dependence on imported fuels and provision of agricultural sector and transport with the competitive biodiesel. Main aim of the “Programme of development of the biodiesel production for the period till 2010” was biodiesel production at level 623 000 tons in 2010 but the real production volume by the end of 2008 contributed to 20 000 tons. As we can see the governmental support programmes are not fulfilled.

But despite all the negative tendencies, biodiesel production in Ukraine grows every year and attracts much attention of agricultural producers.

On May 22, 2009 new Law # 1114 “On amendments to legislative acts concerning assistance to production and usage of alternative fuels” was adopted. This Law provides us with the positive future prospect of biofuel production in Ukraine.

This law foresees abolition of 25% income tax from the selling of biofuels. Saved funds should be turned to re-equipping of material and technical basis of biofuel production. Import dues for equipment and component parts designated for biofuel production will be abolished for nine years. Licences for biofuel production will be issued to the enterprises with the capacity more than 5 thous. of biofuel per year. Excise tax for biofuel will be at zero rate. This law declares plans to produce and consume biofuel in Ukraine at the level of 2% of the general volume of traditional fuel in 5 years in order to improve ecological situation and decrease dependence on petroleum products.

Hope this Law will help to promote further development of biofuel industry. Development of bioenergy technologies would decrease Ukraine’s dependence on imported energy carriers, enhance its energy security at the expense of organizing energy supply based on local renewable sources, create new jobs, and contribute greatly to the improvement of ecological situation.

On an international scale we can summarize that developing bioenergy represents the most immediate and available response to at least five key challenges and opportunities: coping with record-high crude-oil prices; the need for oil-importing countries to reduce their dependence on a limited number of exporting nations by diversifying their energy sources and suppliers; the chance for emerging economies in tropical regions to supply the global energy market with competitively priced liquid biofuels; meeting growing energy demand in developing countries, in particular to support development in rural areas; and the commitments taken to reduce carbon-dioxide emissions as part of the battle against climate change.

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