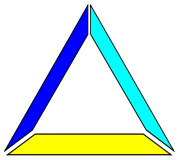
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Renewable Energy Policy in Ukraine:

1 Introduction

Energy security is an important and often controversial component of national and economic security. In recent months, as prices for fossil fuels have grown and Ukraine's conflict with Russia over natural gas deliveries and transit conditions has come to a head, Ukraine's dependence on imported energy and its resulting vulnerability have been highlighted. While specific conditions clearly vary from country to country, rising energy prices and uncertainty regarding the stability and dependability of supplies have lead to great concern in all of the energy importing countries of the world.

This concern has lead to a burgeoning interest in renewable energy sources (RES) such as wind power and biofuels. In many countries it is hoped that RES could contribute to a reduced dependence on energy imports. Increased use of RES also holds considerable hope for agriculture and rural areas as important potential producers of RES. Furthermore, RES could also contribute to reducing some of the negative environmental impacts of fossil fuel use, such as CO_2 and other greenhouse gas emissions.

What role can RES play in the pursuit of energy, agricultural and environmental policy goals in Ukraine, and what policy measures should be implemented to ensure that RES are used as effectively as possible? In the following we discuss these questions and make several recommendations for RES policy in Ukraine. It is assumed that the reader is familiar with RES in general and the main different types of RES.[1] The reader should be warned that making firm forecasts and recommendations in the area of RES is difficult because prices, technologies and institutions in this area are undergoing major changes. Indeed, one of the most important recommendations that can be made is that RES policy should be flexible to allow Ukraine to profit from whatever developments the future holds.

2 RES in Ukraine

2.1 Fundamental considerations

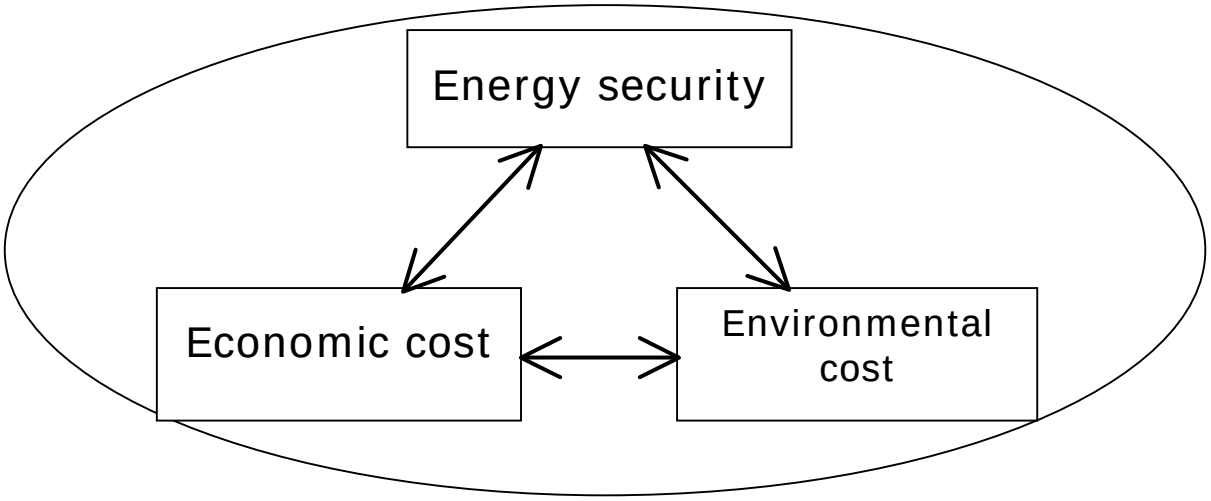
There are three main criteria by which an energy source can be judged (Figure 1). These are political (does the energy source contribute to energy security?), economic (how much does the energy source cost in comparison with others?), and environmental (what environmental costs are associated with the use of an energy source – for example greenhouse gas emissions, destruction of biotopes?).

The interactions between these different criteria are complex. The only certain way of making progress in all three directions simultaneously is to increase the efficiency of energy use, for example by insulating houses, equipping radiators with thermostats, making use of heat produced as a by-product of industrial activity, etc. It has been amply documented that the Ukrainian economy (like the economy in other states of the Former Soviet Union) has an

[1] The main types of RES include: Wind power, hydropower, solar energy (photovoltaic and thermal), geothermal energy, and biomass. The latter can be directly burned (e.g. wood), fermented to produce biogas (e.g. manure, plant residues), and processed into liquid fuels such as bioethanol (e.g. from sugarbeet) and biodiesel (e.g. from rapeseed or palmoil).

exceptionally high energy intensity.[2] Reducing this intensity would make it possible to produce the same level of economic output in Ukraine using less energy, thus reducing costs[3] and environmental damage while increasing energy security. Alternatively, it would permit continued economic growth without increasing pollution, economics costs and dependency on energy imports.

Figure 1
Criteria for judging an energy source



Source: Own depiction.

All other possible courses of action – for example, increasing the use of local fuels such as peat, increasing domestic nuclear power generation capacity, or increasing the use of RES – will lead to gains in some dimensions, but not all. Peat, for example, is domestically produced, so increased use of peat can increase energy security (as long as stocks last). However, peat is not a particularly clean fuel, and peat deposits are often valuable biotopes, the destruction of which leads to environmental damage. Hence, increased use of peat leads to a clash between energy security and environmental goals. Nuclear power can reduce greenhouse gas emissions and it might increase energy security, althought the latter will not hold if nuclear power generation simply shifts import dependence from fossil fuels to uranium. Furthermore, careful cost comparisons suggest that nuclear power is considerably more expensive than many alternatives.[4] Such clashes between energy security, economic and environmental considerations must be squarely dealt with when choosing the best possible energy strategy for Ukraine.

RES can lead to significant environmental benefits in the form of reductions in greenhouse gas emissions, although these benefits vary widely among the various types of RES. Theoretically, burning for example bioethanol only returns to the atmosphere CO_2 that had been removed earlier by the plants (e.g. sugarbeets) used to produce this bioethanol – in other words, burning bioethanol is theoretically CO_2-neutral. In practice, however, producing the machinery, fertilisers and pesticides used to produce sugarbeets also leads to CO_2 emissions. Moreover, transporting sugarbeets to the factory where they are processed into bioethanol, and building this factory itself, also involve CO_2 emissions. To what extent net emissions of CO_2 and other greenhouse gases are reduced is therefore a complex issue that depends on the type of RES being used (wind power, geothermal, biofuels, etc.) and the exact conditions of its generation.

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2 Policy makers in Ukraine are finally beginning to address this issue head on. See, for example, "Prime Minister put emphasis on energy-saving technologies introduction" (http://www.kmu.gov.ua/control/en/publish/article?art_id=28625067&cat_id=2297108).

3 Some of the suggested measures, such as installing thermostats, would cost money. Energy waste in Ukraine is so egregious, however, that many of these measures would yield a positive return on investment themselves very quickly.

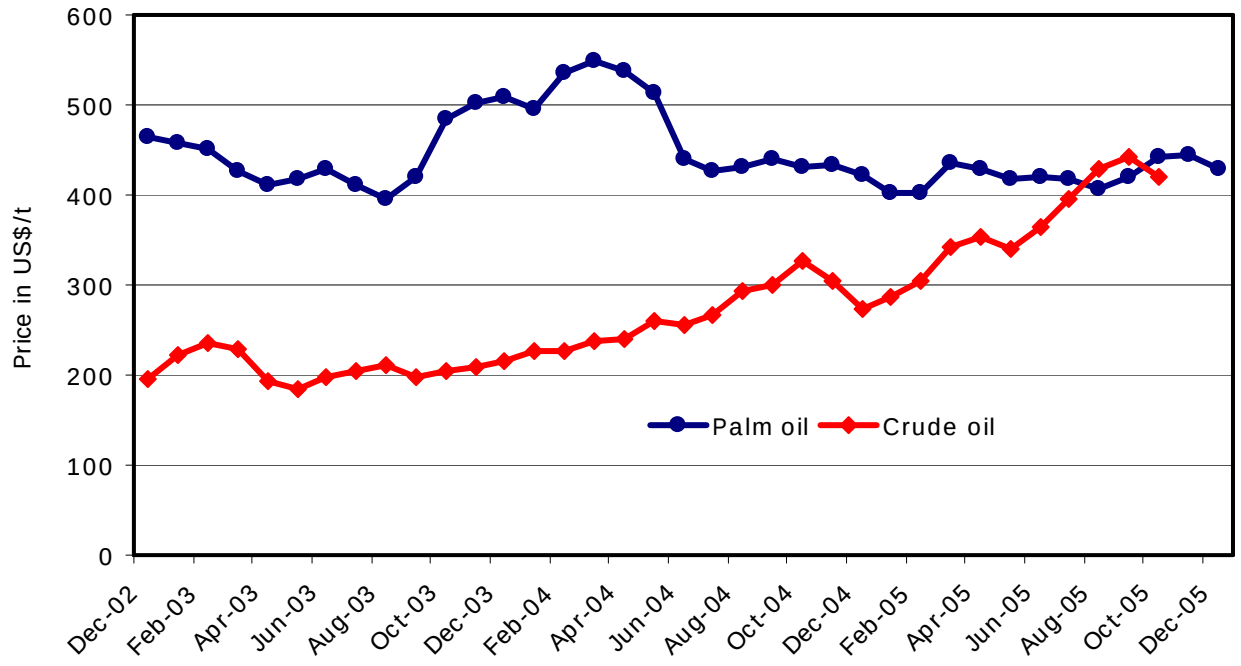
4 In this regard, note that over the last 25 years, not a single privately owned utility has invested in new nuclear powers generation capacity anywhere in the world, unless it has received state support or offtake guarantees (see Hirschhausen and Rumiantseva (2006): *Economics of Nuclear Power Development in Belarus* in an upcoming publication of the German Economic Team in Belarus – http://www.ipm.by).

RES can also contribute to energy security, although it is important to recognise that RES are not necessarily domestic. Biodiesel or bioethanol, for example, could be imported and need not necessarily be produced in Ukraine. Indeed, it may be the case that some imported RES are less expensive than domestic RES, for example because foreign producers enjoy natural advantages (e.g. the sun shines stronger and longer in Brazil than in Ukraine), or because they have gained a technological or scale advantage compared with Ukraine. Of course, the farther away an imported RES is produced, the farther it has to be transported, thus reducing whatever environmental benefits it may entail.

Just because an energy source is imported does not mean that it reduces energy security. Increased dependence on imported RES could improve energy security vis-à-vis the current situation if it leads to a diversification of Ukraine's sources of imported energy. Energy security can climb even though energy self-sufficiency remains constant, if diversification reduces current dependence on a single or few dominant sources of energy imports. Hence, possible trade-offs between energy security and economic costs should be taken into consideration, and it would be taking an overly narrow view to equate energy security with avoiding imports at all costs.

While the use of (domestic or imported) RES could clearly improve energy security in Ukraine, the key question is: At what economic cost? RES are generally (hydroelectric power generation where the natural conditions are given is an important exception) more expensive than fossil fuels. However, this balance is shifting as fossil fuel prices increase, improved technologies for RES use are developed, and economies of scale in RES generation are realised. Figure 2 shows that in recent months, increases in crude oil prices have closed the gap to the prices of some vegetable oils. Since, subject to some technical limitations, vegetable oil can be used directly as a fuel or fuel additive, or processed into biodiesel, there would appear to be growing scope at the margin for some substitution of fossil fuel by RES.

Figure 2
Monthly crude oil and vegetable (palm) oil prices, 2003-2005 in US$/t



Source: IAE

This balance could shift further if market prices for different sources of energy better reflected the environmental costs associated with their use. Fossil fuels would be considerably more expensive if their environmental costs (climate change due to greenhouse gas emissions, the costs of oil spills, political conflict that is linked to attempts to control global oil and gas reserves) were included in their prices. This would improve the competitiveness of RES, subject, again, to the differences in environmental benefits among the various types of RES.

Nevertheless, as Table 1 indicates, considerable cost disadvantages of RES remain to be overcome via technical progress and correct pricing of environmental costs, given that eletricity generation in modern natural gas-burning power stations costs roughly 3,5 cents/kWh.

The Kyoto Protocol and the provisions in it for trading in emission certificates and for so-called Joint Implementation (JI) projects represent an important step towards the monetary valuation of environmental benefits and, hence, a truly comprehensive basis for the comparison of energy sources. There is large potential for Ukraine to benefit from JI projects when investing in the renewable energy sector. Ukraine has already undertaken substantial steps to clarify JI policies and has initiated its first projects with other Annex B countries.[5] Of all the countries that have signed the Kyoto protocol, Ukraine is estimated to have one of the most promising potentials of benefiting from the project-based Joint Implementation mechanism.[6] Consequently, Ukraine could also become one of the main beneficiaries of the European trading scheme if the country is well prepared. In general there are many possible JI projects related to RES opportunities such as those in Table 1.

Table 1
Costs of electricity generation in using different RES

RES	Costs of electricity generation in cents/kWh
Wind	5,5-13
Hydro	3-25
Photovoltaic	50-80
Solar thermal	10-25
Biomass	5-30
Geothermal	7-15

Source: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, (2004): Erneuerbare Energien – Innovation für die Zukunft, Berlin 2004.

2.2 RES in Ukraine: Current use and potential

According to the IEA, the worldwide share of RES in primary energy supply was 13% in 2003 (Table 2). However, this is not the relevant comparison for Ukraine, as the worldwide average includes developing countries with their characteristic energy supplies. More relevant for Ukraine are the EU-25 and Russia, with RES shares in primary energy consumption of 6 and 3%, respectively. The share of RES in Belarus (not included in Table 2) is 1.6%. In comparison, the current roughly 1% share of RES in primary energy supply in Ukraine is quite modest.

Table 2
Total energy supply and the share of renewables for selected countries (2003)

Country	Total primary energy supply (mtoe)	Global share (%)	Renewables (mtoe)	Share of renewables in total primary energy supply (%)
World	10579	100	1404	13
USA	2281	22	95	4
EU-25	1737	16	99	6
China	1409	13	243	17
Russia	640	6	17	3
India	553	5	218	39
Japan	517	5	18	4
Canada	260	2	41	16
Ukraine	133	1	1	1
Others	3049	29	671	22

Source: IEA (2005). Mtoe = million tons oil equivalent.

Estimates of potential and projections must be interpreted with caution, because they can vary widely depending on the assumptions made. Our own calculations based on national cattle and

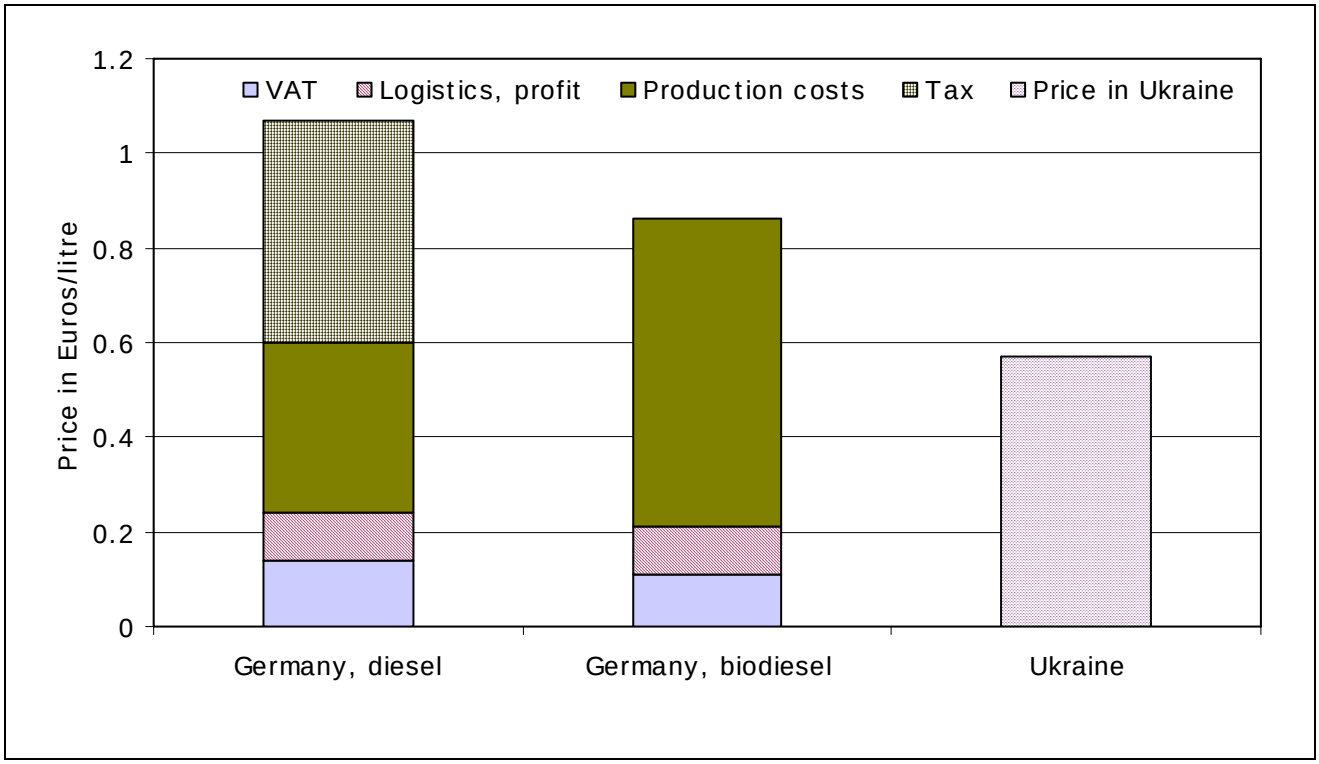
[5] For more info about Ukrainian JI projects, see the Climate Change Initiative Webpage http://www.climate.org.ua/projects/inv_projects.html or the Scientific Engineering Centre "Biomass" Webpage http://www.biomass.kiev.ua/.

[6] See: Fankhauser, S. and L. Lavric (2003). The Investment Climate for Climate Investement: Joint Implementation in Transition Countries. EBRD Working Paper No. 77.

swine herds of roughly 9 and 8 million animals respectively, suggest that Belarus could produce 14.5 billion m³ of biogas per year from manure, for a potential of 78.2 PJ of energy or roughly 1.87 million tons of oil equivalent (mtoe). A more conservative estimate (e.g. Geletukha, 2004, who estimates 0.9 mtoe) would account for example for the fact that only large farms can be expected to collect manure for biogas production. On the other hand, livestock production has fallen dramatically over the last 15 years and can be expected to recover in the medium term, leading to an increase in livestock numbers. Burning the straw from 12.8 million hectares of crop land could produce 300 PJ or 7,2 mtoe, assuming a yield of 23.3 GJ/ha (in Germany, with its higher crop yields, 70 GJ/ha are assumed).What is much more important than technical feasibility, however, are concrete plans to realise economically viable potentials and projections. Developing RES requires investment not only in generating facilities but also in infrastructure for distribution and storage and, in some cases, in changes to the end-users of energy (for example, some diesel engines must be modified if they are to run on biodiesel). Furthermore, as long as RES is more expensive than conventional sources, consumption must be subsidised as well.

To illustrate this second point, consider the example of biodiesel and the situation in Germany, where biodiesel is exempt from energy taxes. The situation in France is similar, where biodiesel qualifies for a tax rebate. This rebate costs the French government an estimated 123 million Euros (the corresponding estimate of the volume of the tax exemption in Germany is roughly 350 million Euros). The French government has recently announced its intention to triple biodiesel production in France between 2004 and 2007. To meet this goal, the production of rapeseed for biodiesel in France will have to more than double over the same period, and the costs of the tax rebate will climb to an estimated 1,2 billion Euros by 2010.[7] As illustrated in Figure 3 for Germany, as a result of the tax exemption and, hence, the tax revenue that the government forgoes, biodiesel is competitive – even though it costs more to produce than conventional diesel. It comes as no surprise, therefore, that the market for biodiesel in Germany, as in France, is booming.[8]

Figure 3
The composition of consumer prices for diesel fuel in Germany



Source: Own calculations based on average prices for 2005 in Germany, current price of diesel in Ukraine.

7 See United States Department of Agriculture (USDA) Foreign Agriculture Service GAIN Report Number FR 5002: *France Oilseeds and Products, New Incentives for Biofuel Production*, Washington DC, 2004.

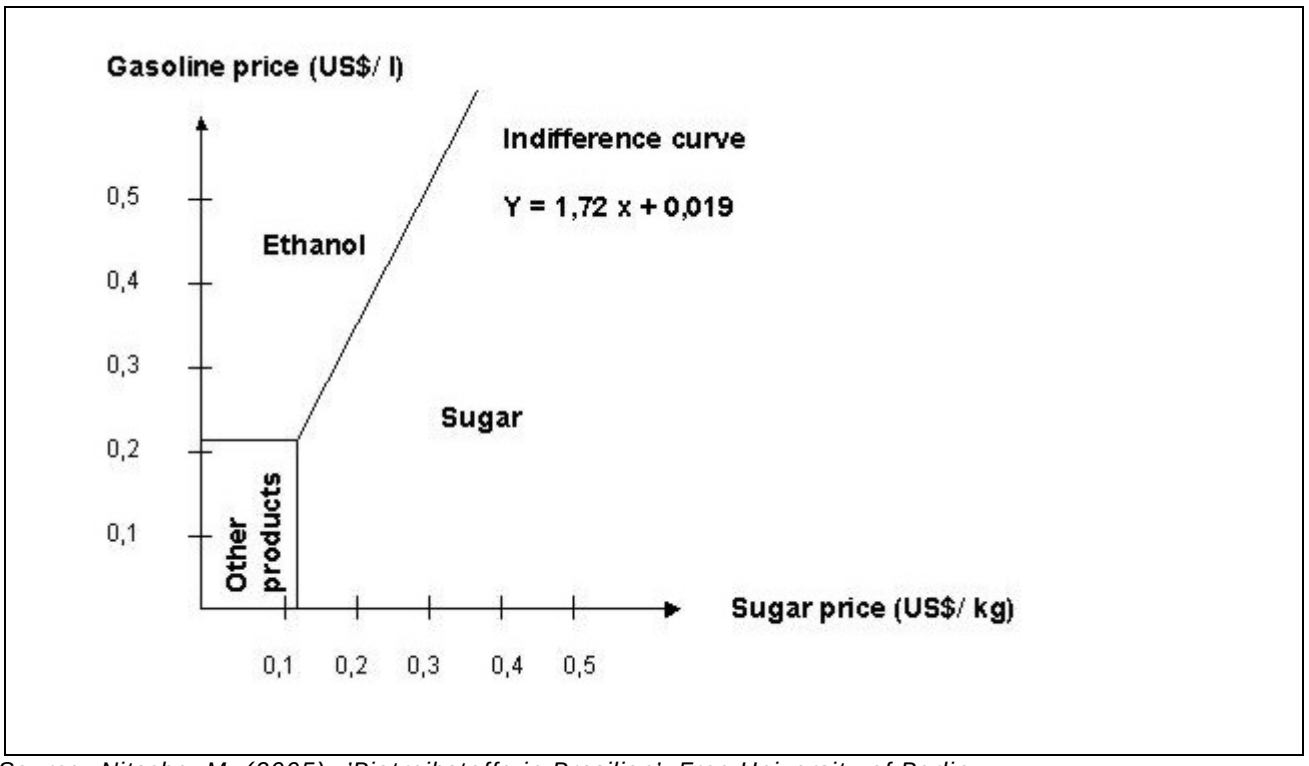
8 Indeed, in 2005, over one half of Germany's total rapeseed harvest will be used not for human consumption but rather to produce biodiesel.

As also illustrated in Figure 3, diesel currently costs the equivalent of roughly 0.57 Euro/litre (retail) in Ukraine. This is less than the production costs of biodiesel, estimated at 0.65 Euro/litre in Germany. Even if biodiesel could be produced in Ukraine at the same cost as in Germany, and without considering taxes, logistics and profits, a purely production-cost-based litre of biodiesel would still cost 0.08 Euro/litre or 14% more than Ukrainian consumers are currently paying for conventional diesel. This example illustrates that expanding the use of RES in Ukraine will require either increasing conventional energy prices to a level at which they approach the costs of RES, or directly subsidising RES production by corresponding amounts.2.3. RES and agriculture

In many parts of the world, RES are seen as a significant opportunity for agriculture. Many RES are produced using inputs (e.g. wood, manure, grain or locations for wind turbines) that agriculture is in a unique position to provide. As conventional energy prices increase and farm subsidies in many countries are reduced due to international trade agreements, for example under the auspices of the WTO, farmers especially in the EU and North America are wondering whether their future might not lie as much in producing energy as in producing food.

There are indications that fossil fuel prices have already reached levels that make it more profitable to transform some agricultural products into energy than into food. One indication of this was already provided in Figure 2 above. Another example is provided by the sugar/ethanol complex. At current world market prices for sugar and ethanol, it makes more sense for many Brazilian producers to process their sugar cane into ethanol rather than sugar for human consumption. Figure 4 illustrates the critical price thresholds that determine whether sugar, ethanol production based on sugar, or another product altogether, is more profitable under Brazilian conditions. Price changes on world energy markets in recent months have shifted the situation from the bottom right 'sugar' sector to the top left 'ethanol' sector of Figure 4. Of course, as sugar is drawn into ethanol production it will be less available for food use, triggering price increases for food sugar. Examples such as these suggest that in the future energy prices could set price floors for major agricultural commodities.

Figure 4
Economic production frontiers for sugar, ethanol and other crops in Brazil



Source: Nitsche, M. (2005): 'Biotreibstoffe in Brasilien', Free University of Berlin.

While this may sound like good news for farmers who have been battling low prices and who would welcome any additional source of demand for their products, a word of caution is in order. To the extent that energy production draws significant amounts of agricultural resources away from food production and drives up food prices, problems of food insecurity will increase. This would have a negative impact on net importers of food. Even in a country such as Ukraine

that is a net exporter of food, increasing food prices will have a negative impact on many poor households. Furthermore, agricultural markets are complex and full of unexpected linkages. A significant increase in the demand for biodiesel based on vegetable oils (from rapeseed or palm oil, for example) would also increase the production of the associated by-products (rapeseed meal, palm expeller). This would be good news for farmers who purchase these by-products as protein feeds for livestock production, but bad news for farmers who produce other types of protein feed. Finally, energy prices are notoriously volatile. Hence, they may act as a floor that supports agricultural prices in the future, but this floor can be expected to move up and down, creating risk and uncertainty for agricultural producers and those who would invest in agricultural-based RES.

There is some concern that RES could be used as a new excuse for providing subsidies to agriculture. The result would be distortions on international markets for RES such as ethanol and biodiesel, instead of sugar and oilseeds. While Ukrainian policy makers may be tempted to use RES as a way subsidising agriculture in circumvention of WTO disciplines, it must be assumed that i) Ukraine would lose in the end because it is not in a position to spend nearly as much on such subsidies as the EU, the US and other rich countries (i.e. it would lose an RES subsidy war), and ii) if the production of RES in agriculture becomes as important as many expect, then it must be assumed that national policies that subsidise this production will be a topic of future international trade negotiations and subjected to appropriate disciplines. Production of RES should be based on the same principles of efficiency and market-driven incentives on which food production ought to be based. Agricultural sectors that have failed to restructure, improve management techniques and increase efficiency in food production are likely to fail at producing energy as well.

RES could have an impact on agriculture not only as a potential supplier of energy, but also as a significant user. Farm and rural communities are often relatively remote, and the costs of supplying such communities with energy from conventional sources is often correspondingly high (infrastructure, transmission losses, etc.). At the same time, energy based on agricultural RES (biomass, manure, etc.) can be relatively inexpensive at its source. In parts of the EU, experience with decentralised energy generation in rural areas is being gathered. Some large farms are experimenting with heating systems based on wood pellets, or the use of rapeseed oil produced on the farm to fuel vehicles; recently an entire village in Germany has begun to implement a project that will make it able to completely cover its energy need with RES.[9] It is too early to say which, if any, of these experiments will prove to be sustainable.

3 Challenges and recommendations for policy

A. The first priority of an energy policy that aims to increase energy security in Ukraine must be to reduce the energy intensity of the Ukrainian economy. Steps in this direction would reduce dependence on imported energy, reduce the negative environmental impact of energy use and increase the overall competitiveness of the Ukrainian economy. Before a single Hryvnia is invested in RES or any other domestic source of energy, the impact on energy security of investing that Hryvnia in increasing the efficiency of energy use in Ukraine should be calculated first.

B. Consumer prices for energy in Ukraine are generally below levels required to cover the full costs of extraction/generation and distribution, and they are certainly below the costs of RES. Hence, even though the gap between the costs of RES and the costs of fossil-based energy is closing due to increasing fossil fuel prices on world markets and technological progress with RES, increased RES use in Ukraine would further increase the cost of subsidising energy consumption. Any scheme for increasing the use of RES in Ukraine must squarely face the question of how to finance these costs. Someone, either the taxpayer or the consumer must pay in the end! The negative consequences for energy infrastructure of forcing suppliers to provide energy to consumers below cost are amply documented in Ukraine. Investments in RES can only be expected if investors have a reasonable expectation of making profits.

C. An important advantage of RES compared with other sources of energy is that RES can provide important environmental benefits such as reductions in greenhouse gas emissions. However, this advantage is not reflected in the relative prices of RES and other sources of

[9] For more information on 'The Bio Energy Village' Jühnde, see http://www.bioenergiedorf.de/.

energy; the prices of conventional energy sources do not reflect environmental costs such as CO_2 emissions that result from their use. The Kyoto Protocol contains provisions that could partially redress this imbalance, and Ukraine could benefit considerably from these provisions.

D. There are many different means of providing state support for the development and use of RES. These range from supporting research and development into RES, to investment aids for the production and installing of facilities such as biogas units or wind turbines that generate energy based on RES, to outright subsidisation of energy produced using RES. The choice of a particular measure must be based on a transparent analysis and comparison of its costs and benefits.

E. RES technologies are changing rapidly. For example, due to technological advances, the annual energy output per wind turbine has increased 100-fold in 15 years, the average weight of this turbines has been halved in 5 years and noise emission levels have been halved in 3 years. In the process, the cost of wind generated electricity has fallen from 0,35 €/kWh in 1980 to roughly 0,05 €/kWh in 2004.[10] The prices of non-RES alternatives are also changing rapidly. Hence, there is no way of knowing today what technologies will prove competitive tomorrow. Some of tomorrow's most profitable technologies may not even exist today. Policy makers should avoid measures that 'lock in' particular technologies that may turn out, in the course of time, to be uncompetitive. An example of such a 'lock-in' policy is Germany's Renewable Energy Law (EEG) which guarantees fixed offtake prices for electricity generated using specific RES (wind, biogas, solar, etc.) over long periods of time. Instead, policies to support RES should be strictly limited in time and subject to review at regular intervals.

F. Investment in research and development into RES should be increased significantly in Ukraine. However, other countries, for example in the EU, have a head start in RES research and development, and have advantages in the large scale production of some commercial RES technologies. Ukraine would be well advised not to 'reinvent the wheel' but rather to join and cooperate in existing RES research and development networks. This will enable Ukraine to take advantage of advances that have been achieved elsewhere and to focus its efforts on areas in which it has special needs and expertise.

G. There are indications that fossil fuel prices have reached levels at which they act as a floor for some types of agricultural production. For example, at current gasoline prices, sugar is, at the margin (e.g. in Brazil) being drawn into ethanol production and away from food use. While it is too early to do more than speculate, these developments could have a major impact on world food markets and price ratios in agriculture. Policy makers in Ukraine would be well advised to follow these developments closely and to invest in expert analysis of their implications for domestic policy.

H. The development of RES can provide impetus to agriculture and rural areas. It can create new markets for agricultural products (for energy generation instead of, or coupled with food production), and it could present interesting local, decentralised energy provision solutions for rural communities. However, the opportunities posed by RES should not be misused as a new excuse for old, inefficient agricultural subsidies. Production of RES should be based on the same principles of efficiency that food production ought to be based on. Farms that have failed to restructure, improve management techniques and increase efficiency in food production will fail at producing RES as well.

Authors: S. von Cramon-Taubadel, E. Lakemeyer.

[10] See EU Commission (2005): Energy RTD Framework Programme – "Success Stories" http://europa.eu.int/comm/energy/res/publications/doc/energy_rtd_success_stories.pdf.