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Towards higher energy efficiency in Ukraine: Reducing regulation and promoting energy efficiency improvements

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Executive Summary

Energy efficiency is rightly one of the most pressing priorities of energy policy in Ukraine. However, in contrast to the visibility of the topic, improvements have been marginal and energy use remains wasteful. The amount of energy used for each unit of goods and services produced is still 3.8 times higher than the European Union average. The implementation of energy efficiency improvements by households and companies as well as state authorities lacks behind in international comparisons. While steps have been taken to address the issue we argue that prior to designing any policy response it is vital to understand the barriers to energy efficiency in the Ukrainian economy. Only that way an effective and consistent policy response which aims at removing those barriers can be formulated.

The underperformance of the Ukrainian economy in the context of energy efficiency can be explained by two factors.

1) Excessive market regulation ("the state failure argument")

2) Lack of promoting energy efficiency ("the market failure argument")

Reducing distorting state interventions is a requirement for any further policy intervention

The key barrier to efficient energy use is the absence of working markets for energy products due to excessive regulation. Drastic government interventions occur in Ukraine on both the demand and supply side of energy markets. On the demand side energy subsidies are still politically accepted as a means to conduct social policy. In the consequence, low energy prices offer little incentive for prudent energy use or investment in energy saving equipment. Furthermore, monopolistic structures on the supply side, state ownership and mismanagement mean that uncompetitive companies with inefficient production technologies characterise Ukraine's energy sector. Also, low energy prices are used to cross-subsidise energy intensive companies, thus cementing non-competitive production technologies. Finally, the state has yet failed to make legislative changes that clarify property rights in the building sector and are required for investments in energy saving measures to happen. Overall, these shortcomings leave little incentive for efficient energy use, inhibit investments in improved energy efficiency and lead to enormous cost to the Ukrainian society. Consequently, removing these distortions is a pre-requisite for any attempt to increase energy efficiency.

Promoting energy efficiency should aim at reducing market failures

Yet, even fully liberalised markets may not deliver the required energy savings without promotion through the government. Market failures inherent in energy markets – such as incomplete information over current and future energy costs, a lack of (long-term) financing, under-pricing of environmental damage, myopic consumers and investors need

to be addressed in a consistent policy framework that aims at increasing energy efficiency.

With a potentially large impact on the distribution of income and wealth in the economy, policy proposals should undergo a rigorous cost benefit assessment. Additionally, and related to this assessment, the economic impact of policy measures should be estimated prior to implementation. Such an evidence-based policy selection process would allow choosing the policies that provide the best value for money for the taxpayer.

Indeed, improving energy efficiency goes in line with improved competitiveness and in turn rising incomes and prosperity for the economy. By identifying the barriers to energy efficiency in Ukraine this paper sets the basis for formulating a consistent policy framework that can unlock this potential.

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1. Introduction

Energy is likely to become one of the main bottlenecks of economic and social prosperity over the next decades. This is reflected in increasing prices of energy. Further costs of wasteful energy use are becoming ever more evident in increasing environmental damage. Thus, prudent consumption of energy and efficient use of natural resources should be in the very interest of individual consumers and companies as well as society.

Against this backdrop, increasing energy efficiency – i.e., reducing the amount of energy that is used to produce a certain amount of goods and services – has become a major focus of energy and economic policy of governments around the world. However, energy intensity various considerably from one country to the next. So does policy makers' progress in improving energy efficiency of the economy. Empirical evidence suggests that Ukrainian consumers and companies are particularly wasteful in their use of energy as Ukrainians use still more than 3.8 times the amount of energy compared to their European Union counterparts.

The purpose of this policy paper is to investigate the underlying reasons for the low energy efficiency witnessed in Ukraine. That way, we can determine which factors need to be addressed in order to find an adequate and effective policy response that aims at increasing energy efficiency.

Following these introductory remarks, we first review the empirical evidence of energy efficiency and use in Ukraine to highlight the magnitude of the problem and the need for action. In the third chapter we will investigate the underlying reasons for punishingly high energy use in Ukraine. Finally, we will argue that an adequate policy response needs to address those very factors in order stand a chance of success. We outline the policy options and sketch how a policy selection process should be designed.

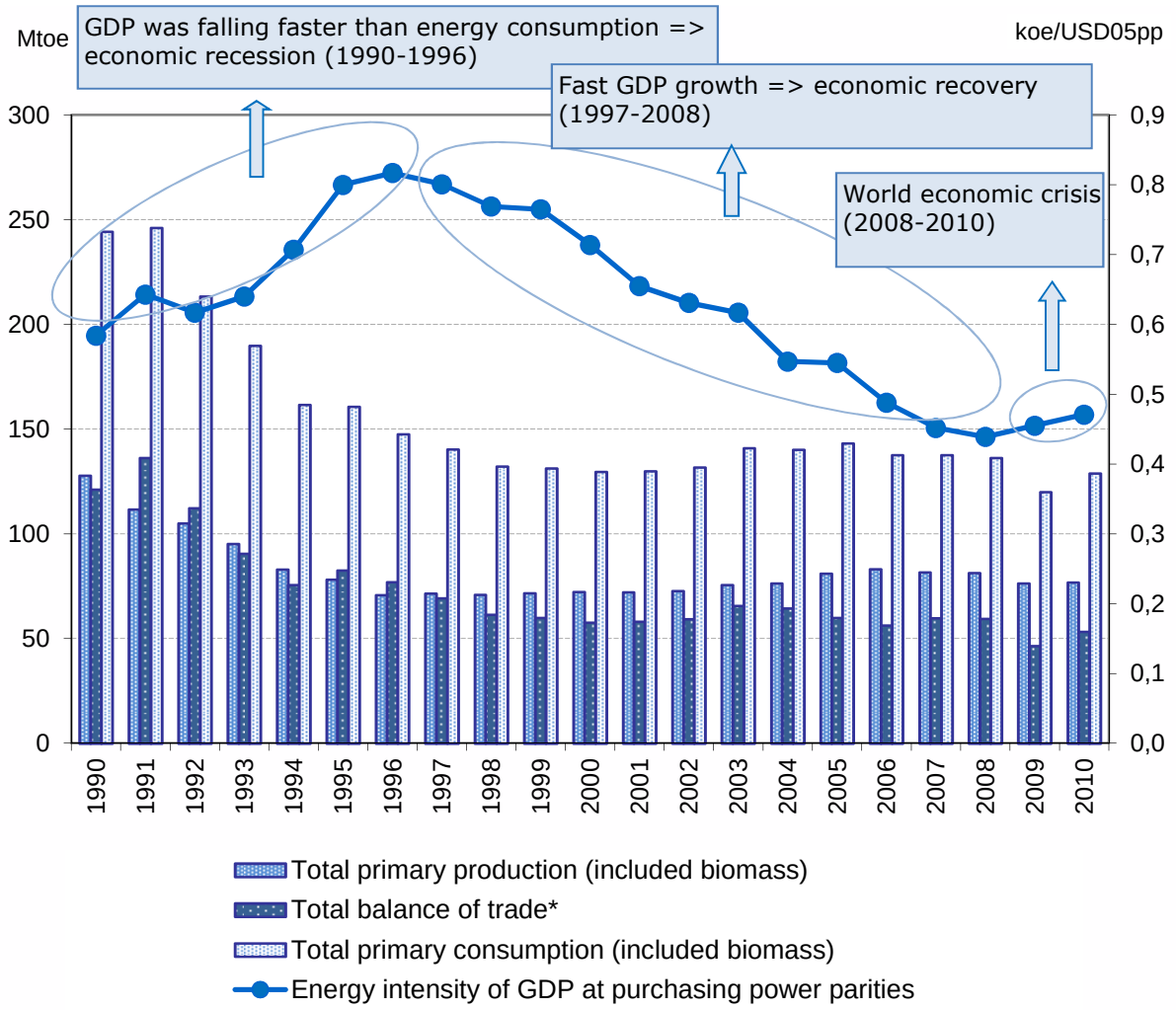
2. Status-quo of energy efficiency in Ukraine

2.1. Primary energy use trends from a macroeconomic perspective

In terms of primary energy consumption Ukraine is ranked number 20 in the world – with the consumption of 118 million tonnes of oil equivalent (toe) of energy in 2010 – while its economy ranked only number 40 in terms of overall size. Ukraine was also the 9th largest importer of natural gas in 2010 (IEA, 2011) – despite a wealth of energy deposits.

Figure 1

Primary energy production, balance of trade*, consumption and energy intensity**



* The trade balance is the difference between imports and exports

** Energy intensity is measured in kilo of oil equivalent per 2005 dollar of output (purchasing power-weighted)

Source: Enerdata Global Energy Statistical Yearbook 2011

As Figure 1 suggests, total primary energy consumption and energy intensity of Ukrainian economy were developing in line with economic growth. The structural economic recession between 1990 and 1996 resulted in a significant decline of demand on primary energy (which fell by over 40% over the period). Indeed, energy intensity – the amount of energy used to produce each unit of gross domestic product (in 2005 USD, purchasing power parity-weighted) – hiked from 0.58 koe in 1990 to 0.82 koe in 1997. This reflects industrial production and economic output falling faster than total energy consumption.

During the period of the economic recovery (1997-2008) the demand for primary energy stabilised at 136 mtoe average level. Meanwhile, energy intensity declined gradually, reaching 0.44 koe per unit of gross domestic product in 2008, as strong economic growth revived and a more efficient industry emerged. However, this was partly reverse through

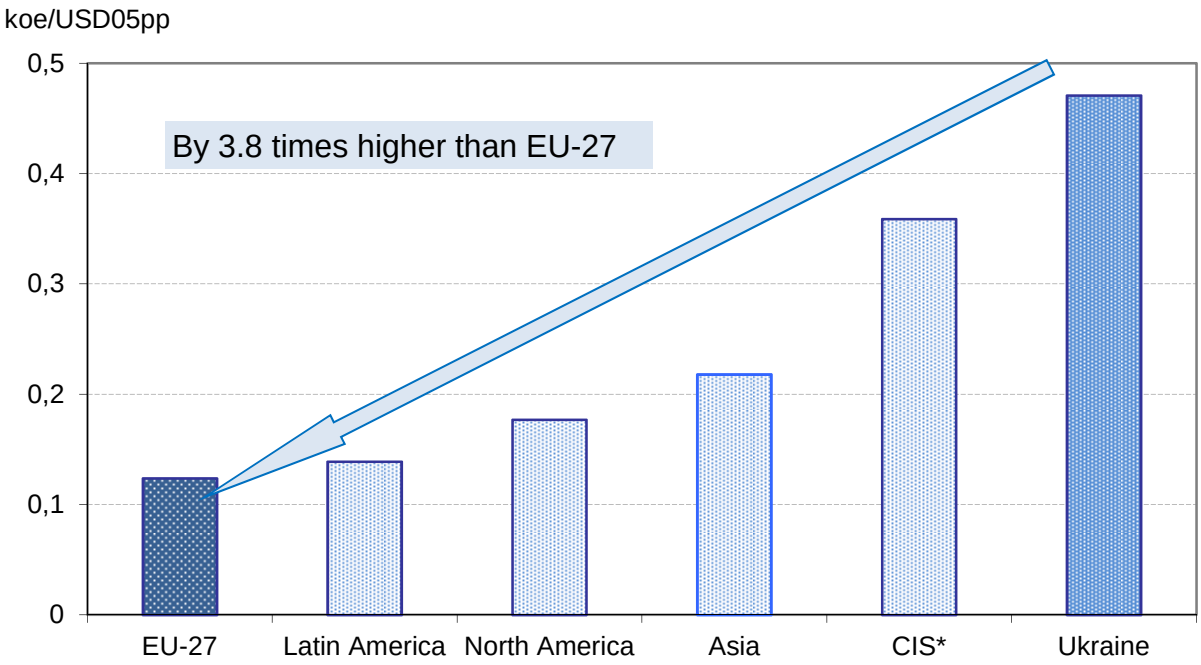
the world economic crisis, which strongly affected the Ukrainian economy between 2009 and 2010, seeing energy intensity increasing again to 0.47 koe in 2010.

Summing up, energy efficiency – as measured by energy intensity – in Ukraine was strongly affected by structural changes in the economy at the beginning of the 90s and high volatility of gross domestic product growth during the period of the economic recovery and subsequent world economic crisis. While energy intensity decreased by 20% between 1990 and 2010 there is strong indication that this has been the result of reduced economic activity as opposed to a concerted effort.

Comparison of Ukraine with other countries in terms of GDP energy intensity

Figure 2

Energy intensity in Ukraine and separate world's regions (as of 2010)



Source: Enerdata Global Energy Statistical Yearbook 2011

Unsurprisingly, as shown in Figure 2, the energy intensity of Ukrainian economy is as much as four times higher than in the EU-27. Moreover, Ukraine has one of the highest energy intensities (and consequently low energy efficiency) compared to other developing regions in Asia and CIS countries. Indeed the country's energy efficiency is one of the lowest observed in international comparison.

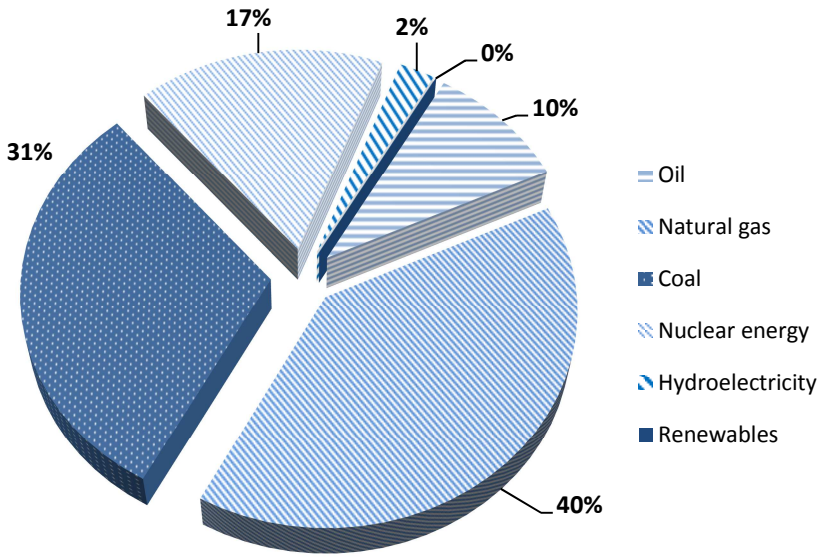
A comparison of Ukraine's energy intensity with other countries suggests that energy intensity in Ukraine can be decreased by at least 55% (compared to the developing Asian region) and by up to 75% (compared to the European Union average).

Structure of energy mix and carbon intensity of GDP

The structure of energy consumption mix in Ukraine is dominated by fossil fuels (oil, natural gas and coal) which constitute 80.4% of total energy consumption.

Figure 3

The energy consumption mix in Ukraine (as of 2010)



Source: BP Statistical review of world energy 2011

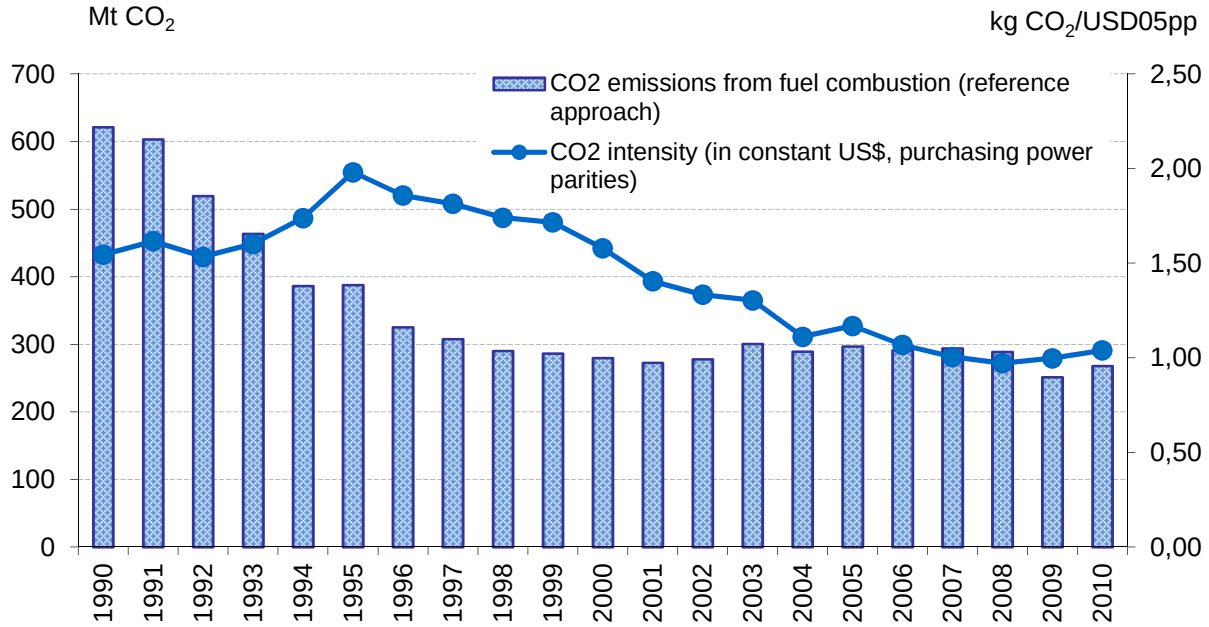
With around 70% of consumed natural gas and almost a half of oil imported from the Russian Federation the prevailing energy mix poses a considerable risk for energy security of the country (as was proven during the winters 2006-07 and 2008-09 when the interruption of Russian natural gas supplies took place after disputes over the gas price).

Furthermore, given the fossil fuel dominated energy mix and inefficient energy production, Ukraine has one of the most carbon-intensive economies in the world. This puts significant pressure the environment and the country's fulfilment of possible future obligations in international carbon reduction agreements.

While Ukraine decreased its CO2 emissions by 30% over the last 20 years (according to Enerdata) it was still ranked as 3rd worst polluter in 2010 in terms of carbon intensity of GDP (with 1.04 kg CO2 emitted per 2005 USD of GDP at purchasing power parity).

Figure 4

Carbon emissions from fuel combustion and CO2 intensity of GDP



Source: Enerdata Global Energy Statistical Yearbook 2011

Summing up, Ukraine heavily relies on fossil fuels to power its economy. With large chunks of it being imported, wasteful energy use causes high import costs to the economy. Furthermore it leads to undesirable import dependencies and poses a threat to energy security. Finally, reflecting the prevailing energy mix and low energy efficiency the country produces more greenhouse gas emission per unit of output than almost any other country of the world. As such it contributes disproportionately to global pollution and hampers its efforts to take part in international agreements on climate change.

2.2. *Improved energy efficiency offers huge economic benefits for Ukraine*

Potential for national, regional and sector energy efficiency

With energy use wasteful as it currently is, the economic benefits of improved energy efficiency are huge. If Ukraine increases its energy efficiency to EU level it could save approx. 27 m toe energy – the equivalent of 34 bn cubic metres of natural gas. Total savings may reach EUR 11.8 bn at 2010 prices, the equivalent of 12% of gross domestic product. Looking at the regional level, the lowest energy efficiency ratings were registered in the highly populated industrial regions of Ukraine (such as the Lugansk, Poltava and Dnipropetrovsk) which feature energy-intensive steel, chemical, mining industries and energy production.

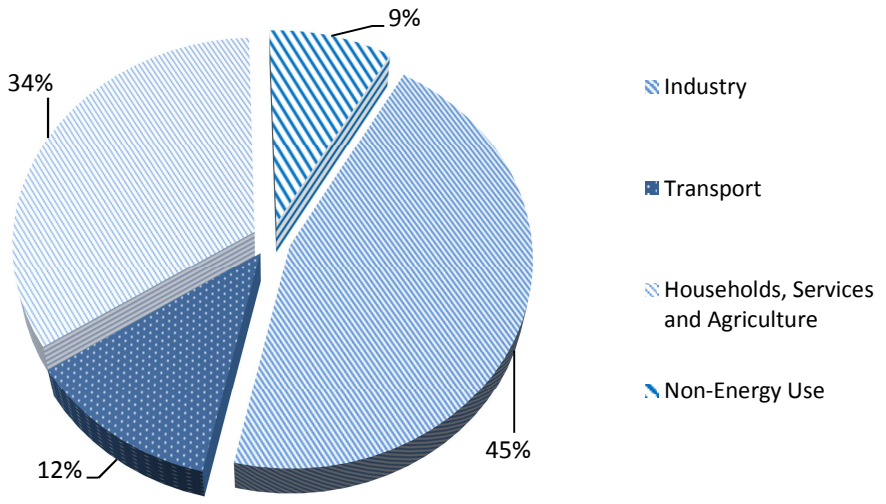
Industry, residential property, utilities and the power sector have the lowest energy efficiency ratings

Heavy industry, residential property, utilities and the power sector have the lowest energy efficiency ratings and therefore will have the largest potential for increased energy efficiency. Indeed, these sectors largely possess outdated technologies along the entire value chain. This partly reflects state interference in ownership and pricing in these

industries which in turn reduce competitiveness. In fact, a wasteful use of resources and lack of implementation of energy efficiency measures is only one aspect of un-competitiveness that characterises large chunks companies in those sectors.

Figure 5

Final energy consumption by sector in Ukraine, 2009

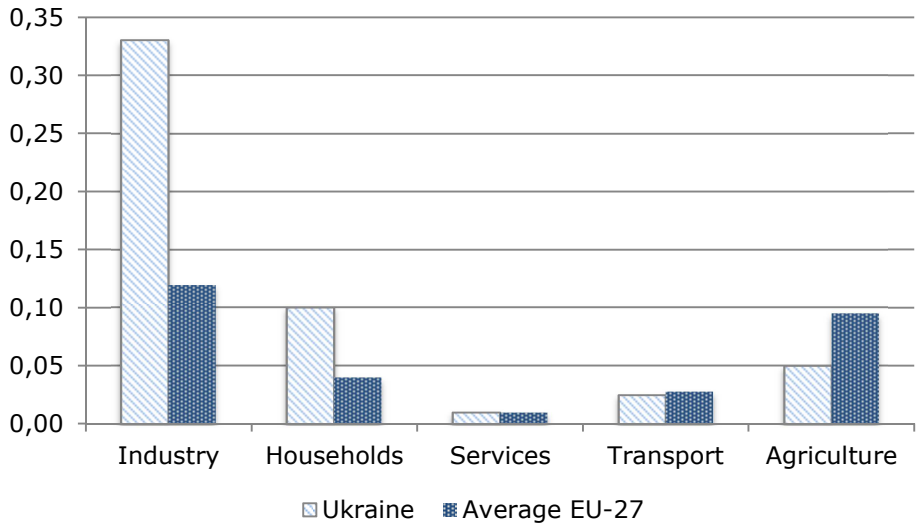


Source: Enerdata Global Energy Yearbook 2011

A closer examination shows that the key source of inefficiency in the industrial sector – which accounts for 45% share of the primary energy use – is the extreme deterioration of production assets coupled with insufficient implementation of modern technologies. For example, the steel industry of Ukraine is considered one of the most energy consuming ones (in terms of energy consumed per 1 tonne of steel produced) due to a prevalence of outdated open-hearth furnaces and consumes almost two times more energy than steel industries in developed economies (Global Energy Efficiency report, 2011). Finally, the absence of monitoring devices and respective automated systems has to be also mentioned as a source of low energy efficiency in the industrial sector (UNECE, 2010).

Figure 6

Energy intensity of different sectors in Ukraine*, 2007



Source: UNECE Report, 2010

* Average project region is the average region in Central and Eastern Europe taken as a basis for comparison

The residential property sector consumes almost 30% of primary energy in Ukraine – although this includes utilities such as heat and power companies. Huge losses of energy are related to centralised district heating companies which operate outdated, poorly insulated and often large distribution networks. Also, a significant part of small- and medium-sized boilers feature a low efficiency factor and are on average older than 20 years. As a result, multi-flat residential buildings consume approximately 40% of the country's heat energy resources. It is estimated that fuel consumption in the heat sector could be reduced by up to 30% by simply improving equipment such as boilers, pipes, pumps, and valves. Further energy savings might be achieved through an appropriate design of plants and effective metering of heat consumption in the household sector (UNECE, 2010). Another reason for low energy efficiency in residential sector is the extremely low number (only 23% according to NERC estimates) of residential buildings that are equipped with individual heat metering and regulation devices. Clearly, not knowing or being able to control heat consumption creates is a huge barrier for households to save heating energy.

The main reason for energy inefficiency in the **power generation sector** can be attributed to the continuing deterioration of the technical and auxiliary equipment, the low quality and high ash content of coal, non-optimal modes of electricity production and distribution, as well as insufficient financing for capital investments. Another source of inefficiency are electricity losses in the grid which accounted for 15% of the total generation in 2006.

The sources of inefficiency in the **transport sector** can be split to the high deterioration of the existing hauling stock, the non-optimal modes of cargo and passenger traffic, as well as the low quality of the road network (UNECE, 2010).

To sum up, the data suggest wasteful energy use across the entire Ukrainian economy. Unsurprisingly, the industrial sector is one the largest consumers of energy, followed by the residential property sector. While the technical factors differ from one sector to the next all sectors are characterised by outdated production technologies and a lack of investment. However, these are only symptoms of the actual lack of energy efficiency. This leaves the question of what the underlying reasons for wasteful energy use in Ukraine are.

3. Barriers to energy efficiency improvements in Ukraine

Addressing the question of why energy efficiency in Ukraine is lacking so drastically behind in international comparison requires an understanding of the barriers to more efficient energy use. From an economics perspective, consumers and companies base their decision of how much energy to use and if to invest in energy saving improvements on the cost of energy. For example, it is efficient for them to reduce their energy use if energy prices rise. Similarly, rising energy prices make investments in energy improvements more profitable. However, for companies and households to make the right decisions about their energy use – and thus energy efficiency – markets need to be allowed to work properly and information need to be complete.

In the Ukrainian context there is strong evidence that consumers and companies cannot make optimal decisions as market are not allowed to function properly due to:

- **Excessive regulation** including state intervention in price setting, cross subsidising and uncompetitive markets
- **Lack of promotion** of efficient energy to overcome so-called market failures in the form of incomplete information, externalities, high transaction costs and lack of financing

Any policy response should directly address these short comings in order to be successful and effective in increasing energy efficiency.

3.1. Reducing market regulation ("the state failure argument")

The key factor responsible for stopping consumers and companies in Ukraine from using energy efficiently is state intervention in energy markets. Any efforts to increase energy efficiency in other areas will fall short as long as these problems are not addressed. The three prominent problems in the context of state failure are:

- Distorted energy prices due to administrative price setting, subsidies and cross-subsidies
- Lack of competition and wasteful energy use due to state ownership, vertically integrated monopolies and subsidies
- Lack of a consistent legislative framework governing property right in the residential sector

The key issue in the context of below average energy efficiency in Ukraine is distorted energy prices. Clearly, in order for consumers to make an optimal decision energy prices need to signal consumers accurately how scarce a resource is. Sadly, this is often not the case in the Ukrainian context since gas, coal, and electricity prices are either subsidised

or set by the public sector. With prices lower than would be warranted by demand and supply in a working market, economic actors have the incentive to consume more than would be the case if prices would be undistorted. Furthermore, with prices kept artificially low there is little incentive for investors to invest in efficiency improvement technology as the return of such investments is too low.

Another issue at the core of wasteful energy use is a lack of competition and administrative meddling in industries along the energy value chain. Indeed, gas, coal, heat and electricity companies are largely state-owned causing large inefficiencies in energy production, distribution and use. Furthermore, price setting is regularly the result of administrative intervention as opposed to contractual agreements and market negotiation.

In conclusion, any attempts to improve energy efficiency in Ukraine need to address the distortion of energy markets due to state intervention and excessive regulation. There is little sense in considering support measures for energy efficiency improvements as long as prices are kept artificially low. Indeed, distorted prices will greatly reduce the effectiveness of promotion measures and, in turn, increase their costs.

3.2. Lack of promoting energy efficiency ("the market failure argument")

Even in the absence of distorting state intervention, a lack of competition and distorted prices, situations exist where consumers and industry fail to enact energy efficiency measures that would be in their interest as well as beneficial for society as a whole.

Such market failures can affect several aspects of economic behavior. They occur when consumers or companies lack the information to make an informed decision, are uncertain about prices or market participants do not face the full costs of their actions (see Box 1).

Box 1

Market failures in the way of efficient energy use

- **Strong discounting** of future energy savings or costs of energy use due to the extreme long investment horizons typical for energy sector investments, uncertainty about energy price developments in the future, lack of a predictable and transparent energy policy.
- **Negative externalities** of global and local pollution are not reflected in the cost of energy use. As such, the costs of this behavior are not considered on an individual level and more energy is consumed than would be in the interest of society.
- **Imperfect information:** Lack of information and/or skills to enact technical options to achieve energy efficiency.
- **High transaction costs:** Even if this information is available it may be costly to acquire by consumers or investors leading to uninformed, suboptimal decisions.
- **Lack of long term financing** leading to an underinvestment in energy efficiency improvements.
- **Asymmetric information** leading to principal agent problems as investors and those that benefit from energy efficiency measures are not one and the same person.

In an ideal world, consumers and investors have complete information about the costs and benefits of their energy use. Yet, in the context of energy use this is often not the

case. For example, a lack of electric, gas and heat metering and flat rate charging of energy consumption means consumers are not fully or wrongly informed about their energy use. Similar examples are the lack of energy consumption indicators for properties allowing tenants to estimate future heating and electricity costs. A lack of information can also concern missing awareness of existing technical or behavioral options that can lead to a reduction in energy consumption.

For industrial users this lack of information could be reduced through offering technical consulting or energy audits – potentially in connection with co-funding. The "Ukraine Energy Efficiency Programme" (UKEEP), although yet small in funding, has highlighted the substantial economic benefits that can be achieved through such a combined strategy (UKEEP, 2011). Additionally, a lack of credible, transparent and predictable government policy can also constitute a lack of information for investors reducing the incentive to make long term investments in energy efficiency improvements (see Appendix A - Current government policy in field of energy efficiency for a review of the status quo of policies).

Finally, given the long term nature of energy efficiency investments, a lack of suitable financing instrument is also a major factor that inhibits improvements in energy efficiency in Ukraine. While it will be difficult to overcome the more fundamental underlying problems in the short term (such as high inflation and corresponding interest rates) initiatives such as public private partnerships aiming at providing investment support can help to overcome some of the bottlenecks. A positive example here are European Bank for Reconstruction and Development loans totaling €34 m to finance government-backed UkrESCO, and a €6.8 m loan to privately owned Energy Alliance. Both companies provide advice and financing to mid-sized Ukrainian firms seeking efficiency improvements to cut costs and improve productivity (EBRD, 2011). Appendix B – International financial support provides an overview of the international finance sources that are available in this context).

Table 1

Barriers to improving energy efficiency in Ukraine

Factor inhibiting energy efficiency improvements	**Specific factors in the Ukrainian context**	**Top level policy response**
Government failure and market imperfections	• Vertically integrated (state-owned) monopolies und thus uncompetitive energy providers in gas, oil, coal and electricity industries • Subsidies prices for gas, coal, electricity amounting to 4.7% of GDP in 2009	• Continue market liberalization programme • Removal of subsidies, means-tested support for households • Abolish administrative price setting
Lack of a consistent, predictable political strategy	• State Program of Social and Economic Development lack consistent strategy and transparent targets	• Development of a policy strategy, definition of national targets
Incomplete Information	• Lack of consistent energy efficiency labeling of buildings, cars, white goods • Metering of energy use • Fluctuation in energy prices • Lack of awareness of technical options	• Mandatory heat and electricity metering • Energy efficiency labeling • Awareness raising of efficiency measures, technological options
Externalities	• Over consumption as emitters do not face the cost of local and global pollution	• Technical standards • Carbon pricing or finance initiatives • Taxation of emissions
High transaction costs	• Lack of gas, electric and heat metering makes it expensive to inform energy use	• Raising public awareness • Mandatory energy audits for energy intensive industries • Public Private Partnerships • Free energy saving consulting for energy-intensive industries • Support of ESCO and ESP
Asymmetric information	• Principal Agent problem in owner-occupier properties • Residential and commercial property lack of control over energy use	• Regulating rent increase for efficiency improvements • Efficiency labeling of properties • Clarifying property rights
Lack of access to long term financing	• High inflation and interest rates impede long term financing markets • Legislative hurdles preventing housing associations / home management companies from access loan finance	• Co-funding of energy efficiency investments • Tax allowances, subsidies • Loan guarantees • Legislative changes to facilitate loan supply to property owners

Source: Own analysis based on EBRD 2011, OECD 2011

To sum up, a mix of misguided market regulation and lack of incentives due to market failures can be identified as the underlying reasons for the punishingly high energy intensity in Ukraine. De-regulating energy markets, fostering competition and removing distortions of prices is a vital pre-requisite for any further attempts aiming at improving energy efficiency. If those problems have been addressed energy efficiency measures should also seek to reduce market failures such as incomplete information, lack of financing, externalities from pollution, etc. In the following section we discuss what policy instruments are at policy makers' disposal to remove the barriers to efficient energy use in Ukraine.

4. Selecting policy options to promote energy efficiency

4.1. Policy options

Several policy instruments are available to implement measures aiming at increasing energy efficiency (IFEU 2005). Indeed, as policy makers can select from a considerable range it makes sense to provide an overview of the three main categories (Jaenicke et al, 2003) that these can fall into:

- Regulatory instruments (requirements, standards, rules including strategy and planning)
- Information and awareness building
- Economic and monetary instruments

Regulatory instruments

Regulatory instruments have the strongest impact on the freedom and ability of households and companies. Typical measures of this group are requirements, bans and rules which set maximal accepted quantities of emissions, limits for energy inputs for production processes or minimal thermal coefficients for buildings. While, this kind of instrument has to be implemented into the law and needs a high effort of enforcement and controlling for the authority, it has no direct impact on the fiscal balance of the government. However, this does by no means mean that they have no costs.

Accompanying these regulatory instruments strategy and planning instruments can be chosen to formulate objectives in regard to the development of sectors, regions and social fields. Examples for such instruments are plans for waste management, water management, and construction planning and landscape designs. For the topic of energy efficiency these instruments have lower importance.

Information and awareness building

Instruments of this type try to increase the knowledge of the society in respect to environmental problems, energy saving and efficient use of resources. Such measures can be supported by other instrument - for example, energy audits can be provided in combination with co-funding for efficiency improvements. As such, they address the problem of high transaction costs and incomplete information which prevent economic actors to make optimal decision in the context of efficient energy use. Additionally, information measures and awareness building can be used to increase the acceptance for governmental activities and promote awareness of long term targets and providing planning certainty for investors.

Economic and monetary instruments

Economic and monetary instruments – such as taxes, subsidies, allowances, and so forth – try to influence the traded and consumed quantities of goods and/or services, i.e. energy. The impact of this group of measures is relatively high because of the direct intervention into prices.

Taxes, duties, charges and licences on the use of resources can generate revenues for the government. Each instrument increases the price for the consumption of a resource,

which leads to a decrease in demand. The construction of the instrument defines how accurate a regulation would be possible.

In contrast, the use of energy efficient goods and technologies can, for example, be subsidised through premiums, tax exemptions and price subsidies on the demand side. Investment in energy saving equipment can be supported through investment supports (e.g. low interest loans) and/or tax allowances.

The decision of which instrument is chosen depends on the ability to achieve the target, its effectiveness, the costs of implementation to the various stakeholders, interdependencies with other measures and political acceptance. Such an evidence-based policy decision can use a cost-benefit analysis and combined economic impact assessment.

4.2. Finding the optimal policy response

A large number of policy measures are potentially available to promote energy efficiency. Depending on the kind of policy tool considered the effectiveness and the cost to the government, households and companies can differ substantially – benefitting one group but leading to cost for the other one. As such, the implementation of policies should follow a thorough assessment of the costs and benefits to society. Only measures for which the benefits to society exceed the corresponding costs should be implemented. Given the importance of the energy sector and energy consumption to the economy such an assessment should also contain an analysis of the economic impact arising from the policy change.

Identifying if a measure is beneficial for society

A well-established method to evaluate policy interventions is the cost-benefit-analysis. As the name suggests, the costs and benefits of a potential policy are estimated and compared. As with any other investment, only if the benefits of a policy exceed its costs the policy should be implemented. In this context it is important that the cost-benefit-analysis is comparing the expected outcome of the policy to the business-as-usual case (without any policy).

One can also look at the net economic benefit at different levels such as for individual households, regions, or the nation as a whole. This disaggregation is important because many of the costs and benefits vary depending on fuel use patterns and local prices of energy and construction materials, on top of the climatic variations in different regions. Considering if an intervention is beneficial at individual households or company level can draw on a simple net present value analysis (see Box 2).

Box 2

Net present value approach

The net present value approach – an instrument in finance – compares the sum of annual cash flows (present values) of one activity with the initial investment which occurs at the beginning of the planning period.

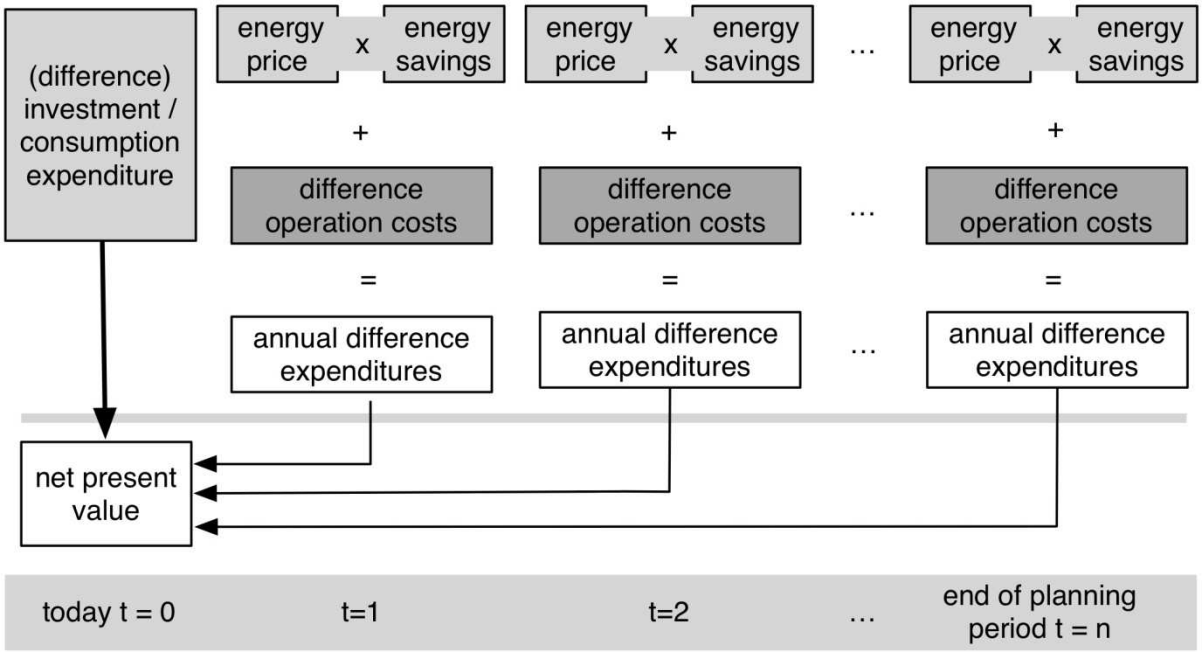
A) Initial investment can result from the installation of a new technology or equipment (e.g. isolation of buildings, new heat generation plants, windows). The expenditure of this occurs usually at the beginning of the planning period (t=0) and is often financed over loans, which lead to interest payments.

B) Over the whole planning period changes in the effort of using the equipment (may) lead to higher or lower operation costs – e.g. maintenance costs.

C) Monetary savings are possible due to smaller expenditure for energy. Obviously energy prices in the future are uncertain; therefore expectations on future price developments have to be taken into account. Figure 7 highlights the procedure of the net present value approach.

Figure 7

Net Present Value Approach



Source: Own analysis

The difference between the net present value of the annual expenditures and the investment amount gives the overall profitability of an investment or an energy efficiency measure. If the initial costs are lower than the net present value of the future savings, an activity is profitable and vice versa. This approach enables the possibility to compare energy efficiency measures and rank them according to their profitability.

On national level, a cost-benefit-analysis should also capture indirect impacts and external costs (such as the benefit of avoided environmental damage). In the context of energy efficiency measures the following main impacts should be considered:

- Consumer expenditure on energy (consumer welfare approach)
- Company income changes (producer rent)
- Tax revenue changes
- Changed subsidy expenditure
- External cost of energy use (emissions and environmental damage)

In situations where a policy measure is likely to have considerable economic ramifications it is also valuable to assess the impact on the economy – such as economic output, income distribution, consumption, investment and employment. Indeed, given the considerable importance of the energy sector to the economy it is likely that polices such as tax changes, removal of subsidies, de-regulation, etc. may have a significant impact on production and consumption patterns and in turn overall welfare of society. Suitable economic modelling should be employed to estimate the effects that can arise here. Within institutions such as the World Bank, OECD and others it is standard practice to employ dynamic economic models for such tasks. Given the structural changes that can be caused by significant changes to energy prices this should ideally utilise general equilibrium models that are able to simulate adjustments in economic behaviours.

To sum up, with the cost-benefit-analysis a proven methodology is available that can assess if an efficiency measure is profitable. Given constrained budgets policy makers can judge which policy instrument provides the best return on investment. In addition, it is good advice to assess the wider economic impact a significant policy measures can cause prior to its implementation.

5. Conclusions

The Ukrainian economy uses disproportionately more energy than its counterparts in Europe and other transforming economies around the world. The costs have become ever more evident in high import costs, a lack of energy security, uncompetitive industries and environmental damage. As such, improving energy efficiency makes sense from an economic as well as an environmental perspective.

However, understanding the current barriers to energy efficiency in the Ukraine is essential for formulating a consistent and effective policy response. Our analysis suggests that the factors for low energy efficiency can be grouped into two areas:

(1) Excessive market regulation that prevents energy market from working properly and (2) a lack of promotion of energy efficiency.

Addressing over-regulated energy markets can go a long way in increasing energy efficiency.

Indeed, as long as energy prices in Ukraine are kept artificially low, households and firms have little incentive to invest into energy efficiency measures and stop wasteful energy use. Therefore, increasing energy efficiency should focus on:

- Energy markets should be further de-regulated and price distortions removed.
- Price setting should be the result of negotiations between market participants and not of administrative meddling.
- Shifting market power from the hands of a few, state-owned, vertically-integrated companies to competitive market incumbents.

In addition to making sure that markets are allowed to work freely the state should consider how to promote energy efficiency further. Such measures should address market imperfections and market failures that prevent households and companies from using energy in an efficient manner. To name only a few measures, this could entail:

- Addressing imperfect information through mandatory labelling, energy audits, a transparent and predictable energy policy, energy savings consulting, etc.
- Providing additional long-term finance through co-funding, loan guarantees and reduced interest loans, tax allowances, etc.
- A clear definition of property rights in the residential property sector.
- Making sure that market participant price in the cost of environmental damage and other external costs of energy use.

Both imperfect market regulation and promoting energy efficiency by addressing market failures require a consistent energy policy strategy. This should entail formulating an overall objective and more specific aims that are consistent with the overall objective. Additionally, clear, transparent and well-defined targets help to create a predictable policy environment which provides planning certainty for long term investments in energy efficiency technology.

Ukraine has to assess which policy options are beneficial for households and companies as well as for society as a whole.

In order to provide best value for money for taxpayers an 'evidence-based' policy response should be employed. That is, policy proposals should undergo an analysis of the micro- and macroeconomic effects through a rigorous cost-benefit analysis and macroeconomic modelling. This should entail an assessment of (undesirable) interdependencies between existing and planned policies.

While the data emphasise the need for action, it is also a reminder of the great economic potential energy efficiency improvements hold in store for Ukrainian economy. Additionally, international financial institutions, the German government, European partners and the Kyoto mechanism provide financial resources that can be tapped into in this context. However, the Ukrainian institutions will have to show that they are able to use the funds effectively and responsibly and have done their homework in terms of formulating a consistent energy policy.

Understanding the barriers of energy efficiency and how to best address them is therefore the key to unlocking this potential.

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Appendix A - Current government policy in field of energy efficiency

Given the need for action that has become evident in the empirical data, we have reviewed which government strategy is currently in place in Ukraine to address the issue of low energy efficiency. Indeed, given the complexity of the task it is vital that the policy response is based on consistent policy strategy that follows predictable and transparent targets.

Targets and strategies not yet following a consistent policy

However, our research suggests that presently Ukraine lacks such a clear and consistent strategy for promoting energy efficiency at national, regional and sector level. Indeed, while some goals and targets relating to energy efficiency are defined at different government levels more should be done.

At central government level three initiatives a worth pointing out:

1. The "State Program of Social and Economic Development for 2013-2014" envisages an annual decrease of natural gas consumption in the industrial sector and utilities through energy savings in and the replacement of natural gas by alternative fuels.
2. The "Economic Program for Energy Efficiency and Renewables and Alternative Fuels Development for 2010-2015" targets are 20% reduction of energy intensity compared to 2008 (implying a 3.3% decline annually) including decreasing natural gas consumption by 20%.
3. The "Energy Strategy" from 2006 envisages a 51.3% reduction of energy consumption in 2030 compared to 2006-levels. Related to GDP it is planned to reach an energy intensity of 0.24 kg of standard fuel per UAH in 2030 which implies an annual 4-6% reduction of energy content in GDP over the period (Energy Strategy, 2006).

   The draft version of the new Energy Strategy, however, does not contain any targets for energy efficiency – although it specifies a decline of total electricity consumption to 63TWh by 2030 (Energy Strategy draft, 2011).

Summing up, the Government targets are not developed as the comprehensive and consistent system aimed at increasing energy efficiency. Instead, the government programmes concentrate mostly on reducing natural gas consumption. Also, the measures specified are too broad to provide meaningful guidance (e.g. "increase of energy saving" or "changes in country's energy mix"). Moreover, the targets of energy intensity decrease are not linked or consistent with carbon dioxide emission reductions.

Regulatory framework

The cornerstones of the current regulatory framework for energy efficiency are the "Law On Energy Saving" , the "Law on Alternative Energy Sources" and the "Law on Alternative Fuels", supported by various other regulations.

Contrary to the development of alternative energy sources the energy efficiency measures are weakly supported in national legislation. At the level of law only the Law of Ukraine "On Amendments of the Certain Legislative Acts of Ukraine in Regard to Promotion of the Energy Saving Measures" was adopted envisaging tax and duty

preferences for import of the energy efficient equipment. But the list of such equipment is developed by the Cabinet of the Ministers manually without setting the stringent characteristics that made these provisions inefficient in practice.

However the general view is that the regulatory framework taken as a whole is insufficient to ensure effective regulation of the energy efficiency in Ukraine. In order to mitigate the gap in national legislation several draft laws were elaborated and registered in parliament: the most recent draft "On Effective Usage of Fuel and Energy Resources"[1] and the draft law "On Energy Efficiency"[2], both aim at establishing fundamental legal basis for energy efficiency, ensuring economic and organisational conditions for effective and money-saving usage of fuel and energy resources.

Unfortunately, these draft laws are mainly of a declarative character and need to be further improved. This concern in particular the establishment of basic national standards of energy resource usage, a measurement system for energy efficiency and more stringent economic sanctions for violation of energy efficiency than those set forth in the current version of the "Law on Energy Saving" (Integrites, 2010).

Evaluation government funding for efficiency improvements

Total funding of energy efficiency measures between 2005 and 2010 reached UAH 26.8 bn, consisting of UAH 1.7 bn from state budget and UAH 16.4 bn from private investment. The 2011 budget envisaged UAH 900 m but actual expenditure was only UAH 100 m. In comparison, the total investment demand in energy efficiency has estimated to amount to UAH 35-40 bn for 2012.

Appendix B – International financial support

In general international financial support for investments in energy efficiency and energy savings in Ukraine are dispersed by the number of the small projects. The largest donors in this field are international financial organizations (IFI) that either support local initiatives as part of development programmes or develop own specific programmes for Ukraine. The initiatives aim at improving energy efficiency in small and medium sized (SME) industrial enterprises and local utilities companies owned by municipalities.

[1] No. 6212 as of 19 March 2010

[2] No. 5016 as of 23 July 2009

Table 2

Major current international financial support programs in Ukraine in field of energy efficiency

Provider of support	Name of the current/planned program	Duration	Funding	Priorities
EU	Direct support of Ukrainian budget energy efficiency programs (through NAER)	From October 2011	EUR 31 m in Oct-2011; EUR 70 in 2011-2013	Mainly energy saving technologies in public sector
EBRD	UkrESCO	Current	EUR 34 m	Industrial SME
	Energy Alliance	Current	EUR 7 m	Co-generation equipment
	UKEEP	Current	USD 105 m	Industrial SME
UNDP	Transforming the Market for Efficient Lightning	2010-2015	USD 31 m	Public entities and residential buildings
USAID	Municipal Heating Reform Project (MHRP)	Current	USD 16 m	Local heat companies

Source: EUEA, 2011; Web-sites of indicated IFOs

The EBRD has the longest history of supporting energy efficiency projects in Ukraine. One of the first projects of the bank in this field was the establishment of so-called "Energy Service Companies". UkrESCO (the network of service companies) and Energy Alliance used EBRD loans for investing in energy saving projects. The EBRD provided two tranches of loans amounting to USD 50 m in 1998 and again in 2005 for UkrESCO and USD 10 m for Energy Alliance in 2003.

While Energy Alliance used the EBRD loans to finance the purchases of co-generation equipment by Ukrainian companies, the UkrESCO successfully implemented 24 energy saving projects in different industries, primarily in the fields of co-generation, replacement of outdated equipment and modernisation of heat and cold supply systems. The projects' cost usually ranged between USD 200,000 and five million with project payback periods of 1-4 years (UNECE, 2010). Currently, the EBRD has extended two loans totaling EUR 34 m to finance government-backed UkrESCO, and a EUR 6.8 m loan to privately owned Energy Alliance.

One of the largest programmes of the EBRD in the field of energy efficiency is called **Ukraine Energy Efficiency Programme (UKEEP)** and is designed for providing loans and technical assistance for small and medium-sized companies through selected Ukrainian banks. As of March 2011, UKEEP has committed approx. USD 105 m to energy efficiency projects in various sectors. Also, the EBRD provided a number of significant loans to for energy efficiency projects in large industrial enterprises, power companies and public utilities supporting their efforts in modernizing outdated equipment.

The World Bank cooperates with Ukraine in the framework of several mechanisms, including the

- *Carbon Partnership Facility* (with capitalization of USD 5 bn) with its two structural units: Carbon Assets Development Fund and Carbon Fund, as well as

- the *Climate Investment Funds* (Strategic Climate Fund and Clean Technology Fund)
- Additionally the World Bank started the *Energy Efficiency Project* which is a credit line with sub-lending through two national banks. The total amount of loans is USD 200 m which will be provided until March 2016 (WB, 2011).

The United States Agency for International Development approved financing for energy efficiency projects in the Ukrainian industrial sector. However, due to restrictive requirement of USAID towards the applicants the uptake was low (UNECE, 2010).

Currently USAID also assists 36 municipalities across Ukraine with the *Municipal Heating Reform Project (MHRP)* which provides USD 16 m over three years.

The European Union started supporting to Ukrainian energy efficiency programmes only recently due to inconsistence of Ukrainian legislation to EU regulation. It was announced that Ukraine will receive the first tranche of financial assistance amounting to EUR 31 m in late-2011 for implementation of energy efficiency programmes - primarily in the public sector. Over the 2011-2013, Ukraine expects to receive further EUR 70 m in EU funds, including EUR 18 m in 2012 and EUR 21 m in 2013. Of these, EUR 63 m are to be spend on the energy efficiency programmes and EUR 7 m on technical assistance (NAER, 2011).

The United Nations Development Programme is currently conducting a targeted project called "Transforming the Market for Efficient Lighting" aiming promoting new efficient lighting technologies and a gradual phase-out of inefficient lighting products in residential and public buildings. Total funding for the project is USD 31 m over the 2010 – 2015 period.

In conclusion, international financial support plays an important role as a source of funding for energy efficiency projects in Ukraine - especially for those sectors with limited access to financial markets (e.g. SME and public utilities companies). Additionally, international support often also entails knowledge transfer access to technical consulting. However, despite the considerable investments provided, international support cannot replace functioning domestic markets and relieve the Ukrainian government from creating an environment that provides the incentives to invest in energy efficiency technology.

Appendix C – Energy saving technology options

There is a wide variation of possible technology options aiming at increasing energy efficiency. Due to replacement of old equipment (e.g. pumps, engines, white ware like refrigerators) energy consumption can be reduced substantially. Technology options can be differentiated in respect to the energy type which would be saved – namely, electricity, heat, fuel, and comprehensive technologies.

Every technology option can also be applied to different sectors. In Table we highlight possible efficiency measures providing an overview of which technology is applicable in for specific applications. We also indicate of the measures are likely to generate major or minor savings.

Several measures require the implementation of further measures to work effective, e.g. insulation of houses is ideally combined with installation of new windows. Therefore every measure has to be evaluated in respect of complementary applications of further measures.

Table 3 Example for the description of a measure matrix

		private	industries			SME´s			public institutions		
			various	power generation	food industry	various	hotel and catering	agri-culture	various	schools	hospitals
Electricity	optimisation electricity transmission			o	o		o				
	replacement of white goods	x									
	energy efficient entertainment electronics	x					o				
	optimisation street lighting								x		
	energy efficient computers and IT-equipment	x									
	energy efficient lighting	x	x			x			x		
	energy efficient cooling and air conditioning	x	x			x			x		
	Replacement of inefficient trams								x		
	Engines: optimisation of demand							o			
	Engines: reduction of engine no-load lost			o				o			
	Engines: recovery of energy			o	o			o			
	Engines: optimisation efficiency	x	x			x					
	Engines: reduction mechanical loses			o				o			
	Engines: optimisation load transmission			o							
	Engines: replacement inefficient engines		x			x					
	replacement inefficient pumps	x	x			x		o	x		
Heat	insulation of buildings	x	x			x	o	o	x	o	o
	replacement of windows and doors	x	x			x					
	replacement of heating	x	x		o	x	o		x	o	o
	optimisation heat management	x	x		o	x	o		x	o	o
	replacement of water boiler	x	x		o	x	o	o	x	o	o
	optimisation thermic processes	x	x			x			x		
	utilisation of waste heat		x	o	o	x	o	o			
	reduction of room temperature	x	x			x			x		
Fuels	replacement inefficient cars	x	x			x		o			
	optimisation fuels		x			x					
	optimisation vehicle use	x	x			x		o			
Other	reduction of waste	x	x			x			x		
	recycling of waste	x	x		o	x	o	o	x		o
	optimisation fertilisation					x		o			

Source: Own presentation, x – measure applicable for the whole sector, o – applicable for specific sub-sectors

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