3rd Project Report

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Project

“Capacity Building for Low Carbon Growth in Ukraine”


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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AAU</td>
<td>Assigned Amount Unit</td>
</tr>
<tr>
<td>BAU-scenario</td>
<td>Business-as-usual scenario</td>
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<tr>
<td>CAGR</td>
<td>Compound Annual Growth Rate</td>
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<tr>
<td>CP1</td>
<td>First Commitment Period (Kyoto Protocol)</td>
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<tr>
<td>CP2</td>
<td>Second Commitment Period (Kyoto Protocol)</td>
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<tr>
<td>ETS</td>
<td>Emissions Trading System</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GHG</td>
<td>Greenhouse Gas</td>
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<td>LCD</td>
<td>Low Carbon Development</td>
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<tr>
<td>LULUCF</td>
<td>Land Use, Land-Use Change and Forestry</td>
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<tr>
<td>MAC</td>
<td>Marginal Abatement Cost</td>
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<tr>
<td>QELRO</td>
<td>Quantified Emission Limitation or Reduction Objective</td>
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<tr>
<td>UAH</td>
<td>Ukrainian Hryvna</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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Executive summary

This report contains the following outputs of the work in the project:

1. Draft of Sectoral Economic Analysis - development of the specific forecasting models of certain sectors Ukrainian economy (energy, heat supply, etc), including incorporation of available sector-specific MAC curves
   Technical Paper No. 2 extends our work on the sectoral analysis in the industry. This approach is based on international benchmarking and aims to identify environmentally sustainable and economically viable technology options for each of the key industrial sectors in Ukraine. Presented results concern the non-metallic minerals industry and the chemical industry.

2. Second short analytical paper on economic analysis of policy options to support low carbon policy analysis.
   Specifically, we focus on relevant official program documents and the corresponding policy potentials suggested in literature.

3. Draft impact assessment of identified policies and measures at the macroeconomic and sectoral levels; development of BAU economic scenarios of Ukraine’s development to 2020 and 2050, including but not limited to official government forecasts and development strategies.
   Specifically, we develop BAU economic scenarios till 2020 and 2050 for main economic indicators, energy use and GHG emissions, based on existing official strategies of the Ukrainian government and other consistent forecasts.

4. Short-term, ad hoc expertise and consulting to decision-makers and key stakeholders for current topics on the political agenda
   Policy Paper No. 3 gives an assessment of the implications of the latest round of climate talks in Doha for Ukraine.

5. Draft concept of a low carbon development plan of Ukraine setting out a vision of the country’s new development path to 2020 and 2050.

1. Introduction

This is the third report prepared by the consultants of DIW econ in the frame of on-going project on development of a low carbon growth strategy for Ukraine. The project was commissioned by UNDP and is funded under the international climate change initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. The project is jointly implemented by DIW econ and Thompson Reuters. The beneficiaries of the consulting services are the State Environmental Investment Agency (SEIA) of Ukraine and the Government of Ukraine.

The project aims to strengthen the institutional capacity of Ukraine to design and implement long-term policies and measures directed at reducing emissions of greenhouse gases and enhancing absorption by sinks. In particular the project will support the Government of Ukraine in developing a low emission pathway for Ukraine's long-term economic development. To this effect, the project will:

- Develop new generation GHG models and comprehensive projections of GHG emissions;
- Prepare the concept of Ukraine's low carbon growth strategy until 2020 and 2050;
- Prepare an enabling environment for the introduction of a domestic emissions trading scheme in Ukraine;
- Improve the measurement, reporting and verification of greenhouse gas emissions;
- Strengthen the institutional capacity to implement climate change policies in Ukraine.

The third report by DIW econ summarizes the work done on:

- Identifying environmentally sustainable and economically viable technology options for emission reduction in the non-metallic minerals industry and the chemical industry of Ukraine
- Analysis of the recent official program documents and policy options
- Development of BAU economic scenarios till 2020 and 2050 for main economic indicators, energy use and GHG emissions, based on existing official strategies of the Ukrainian government and other consistent forecasts
- Assessment of the implications of the latest round of climate talks in Doha for Ukraine
- Drafting the concept of a low carbon development plan of Ukraine setting out a vision of the country’s new development path
- Drafting an outline for the economic assessment of a domestic emissions trading system
2. Sectoral economic analysis

The consultants reported the findings of a detailed sectoral analysis on GHG mitigation potential in the non-metallic minerals industry and the chemical industry of Ukraine (Technical Paper No. 2 “Benchmarking for sustainable and economically viable technology options: selected industries in Ukraine”). The executive summary of the paper is presented in this section.

To determine green growth potentials in Ukraine a detailed sectoral analysis is necessary. This includes assessing the economic viability and the environmental sustainability of the different sectors. The focus of this paper is on the chemicals and chemical products industry as well as on the non-metallic mineral products industry in Ukraine.

The presented international benchmarking approach identifies the countries that have the best combination of sustainability and economic viability. That will take into account comparing the performance of:

- **High** levels of *desired outputs* such as production volumes (in physical unites) or revenues (values),
- **Low** levels of *undesired outputs* like GHG emissions or pollution, and
- **Low** levels of *factor inputs* like labour or energy use as well as other arising production costs.

Based on detailed analysis of the structural characteristics of the industries, feasible peer countries for Ukraine are identified. As a result, a technological yardstick allowing to quantify the potential for reducing greenhouse gas emissions is determined for each sector. For the non-metallic mineral products industry a full realisation of this potential would result in abating **8.2 Mt of CO₂ equivalents per year**. For the chemicals and chemical products industry our analysis shows that there is an emission savings potential of at least **1.3 Mt of CO₂ equivalents per year** through technical improvement. The analysis also shows an additional emission savings potential through scale adjustments. However, to identify this potential further research is needed.
3. Second economic analysis of policy options to support low carbon policies

3.1 Introduction

In 2008, direct GHG emissions made by industrial enterprises comprised more than 30% of total emissions in Ukraine, not including indirect emissions through industrial electricity use. Therefore, an analysis of potentials for emission reductions in industry should be an important part of a low-carbon development plan for Ukraine.

In the following we aim to review the existing policy proposals for future development in Ukraine’s industry.

We proceed as follows. First, we present the official GHG emission forecast and list the policy goals announced by the government. Then, we compare these options with the other recent proposals. In particular, we take the NERA report (NERA Economic Consulting, 2012) as the most comprehensive reference for our analysis.

The analysis shows that the current policies of Ukraine are not well coordinated and do not rely strongly enough on exploring the existing high potentials for energy saving in industry. The conclusions offered in this chapter are preliminary though; the issue has to be analysed in more detail based on sound empirical modelling, which is envisaged for the course of the current project.

3.2 Status quo and the planned policies in industry

At present, the expectations and plans about the development of the Ukrainian industry, its future energy demand and corresponding GHG emissions are very contradictory between different governmental bodies.

The latest official forecast of GHG emissions, which was published in 2009, envisaged that the emissions from industrial enterprises would rise – over the period 2010-2017 they would grow with the average rate of 5.7-6.0% per year, depending on the scenario (“3rd, 4th and 5th National Communication of Ukraine to the UNFCCC”, 2009). According to the National Communications, if cost-effective emission reduction measures are undertaken by industrial
enterprises, the potential emission reduction would reach 18.6 million tons of CO2-equivalents. If advanced measures, which would specifically target emission reduction, are undertaken, the potential for emission reduction would add another 4.9 million tons of CO2-equivalents (see Figure 1).

**Figure 1: GHG Emissions by the Ukrainian industry, million tons of CO2-equivalents**

![Graph showing GHG emissions over time](image)


In early 2009, the Ministry of Industrial Policy of Ukraine adopted “The Programme for Energy Efficiency and Energy Saving in Industry until 2017”. The Programme aims to bring the energy intensity of industrial processes to the standards of developed countries, particularly the EU.

The Ministry recognises that the successful achievement of this goal would considerably help to secure energy independence of the country and to decrease imports of fuels. It is expected that substantial investments into energy efficiency will be made by industrial enterprises from their own funds or will be facilitated by bank credits; resources of the state budget would only cover the relevant research and development activities. The energy demand by industrial sectors and the corresponding energy saving goals are presented in Table 1.

According to the *Programme for Energy Efficiency*, upon implementation of the envisaged measures, the demand for primary energy by the three key emitting sectors – metallurgy,  

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1 The Programme entered into force with the Order of the Minister of Industrial Policy of Ukraine No.152 from February 25, 2009.
2 At present, energy intensity of Ukraine’s industry is 0.5 kg of oil equivalent per USD. This is 2.6 times more than the international standards (0.21 kg per USD) Source: “The Programme for Energy Efficiency and Energy Saving in Industry until 2017” (p.4) High energy intensity is often claimed to be one of the reasons for the economic crisis in the 1990s.
3 In 2010, energy import dependency ration was almost 40%. Source: OECD/IEA (2012).
machine building and chemistry – would grow with an annual rate of 0.93%. Evidently, the development of the Programme has not been coordinated with the team of experts, who were responsible for the preparation of the National Communications to the UNFCCC, where even the most optimistic scenario of future industrial emissions does not rely on an assumption of such high energy efficiency improvement in industry.

Table 1: Programme for Energy Efficiency and Energy Saving in Industry (2009-2017), selected numbers

<table>
<thead>
<tr>
<th>Share in output</th>
<th>Energy demand, million tons of oil equiv.</th>
<th>Energy intensity, kg of oil equiv. / UAH</th>
<th>CAGR of energy demand over 2010-2017</th>
<th>Planned investments, billion UAH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007 (status quo)</td>
<td>2010 (goal)</td>
<td>2015 (goal)</td>
<td>2017 (goal)</td>
</tr>
<tr>
<td>Non-fuel mining &amp; metallurgy</td>
<td>52%</td>
<td>48.6</td>
<td>0.39</td>
<td>0.27</td>
</tr>
<tr>
<td>Machine building</td>
<td>23%</td>
<td>4.6</td>
<td>0.08</td>
<td>0.069</td>
</tr>
<tr>
<td>Chemistry</td>
<td>16%</td>
<td>12.5</td>
<td>0.33</td>
<td>0.29</td>
</tr>
<tr>
<td>Light industry &amp; wood processing</td>
<td>9%</td>
<td>n.a.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Not including light and wood processing industries.


A later official document – “The Revised Energy Strategy of Ukraine for the Period until 2030”, which was made public in 2012, – stipulates that over the next ten years the demand for energy by industry over 2010-2017 will change as follows: the demand for natural gas will decrease by 1.60% per year while industry demand for coal will grow by 1.4% per year. Total energy demand will decrease by 1.2% per year in the same period. Some detailed information is presented in Table 2.
In the framework of the *Energy Strategy*, the Ministry of Energy and Coal Industry plans extensive investments, 694 billion UAH over 2010-2020, into new electricity generating capacities (most of new power plants will be based on coal combustion) and new coal extraction capacities in order to meet the increasing energy demand for electricity and coal by the industry. The forecast about the future energy demand is based on about 30% to 35% energy efficiency improvement. Although the *Energy Strategy* recognises an important role of energy efficiency and emphasises the need for a comprehensive Programme of measures to achieve energy-efficiency goals, it does not go much further than that. While trying to secure energy independency of Ukraine, the Ministry of Energy and Coal Industry urges the industrial enterprises to use domestic coal and to withdraw from usage of gas, which is imported from Russia. The coal mining sector is expected to develop very quickly: according to the *Energy Strategy*, the yearly volumes of coal extraction should grow by 40-50% till 2030, whereas its consumption by industry will grow by nearly 50%.

### Table 2: Demand for energy in industry: Official forecast

<table>
<thead>
<tr>
<th></th>
<th>2010 (real data)</th>
<th>Forecast – basic scenario&lt;sup&gt;4&lt;/sup&gt;</th>
<th>CAGR of energy demand over 2010-2017</th>
<th>Energy savings potential used for the forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2015</td>
<td>2020</td>
<td>2025</td>
</tr>
<tr>
<td>Electricity demand, billion KWt/h</td>
<td>97.6</td>
<td>111.0</td>
<td>120.4</td>
<td>131.0</td>
</tr>
<tr>
<td>Demand for natural gas, billion m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>21.3</td>
<td>19.6</td>
<td>18.2</td>
<td>18.1</td>
</tr>
<tr>
<td>Demand for industrial coal, million tons</td>
<td>3.1</td>
<td>3.3</td>
<td>3.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Total energy demand, million tons of oil equivalent</td>
<td>18390</td>
<td>17247</td>
<td></td>
<td></td>
</tr>
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</table>


<sup>4</sup> Under the basis scenario, the Energy Strategy of Ukraine assumes average GDP growth at 5% up till 2030 of economic development; in pessimistic scenario, about 3.8% average yearly GDP growth is envisaged. At the same time, according to IMF, the most realistic rate for average yearly GDP growth in 2014-2018 is 3.5%. The economic growth of the last few years also does not allow for better than pessimistic view on the economy, if classified according the assumptions in the Energy Strategy.
Based on official regulatory documents, developed by different Ministries, we have different expectations with respect to future dynamics of direct GHG emissions and the demand for energy by industrial enterprises; Figure 2 depicts the results. Whereas the Ministry of Environmental Protection foresees extensive fuel combustion in industry and the corresponding growth of GHG emissions by 5.77% per year, the Ministry of Energy and Coal Policy relies on low growth of energy demand by the industry. After some recalculations for the Ministry’s original set of data, we obtain that the corresponding emissions, expressed in CO2 equivalents, would decrease yearly by almost 1%; the demand for energy would remain stable, although the demand for fuels would decrease as well. At the same time, the Ministry of Industrial Policy expects 1% increase yearly in demand for energy, if expressed in oil equivalents.

**Figure 2: Direct GHG emissions and the demand for energy by industrial enterprises, as foreseen by different ministries.** Yearly expected percentage changes over 2010-2017.

First of all, the evident inconsistencies, described above, may indicate an absence of well organised policy coordination between the governmental bodies. As we see, the development of the industrial policy in Ukraine is currently coordinated neither with the
energy policy nor with the environmental policy. This calls for development of a comprehensive inter-sectoral strategy for low carbon growth in Ukraine, which must become a foundation and an instrument for any sub-programme, which would be later on elaborated by sectoral Ministries or lower-ranking sub-sectoral agencies.

3.3 Potential for emission reduction in industry: Assessments from the literature

According to the recently published NERA report, there is a high potential for cost-effective emission reduction in the Ukrainian industry (NERA Economic Consulting, 2012). Under the assumption of static energy-intensity (status quo), there is a potential for “a reduction of over 30% of the industrial emissions that would be implied by the static intensity projection for 2030” (NERA Economic Consulting, 2012, p.65). This comprises about 65 Mt CO₂ abatement, out of which 51 Mt CO₂ is cost-effective. If the government undertakes enhanced policy measures, the abatements could reach 77 Mt CO₂, out of which 72 Mt CO₂ is cost-effective. If recalculated into percentage changes of emissions, NERA’s result implies that industrial emissions can grow by +2.53% to +4.14%. The growth rate of emissions depends on the policy measure that is undertaken. The detailed estimations are presented in Table 3.

<table>
<thead>
<tr>
<th></th>
<th>Cost-effective measures undertaken</th>
<th>All potential measures undertaken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned policies scenario</td>
<td>+4.14%</td>
<td>+2.96%</td>
</tr>
<tr>
<td>Enhance policies scenario</td>
<td>+3.44%</td>
<td>+2.53%</td>
</tr>
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Relying on projections from the table, we may view the planned policies of the Ministry of Industrial Policy and expectations about the future energy demand of the Ministry of Energy and Coal Industry as relatively optimistic. A comprehensive empirical analysis, based on

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5 The industrial policy is under responsibility of the Ministry of Industrial Policy of Ukraine; the energy policy is conducted by the Ministry of Energy and Coal Industry of Ukraine; the environmental policy the area of the Ministry of Ecology and Natural Resources of Ukraine.
realistic expectation about economic development of Ukraine and industrial growth in particular, is urgently needed in order to develop a broad policy package.

3.4 What can the government do for the low carbon development?

Except many obstacles on the way to implementation of governmental strategies (financial, lack of effective energy management systems and techniques skills, etc.), the absence of policy coordination, wrong estimation of the status-quo platform, and little apprehension of potential growth impulses, which may arise from cost-effective investments into green technologies, are the foremost reasons for the breakdown of the industrial strategies of the government even before their implementation starts. With better policy coordination and with some additional political determination toward energy saving, the allocation of funds between different energy-related projects would become more effective and the Ukrainian industry would converge to the low carbon development path. The economy would benefit from saved energy costs, higher and sustainable growth and higher employment.

A green growth strategy for Ukraine should include a comprehensive set of energy efficiency measures, which would benefit Ukraine while inducing growth and employment. A thorough analysis of measures for such a programme will be done on the basis of sound empirical modelling, which is envisaged for the course of the current project.
4. Draft impact assessment of identified policies and measures and development of BAU scenarios to 2020 and 2050

4.1 Introduction

Due to the high energy intensity of its economy Ukraine currently remains among the largest contributors to global greenhouse gas (GHG) emissions. First policy steps to mitigate emissions of GHG were recently taken: the Government of Ukraine adopted the “Energy Strategy till 2030” with a clear focus on the reduction of energy intensity of its economy. This paper examines how these planned policy measures will affect economic development and the amount of GHG emissions. We present two business-as-usual-scenarios (BAU) until 2050 describing the hypothetical development of the economy – one scenario with planned policy measures and as a counter-factual one scenario without active policy measures.

4.2 Historical greenhouse gas emissions and economic development

4.2.1 National level

During the transformation process of the Ukrainian economy following the breakdown of the Soviet Union in 1991, the gross domestic product (GDP) fell sharply and greenhouse gas (GHG) emissions declined at almost the same rate. In 2000, the economy started to recover and apart from the downward slope following the financial crisis in 2008, the country’s economy has been growing steadily within the last decade. In the same time period, GHG emissions have grown slower than GDP, leading to a de-coupling of GDP growth and GHG emissions. This implies that the emission intensity, measured as amount of emissions per unit of GDP, has decreased (Figure 3).
Overall, the emission intensity of Ukrainian economy improved considerably from 1990 to 2011, decreasing by almost 40 percent. But despite this improvement, with an output of emissions equal to 4.2 kg of CO₂ equivalents (CO₂e) per unit of GDP (in constant US$ of 2005), Ukraine still ranks among the largest emitters in the world. Other former transition economies such as Poland or the Russian Federation show higher rates of improvement (Figure 4). This is even more remarkable since they were already more efficient in terms of output of emissions per unit of GDP in 1990. But even Kazakhstan with a higher level of emission intensity in 1990 outperformed Ukraine in the reduction of GHG emissions. As a result, Ukraine shows a large potential for improvement.
Figure 4: Emission intensity in selected Eurasian economies 2011 vs. 1990

Source: DIW Econ based on UNFCCC (2013a), IMF (2013) and World Bank (2013)

4.2.2 Sector level

On the level of economic sectors, the largest share of GDP in 2010 can be attributed to the service sector (60 percent of total value added), followed by the industry sector (31 percent) and agricultural sector (8 percent). The industry sector is the most energy-intensive as its energy consumption amounts to almost half of the total, while it is producing 31 percent of the GDP. Consequently, the other sectors produce with 50 percent of the total energy consumption almost 70 percent of the GDP. Additionally, GHG emissions resulting from the industry sector are much higher than in the other sectors (see Figure 5). Main drivers behind the high GHG emissions in the industry sector are the high share of emission-intensive coal in the fuel mix as well as fugitive emissions from industrial processes.
As a result, the highest potential for GHG abatement is in the industry sector. It also implies that GHG emissions and emission intensity depend on the composition (structure) of GDP. Therefore structural changes of an economy, e.g. an increasing share of service sector in GDP, can lead to an overall reduction of emission intensity.

4.3 Greenhouse gas mitigation – International targets and domestic policy measures

On the international level, the United Nations Framework Convention on Climate Change (UNFCCC) coordinates the countries’ efforts to reduce GHG emissions. With the extension of the Kyoto protocol to the 2nd commitment period (2013-2020), the aim of reducing GHG emissions on a global level was reinforced. As described in detail in Policy Paper No. 3, the following targets apply for Ukraine if they ratify the amendment to the Kyoto Protocol for the 2nd commitment period (UNFCCC 2013b):

- In 2020, reduction of emissions by 20 percent with reference to the 1990 level
However, as a result of the Kyoto Protocol amendment, the effective target equals the average emissions of the years 2008 to 2010, which is 58 percent lower than the 1990 emission level.

Furthermore, Ukraine pledged to reduce its emissions by 50 percent with reference to 1990 by 2050.

These rather ambitious targets provide incentives for the Ukrainian government to take further steps in reducing GHG emissions. First steps were already implemented during the first commitment period of the Kyoto Protocol: In 2006, the Government of Ukraine adopted “The Energy Strategy of Ukraine until 2030” with a clear focus on the reduction of energy intensity”. In 2012, an update of this Energy Strategy had been revised\(^6\), in which the government reinforced the target to reduce energy intensity by about 60 percent compared to 2009 by 2030 (“The Revised Energy Strategy of Ukraine for the Period until 2030.”) Precondition for reaching this target, in addition to government investments, is substantial investment effort from the side of private owners of the industrial facilities. This is all the more noteworthy since in the years following the first Energy Strategy investments were far below the planned amount necessary to achieve the goal (World Bank 2013b).

A reduction of the energy intensity as foreseen by the Ukrainian Government would lead to a reduction of the amount of energy input needed to produce a unit of output in the affected sectors. As a result, energy consumption per unit of GDP and hence GHG emissions would decrease. How exactly this would affect future trajectories of economic development and GHG emissions is presented in the following section.

4.4 Business-as-usual scenarios

4.4.1 Approach and database

The business-as-usual (BAU) scenario describes a hypothetical development path of the economy and future GHG emissions. In our analysis we differentiate between two scenarios, each on a macroeconomic and sector level, with the following assumptions:

\(^6\) Throughout the paper we refer to the update of the Energy Strategy as drafted in 2012.
BAU 1: scenario without substantial policy measures

BAU 2: scenario with substantial policy measures

Our analysis is based on historical trends, data projections and assumptions about future development paths. The following national and international data sources and forecasts are used:

- The GHG emission inventory of Ukraine (Source: UNFCCC 2013a)
- World Development Indicators (Source: World Bank 2013a)
- World Economic Outlook (Source: IMF 2013a)
- Relevant publications by the IEA, OECD and EIA

Our projections of economic growth are based on current forecasts of the IMF (World Economic Outlook 2013). The emissions’ performance is calculated from emission intensity levels. For BAU1 scenario we assume constant emission intensity based on the average emission intensity of the last 3 years (compare Clapp and Prag 2012). BAU2 scenario models the development path of the economy in case of a reduction of energy intensity by 60 percent compared to 2009 by 2030 as stated in the national Energy Strategy. This leads to the following scenario set-up including key assumptions:

**BAU1 scenario**

- GDP growth
  - Compound annual growth rate of 2.8 percent for 2012-2018 (IMF 2013)
  - Compound annual growth rate of 3.5 percent for 2018-2030
  - Compound annual growth rate of 2.6 percent for 2030-2050
Figure 6: Annual growth rate of GDP in BAU scenarios

Source: DIW Econ

- Emission intensity
- Constant emission intensity of 0.58 kg of CO\textsubscript{2} e per UAH of GDP for 2012-2050 (this is in line with the average emission intensity of 2009-2011\textsuperscript{7})

BAU2 scenario:
The modifications in comparison with BAU1 concern:
- Structural changes of the economy
- Emission intensity decreases as energy output per unit of GDP decreases
- These assumptions are described in detail in Box 1.

These BAU scenarios should not be understood as forecasts (i.e. the most realistic development) of the economy but rather as a benchmark for comparing the results of different policy scenarios and a motivation for policy action.

\textsuperscript{7} The latest available GHG emissions inventory of Ukraine is from 2011 (UNFCCC 2013).
Box 1: Elements of BAU2 scenario

   - Structural development of the economy for 2010 - 2030:
     - Value added share of agricultural sector increases by 0.7 percentage point
     - Value added share of service sector increases by 9.6 percentage points
     - Value added share of industry sector decreases by 10.3 percentage points
     - Energy consumption forecast by fuel type for 2010 – 2030
     - 60 percent reductions of energy intensity between 2009 and 2030

2. Additional assumptions
   - GHG emissions from industrial processes grow with the same rate as GDP
   - GDP growth as in BAU1 scenario (see Figure 6)
     - Compound annual growth rate of 2.8 percent for 2012-2018 (IMF 2013)
     - Compound annual growth rate of 3.5 percent for 2018-2030
     - Compound annual growth rate of 2.6 percent for 2030-2050
   - Policy measures in energy efficiency continue after 2030

3. Results
   Using the above mentioned data and assumptions as well as additional data sources (“The Revised Energy Strategy of Ukraine for the Period until 2030” and UNFCCC, 2013a) we calculate:
   - Energy consumption trends by sector and fuel type
     - Energy intensity (energy consumption per unit of GDP) decreases by 56 percent in the period 2010 - 2030
   - GHG emissions trends by sector and fuel type
     - Emission intensity (GHG emissions per unit of GDP) decreases by 53 percent

Source: DIW Econ 2013
4.4.2 Scenarios on a national level

Based on the database and assumptions described in Section 4.4.1 we derive the projected emissions and the GDP pathway on a national level. Given the assumption of constant emission intensity in BAU1 scenario, GHG emissions increase with the same growth rate as GDP. With a compound annual growth rate of 3.3 percent from 2012 to 2020, GDP would reach the level of 868.8 billion UAH in 2020, while GHG emissions would amount to 508 Mt. This is a total increase of almost 30 percent compared to 2011 (Figure 7).

Figure 7: BAU1 scenario - without domestic policy measures

For BAU2 scenario the same GDP growth rate as in scenario BAU1 is assumed. However, as a result of policy interventions, GHG emissions are assumed to decouple from GDP growth. Under the precondition that the energy intensity gradually reduces as planned by the Ukrainian Government, GHG emissions would amount to 351 Mt of CO$_2$e in 2020. This corresponds to a reduction of GHG emissions of 13 percent compared to 2011 (Figure 8). In total, GHG emissions of about 711 Mt are saved until 2020 in the BAU2 scenario compared to the BAU1 scenario.
The BAU scenarios serve as a benchmark for the economic performance and the carbon record of Ukraine in the light of the Kyoto target for 2020. As illustrated in Figure 9, in BAU1 scenario the GHG emissions are 30 percent above the Kyoto target for 2020. However, under BAU2 scenario with an average annual emission reduction rate of 1.5 percent from 2012 to 2020, the Kyoto target is fulfilled. This implies that the Kyoto target is only reached if active policies aiming at the reduction of GHG emissions are implemented.
Figure 9: BAU scenarios in the light of the Kyoto Target 2020

For the post-2020 period, the Ukrainian Government pledged to reduce emissions by 50 percent compared to 1990. This sets the targeted emission level to 465 Mt in 2050. Under the assumption of an average annual growth rate of 2.9 percent from 2012 to 2050, GDP would amount to 2064.7 billion UAH at constant prices of 2007. In BAU1 scenario with the assumption of constant emission intensity this would result in 1.207 Mt CO$_2$e in 2050. Accordingly, GHG emissions in BAU1 scenario would be almost three times higher than the pledged target for 2050. However, in BAU2 scenario under the assumption that investments in energy efficiency continue, even though at a lower rate, GHG emissions would amount to 440 Mt in 2050. Albeit the fact that long term forecasts are extremely uncertain, the estimated results show the importance of getting engaged in mitigation actions today. The Energy Strategy might be the first component of Ukraine’s long way towards a low-carbon economy.
4.4.3 Scenarios on a sector level

With no structural changes and constant emission intensity as assumed in BAU1 scenario, GHG emissions would increase with the growth rate of GDP, leading to 33 percent higher emissions level in each sector by 2020 compared to 2010. As a result, GHG emissions in the industry sector would amount to 272 Mt of CO$_2$ equivalents, followed by the service and agricultural sectors, accounting for emissions in the amount of 181 and 57 Mt of CO$_2$e, respectively.

In BAU2 scenario we account for structural changes in the economy and for an increase in the energy-efficiency of all sectors. Compared to BAU1 scenario, GHG emissions in the industry sector would be 15 percent lower, accounting for 187 Mt of CO$_2$e by 2020. In the service sector the emissions in 2020 are equal to 127 Mt of CO$_2$e, which is 10 percent less than in the counter-factual scenario without structural changes and policy measures. A reduction of 13 percent to the level of 40 Mt is also achieved in the agricultural sector. These numbers are illustrated in Figure 10.

Figure 10: BAU scenarios - GHG emissions by sectors 2020

GHG emissions excl. Land Use, Land-Use Change and Forestry (LULUCF)
The reduction of GHG emissions by 2020 in BAU2 scenario is mainly driven by two effects:

- First, the investments in energy efficiency in all sectors as aimed for in the Energy Strategy would lead to less energy consumption per unit of GDP. The most pronounced improvements of energy intensity would be achieved in the agricultural and service sectors with reductions of energy intensity of almost 40 percent by 2020 compared to 2010. In the industry sector energy efficiency would improve by almost 20 percent within the same time period. This would lead to a decoupling of energy consumption and value added in all sectors. As GDP would increase by 33 percent, total energy consumption would decrease by 12 percent. As a result, total GHG emissions would decrease.

- Second, GHG emissions would decrease as a result of a growing service sector, which is less energy- and emission-intensive compared to the industry sector. In 2020, the share of the service sector on total value-added would amount to 65 percent, followed by the industry and agricultural sector with value added shares of 26 and 9 percent, respectively (see Figure 11).

**Figure 11: Sector shares of value added 2010 and 2020 (BAU2 scenario)**

The gap of GHG emission levels between both scenarios, in particular with respect to the industry sector, emphasizes the great difference between taking policy action today and postponing it. Immediate investments in energy efficiency combined with structural reforms would substantially improve the carbon record of the industry sector by 2020.
4.5 Conclusions

The business-as-usual scenarios as presented in this chapter emphasize the need for the Ukrainian Government of taking policy action today. By implementing the measures included in the current Draft Energy Strategy, GHG emissions can be reduced by 13 percent by 2020 compared to 2011. Given the forecast of GDP growth by 27 percent within the same period, this implies a further decoupling of GDP and GHG emission trajectories. In particular, the carbon record of the industry sector would substantially improve with the planned investments in energy efficiency combined with structural reforms. In the counter-factual scenario without policy measures and structural changes GHG emissions would increase to 508 Mt of CO$_2$ equivalents by 2020.

Furthermore, the Kyoto target of the 2$^{nd}$ commitment period is only reached in the scenario with active policy measures and an emission level of 350 Mt of CO$_2$e by 2020. We further elaborate on these findings in Chapter 3 of this Third Project Report, where policy options to support low carbon policy in industry are evaluated.
5. **Short-term, ad hoc expertise and consulting**

The Policy Paper No. 3 “The 2012 Doha Amendment to the Kyoto Protocol: Implications and Recommendations for Ukraine” outlines the implications of the new regulations for Ukraine and discusses the benefits of participation in the second commitment period of the Kyoto Protocol. This chapter includes the executive summary of the paper. An illustration of the assumptions under which Ukraine will be able to achieve the Kyoto emission targets is presented in Chapter 4 of the Third Project Report, where the business-as-usual economic scenarios till 2020 and 2050 are developed.

The international climate negotiations in Doha at the end of 2012 resulted in the adoption of an amendment to the Kyoto Protocol regulating the second commitment period (CP2) from 2013 to 2020. Although Ukraine joined the negotiation text with a 20 percent reduction target for 2020, it indicated that it may decide not to ratify the Doha Amendment. This paper outlines the implications of the new regulations for Ukraine and discusses the benefits of participation in CP2.

During the first commitment period (CP1) of the Kyoto Protocol (2008-2012), Ukraine significantly benefited from the financial opportunities available through the flexible mechanisms. With more than 47 million sold assigned amount units and about 470 million Euros received through emission trading, Ukraine was one of the major beneficiaries of CP1.

The regulations for CP2 restrict the quantity of emission allowances for a country to its average emissions from 2008 to 2010 times eight. For Ukraine, this corresponds to emission allowances of about 3.1 billion tons of CO2 equivalents for CP2 and to an average of about 0.39 billion tons of CO2 equivalents per year. Compliance with this ambitious reduction target is only possible if Ukraine undertakes immediate structural reforms to fundamentally shift away from its current carbon-intensive growth path towards significant improvements in energy efficiency. Further active engagement in a Low Carbon Growth Strategy should therefore be a focus of Ukrainian policy.

Despite the challenging emission target, the arguments in favour of participation in CP2 predominate. Participating in CP2 would foster Ukraine’s political and economic integration with the European Union (EU) which is of great importance for Ukraine considering its interest in the association to the EU. Furthermore, it would increase the international
competitiveness of Ukrainian exports and represent an important step of preparation for a post-2020 global climate framework.

Finally, Ukraine should consider engaging in bilateral agreements with the European Union or South Korea to receive short-term financial or technological assistance in compliance with the emission targets.
6. Draft concept of a low carbon development plan of Ukraine

6.1 Introduction

Ukraine is one of the most energy-intensive economies in Europe. New impulses are needed to overcome traditional production structures that are no longer efficient and unsustainable in social and environmental terms. The strategic vision for the new development path should contain clearly defined and economically justified low carbon development (LCD) goals, clarify the method for ranking the priority areas on the path and for selecting the measures, which would be necessary to implement.

The current concept represents a purely methodological approach for drafting the low carbon development plan for Ukraine.

6.2 Defining the LCD goal

Having declared the political will to bring Ukraine on the LCD path, the government now has to define the ultimate goal, which is to be reached at long last. The possible options are:

- Supreme LCD goal. In this case, the government declares its ambition to bring the country in the cohort of top countries of the world regarding usage of the best possible energy-efficient technologies.
- Absolute LCD goal. Here, the government declares an absolute numbers of the emission reductions, energy consumption, etc., which are to be achieved within a predefined period of time.
- Relative LCD goal. With this, the government aims to implement contemporary international standards of energy efficiency or achieve emission reductions, which would align the country to other selected countries of the world. These standards or emission volumes may be applied country-wide or in some pre-selected economic sectors.

Below, we show the examples of each type of LCD goals having being set in different world regions/countries. Further on, we select and discuss a proper goal for the case of Ukraine.
Supreme LCD goal

There are many examples of declaring ambitious supreme LCD goals in different regions. Within the borders of the former Soviet Union, Kazakhstan has recently affirmed its goal to become one of the top 30 technologically advanced countries in the world in the next 35 years. According to the Strategy “Kazakhstan-2050” (announced in 2012), by the year 2050, alternative and renewable energy sources should supply more than a half of all energy consumption in the country and the country should possess the best possible industrial technologies in the world in terms of energy efficiency.

To be trustworthy and realistic while declaring a supreme goal, the government has to make sure that there is an economic justification for such goal, that the relevant incentive mechanisms are in place, the legal base is provided, and that the country possesses or is able to attract enough investment resources, which are necessary to achieve such an ambitious goal. The current economic development of Ukraine proves that the economic growth is unsustainable and the growth prospects are very unclear. Setting a supreme goal thus would not be trustworthy.

Absolute LCD goal

To name one example of such goal-setting, the European Union has committed itself to cutting its emissions to 20% below 1990 levels by 2020 (UNFCCC, 2010). This commitment is one of the headline targets of the “Europe 2020” growth strategy and is being implemented through a package of binding legislation. The EU has simultaneously offered to strengthen its emission reduction to 30% by 2020 if other major emitting countries in the developed and developing world commit to undertake their fair share of a global emission reduction effort.

Most of the countries, which joined the Kyoto protocol, have pledged to achieve some absolute limits of emissions in the future. However, in the current situation with respect to the second phase of Kyoto Protocol (see Policy Paper No. 3), setting further goals for Ukraine does not seem a feasible option.

Relative LCD goal

As an example, Canada pledges to align its emission reduction target with the target of the United States in enacted legislation (UNFCCC, 2010). Upon Croatia accession to the
European Union, the country pledges to review its LCD goal in line with the European Union mitigation effort (UNFCCC, 2010)\(^8\).

A relative LCD goal seems less ambitious or attractive as it foresees neither technological leadership in the world or geo-political recognition, nor strong domestic support for the policy-makers. Nevertheless, in many cases setting comparative sectoral standards (relative goals) is the most economically appealing and meaningful way of a country's development.

A relative LCD goal would bring up a higher growth potential for Ukraine, whereas efforts to achieve other types of goals might turn into an economic burden for the economy. It is important that any measures, which should be implemented toward achieving such a goal, are well-justified in terms of economic benefits, but not in terms of their GHG mitigation effects.

### 6.3 The concept of LCD plan of Ukraine: structure and background

As discussed above, the best suitable tactic is to set up a LCD plan aimed to make Ukraine a "world-equal" country, i.e. to enter the cohort of countries, which effectively apply modern technologies and implement high levels of energy efficiency standards. The plan should induce economic growth, and not impair it. Further elaboration of the Concept of LCD plan of Ukraine will be based on these considerations.

Taking into account the current status quo with regard to energy-efficiency of Ukraine’s economy in international comparison, there should be enough potential for energy savings and emission reductions that may ensure solid economic progress and welfare growth. We are going to verify this potential sector by sector and to develop a reasonable, economically attractive LCD plan of Ukraine up to 2020 and 2050.

The LCD Plan should be based on:

- Sectoral assessment
- Evaluation of the “Energy Strategy” of Ukraine and other relevant government pledges
- Empirical analysis with the help of a macroeconomic model for Ukraine

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\(^8\) -5% in emissions vs. 1990 emission level was declared as a temporary target for Croatia.
Further we sketch each listed component.

**Sectoral assessment.**

Although the goal is to implement contemporary international standards country-wide, the LDC plan should be developed on a sectoral and even sub-sectoral basis: particularities of the relevant sectors have to be taken into account and the sector-specific goals are to be set. We will apply an approach based on international benchmarking.

The key objective of our benchmarking approach is to identify technology options for a given industrial sector to best combine sustainability and economic viability. The yardstick for this comparison is a balanced combination of:

- **High** levels of *desired outputs* such as production volumes (in physical units) or revenues (values),
- **Low** levels of *undesired outputs* like GHG emissions or pollution, and
- **Low** levels of *factor inputs* like labour or energy use, or production costs.

The focus of the benchmarking approach is on technologies that are currently used in practice in the countries that can be considered as technological leaders, while theoretical solutions and technologies that are not yet implemented are not considered. Thus, only technically as well as economically feasible and viable solutions are considered as benchmarks. It is also important to account for the specific structural configuration of the sectors in the benchmark countries as well as in Ukraine, and to check whether the comparisons make sense at all. The benchmarking methodology examples are described in Low Carbon Policy Paper No. 1 and Technical Paper No. 2. The aim of the benchmarking analysis is to cover all main GHG-emitting sectors of the Ukrainian economy. Figure 12 below summarizes some of our findings for Ukrainian sectors.
Figure 12: Benchmarking results for emission reduction potential in different sectors

The proper format for sectoral analysis based on benchmarking is depicted in Table 4. Column 2 contains indicators of the best world performers in the corresponding sectors. To judge whether there might be any potential for energy-saving and emission reduction, the data of best performing sectors internationally should be compared with current statistical data of the corresponding sectors of Ukraine (column 3). Further, the official governmental pledges should be examined (column 4) and the relevant adjustments proposed (column 5).

**Evaluation of the “Energy Strategy” of Ukraine and other relevant government pledges**

As a background for the LCD plan, we will take the “Energy Strategy of Ukraine until 2030”, which was adopted in 2006, reviewed and amended in 2012. The Strategy contains the official forecast for energy demand and supply until 2030 and lists the government’s intentions and planned measures toward better energy security and efficiency. While developing the concept of LCD plan, we have to evaluate the Energy Strategy in terms of its feasibility and expected impact. The assessment of the major policy steps suggested in the “Energy Strategy” and the “Programme for Energy Efficiency and Energy Saving in Industry” should be conducted and proved in terms of their economic meaningfulness. We will revise these policies and provide the appropriate advice for essential amendments (see also Chapter 3 of this Report). The resulting LCD plan should be seen as an adjustment of the current “Energy Strategy” of Ukraine.
Empirical analysis on the basis of the macroeconomic green growth model

As an empirical tool for the described sectoral analysis, the Green Growth model for Ukraine will be elaborated. This model covers the whole economy of Ukraine and distinguishes between 20 production sectors.

The production activity in every economic sector in the model is explicitly linked to energy use by means of a production function. Energy is one of the production factors and the energy mix consists of different energy sources which can be substituted between each other, based on relative prices. The choice of energy source by producers is described by explicit production functions which distinguish between the use of different fuels, such as coal, gas, and oil products. The combustion of every unit of these fuels leads to emission of greenhouse gases, measured in CO2 equivalent. In addition, emissions from industrial processes (e.g. in chemistry, agriculture, waste management, etc) are also linked to the production levels in the economic sectors through a Leontief functional relationship. The sources of the energy use and emission data are the official publications of the State Statistics Service of Ukraine and the UNFCCC.

With the help of relevant simulations of the model we will be able to:

- verify the ultimate development goals and forecasts for production and consumption of energy, which are specified in the Energy Strategy of Ukraine;
- identify the areas, where the government intentions are too costly to implement; suggest the needed amendments.
- check whether there are some additional opportunities for LCD and whether the government can provide some support in some particular areas in order to create incentives for energy savings or investments in energy-efficient technologies. In this part, a simulation of the CO2 pricing scheme and the investment into innovation development will be conducted and assessed.

The results of simulations will be analysed. At the end, economic benefits of each measure should be a priority argument for inclusion of the measure as component of the LCD plan.
6.4 Closing remarks

In the presented document, we sketched the concept of a LCD plan of Ukraine. Each measure, which finds its place in the final version of LCD plan, should be justified in terms of its economic benefits, but not in terms of its emission reduction potential. The assessment should be based on criteria of achievable efficiency relative to the standards of the modern world, not the absolute ones. Moreover, these criteria should be very accurately developed taking into account particularities of sectoral and sub-sectoral production structure (especially in such sectors as metallurgy and chemistry), energy demand structure and the level of infrastructure in Ukraine. Finally, we identified the next steps in developing a comprehensive LCD plan of Ukraine.
7. Draft outline for the economic assessment of domestic ETS


The relevant analytical work to this end will be carried out during 2013 under the framework of the current UNDP Low Carbon Development Project. Our consortium partners Thomson Reuter Point Carbon support SEIA in the preparation of a new version of the draft law on emissions trading.

7.1 The ETS concept

Emissions trading is a market-based mechanism used to reduce the level of GHG emissions. The three main building blocks of an Emissions Trading System are:

- First, an overall cap on “allowed” GHG emissions, which results from the level of emission reductions that policy makers seek to achieve.\(^9\)
- Second, an initial allocation of the allowed emissions – through emission permits – to the sectors that operate installations where GHGs are emitted.
- Third, a monitoring system which keeps track of actual emission levels of all those installations.

Under the ETS, sectors are required to ensure that their actual levels of GHG emissions are backed by the same amount of emission permits. Typically, compliance is assessed over a specific trading period of one or several years. If a sector violates this provision, heavy fines are imposed. Hence, there is no financial incentive for sectors to have own GHG emissions exceeding the number of emission permits which they hold.

\(^9\) In fact: \([\text{overall cap}] = [\text{initial or current GHG emissions}] - [\text{intended reduction volume}]\)
The key feature of an ETS is that emission permits are tradable, i.e. they can be bought and sold between sectors (i.e., all permits are fully tradable). Hence, all sectors can actually choose between:

- either, buying additional permits from other sectors,
- or, selling permits to other sectors.

If a sector decides to buy additional permits, it can use them to cover higher levels of GHG emissions at its installations. This can e.g. be necessary when the sector wants to increase its output. On the contrary, if a sector decides to sell (a part of) its emission permits, it must also reduce GHG emissions at its own facilities. This is possible through measures that increase energy efficiency or other modernization measures. Overall, the key advantage of such an Emission Trading System is that any given cap on aggregate GHG emissions – and hence, any level of intended emission reductions – can be realized at the lowest costs to the economy.

The price level of emission permits under an ETS will be such that the costs of abating an additional unit of GHG (i.e. the marginal abatement costs) are equal for all sectors. In general, this price depends on two key issues:

- the scarcity of carbon allowances available to all sectors (demand, determined by the overall cap), and
- the available options to reduce emissions (supply, determined by marginal abatement costs).

While the ETS ensures that the costs of reducing GHG emissions by a given amount are minimised, the system is still designed to impose costs for GHG emissions (that is, to introduce carbon pricing) to all sectors. Compared to a situation where carbon emissions are costless, the introduction of an ETS will of course have an impact on production costs of all sectors that fall under this regulation. Accordingly, output prices of these sectors, e.g. on electricity, heat, or energy-intensive products, such as steel, are likely to rise. In fact, this is even a desired effect, as higher prices for carbon-intensive products reduce the demand for these products and thus, help to further reduce emissions. Nevertheless, it must be acknowledged that introducing an ETS causes additional costs to the economy and that these have to be kept at a sustainable level, in particular during the first trading periods when
the system is introduced and market participants need to adjust to the new system. In the next section, we will consider this when discussing the challenges of introducing an ETS in Ukraine.

7.2 Economic evaluation of an ETS: a modelling approach

Above we have described all key elements that influence the effectiveness of an ETS. The evaluation approach must therefore be able to take account of all these factors and of the actual process of interaction between the ETS participants.

We will simulate the introduction of an ETS in Ukraine using a powerful modern computational tool, a computable general equilibrium model of the Ukrainian economy. The model covers all main sectors of the economy, the private households, public sector, as well as external accounts (the rest of the world).

The production activity in every economic sector in the model is explicitly linked to energy use by means of a production function. Energy is one of the production factors and the energy mix consists of different energy sources which can be substituted between each other. The choice of energy source by producers is described by explicit production functions which distinguish between the use of different fuels, such as coal, gas, and oil products. The combustion of every unit of these fuels leads to emissions of greenhouse gases, measured in CO2 equivalents. In addition, emissions from industrial processes (e.g. in chemistry, agriculture, waste management, etc) are also linked to the production levels in the economic sectors through a Leontief functional relationship. The sources of the energy use and emission data are the official publications of the State Statistics Service of Ukraine and the UNFCCC.

The production activity in all model sectors is thus generating GHG emissions. Due to a link of emissions to energy consumption and to the output level, GHG emissions in fact represent an additional production factor in the model. In general, an increase of production thus leads to an increase in the emission level.

At the start of the ETS, each participating sector will be endowed with a certain number of permits, corresponding to the initial allocation plan. This initial endowment will also be reflected in the model. The difference between the actual emission amount connected to the
production process in each sector and the initially allocated number of permits is the source of demand for the permits. The potentially lacking permits can be bought from the sectors that find economically feasible technological possibilities to reduce emissions. The scope of these technological possibilities is described by the marginal abatement cost (MAC) curve for each sector. For Ukraine, these sectoral MAC curves were recently produced by NERA (2011).

In our modelling exercise, we will incorporate the technological options to reduce GHG emissions that are described by the sectoral MAC curves. These options include mostly different stages of energy efficiency improvement: from relatively cheap measures concentrating on reducing losses to expensive measures involving substantial changes in the existing technological processes.

The process of permit price determination in the model can be most easily explained using a graphical illustration. Consider two sectors, 1 and 2. Assume further that policy makers want to reduce aggregate GHG emissions by a certain amount and that this would require both sectors to reduce their GHG emissions by a certain amount (in Figure 13 the amount of reduced GHG emissions is drawn on the horizontal axes; $R_1$ and $R_2$ indicate the required reduction volumes for the two sectors). We also assume that both sectors have possibilities to abate GHG emissions but that doing so imposes additional costs (per-unit costs of abating emissions are drawn on the vertical axes). For both sectors, the MAC$_1$ and MAC$_2$ curves indicate the costs of abating a given amount of GHG emissions, which increase with the amount of reduced emissions (hence, the upward slope of the MAC$_1$ and MAC$_2$ curves).

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10 Technically, the curves indicate the costs of avoiding an additional unit of GHG emissions for the two sectors. They are therefore called Marginal Abatement Costs (MAC) curves. Total costs of abating GHG emissions are given by the area below a MAC curve.
In principle, both sectors are able to cope with the required reductions on their own. However, sector 1 can achieve its relevant reduction volume (R₁) at lower costs than sector 2. Let’s assume that policy makers introduce an ETS to achieve their overall reduction goal and that they allocate to each sector an amount of emission permits equal to previous emission levels of the respective sector minus the amount it is required to reduce (R₁ and R₂, respectively). Then, sector 1 has an incentive to reduce its emissions even further – e.g. to the level of A₁ – and to sell a corresponding amount of emission permits at a price higher than its cost of abatement (i.e. the MAC₁ curve). Trade is also beneficial for sector 2, as long as the price for an emission permit is lower than the costs of abatement that sector 2 faces (i.e. the MAC₂ curve). Eventually, both sectors will agree to a price level of P and to abatement levels of A₁ and A₂, respectively. At this price level, it is no longer profitable for sector 1 to offer additional emission permits since the corresponding costs of further abating emissions exceed price P. At the same time, it is also no longer profitable for sector 2 to buy additional permits since its own abatement costs fall below P for lower volumes of emission reduction.¹¹ In other words, the price level of emission permits under an ETS will be such that the costs of abating an additional unit of GHG (i.e., the marginal abatement costs) are equal for all sectors.

The difference of the described simple example to the actual procedure in the model is that the MAC functions applied in the model would describe costs for reaching a certain level of

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¹¹ Formally, price P is defined such that MAC₁ > P for emission reductions > A₁ and that MAC₂ < P for emission reductions < A₂.
energy efficiency, and not the actual emission reduction amount. The GHG emission levels will be calculated based on the resulting demand of sectors for different energy sources, taking into account the cost of additional (in excess of the initial sectoral endowment) emission permits.

Once the mechanism of permit price determination is incorporated in the model in the way described above, the model can be used for economic evaluation of the consequences of ETS introduction at macroeconomic and sectoral level. It would be possible to evaluate alternative proposals for ETS design, and to quantify additional cost burden on the part of the sectors falling short of emission permits as well as additional revenues of the sectors able to abate emissions and sell a surplus to others. The model will also allow forecasting the development of the permit price in the future years, given the time path of the corresponding emission cap.
References

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