

# **THE 2030 REPORT**

**Impact of the European Commission's Energy and Climate Package of 23 January 2008 on energy system, economy and households in Poland**

## **A SYNTHESIS**

Version of 19 June 2008

**This study has been carried out by a company Badania Systemowe "EnerSys" Sp. z o.o. (System Research "EnerSys" Co. Ltd.) under the Agreement with Polski Komitet Energii Elektrycznej (the Polish Electricity Association) of 7 October 2007**

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## 1. Basis, purpose and scope of the study

The basis for this study is the Agreement entered into on 7 October 2007 by and between Polski Komitet Energii Elektrycznej (the Polish Electricity Association) and a company Badania Systemowe "EnergSys" Sp. z o.o. (Systems Research "EnergSys" Co. Ltd.) for the carrying out of a study entitled: „*Report on the Impact of the Proposed EU Regulations Regarding the Introduction of a European Strategy for the Development of Carbon Dioxide (CO<sub>2</sub>) Free Energy on the Energy Security of Poland, and on a Possibility to Restore Generation Capacities Using Fossil Fuels in Particular as well as on Prices for Electricity*”, hereinafter referred to as „**The 2030 Report**”.

The primary purpose of this study is to comprehensively assess the consequences of **the Energy and Climate Package** of 23 January 2008 introduction in Poland and particularly, its consequences for the electricity system, the entire national economy and individual households.

The other purposes of this study are the following:

- ⇒ to support the preparation of well justified position for a debate on the EU proposals including a new energy policy for Europe.
- ⇒
- ⇒ to formulate a methodological framework and to collect data for the needs of any further strategic analyses including key issues for the future development of the Polish energy sector and national economy.

At the start point of this study an EC documents package was assessed which is a part of a proposal for a new energy policy for Europe published on 10 January 2007. When the first phase was completed, in January 2008 another set of the EC documents was published which makes up **the Energy and Climate Package**. Due to its importance, any further work focused on the assessment of the consequences of the Package implementation in Poland.

The analyses concern **the time-period up to 2030**. Due to many factors' strong influence on the future development of the electricity system in Poland, the study covered also analyses of interrelated sectors, key elements of the business environment as well as scenario-based research on the development of the entire national economy.

## 2. EU energy policy new objectives and requirements

In January 2007 the European Commission presented a package of proposals which made up a draft new EU energy policy<sup>1</sup>. The European Council confirmed the objectives presented in the EC proposal (the Presidency conclusions at the meeting held on 8-9 March 2007).

Following the above, the European Commission prepared a set of documents (a so called Energy and Climate Package) which are to transform the politically agreed objectives into concrete actions.

### 2.1. Energy Policy for Europe objectives

#### Superior objectives

There are three major objectives of the European energy policy:

- ⇒ to combat climate change;
- ⇒ to limit the EU's external vulnerability to imported hydrocarbons;
- ⇒ to promote economic growth and raise of employment.

#### Quantitative objectives (a so called 3\*20 Package)

The priority objective of the EU energy policy is to protect the climate. Taking into account this objective, the EC formulated and the European Council approved the following quantitative objectives for the entire European Union:

- ⇒ to reduce CO<sub>2</sub> emissions **by 20%** by 2020;
- ⇒ to increase the share of renewable energy **up to 20%** in its overall mix;
- ⇒ to improve the energy efficiency in order to reduce the use of fuels **by 20%**;
- ⇒ to increase the share of biofuels **up to 10%** in the use of oil fuels.

### 2.2. The 2008 Energy and Climate Package

The most important elements of the Energy and Climate Package for Poland are the following:

- 1) Modification of the EU ETS, including:
  - a. the establishment of one emission cap for the entire EU and a central allocation plan (resignation from national allocation plans);
  - b. the introduction of an obligation to purchase emission allowances by auctioning for power plants in 100% as early as in 2013 and for other sectors gradually – from 20% in 2013 to 100% in 2020 and later on.

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<sup>1</sup> COM(2007) 1: COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN COUNCIL AND THE EUROPEAN PARLIAMENT - An Energy Policy for Europe (and related documents).

- 2) Limitation of greenhouse gases emissions from non-ETS sources (which are not covered by the emission trade scheme) to **114%** of the 2005 greenhouse gases emissions;
- 3) Introduction of an obligation for Poland to generate energy from renewable sources as of 2020 in the amount of **15%** of the final use of energy;
- 4) Introduction, by virtue of Directive CCS<sup>2</sup>, of new provisions to Directive 2001/80/EC<sup>3</sup> concerning an obligation of adjusting <300 MWth combustion plants to use CCS installations (so called '**CCS ready**').

In addition to the obligatory purchase of emission allowances by the ETS participants, Poland is to receive a certain quantity of emission allowances for auctioning sale. Any revenues from auctioning will go to the budget and a part of them (about 20%) has to be spent for the purposes specified in the Directive whereas the rest can be spent for other purposes up to the Government's own decision.

In accordance with the EC analyses, the price for emission allowances under the EU ETS after 2013 will be **EUR 30-39/t** which will depend on a possibility to use CDM (Clean Development Mechanism) credits by the ETS participants to cover their CO<sub>2</sub> emissions.

The above elements were subject to analyses in order to assess their quantitative and qualitative consequences for the energy system, economy and inhabitants of Poland.

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<sup>2</sup> COM (2008) 18: Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006;

<sup>3</sup> Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants;

### 3. Methodology

#### 3.1. Calculating models

A set of three models was used for a quantitative assessment of the consequences of the new EU policy both for the electricity production sector and related energy and economy processes. The three model set consists of:

- ⇒ a macroeconomic general equilibrium model (CGE-PL);
- ⇒ an energy demand forecasting model (PROSK-E);
- ⇒ an optimizing model of the entire national energy system (EFOM-PL).

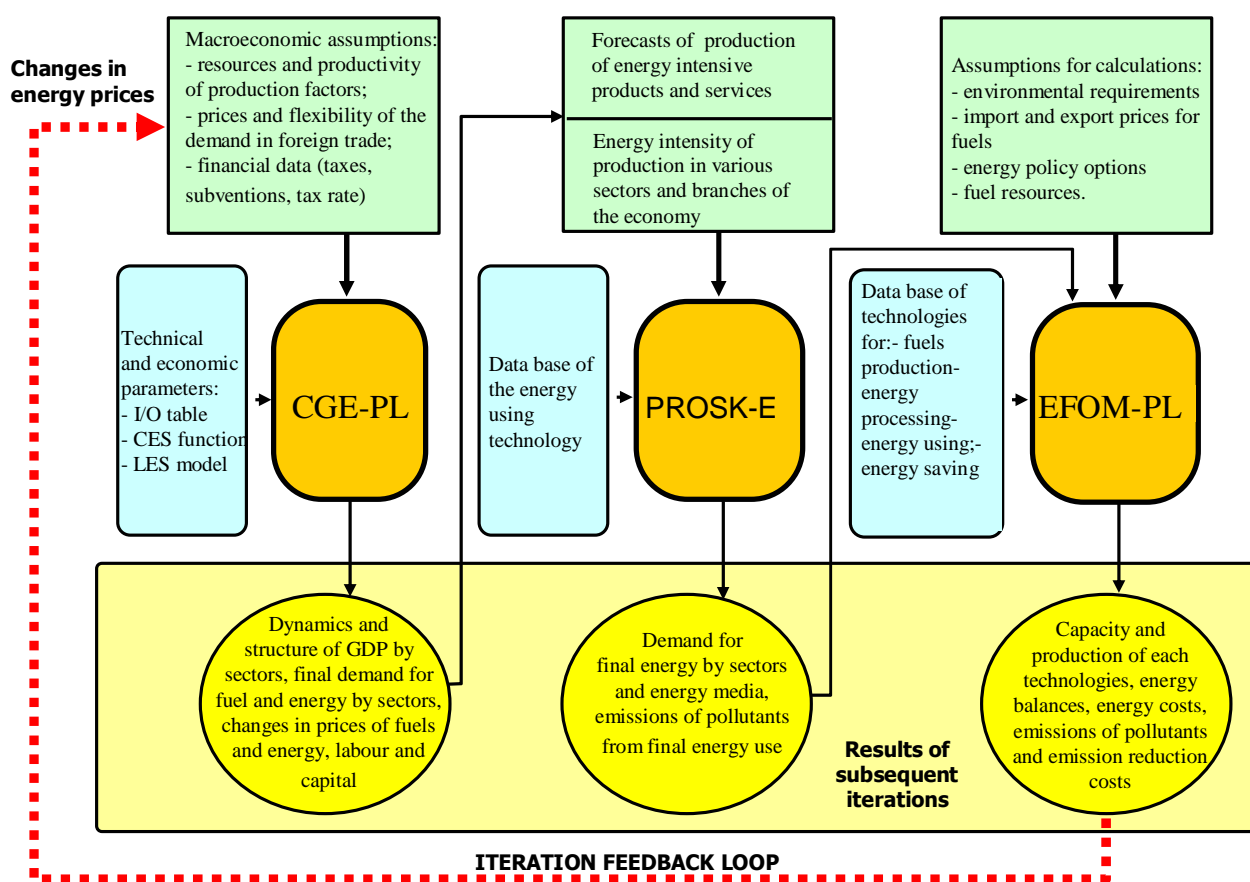


FIG I: Calculating scheme of CGE-PL, PROSK-E and EFOM-PL models

The above set of models has been numerously used in studies for government administration bodies (the Ministry of Environment, the Ministry of Economy) and for international organisations such as the World Bank). Use of the feedback conjugation between the results of the EFOM-PL and CGE-PL models turned out to be very important for this study. The results of the EFOM-PL model defining the marginal costs of electricity supplies were used to formulate assumptions concerning changes in electricity prices in the CGE-PL model. The model was then applied to indicate the impact of changes in energy prices on the economy.

## 3.2. Calculating variants (scenarios)

Three variants of the new EU energy policy were adopted for calculating purposes where the following requirements proposed by the EC were introduced: (i) intensification of actions for the reduction of CO<sub>2</sub> emissions, (ii) obligatory objectives regarding the development of renewable energy sources, (iii) hypothetical obligation to use CCS installations (carbon dioxide capture and storage). These variants were marked with the names of the EU sources of their main components: EU\_CO<sub>2</sub>, EU\_MIX and EU\_CCS. Such a set of calculating variants makes it possible to assess the impact of each component of the EU energy and climate policy.

TABLE 1: Description of the analysed energy and climate policy variants

Name of variant	Main assumptions	Interpretation
<b>BAU</b> (Continuation)	<ul style="list-style-type: none"> <li>⇒ Energy sector functioning conditions as of the end of 2007, including:</li> <li>⇒ zero price for CO<sub>2</sub> emission allowances</li> </ul>	A comparative variant for the assessment of the entire EU climate policy consequences, including its price consequences compared to the period before 2008.
<b>ODN</b> (Reference)	<ul style="list-style-type: none"> <li>⇒ Without any new actions for the reduction of CO<sub>2</sub> emissions in Poland and the EU;</li> <li>⇒ The present EU ETS, the price of EUR 20/t, mostly free allocation of emission allowances;</li> <li>⇒ Objectives related to renewable energy sources in accordance with the current policy (7.5% share of renewable sources in electricity production as of 2010 and 5.75% share of biofuels)</li> </ul>	A comparative variant for the assessment of the new EU policy consequences included in the 2007 and 2008 proposals compared to the previously introduced requirements by the currently functioning EU ETS.
<b>EU_CO<sub>2</sub></b> (Greenhouse gases emissions reduction)	<ul style="list-style-type: none"> <li>⇒ The price for emission allowances of EUR 39/t after 2013;</li> <li>⇒ Allocation of allowances in the electricity sector 100% payable after 2013, at heating producers 20-100% payable in the period of 2013-2020 and 100% payable after 2020;</li> <li>⇒ Revenues from auctioning of emission allowances allocated for Poland will go to the budget and indirectly, they will increase the income of households and production sectors;</li> </ul>	<p>This variant will show the consequences of the introduction of the proposed EU ETS modifications:</p> <ul style="list-style-type: none"> <li>a) payable emission allowances allocation by auctioning;</li> <li>b) growing prices for emission allowances.</li> </ul> <p>The consequences will be mainly described by:</p> <ul style="list-style-type: none"> <li>a) changes in the technological and fuel structures in the energy sector;</li> <li>b) changes in the production costs</li> </ul>

	⇒ Without any new commitments in the area of renewable energy sources and co-generation (they will develop up to the level of the required emissions reduction)	of energy
<b>EU_MIX</b> (Greenhouse gases emission and renewable energy sources development)	⇒ Stimulating of CO2 emissions reduction and revenues from auctioning as in the EU_CO2 above; ⇒ New EU objectives with respect to energy production from renewable energy sources (15% in 2020, including 10% share of biofuels)	This variant will make it possible to assess the performance and consequences of proposed new objectives related to the development of renewable energy sources
<b>EU-CCS</b> (Additionally, obligatory CCS)	⇒ Requirements concerning CO2 emissions reduction and renewable energy sources development as in the EU_MIX above; ⇒ A need to use CCS installations in new coal-fired power plants as of 2025	Assessment of the cost and price consequences of hypothetical obligatory use of CCS as of 2025

Comparative policies were used for the assessment of different options of the EU policy. In accordance with the first one (a so called "Reference" policy), the current energy and climate policy should be maintained up to 2030, including the present EU ETS with the price of emission allowances of EUR 20/t.

To assess all the consequences of the EU climate policy as the reference point, the Continuation policy (BAU) was used which assumes a zero price for CO2 emission allowances and is a continuation of operating conditions of the energy sector before 2008.

The 2008 Energy and Climate Package consequences were assessed under the BASIC conditions of a macroeconomic scenario and two variants of the demand for energy:

- ⇒ **Basic** variant - without any special actions in favour of the energy efficiency improvement;
- ⇒ **Effective** variant - which assumes the implementation of an active policy of energy effectiveness aimed to reach a 20% reduction of energy use in 2020, in accordance with the EC proposal under the 3\*20 Package of 2007.

Each variant of the energy and climate policy was analysed under the continuation conditions of the current effectiveness policy and under hypothetical conditions of the active policy of effectiveness improvement. Such a scheme of modeling calculation makes it possible to notice whether the implementation of the active policy of energy effectiveness will allow to considerably reduce cost and price consequences of the 2008 EC proposal.

TABLE II. Scheme and names of the calculating variants (scenarios)

Policy of climate protection and renewable energy sources development		Macroeconomic scenario and demand for energy	
Variant	Description of requirements	BASIC scenario BASIC variant (without the effectiveness improvement policy)	BASIC scenario EFFECTIVE variant (with the effectiveness improvement policy)
Current requirements	Without the EU ETS or zero prices for allowances - like up to 2007	<b>BAU</b>	<b>BAU-E</b>
	EU ETS - prices for allowances as for the period of 2008-2012	<b>ODN</b>	<b>ODN-E</b>
2008 EC Package	New EU ETS, higher prices for allowances, allocation by auctioning	<b>EU_CO2</b>	<b>EU_CO2-E</b>
	New EU ETS and renewable energy sources development (15%)	<b>EU_MIX</b>	<b>EU_MIX-E</b>
Obligatory CCS	Obligatory CCS in coal-fired power plants as of 2025	<b>EU_CCS</b>	<b>EU_CCS-E</b>

Note: Variants with results presented in full are marked with bold type

## 4. Assumptions for model analyses

### 4.1. A set of the most important assumptions

A general scheme of assumptions reflects groups of the most important factors that influence the development of the energy system in Poland. These are: the demand for energy, conditions of fuel supplies, legally binding ecological requirements (eg. an emission cap) or energy requirements (eg. a required share of energy from renewable sources), available development options and costs of capital. Below you can find a synthesis of the calculating assumptions indicating main groups of the assumptions and principles of their differentiation among various calculating variants.

TABLE III. Main groups of the assumptions and results as well as their differentiation in calculating variants (scenarios)

	<b>BAU</b> (BAU-E)	<b>ODN</b> (ODN-E)	<b>EU_CO2</b> (EU_CO2-E)	<b>EU_MIX</b> (EU_MIX-E)
<b>A. Framework volumes</b>				
<b>Calculating parameters</b>	<ul style="list-style-type: none"> <li>⇒ discount rate: 10%</li> <li>⇒ calculation years: 2005, 2010, 2015, 2020, 2025, 2030</li> <li>⇒ monetary unit: PLN'2005 (a constant purchase power of PLN in 2005)</li> <li>⇒ USD 1=PLN 3.24; EUR 1=PLN 4.05 (average exchange rates in 2005)</li> </ul>			
<b>B. DEVELOPMENT SCENARIO</b>				
<b>Economic development</b>	<p>In the first phase: the BASIC scenario uses official documents and government forecasts</p> <p>In the second phase: calculated changes in GDP as a result of changes in energy prices</p>			
<b>Demand for energy</b>	<p>In the first phase:</p> <p>Two variants coherent with the BASIC scenario:</p> <ul style="list-style-type: none"> <li>⇒ BASIC - without the effectiveness improvement policy</li> <li>⇒ EFFECTIVE - with the active effectiveness improvement policy</li> </ul> <p>In the subsequent cycle: calculated changes in the demand for energy</p>			
<b>C. LEGAL AND MARKET CONDITIONS</b>				
<b>Fuel supply</b>	<p>One set determining price conditions and maximum amounts of domestic and import supplies of:</p> <ul style="list-style-type: none"> <li>⇒ coal, lignite, natural gas and oil</li> </ul>			

<b>Ecological requirements in force and subsequent market obligations</b>	One set of instruments and requirements concerning in particular: ⇒ objective standards of SO <sub>2</sub> and NO <sub>x</sub> emissions (Directive LCP); ⇒ share of energy from high-effective co-generation and from renewable sources; ⇒ share of biofuels			
<b>Energy and climate policy of EU</b>	Without the EU ETS or zero price for allowances	EU ETS price as in the period of 2008-2012	New EU ETS	New EU ETS + renewable energy sources + CCS ready
<b>D. LIMITATIONS TO DEVELOPMENT</b>	One set of the assumptions, including: ⇒ sustainable balance of electricity exchange (import = export); ⇒ lack of protection for domestic mining; ⇒ permitted supplies of gas from any available directions; ⇒ permitted development of nuclear energy as of 2020			
<b>E. SENSITIVITY ANALYSES</b>				
Prices for CO <sub>2</sub> emission allowances		+		
Level of renewable energy sources development			+	
Obligatory CCS				+
<b>F. ASSESSMENT INDICES</b>				
Direct indices <sup>4</sup>	One set			
Indirect indices (economic and social)	-	-	Changes in GDP and other macroeconomic categories	

The purpose of sensitivity analyses is to assess the impact of one of the assumptions on the achieved results. They are made with respect to particularly uncertain assumptions or those which have a significant impact on the results.

All the calculating variants are described with the same set of results. In case of those variants which assume the full implementation of the EU Energy and Climate Package, economic and social consequences are also calculated.

## 4.2. Macroeconomic scenario and energy demand forecast

<sup>4</sup> Energy production, capacities, structure of technology, fuel consumption, CO<sub>2</sub> emissions, production costs, investments and marginal costs.

The BASIC macroeconomic scenario was grounded on government assumptions regarding a possible pace of economic development in a medium time-period and the continuation of operations favourable to that trend throughout the whole period. The qualitative and quantitative descriptions of this scenario are presented in the tables below:

TABLE IV: Qualitative description of the BASIC scenario

Element	Description
Macroeconomic processes	The scenario is characterized by a rapid pace of economic growth ( <b>5,1% of the average annual growth of GDP</b> ) throughout the whole period (2006-2030). In periods of slower economic development the GDP growth rate drops to 3.4% and the highest annual growth is 6.7%. Favourable external conditions for economic development still exist thanks to the stable GDP growth of developed countries and a tendency to stabilize over a long time-period of import prices for fossil fuels. An important pro-development factor is a growing number of direct foreign investments to Poland, in accordance with the trends observed in the years 2006-2007. An increase in the financial standing of households favours the quick development of the housing sector and a growth of energy consuming facilities in households.
Processes determining the demand for energy	The same assumptions are made for both calculated variants of the demand for final energy regarding the economy's activity level. In the basic variant any changes in the energy consumption take place in accordance with long-term trends in individual sectors of the economy and in the effective variant a significant acceleration of the efficiency improvement is assumed which results from a consistent policy of actions supporting its improvement both in the production sector and in households.

TABLE V. Quantitative description of the BASIC scenario

Item	Category	Unit	2005	2010	2015	2020	2025	2030
B1.3	GDP	PLN billion	981	1,292	1,656	2,075	2,707	3,429
B1.4	Population	million	38.2	37.7	37.6	37.3	36.6	36.1
B1.5	Labour resources	million	24.4	24.7	23.9	22.6	21.6	20.8
B1.6	Unemployment rate	%	17.6	7	7	7	5	5
B1.7	Living area	million of m <sup>2</sup>	810.9	888.4	997.4	1,100.5	1,160.8	1,217.2
B1.8	Steel production	million of tonnes	8.4	12.0	13.0	13.8	14.2	14.4
B1.9	Cement production	million of tonnes	12.6	16.0	16.0	16.0	16.0	16.0
B1.10	Road transportation of passengers	billion of p-km	47.5	46.2	45.4	44.4	43.1	41.4

B1.11	Road transportation of goods	Billion of t-km	169.7	198.8	209.5	217.8	234.8	248.2
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Taking into account the BASIC scenario of the economic development, a two-variant forecast for the demand for energy was prepared which is presented below:

TABLE VI. Forecast for the demand for energy. **BASIC** macroeconomic scenario, **Basic** energy demand variant

Item	Category	Unit	2005	2010	2015	2020	2025	2030
	a) by sectors							
B2.1	AGRICULTURE	PJ	189	193	193	194	203	212
B2.2	INDUSTRY AND CONSTRUCTION	PJ	769	880	973	1,024	1,036	1,020
B2.3	TRANSPORTATION (incl. individual)	PJ	526	608	685	791	792	879
B2.4	SERVICES	PJ	214	238	298	349	402	449
B2.5	HOUSEHOLDS	PJ	778	835	899	958	991	1,026
	b) by energy carriers							
B2.6	Solid fuels	PJ	423	455	459	437	416	375
B2.7	Gas fuels	PJ	404	441	507	567	604	632
B2.8	Liquid fuels	PJ	725	815	899	1,009	1,020	1,106
B2.9	Other fuels	PJ	156	167	174	182	184	188
B2.10	Electricity	PJ	355	423	519	598	673	745
B2.11	Heat	PJ	413	452	490	522	527	538
	<b>TOTAL</b>	<b>PJ</b>	<b>2,476</b>	<b>2,754</b>	<b>3,048</b>	<b>3,317</b>	<b>3,424</b>	<b>3,585</b>

TABLE VII. Forecast for the demand for energy. **BASIC** macroeconomic scenario, **Effective energy demand** variant

Item	Category	Unit	2005	2010	2015	2020	2025	2030
	a) by sectors							
B2.12	AGRICULTURE	PJ	189	190	190	191	198	202
B2.13	INDUSTRY AND CONSTRUCTION	PJ	769	824	863	866	894	876
B2.14	TRANSPORTATION (incl. individual)	PJ	526	587	609	658	674	664
B2.15	SERVICES	PJ	214	227	286	311	376	356
B2.16	HOUSEHOLDS	PJ	778	794	805	815	817	816
	b) by energy carriers							

B2.17	Solid fuels	PJ	423	427	414	374	349	307
B2.18	Gas fuels	PJ	404	414	449	482	520	522
B2.19	Liquid fuels	PJ	725	790	814	857	877	857
B2.20	Other fuels	PJ	156	161	160	159	158	155
B2.21	Electricity	PJ	355	404	476	536	618	636
B2.22	Heat	PJ	413	426	440	433	437	437
	<b>TOTAL</b>	<b>PJ</b>	<b>2,476</b>	<b>2,623</b>	<b>2,752</b>	<b>2,840</b>	<b>2,959</b>	<b>2,913</b>

## 5. ASSESSMENT OF CONSEQUENCES

### 5.1. CO2 emissions reduction and reduction costs

The reduction of greenhouse gases emissions, including CO2 emissions is the major purpose of the EU energy policy. Below you can find changes in CO2 emissions in Poland along with the implementation of subsequent components of the EU policy.

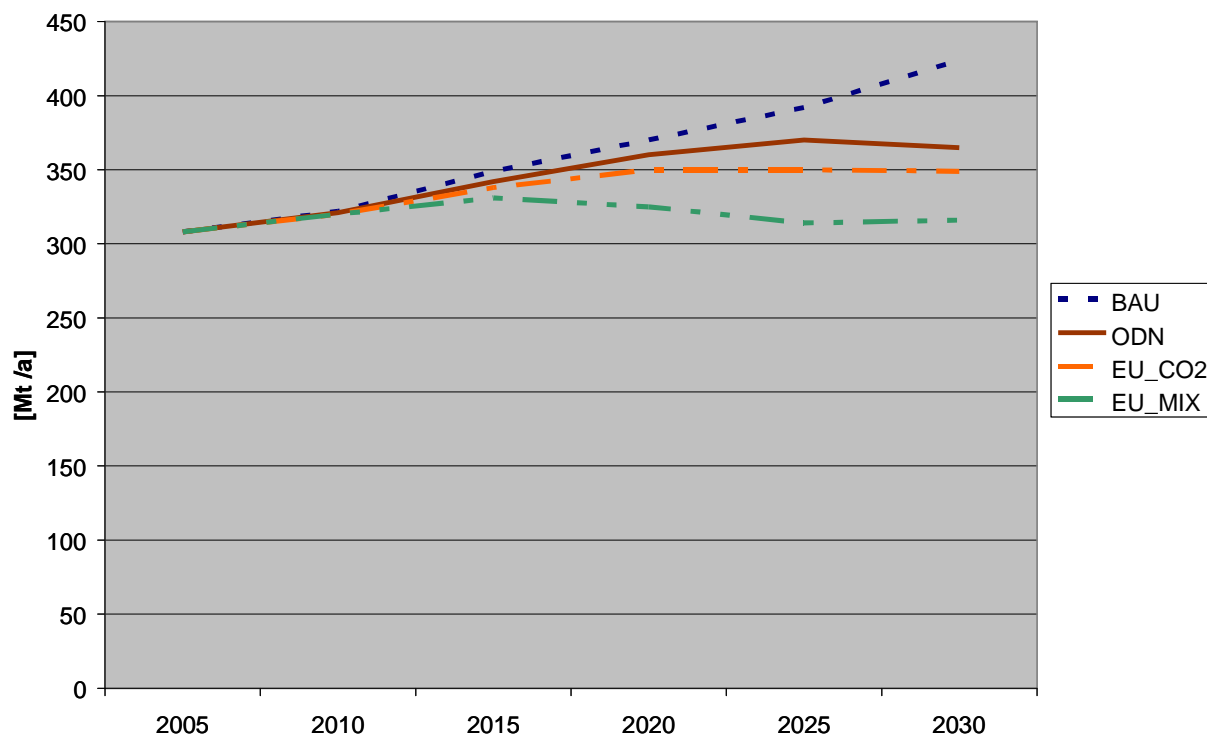


FIG II: CO2 emissions in various scenarios, **without the effectiveness improvement policy**

The achievement of the CO2 emissions reduction results from bearing higher costs of the implementation of lower emission technologies or from using more expensive fuels of lower emission indices. Both emissions reduction effects and costs of their achievement differ according to the applied instruments of the climate policy. Table VIII presents the comparison of emissions reduction effects, costs related to their achievement and unit costs calculated on this basis.

TABLE VIII: Effects and costs of the implementation of the EU energy and climate policy subsequent instruments. Scenarios without the energy effectiveness policy

Instrument	2010	2015	2020	2025	2030
<b>A. Effects (CO2 emissions reduction)</b>					<b>[Mt/a]</b>
1. EU ETS (EUR 20/t)	1	7	10	22	59
2. EU ETS modification (EUR 39/t +	1	4	10	20	16

auctioning)					
3. RES new objectives (15%)	0	7	25	36	33
4. The entire 2008 EC package (compared to BAU)	2	18	45	78	108
5. The entire 2008 EC package (compared to ODN)	<b>1</b>	<b>11</b>	<b>35</b>	<b>56</b>	<b>49</b>
<b>B. Increment of annual costs of meeting energy needs</b>					<b>[Million of PLN/a]</b>
1. EU ETS (EUR 20/t)	12	91	130	483	4,066
2. EU ETS modification (EUR 39/t + auctioning)	117	662	1,319	2,297	2,451
3. RES new objectives (15%)	32	1,435	7,202	10,021	7,863
4. The entire 2008 EC package (compared to BAU)	162	2,262	8,536	12,801	14,381
5. The entire 2008 EC package (compared to ODN)	<b>149</b>	<b>2,096</b>	<b>8,521</b>	<b>12,318</b>	<b>10,314</b>
<b>C. Average unit costs of CO2 emissions reduction</b>					<b>[PLN/t]</b>
1. EU ETS (EUR 20/t)	12	13	13	22	69
2. EU ETS modification (EUR 39/t + auctioning)	117	165	132	115	153
3. RES new objectives (15%)		205	288	278	238
4. The entire 2008 EC package (compared to BAU)	81	126	190	164	133
5. The entire 2008 EC package (compared to ODN)	<b>149</b>	<b>191</b>	<b>243</b>	<b>220</b>	<b>210</b>

NOTE: The above costs of CO2 emissions reduction are related with the achievement of technological structures optimal for given requirements and do not include costs of the purchase of CO2 emission allowances

Both the effects of emissions reduction and an increment of energy supply costs were shown separately for subsequent instruments of the climate policy which will enable to compare their effectiveness. Also the effects and costs of reduction were presented for the entire 2008 EC Energy and Climate Package in two variants: in comparison with the situation before the implementation of the emission trade scheme (BAU scenario) and in comparison with the situation of the present functioning of the EU ETS (ODN scenario).

While comparing unit costs of CO2 emissions reduction (see: Part C), it is worth noticing that their value is growing along with the implementation of subsequent instruments of the climate policy. Average costs of emissions reduction in the present EU ETS amount to PLN 48/t throughout the whole period up to the year 2030. The modification of the EU ETS operating principles and an increase in prices for CO2 emission allowances to EUR 39/t will start additional undertakings of an average unit cost of CO2 emissions reduction of PLN 135/t throughout the whole period. The achievement of the renewable energy sources objectives as proposed by the EC is connected with the emissions reduction at the average cost of PLN 263/t.

An average cost of CO<sub>2</sub> emissions reduction calculated as total for the 2008 EC proposal (modification of the EU ETS and the obligatory renewable energy sources objectives) was estimated at PLN 220/t. The costs are very high. They are considerably higher than the target price for allowances of EUR 39/t (about PLN 160 in 2005).

## 5.2. Consequences for the energy system

### 5.2.1. Structure of electricity production

The following trends were noticed in the forecasts produced up to the year 2030 (see the chart below):

1. The production is decreasing in the existing heat power plants;
2. The production is moderately increasing in the industrial heat and power generating plants;
3. The production from renewable energy sources is growing;
4. A dominant role is played by new heat power plants, and their development scale differs substantially according to the analysed scenario.

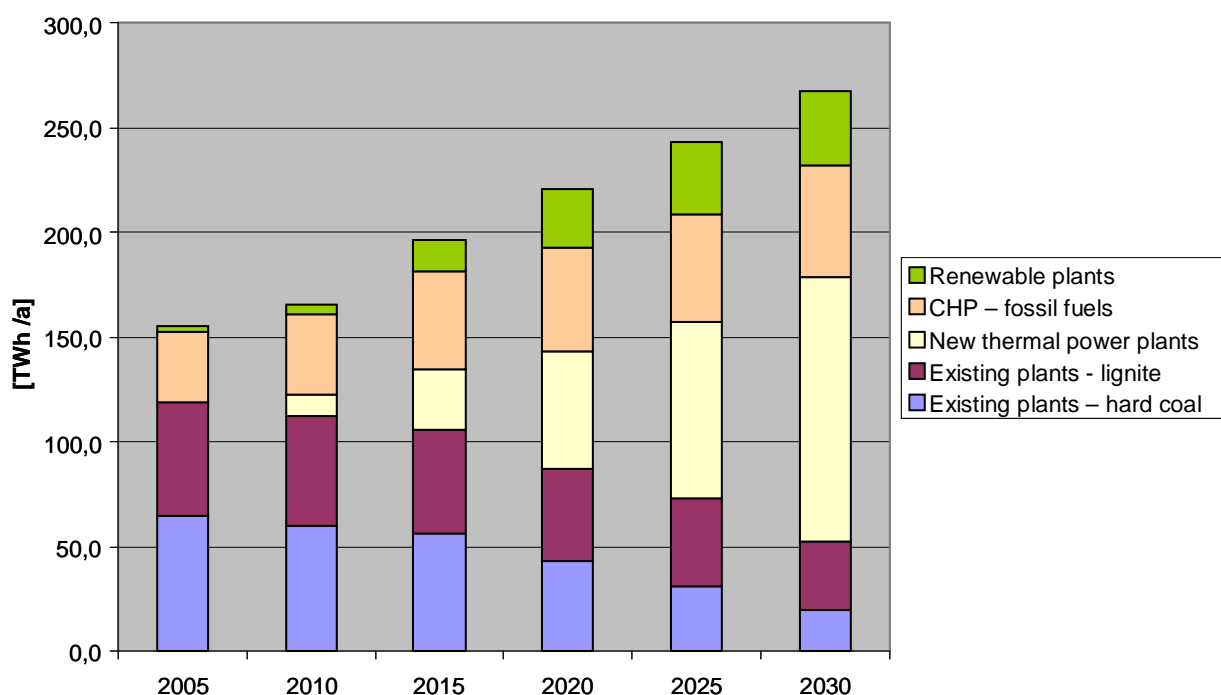


FIG III: Electricity production by the type of producers. **EU\_MIX** Scenario

The structure of fuels is considerably changing. Nuclear energy, gas energy and more and more considerable amounts of energy from renewable sources appear in those calculating scenarios which assume the implementation of the Energy and Climate Package (see: Chart IV). This means a major change in the energy generation structure, and the construction, almost from the very beginning, of nuclear energy and gas energy sectors as well as wind power development. To make such a significant

change within the period of about 20 years is a serious challenge for the electricity sector and the entire economy, as well as for the Government.

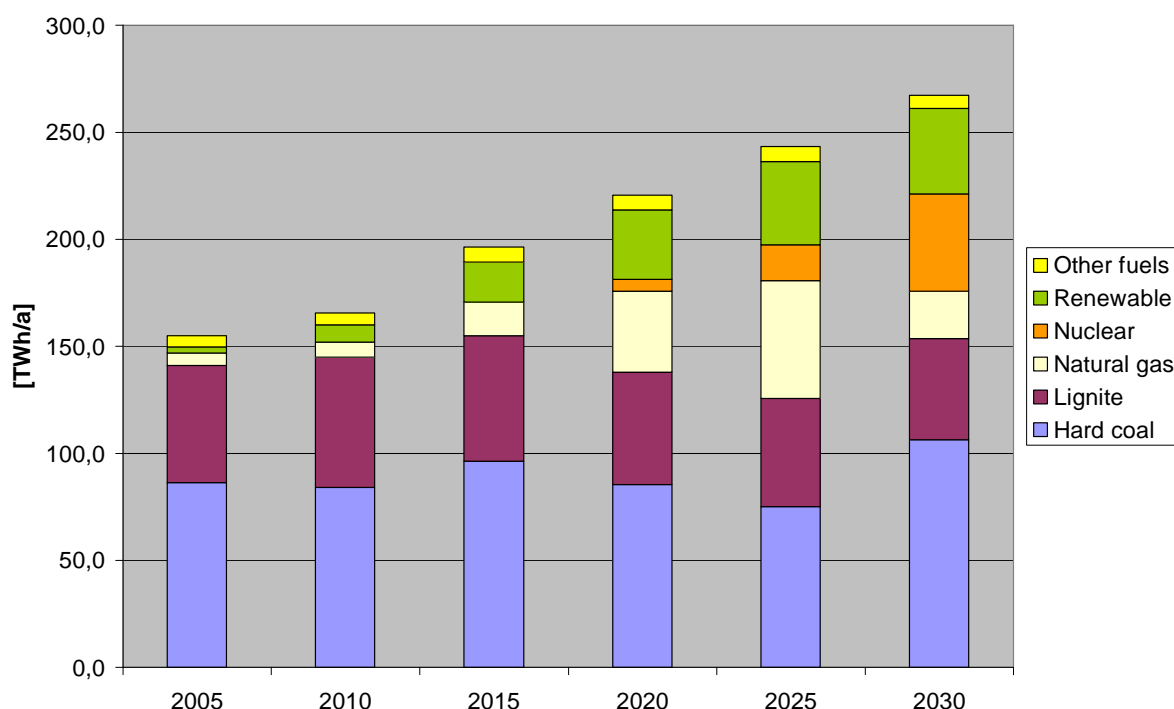


FIG IV: Electricity production by the types of fuels. EU\_MIX Scenario LigniteCoal

## 5.2.2. Structure of power

The balance of power indicated by each analysed scenario shows the following levels:

- 1) Scenarios without the effectiveness improvement policy:
  - a. a level growing **from 48 to 59 GW** in the period of 2020-2030 (without 15% renewable energy sources);
  - b. a level growing **from 53 to 66 GW** in the period of 2020-2030 (with 15% renewable energy sources).
- 2) Scenarios with the effectiveness policy:
  - a. a level growing **from 43 to 50 GW** in the period of 2020-2030 (without 15% renewable energy sources);
  - b. a level growing **from 48 to 57 GW** in the period of 2020-2030 (with 15% renewable energy sources).

## 5.2.3. Electricity production technologies

TABLE IX: Optimal set of electricity production technologies in the group of public power plants. EU\_MIX Scenario

[MW/ps]

	2005	2010	2015	2020	2025	2030
<b>A. Existing thermal power plantplants</b>						
Existing lignitelignitepower plantlignite power plants	8,879	6,219	3,084	1,984	1,744	0
Existing coal power plants	15,688	15,133	13,638	9,517	8,794	3,837
Modernized power plants <sup>*)</sup>	0	1,480	4,858	4,985	4,985	4,985
<b>B. New heat power plants</b>						
PC boilers (overcritical parameters)	0	1,492	2,983	2,984	2,984	2,984
IGCC (coal gasification)	0	0	0	0	0	5,000
PC boilers with CCS	0	0	0	0	0	0
IGCC with CCS	0	0	0	0	0	1,378
Oxygen combustion with CCS	0	0	0	0	0	0
CCGC (natural gas) power plant	0	0	1,000	3,400	5,800	5,800
Peak -load gas turbines	0	0	0	3,623	3,623	3,623
Nuclear power plants	0	0	0	800	2,400	6,500
<b>C. Renewable energy sources power plants</b>						
Biomass cogeneration plants	31	394	794	1,863	2,102	2,297
Hydro power plants	915	926	1,504	1,504	1,504	1,504
Wind power plants	121	999	4,995	10,367	14,568	14,525
<b>D. Water pumped-storage power plants</b>						
	1,406	1,406	1,406	1,406	1,406	1,406
<b>TOTAL</b>	<b>27,040</b>	<b>28,050</b>	<b>34,261</b>	<b>42,434</b>	<b>49,910</b>	<b>53,839</b>

\*) Incl. mainly 360 MW units of the Belchatów Power plant

The following conclusions can be drawn from the achieved results:

- 1) Nuclear power plants turn out to be profitable in all the scenarios of the climate policy at the allowance price of as little as EUR 20 per tonne of CO<sub>2</sub> emissions;
- 2) Gas power plants turn out to be profitable in similar conditions than nuclear power plants but the difference is that at the growing prices for gas and high prices for CO<sub>2</sub> emission allowances they are economically worse than nuclear power plants;
- 3) Coal blocks with overcritical boilers are a dominant choice of new heat power plants in the situation there is no CO<sub>2</sub> emissions reduction policy (the BAU scenario); they also develop in moderate 'climate pressure' conditions (the ODN scenario) but they will become unprofitable if the price for CO<sub>2</sub> emission allowances tends to grow. At the CO<sub>2</sub> emission allowances prices of EUR 39/t, technologies with coal gasification without CCS turn out to be more attractive, and if they are consequently improved in approximately 2030 they will be attractive in the version with CCS (the EU\_MIX scenario);

- 4) Wind power plants are dominant in the group of renewable energy sources power plants thanks to their biggest potential rather than profitability. They can develop when cogeneration plants for biogas or solid biomass use up their production potential.

The above results do not refer to power plants equipped with pilot or demonstrative CCS installations. It should admit, however, that a fully commercial application of coal technologies with CCS installations in approximately 2030 will require the construction of pilot and demonstrative installations in good time before as well as the carrying out of suitable research work.

## 5.2.4. Electricity production costs

### Marginal costs

The chart below shows a curve of electricity production marginal costs for all the analysed scenarios. A reference point is an average cost of electricity production in 2005 (PLN 113.3/MW) which was calculated as an average total cost of energy supply on the market (PLN 131.4/MW) decreased by trade costs of PLN 18.14/MWh (mainly excise duty).

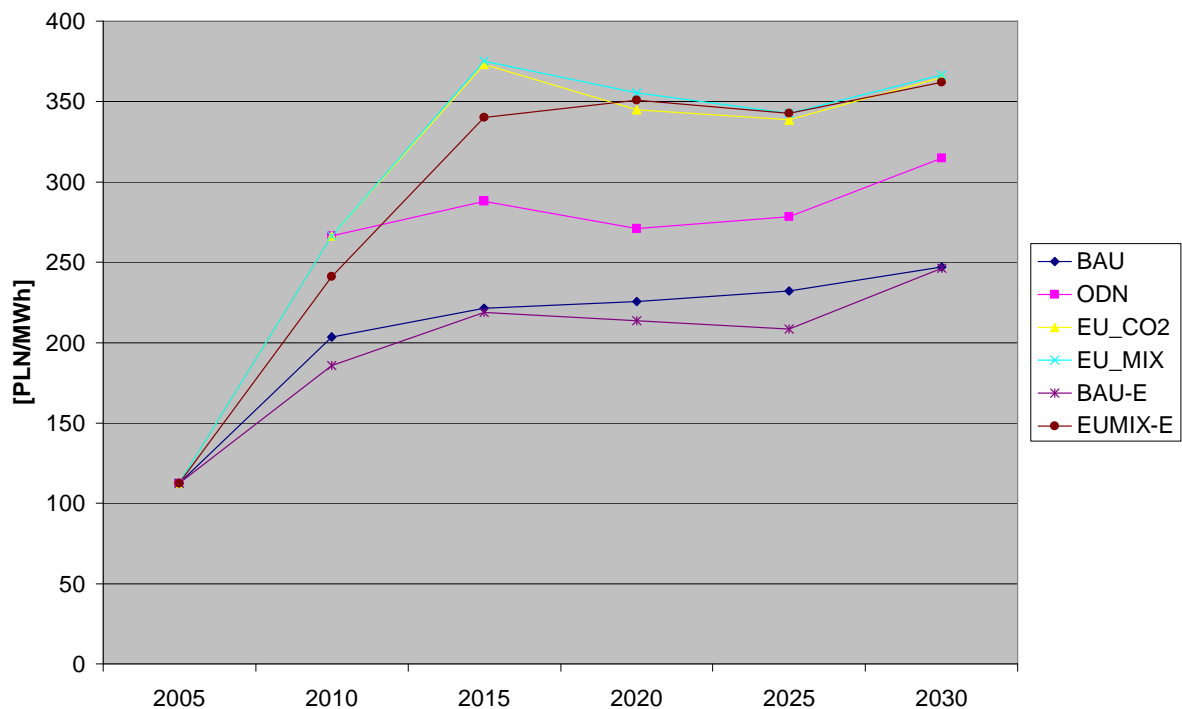


FIG V: Curve of electricity production marginal costs

Marginal costs amount to as much as PLN 350/MWh in the EU energy and climate policy scenarios which means a three-time increase in prices for energy purchased from energy producers compared to 2005 and a 60% higher price than assumed in the scenarios without the climate policy.

Average costs of electricity production in all the analysed scenarios are shown in Chart VI.

⇒ The chart of average electricity production costs is clearly divided into two bunches of lines. What matters to become the upper or lower bunch of lines are the conditions of the purchase of and prices for emission allowances. One can notice a rapid increase in the average cost of electricity production as of 2013 (2015 in model calculation) in the three EU climate policy scenarios. Indeed, the cost becomes two times as much over one year.

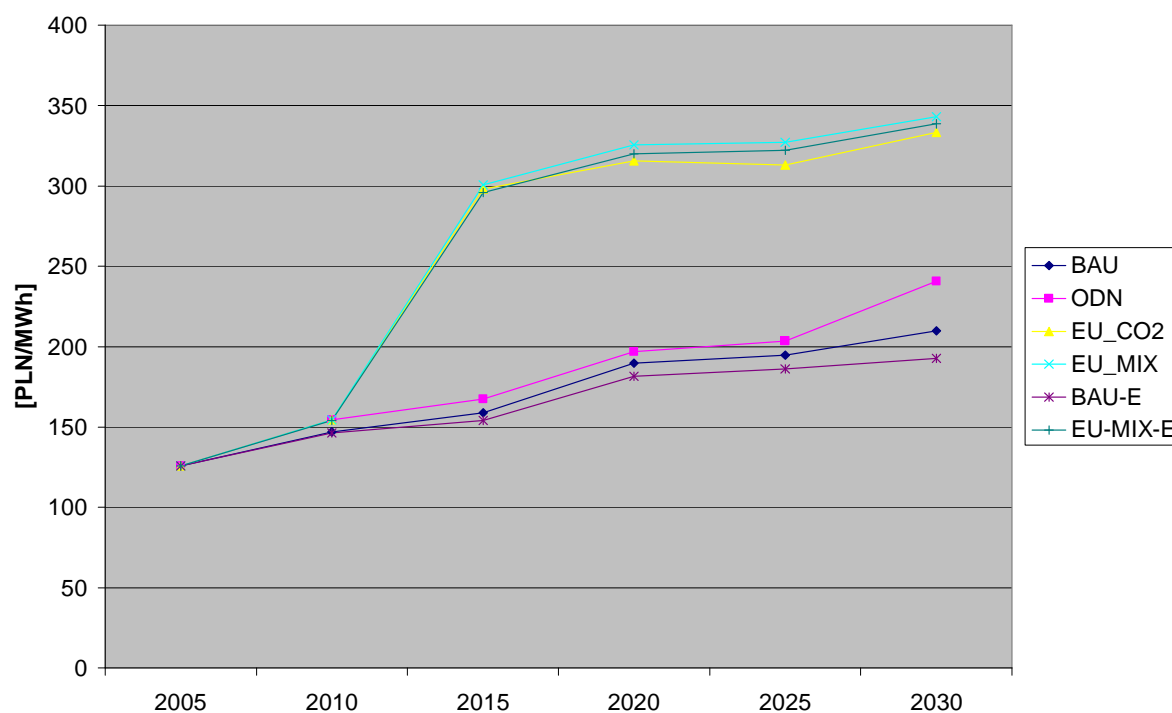


FIG VI: Average costs of electricity production in analysed scenarios

On the basis of calculated results concerning average costs one can conclude that:

- ⇒ Average costs are fast approximating marginal costs in the scenarios assuming the modification of the EU ETS functioning (EU\_CO2, EU\_MIX after 2013) (it is 2015 in the model). This proves the previously assumed thesis that if the Energy and Climate Package is implemented, the prices for electricity will be similar to the path indicated by marginal costs.
- ⇒ If the CE proposal is modified so as the allocation of allowances is partially payable, the average costs will decrease without a change in marginal costs.

## 5.2.5. Investment expenditures

Investment expenditures are, from Poland's point of view, an important assessment index of various options of the EU policy. The results of calculations are shown in the two tables below, separately for the scenarios without the effectiveness improvement policy and for the scenarios with the effectiveness improvement policy.

TABLE X: Investment expenditures for new power plants, scenarios without the effectiveness improvement policy

	[PLN billion]					
	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	2006-2030
<b>BAU scenario</b>						
Thermal power plants	8.1	19.8	25.9	27.1	38.6	<b>119.5</b>
Renewable power plants	6.8	18.5	4.1	5.5	14.6	<b>49.4</b>
TOTAL:	14.9	38.2	30.1	32.5	53.2	<b>168.9</b>
<b>ODN scenario:</b>						
Thermal power plants	8.1	16.1	18.5	17.6	126.2	<b>186.4</b>
Renewable power plants	6.8	18.5	4.1	5.5	14.6	<b>49.4</b>
TOTAL:	14.8	34.5	22.6	23.0	140.8	<b>235.8</b>
<b>EU_MIX scenario:</b>						
Thermal power plants	7.9	11.3	22.0	30.8	108.8	<b>180.8</b>
Renewable power plants	6.8	29.5	41.0	26.5	9.0	<b>112.8</b>
TOTAL:	14.6	40.8	63.0	57.3	117.8	<b>293.6</b>

TABLE XI: Investment expenditures for new power plants, scenarios with the effectiveness improvement policy

	[PLN billion]					
	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	2006-2030
<b>BAU-E scenario</b>						
Thermal power plants	4.0	13.1	22.4	27.0	25.2	<b>91.7</b>
Renewable power plants	6.8	13.9	3.4	4.6	10.4	<b>38.9</b>
TOTAL:	10.8	27.0	25.8	31.5	35.5	<b>130.7</b>
<b>EU_MIX-E scenario:</b>						
Thermal power plants	4.0	4.5	23.5	30.8	84.0	<b>146.8</b>
Renewable power plants	6.8	24.5	35.5	28.6	5.9	<b>101.2</b>
TOTAL:	10.7	29.0	59.0	59.4	89.9	<b>248.0</b>

The following conclusions can be drawn from the above data:

- 1) The implementation of the 2008 Energy and Climate Package will require by **PLN 110-130 billion** of investment expenditures more than in comparative scenarios without the climate policy (PLN 250-290 billion compared to PLN 130-170 billion).
- 2) The implementation of the Energy and Climate Package will require by **PLN 50 billion** of investment expenditures more than in the ODN scenario which assumes the continuation of the present climate protection policy and renewable energy sources development (PLN 293 billion compared to PLN 235 billion).

### 5.3. Consequences for the economy

The most noticeable consequence for the Polish economy of the policy's full implementation to further reduce anthropogenic CO<sub>2</sub> emissions in Europe is a considerable slowdown of the GDP development pace. The results of the conducted model analyses show Poland will lose annually on average 0.6 % of the GDP development rate in the analysed time-period, taking into account the burden of the economy. In the analysed scenario of a quick, stable and long-term growth, it means such losses will exceed a half of the 2005 GDP. The table below shows the comparison of calculation results concerning GDP in the analysed years as well as the annually-average GDP development rates for the subsequent five-year-time-periods for both calculating variants.

TABLE XII: Impact of changes in energy prices on GDP in the period of 2005-2030

	Unit	2005	2010	2015	2020	2025	2030
GDP_2005 Prices							
GDP in the BAU scenario	PLN billion	983	1,275	1,665	2,024	2,716	3,399
GDP in the EU_MIX scenario	PLN billion	983	1,259	1,594	1,869	2,348	2,895
Difference in GDP levels (BAU-EU_MIX)	PLN billion	0	16	71	154	368	503
Relative decrease in GDP (EU_MIX/BAU)	-	1,000	0.987	0.957	0.924	0.864	0.852
Annually-average GDP development rates over five-year time-periods							
			2006-2010	2011-2015	2016-2020	2021-2025	2026-2030
BAU scenario	-	-	5.33	5.49	3.98	6.06	4.59
EU_MIX scenario	-	-	5.06	4.84	3.24	4.66	4.29

One of the reasons for a slower development pace is a significant decrease in the production of the most energy-consuming industrial sectors, particularly those where a significant part of the production is placed on markets outside the territory of Poland.

The biggest effects were noticed in metallurgical and chemical industries. At the end of the analysed period the EU\_MIX scenario related production in the above sectors of industry is lower by about 20% in comparison with the BAU scenario. It is worth mentioning that the calculated slowdowns of the production dynamics in the EU\_MIX scenario do not mean its absolute decrease. For example, in the case of chemical industry in 2030 the production will be more than three times higher than in 2005 in reality.

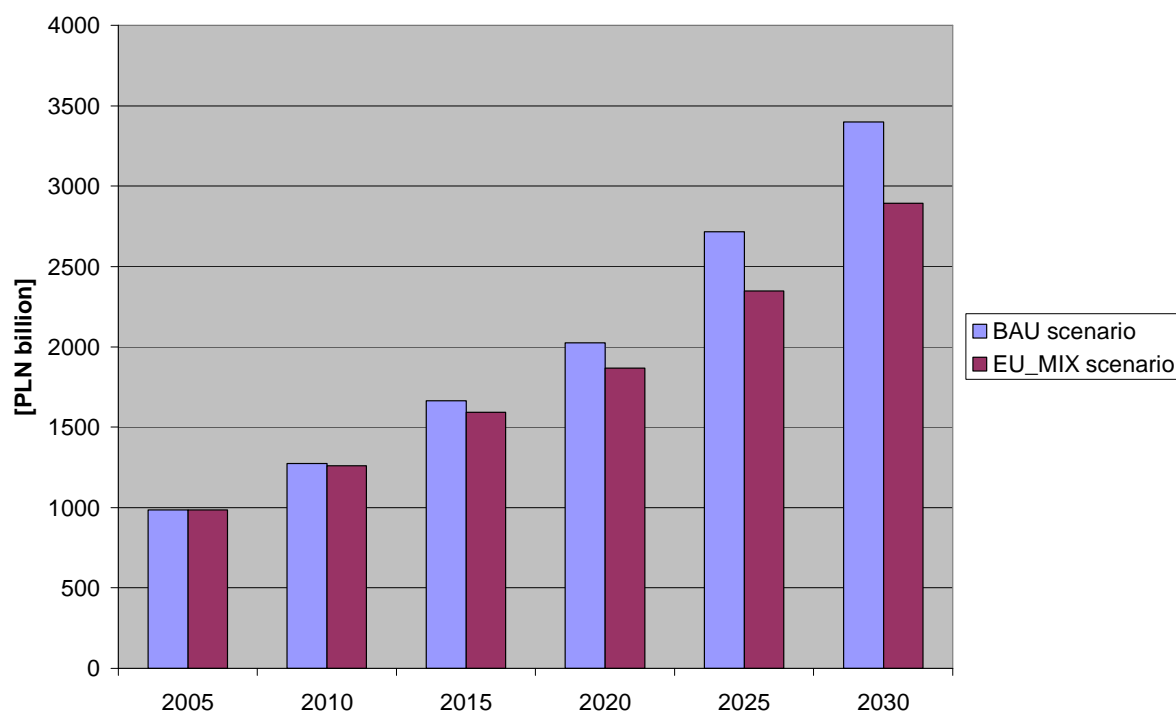


FIG VII: The comparison of the GDP levels in BAU / EU\_MIX calculating scenarios.

Table XIII shows the comparison of annually-average inflation rates for the two calculating scenarios. Taking into account the analysed changes in energy prices, the differences between the annually-average inflation rates of the two calculating scenarios do not exceed 0.2% and 0.4% in the years 2006-2020 and 2021-2030 respectively. A negative impact of the inflation growth on home budgets is levelled by growing wages in part only.

TABLE XIII: Comparison of annually-average inflation rates in BAU /EU\_MIX calculating scenarios

Annually-average inflation rate	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030
BAU scenario	2.6%	2.4%	2.8%	2.4%	2.7%
EUMIX scenario	2.6%	2.6%	3.0%	2.8%	3.3%

The analysis showed that even a small increase in prices caused by inflation in the Polish economy (above the inflation level on trade partner markets) can have a significant impact on the balance of foreign trade. While calculating it was assumed that the international prices for products subject to trade turnover with Poland will grow a bit slower than the prices in Poland (80% of domestic inflation rate).

Table XIV shows the comparison of the imports and exports values expressed in stable prices for both scenarios. Whereas Poland has a positive foreign trade balance in the BAU scenario in the period of 2010 - 2015, the foreign trade balance in the EU\_MIX scenario is negative up to 2025 and remains more or less at the current level. An increase in inflation favours an increase in the imports and reduces the exports possibilities.

TABLE XIV: Comparison of Poland's foreign trade balance up to 2030 for analysed scenarios

	Unit	2005	2010	2015	2020	2025	2030
<b>BAU scenario</b>							
Import value	PLN billion	368	419	486	542	640	746
Export value	PLN billion	365	418	486	544	644	751
Foreign trade balance	PLN billion	-3.35	-1.07	0.51	1.98	4.09	5.05
<b>EU_MIX scenario</b>							
Import value	PLN billion	368	419	489	543	644	747
Export value	PLN billion	365	418	483	539	642	749
Foreign trade balance	PLN billion	-3.35	-1.12	-5.72	-4.20	-2.07	1.68

The reduction of the final demand for electricity and heating was estimated in more detail in the last phase of the analysis with the use of the PROSK and EFOM models results as well as the assumptions concerning users' sensitivity to an increase in prices.

The results of the calculations show that if a policy for the CO<sub>2</sub> emissions reduction and RES development is implemented in Poland, a real **decrease** will be noted **in the demand** for energy sector services, i.e. by **8-10% for electricity** and by **7-13% for heating**. Industry and services sectors are particularly sensitive to an increase in electricity prices, and a rise of heating prices is severely felt by households.

## 5.4. Consequences for households

The consequences for households were determined by changing households budgets burden with energy costs and a decrease in available incomes due to lower GDP. Table XV shows the level of unavoidable expenditures according to the implemented energy policy.

TABLE XV: Impact of the EU-MIX scenario implementation on the level and share of unavoidable expenditures, including electricity costs in households

Expenditures of households	Unit	2005	2010	2020	2030
<b>BAU scenario</b>					
Expenditures for the usage of the living area and energy, including:	PLN/man/month	135.6	174.1	228.6	310.7
Energy media, including:	PLN/man/month	75.8	105.6	143.6	208.6
Electricity	PLN/man/month	25.6	41.4	66.8	90.4
% of total expenditures					
Expenditures for the usage of the living area and energy, including:	%	19.6	21.1	20.2	19.2
Energy media, including:	%	11.0	12.8	12.7	12.9
Electricity	%	3.7	5.0	5.9	5.6
<b>EU-MIX scenario</b>					
Expenditures for the usage of the	PLN/man/month	135.6	174.9	255.7	336.7

living area and energy, including:					
Energy media, including:	PLN/man/month	75.8	106.4	170.7	234.6
Electricity	PLN/man/month	25.6	42.3	79.1	102.6
% of total expenditures					
Expenditures for the usage of the living area and energy, including:	%	19.6	21.6	24.2	23.3
Energy media, including:	%	11.0	13.2	16.2	16.2
Electricity	%	3.7	5.2	7.5	7.1

Source: Own studies

An increase in the expenditures for the usage of the living area and energy in households if the EU-MIX scenario is followed with a simultaneous decrease in the income growth pace will bring about an increase in the share of those expenditures in the total expenditures of households from 11% to more than 16%. It is a huge growth which will result in rising 'energy poverty'.

A term of a socially sensitive user on the electricity or gas markets has not been defined in detail in the European Union yet but the obligation to protect such users has been imposed on EU Member States by virtue of Directive 2003/54/EC<sup>5</sup> and Directive 2003/55/EC<sup>6</sup>. Certain EU Member States implement the provisions of the Directives through general forms of social welfare (eg. Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Norway and Slovakia). In Finland assistance is given to the chronically ill and the unemployed. An exemption from the rule is the United Kingdom where the energy poverty has been defined as the status of the household which has to spend more than 10% of its incomes on the sufficient level of heating and other energy needs.

A high increase in the share of basic components of unavoidable costs of living would result in a civilisation regress and a radical impediment of the socially sensitive users' lives. If the current differentiation of incomes and expenditures by the types of households maintains, the radical worsening of the situation of old-age retirees and pensioners as well as of workers can be clearly visible (see: Table XVI and Chart VIII).

TABLE XVI: Changes in the share of expenditures for energy and the usage of the living area in the EU-MIX scenario by the types of households

Expenditures	[%]				
	Households of workers	Households of employees other than workers	Households of farmers	Households of self-employees	Households of old-age retirees and pensioners
<b>2020</b>					
Usage of the living area and energy,	24.4	21.6	19.5	20.9	27.8

<sup>5</sup> Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC.

<sup>6</sup> Directive 2003/55/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in natural gas and repealing Directive 98/30/EC.

including					
Expenditures for energy media, including:	16.5	13.3	13.4	13.8	19.6
Electricity	8.3	5.8	8.0	7.2	8.3
<b>2030</b>					
Usage of the living area and energy, including	23.5	20.4	19.2	20.3	27.0
Expenditures for energy media, including:	16.5	13.2	13.8	14.1	19.8
Electricity	7.9	5.5	7.6	6.8	7.9

Source: Own studies

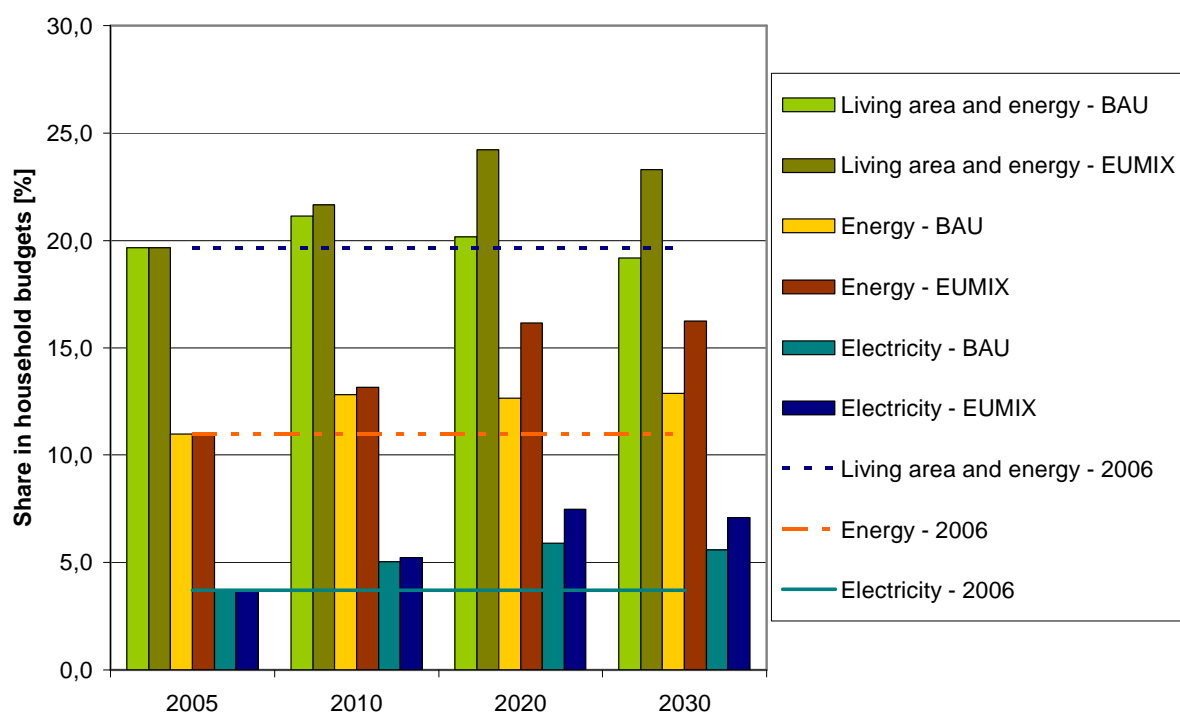


FIG VIII: Increase in the share of costs of the living area and energy in the expenditures of households up to 2030 resulting from the EU\_MIX scenario implementation

An increase in the share of expenditures for energy in household budgets can be partly reduced with the help of certain instruments such as energy and tax policies related measures. It was assumed that due to the introduction of payable allocation of CO2 emission allowances, the state budget will receive additional revenues from auctioning of those allowances and will allocate them for the diminishing of the severity of social consequences resulting from the country's energy and environment policy's new priorities.

TABLE XVII: Impact of the transfer of 50% of revenues from auctioning of EUA allowances in the EU-MIX scenario on changes in the expenditures for energy in household budgets

Expenditures of households	Unit	2005	2010	2020	2030
<b>EU-MIX scenario</b>					
Expenditures for the usage of the living area and energy, including:	%	19.6	21.6	24.2	23.3
Energy media, including:	%	11.0	13.2	16.2	16.2
Electricity	%	3.7	5.2	7.5	7.1
<b>EU-MIX scenario with the transfer of revenues from auctioning</b>					
Expenditures for the usage of the living area and energy, including:	%	19.6	21.6	22.2	21.4
Energy media, including:	%	11.0	13.2	14.1	14.4
Electricity	%	3.7	5.2	6.6	6.2

Source: Own studies

**As the above calculations show, in spite of taking special measures to diminish the severity of growing marginal costs of electricity, a considerable increase is still forecast in the share of expenditures for energy in home budgets.**

It is worth mentioning that an increase in the expenditures for energy and the living area of home budgets which is assessed unfavourably was achieved on the basis of optimistic assumptions related to the macroeconomic scenario as well as on the assumption that the available incomes of the population will be stronger related to an increase in GDP. This effect is only partly reduced by the assumed transfer of additional revenues from auctioning of CO2 emission allowances by the Government.

In addition to the above, there are some threats related to an additional increase in the expenditures for the living area due to higher prices for oil derivative products (the calculations were based on a moderate increase in a world prices scenario) or additional expenditures related to the water and sewage management as well as costs generated by an increase in ecological requirements with respect to waste disposal.

## 6. Integrated assessment of the Energy and Climate Package consequences

### 6.1. Assessment of the consequences for various areas of the economic and social system of the country

Below you can find a comparison of the results of model calculations reflecting the consequences of the new EU policy for Poland for various areas of the economic and social system.

TABLE XVIII: Collective comparison of quantitative consequences of the Energy and Climate Package implementation in Poland

Major analysed consequences	Reference scenario (ODN) (without the 2008 Package)	EU-MIX scenario (with the 2008 Package)
<b>A. Electricity system</b>		
1. Required scale of production capacity development	Calculated for the period 2020-2030: <b>48-58 GW</b>  Including new sources with the capacity of <b>18-35 GW</b>	Calculated for the period of 2020-2030: <b>53-66 GW</b>  Including new sources with the capacity of <b>25-44 GW</b>
2. Investment expenditures in the period of 2006-2030	<b>PLN 235.8 billion</b> , including: ⇒ PLN 186.4 billion for thermal power plants; ⇒ PLN 49.4 billion for renewable power plants	<b>PLN 293.6 billion</b> , including: ⇒ PLN 180.8 billion for thermal power plants; ⇒ PLN 112.8 billion for renewable power plants
3. Changes in the production technology forced by changes in operating conditions	⇒ Development of the nuclear energy sector as of 2030; ⇒ Development of the wind energy sector up to <b>5,000 MW</b>	⇒ Development of the nuclear energy sector as of 2020; ⇒ Development of the wind energy sector up to <b>15,000 MW</b>
4. Average costs of electricity production ( <b>PLN 113/MWh</b> in 2005)	Increase up to <b>PLN 155/Mwh</b> in 2010 and up to <b>PLN 197-241/MWh</b> in the period of 2020-2030	Increase up to <b>PLN 155/MWh</b> in 2010 and up to <b>PLN 326-343/MWh</b> in the period of 2020-2030
5. Marginal costs of electricity production - market prices	Increase from <b>PLN 65/MWh<sup>7</sup></b> in 2005 up to <b>PLN 266/MWh</b> in 2010 and up to <b>PLN 271-315/MWh</b> in the period of 2020-2030	Increase up to <b>PLN 266/MWh</b> in 2010 and up to <b>PLN 355-366/MWh</b> in the period of 2020-2030
6. Decrease in the demand for electricity due to higher prices for energy	Considerably lower decrease in the demand for electricity due to lower prices for electricity (no detailed	Decrease in the demand for electricity as of 2015 by <b>(-8.4%)</b> and down to <b>(-9.9%)</b> in 2030

<sup>7</sup> Short-term marginal costs.

	calculations)	
<b>B. Energy system</b>		
7. Increase in the costs of meeting energy needs	Additional annual costs will amount to <b>PLN 90 million/a</b> in 2010 and grow up to <b>PLN 480 million</b> in 2025 and to <b>PLN 4 billion</b> in 2030	Additional annual costs will amount to <b>PLN 2.1 billion/a</b> in 2010 and grow to <b>PLN 8-12 billion</b> in the period of 2020-2030; the costs are <b>PLN 8-12 billion/a</b> higher in the period of 2020-2030 than in the ODN scenario
8. Level and structure of demand for fuels, particularly for domestic coal	Increase in the demand for coal from about 1,600 PJ in 2005 to about <b>1,700-1,800 PJ</b> in the period of 2020-2030  Increase in the use of natural gas up to <b>820-1,020 PJ</b> in the period of 2020-2030	Decrease in the demand for coal to about 1,200-1,400 PJ in the years 2020-2030  Increase in the use of natural gas up to 840-1,040 PJ in the period of 2020-2030
9. Change in the vulnerability to imported hydrocarbons	Growing imports of liquid and gas fuels of a similar scale in both scenarios: ⇒ small increase in the imports of gas in the EU_MIX scenario compared to the ODN scenario; ⇒ small decrease in the imports of liquid fuels in the EU_MIX scenario compared to the ODN scenario	
10. Requirements towards the development of infrastructure systems	⇒ Development of the infrastructure necessary for the construction and operation of a nuclear power plant as of 2030 ⇒ Relatively small required investments related to the development of the wind energy sector (5,000 MW)	⇒ Considerably quicker development of the nuclear energy infrastructure; ⇒ Large investments in the development of power grids to facilitate the co-operation with wind power plants of capacity of 15,000 MW
<b>C. NATIONAL ECONOMY</b>		
11. Scale of electricity prices increase	In the EU_MIX scenario the producer's prices for energy are <b>15-30%</b> higher on the basis of marginal costs than in the ODN scenario  In case of an effective regulation which will provide the pricing at the level of average production costs, the producer's prices in the EU_MIX scenario will be <b>40-80%</b> higher compared to the ODN scenario	
12. GDP development pace	Less negative consequences due to lower prices (no detailed macroeconomic analyses in this scenario)	Decrease in GDP by <b>0.3-1.3%</b> in the period of 2010-2030 in comparison to the BAU scenario without the climate policy

13. GDP loss	As above	Lower level of GDP in comparison with the scenario without the climate policy (BAU) by 7.5% and by 15% in 2020 and 2030 respectively  In absolute values - <b>a loss of PLN 154 billion/a</b> in 2020 and <b>PLN 503 billion/a</b> in 2030.
14. Inflation	As above	<b>Increase in inflation</b> in comparison with the BAU scenario after 2015 by <b>0.2-0.6%</b>
15. Foreign trade balance	As above	Negative impact on the foreign trade balance <b>Negative balance over the whole analysed period</b> in comparison with the positive balance as of 2020 in the BAU scenario
16. Impact on the capacity of energy consuming branches of industry	As above	20% decrease for energy intensive branches of industry (steel industry, chemical industry) in comparison with the BAU scenario
<b>D. Households</b>		
17. Burdening of home budgets with energy costs	Less negative consequences due to lower prices (no detailed analyses of home budgets in this scenario)	Increase in the share of energy costs in home budgets from <b>11%</b> in 2005 to <b>14.1%</b> in 2020 and <b>14.4%</b> in 2030 <sup>8</sup>
18. Incl.: burdening with electricity costs	As above	Increase in the share of electricity costs in home budgets from <b>3.7%</b> in 2005 to <b>5.2%</b> in 2020 and <b>6.2%</b> in 2030
19. Available income in households	As above	Decrease in comparison with the scenario without the climate policy (BAU) by about 10.5%

### 6.1.1. Assessment from the climate policy's and the economic and social policy's perspectives

<sup>8</sup> The results assume the transfer of 50% of revenues from the auctioning of CO2 emission allowances to home budgets.

Table XIX shows the qualitative comparison of costs and benefits resulting from the implementation of the energy and climate package together with their allocation for the relevant economic and social policy.

TABLE XIX: Synthetic assessment of costs and benefits resulting from the introduction of the Energy and Climate Package from the perspective of various policies

Assessment perspective	Benefits	Costs
Environmental and climate policy	⇒ Reduction of CO2 emissions	⇒ Not fully analysed consequences of the interference in water structures in the case of CO2 storage on a big scale in CCS installations
Energy policy	⇒ Unnoticed	⇒ Higher investment expenditures and production costs ⇒ Higher investment and operational risk
Economic policy	⇒ Unnoticed	⇒ Decrease in GDP ⇒ Increase in inflation ⇒ Worsening of the foreign trade balance ⇒ Weakening of the development of energy intensive branches of industry
Social policy	⇒ Small (e.g. an increase in the employment rate in agriculture for energy needs production)	⇒ Lower available incomes ⇒ Higher burdening of home budgets with energy costs

Although incomplete, the above comparison clearly shows an important feature of the EC's proposal from the Polish perspective. The proposal aims at the emissions reduction effects which is the main objective of the EU climate policy. However the consequences are apparently negative for the energy as well as the economic and social policies. The most important consequences are described below together with concrete assessments expressed in numbers.

## Direct costs and effects

The most important effectiveness ratio of the Energy and Climate Package from the climate policy's perspective are unit costs of the CO2 emissions reduction. The results of calculations with respect to the effects and direct costs of the CO2 emissions reduction are presented in

detail in the final report. Below you can find unit costs of the CO<sub>2</sub> emissions reduction with respect to each main component of the energy and climate policy.

TABLE XX: CO<sub>2</sub> emissions reduction costs as a result of the introduction of subsequent EC energy and climate policy instruments

Instrument	2010	2015	2020	2025	2030
EU ETS (EUR 20/t)	12	13	13	22	69
EU ETS modification (EUR 40/t + auctioning)	117	165	132	115	153
RES new objectives (15%)		205	288	278	238
The 2008 EC package (EU_MIX compared to ODN)	<b>149</b>	<b>191</b>	<b>243</b>	<b>220</b>	<b>210</b>

The results show that the costs of emissions reduction will grow in subsequent phases of the energy and climate policy implementation. This means a fast decrease in the effectiveness of further actions from the climate policy's perspective. Particularly high costs of the reduction are connected with the development of renewable energy sources up to a 15% share in the final usage. The emissions reduction costs achieved this way are considerably higher than emission allowances prices in the modified EU ETS which, in accordance with the EC's calculations should amount to EUR 30-39/t (i.e. about PLN 120-160/t). The presented results show a lack of justification for the proposed development objectives of renewable energy sources only in the framework of the climate policy. Other benefits of the renewable energy sources development as emphasized by the EC such as the reduction of vulnerability to imported hydrocarbons do not occur in Poland due to the fact the Polish electricity sector is based on domestic coal.

The UE climate policy will cost Poland about **PLN 2 billion/a** as of 2010 and up to **PLN 8-12 billion/a** in the period of 2020-2030.

## Indirect costs and effects

Direct costs of the implementation of the Energy and Climate Package in the amount of **PLN 8-12 billion** taken into account while calculating the costs of the reduction will burden mainly the electricity sector. The whole climate policy costs will be **PLN 8-14 billion** annually in the period of 2020-2030.

Indirect costs are connected with the impact of the electricity prices on the economy and negative indirect consequences in the form of an economic slowdown, a decrease in households available incomes and an increase in the share of energy costs in household budgets. On the basis of calculations, the most important negative economic and social consequences of the implementation of the EU climate policy in Poland connected with the development of renewable energy sources are the following:

- 1) A loss of GDP in the amount of **PLN 154 billion** and **PLN 503 billion** annually as of 2020 and 2030 respectively;
- 2) A decrease in available incomes of households in 2030 from **PLN 1,800/man/month** to **PLN 1,610/man/month**;
- 3) An increase in the share of energy costs in home budgets from **11% in 2005** to **14.1-14.4% in the period of 2020-2030** in comparison with 12.7-12.9% without the climate policy (and to 6.6%-6.2% respectively compared to 5.9%-5.6% for electricity).
- 4) An average **burdening of households budgets with the costs of energy of more than 10%** throughout the entire analysed period which in some EU Member States is considered to be an energy poverty criterion.

On the basis of the results, one can assume that indirect costs in the form of the GDP loss will be more than 10 times higher than direct costs which, even when one takes into consideration the uncertainty related to this type of estimations will show high indirect costs of the EC's proposal for the entire Polish economy.

To sum up the effectiveness assessment of the Energy and Climate Package one should underline **large direct, indirect and social costs of the implementation of the Energy and Climate Package in Poland versus highly uncertain benefits** (uncertainty relates both to the potential reduction of climate change threat as well as actual benefits for Poland).

## **6.2. Qualitative assessment of the Energy and Climate Package implementation consequences**

Due to the complex nature of economic and social systems, the quantitative assessment of the consequences of certain actions is not always possible. In such cases a qualitative analysis turns out to be helpful to determine the consequences by indicating expected directions of changes as a result of certain events.

Below there is an attempt to show qualitative consequences of the Energy and Climate Package implementation for selected analysed economic and social subsystems.

### **1. Electricity sector**

- ⇒ The changes in technological and fuel structures required by the implementation of the Package will be a serious challenge for the country's electricity sector. The higher usage of natural gas, construction of nuclear power plants, construction of wind power plants of 15,000 MW capacity, construction of heat and power generating plants for biomass and construction of coal-fired power plants with CCS installations by 2030 will constitute big

challenges for the electricity sector. The successful carrying out of the above operations will depend on the clear, consistent and effective energy policy.

- ⇒ The development of nuclear power as of 2020/2025 requires to take practical measures almost at once to create favourable conditions for such investments. It is necessary to quickly create or complete legal and institutional systems as well as the infrastructure to ensure the correct management of nuclear fuel and radioactive waste. It will be necessary to carry out a relevant informational campaign and other actions to select the place for a nuclear power plant. Due to its scale and risk, the nuclear power plant investment can require governmental security papers.
- ⇒ A dynamic increase in the use of wind energy as required by the objectives of renewable energy sources will force high investments to strengthen the transmission system and to adjust it to the needs of co-operation with wind power plants. They are distinctive of high changeability of generation according to wind conditions, and the cross-border exchange capability has to be provided amounting to 10% of the country's use, as required by the EU law. The wind power plants will also need a high power reserve to start quickly in case of a radical decrease in the generation level; it has not been included in the system yet.
- ⇒ The operational and investment risks will enormously grow which results from the uncertainty about the EU's and the EU Member States' authorities determination to maintain an active climate protection policy and renewable energy sources development policy over a long time-period, from the technological risk related to new "zero-emission" coal technologies, the risk posed by the emissions trade scheme, growing localization problems and probably low efficiency and quality of legal and regulatory actions in Poland.

## **2. Legal and regulatory system in Poland**

- ⇒ Due to a large scale of new challenges it will become necessary to prepare effective mechanisms for the regulation of the electricity sector operation in highly complex future conditions, the development of mechanisms to ensure the energy security in the future in the situation more than one risk occurs.
- ⇒ A rapid improvement in the quality of legal provisions and legal and administrative procedures will be required to reduce an enormous risk of energy enterprises related to the production of electricity in new conditions.
- ⇒ Due to a substantial increase in energy prices it will probably be necessary to launch effective mechanisms to support households, especially those affected by an increase in energy prices.

## **3. National economy**

- ⇒ In case the Government does not follow an active energy policy and companies representing various branches of energy sector do not carry out any co-ordinated actions,

energy problems can cumulate, energy prices can increase and the quality of services as well as the security of supplies can worsen. In such a situation the development of the economy can be limited by energy factors.

- ⇒ High energy prices in Poland, especially combined with a poor quality of energy services caused by premature close-downs of generating units and a lack of sufficient investments in the sources as well as the disturbances of the grids functioning due to the new EU energy policy - all of the above factors can have a negative impact on the profitability of the production in many sectors of the economy, not only those energy intensive but also those which require certainty and high quality of energy supplies.
- ⇒ Mass investments in wind power plants will result in a high number of orders for the imports of special equipment which will not stimulate the national economy and will worsen the negative balance of foreign trade.

#### **4. Social system**

- ⇒ An effect of energy poverty will considerably grow due to a high increase in prices for energy, including electricity.
- ⇒ Social conflicts can occur over the localization of new energy buildings (wind farms, nuclear power plants, CCS installations and condensed CO<sub>2</sub> transmission networks).
- ⇒ The development of biomass production for energy purposes as well as the development of biofuel production will result in an increase in employment in agriculture and other agriculture service sectors.
- ⇒ Higher production of biomass will result in an increase in food prices as a side effect which in connection with an increase in energy prices and other infrastructural services (such as water, sewage system, waste disposal) will intensify the economic pressure on households. The pressure will be particularly severe for the poorest (old-age retirees and pensioners).

The presented quantitative assessments were made with the assumption that Poland will carry out all the activities to minimize the costs of the new EU energy policy implementation. The qualitative assessments point out to the risk of insufficient actions of the Government and energy sector enterprises, including insufficient research and development activities. If the above risks do occur, the implementation of the new EU policy in Poland will require considerably higher direct and indirect costs.

## 7. Summary

The quantitative and qualitative analyses show the implementation of the Energy and Climate Package in Poland in accordance with the EC proposal of 23 January 2008 will cause a number of negative consequences for the electricity sector, national economy and living conditions of the society.

The most important qualitative consequences of the 2008 Package calculated with the use of a set of calculating models are the following:

1. Direct costs of the adjustment of technological and fuel structures to the new EU energy policy requirements will be **PLN 8-12 billion annually** in the period of 2020-2030;
2. Prices for energy to be purchased from the producers will increase by about **60%** in comparison to the scenario without the climate policy;
3. Indirect costs related to a decrease in GDP will be **PLN 154 billion annually** in 2020 and will grow to **PLN 503 billion annually** in 2030.
4. **Available incomes of households will decrease by about 10%** in 2030 due to the above mentioned decrease in GDP;
5. Energy costs share in home budgets will grow from **11% in 2005** to **14.1-14.4%** in the period of 2020-2030 in comparison with 12.7-12.9% without the climate policy (with the assumption that households will be supported with the revenues from auctioning).

CO2 emissions reduction effects to be achieved thanks to the implementation of the new EU energy policy will be very costly, and the costs will be considerably higher than the expected EU ETS prices for emission allowances after 2013.

Irrespective of the above quantitative effects, the following consequences should also be underlined which are hard to estimate:

1. A significant increase in production and investment operations risks in the electricity sector which will result from the multitude of political objectives, uncertainty about future conditions for operations, including the determination to follow the policy over a long period of time once it has been accepted, uncertainty about the situation on fuel markets, uncertain conditions of emission allowances purchase, uncertainty about the availability and ownership of so called 'clear' coal technologies.
2. A high number of political objectives and a lot of instruments used to achieve them (the EU ETS, a policy to reduce emissions in the non-ETS sector, required development of renewable energy sources, development of co-generation, further amendments to Directive IPPC, Directive LCP and so called 'ceiling' Directives) create very high requirements for the quality of governmental administration operations. Such a multitude of regulations, purposes, objectives and instruments poses a threat of a complete paralysing of the electricity sector which will indirectly affect the development possibilities of the entire national economy.

The above mentioned most important direct and indirect consequences for Poland prove the thesis that the implementation of the Energy and Climate Package in Poland will pose a growing threat to the energy security of the country, fast economic development and improvement in the quality of life of its inhabitants.

The threat to the energy security of Poland will be caused by subsequent complication of the electricity sector operating conditions, late decision-making on the construction of new capacities in the electricity sector, enormously costly investments to achieve the objectives of energy production development from renewable sources and a considerable increase in energy prices which will significantly reduce the possibility of meeting energy needs of poorer households. A need of considerable investments is also important to adjust energy transmission grids to the co-operation with wind farms of a total capacity of 15,000 MW.

A threat to rapid economic development and civilisation progress results from an envisaged fast increase in electricity prices in Poland and its negative impact on the economic development pace. As a result of those changes, a share of energy costs in home budgets will considerably grow from the current 11% to more than 14% thus significantly exceeding the threshold level of 10% which is considered in some EU Member States as the energy poverty threshold.