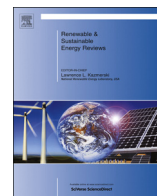




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## State and economic prospects of developing potential of non-renewable and renewable energy resources in Ukraine

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## ABSTRACT

The paper reports the state-of-the-day for non-renewable and renewable energy in Ukraine and state policy of its development in the long-term perspective. Despite total dependence on imported energy resources and complex natural conditions to develop new own deposits of fossil fuels; the state does not pay enough attention to RE development. The article investigates the advantages and usefulness of the development of renewable energy sources, which are considered along with analysis of the most economically profitable directions of their use. The key obstacles, which reduce the effectiveness of RE deployment and barriers to the realization of RE projects by investors are analyzed. Considering Russia's military intervention, we paid attention to the peculiarities of the functioning of green power plants in the occupied Crimea and the loss of Ukrainian renewable energy sector from the annexation of the peninsula.

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## 1. Introduction

Ukraine has considerable potential of renewable energy sources (RES) development of which can provide significant economic, ecological, and social benefits [1]. However, at its current stage, the degree of its use remains low.

Despite the significant dependence on energy resource exports, none of the policy documents, which determine the energy sector development of Ukraine, include ambitious targets for renewable energy (RE) deployment.

The Energy Strategy of Ukraine for the period until 2030 (ESU) [2] provides the change of energy consuming structure: reducing the consumption of imported natural gas, diversification of its supplies, increasing nuclear and carbon components. RE development assigned a secondary position in that document.

The National Action Plan for RE development (NAP RE) [3], which currently is a key document for RE development in long-term perspective, aims to develop of RES for providing only 11% part of total energy balance in 2020. It should be noted that the figure in NAP RE for 2009–7.1% of RES in the electricity balance includes 7% of the electricity generated by large hydropower plants, which were built 60–80 years of the 20th century; therefore Ukraine plans to increase the share of modern RES only 4% in the period from 2009 to 2020.

Unlike Ukraine, in regard to member states of the European Union, the key emphasis is placed on RE development and energy efficiency. Sweden plans to achieve 49% RES to 2020, Latvia – 40%, Finland – 38%, Austria – 34%, Denmark – 30%, Estonia – 25%, France – 23%, Germany – 18% [4]. In December 2011, the EU Commission had presented «Energy Road Map 2050» with energy development perspectives up to 2050. In reducing carbon emission up to 54% in 2030 in comparison with 1990 and it is to up to 80% in 2050; this aim needs considerable changes of energy balance: the part of renewable energy is to be 49%, the part of nuclear energy should be no more than 17%, and part of non-renewable sources is to be no more than 34% [5].

It is likely that these intermediate figures of RES in NAP RE are influenced by minor requirements for Ukraine relative to reducing CO<sub>2</sub> emissions (20% from 1990). Economic decrease in Ukraine was about 60% in first 10 years of independence, and CO<sub>2</sub> emissions also significantly decreased. Beginning from 2001, CO<sub>2</sub> emissions started to increase and at the end of 2012, they were 47% (lower than the figure of 1990) [6,7]. Thus, the official goal to reduce CO<sub>2</sub> emissions does not forbid their increase. However, at the end of 2013 and despite the fulfilment of CO<sub>2</sub> emissions' requirements, Ukraine was ranked 21st among member states – the biggest CO<sub>2</sub>-contaminators due to using fossil fuel resources and cement production, and Ukraine also has the 1st place in CO<sub>2</sub> emissions per unit of gross domestic product [8]. So, the setting of more ambitious targets for green energy generation also would be logical to reduce anthropogenic influence on the environment.

The aim of this paper is to study the available potential of RES in Ukraine, development of which can and should be the basis of achieving energy independence of the country, when taking into account ecological benefits.

## 2. Non-renewable resources in Ukraine

Ukraine belongs to the group of nations having stocks of all kinds of primary energy resources such as crude oil, natural gas, coal, etc., but their production level provides only 47–50% of necessary hydrocarbons.

### 2.1. Nuclear energy

Nuclear energy of Ukraine plays a key role in stable energy supplying of the nation. Fifteen power units of nuclear power plants

(NPP) are producing energy in total capacity 13,107 MW, 2 power units of Khmelnytsky NPP with total capacity 1900 MW are under construction (as of 1 July 2014 [9]). Besides that, it is foreseen to prolong exploitation terms of 13 acting power units up to outside design term. At the end 2013 the part of nuclear energy in energy balance of Ukraine is 19% [10], allowing to meet about 48% demand of electricity.

Despite the fact that the accident at the Chernobyl NPP remains one of the hardest disasters in the human history the ESU defines the developing of nuclear power in Ukraine as a priority in the future. It should be noted overcoming the consequences of the disaster appeared as additional burden on the budget (according to various estimations, direct losses in exclusion zone were about 1.4 billion USD), expenses for the weakening of the consequences of the disaster were about 6 billion USD and in some years were 8–10% of the nation budget [11]. According to [2] it is planned to use nuclear energy generation as a half of total annual electricity generation up to 2030. Unlike some nations in Europe (Germany, France, and Switzerland) after the Fukushima Daiichi disaster had decided to reduce the part of nuclear power in their total energy balance [12].

The decision about further development of nuclear energy in Ukraine was caused by the following factors:

- high efficiency of NPP. Comparative analysis of power plants using different types of energy resources shows that the efficiency of NPP is 2.7 times higher than the efficiency of hydropower plants and 2.9 times higher than the thermal plants and the profitability of Ukrainian “Energoatom” is over 100% [13];
- low costs nuclear of electricity generation (20.6 USD/MW h);
- availability of domestic uranium resources. Ukraine has good uranium stock (10th place in the world and 1st place in Europe), – explored reserves are 200,000 ton [14].

Despite the 30% providing of needs for domestic nuclear energy generation, the uranium stocks in Ukraine allow for more than 100 years of NPP functioning at the present.

Based on the above, the nuclear energy has one of the main positions in the electricity sector of Ukraine.

### 2.2. Coal

Ukraine is the world's 12th largest producer of coal and has the world's 10th largest reserves – 16.8 billion tons. [15]. However, 80% of the stocks are in beds with seam thickness of occurrence 1.2 m. Ukraine's coal is characterized by high gas content, the propensity to spontaneous combustion. Ash content of Ukraine's coal is more than 40%. Coke import is about 25% of domestic production of Ukraine [16]. Complex nature conditions of the development of new deposits and low technical level cause the lack of competitiveness of this sector.

Lack of investments in the coal industry in Ukraine resulted to trend of reducing coal production. In 1991–2012 the production of coal mines decreased from 192.8million ton/year to 86 million ton/year (almost in 2.2 times).

The concept of the reform of the coal sector accepted in 2008 foresees further privatization of coal mines while the profitability index of privatized mines is higher than that of state mines. In 2012 the privatized mines produced 71% of coal; 29% of coals were produced by the state mines. In general, the acting mines are working with 3 billion tons coal, 24 reserve plots with 4.6 billion tons of stock of coal.

According of ESU it is planned to increase the volume of coal production up to 1.1 billion tons/year by the end of 2020. However, at the beginning of the heating season in 2014–2015, the first time in the history of independence, Ukraine was in a situation of acute

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