ЕНЕРГЕТИЧНІ СИСТЕМИ ТА КОМПЛЕКСИ
ENERGY SYSTEMS AND COMPLEXES

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MODELLING OF COAL CONSUMPTION IN UKRAINE BY USING THE GROUP METHOD OF DATA HANDLIN

This paper deals with issues of coal consumption in Ukraine. The dynamics of consumption of coal is analysed and proposed guidelines for the efficient production, consumption and use of coal in Ukraine. Constructed and developed predictive models of coal consumption in Ukraine through the use of modern software and using the group method of data handling, which allowed building adequate predictive models of coal consumption in the system of Ukraine's energy balance. Researched and forecasted scenarios of coal consumption in the Ukraine.
Keywords: energy conservation, energy efficiency, energy balance, energy statistics.

Introduction

The problem of efficient use of energy resources is critical for sustainable economic development against the backdrop of energy saving national economy depends on energy imports, on the one hand, and rising prices for these resources. The basic foundation of the formation energy system of Ukraine is to build forecasting scenarios for different types of energy and different criteria for effective use of energy resources. Solving this problem is not only with ensuring energy security, but also with the level of development of regions of Ukraine and ensuring quality of life.

Forecasting coal consumption in Ukraine today is the extremely important issue of strategic importance since conducted through analysis and building predictive models will be possible to develop guidelines for the efficient production and consumption of coal throughout Ukraine as a whole.

Formulation of the problem.

Construction and development of predictive models of coal consumption in Ukraine using the group method of data handling and by using modern software.

Analysis of recent research and publications.

In [3] shows the comparison as previously proposed and those developed methods for short-term forecasting of coal consumption, regression analysis, neural networks and fuzzy neural networks. Intensive development of software products aimed at forecasting coal consumption [4], theory and practice modeling, forecasting processes in new ways raises the question of developing a new multi multivariate predictive model that takes into account more parameters and factors unlike the existing ones.

We consider the system of forecasting coal consumption in Ukraine, built on the basis of group method of data handling.

The aim of the study.

The purpose of research is to develop methodical positions on prediction of coal consumption in Ukraine using Multi method of data handling.

Material and research results

Changes in energy prices immediately reflected in all industries, and the rest - the price of the final product. The level of energy has a decisive impact on the economy of the state, resolving social problems and living standards of citizens. So instead of quantitative energy objectives underlying Ukraine's economy in recent decades, energy has to go to power sustainable economic development, as they are focused now in developed countries. The said research leads scientists to balance the energy balance of Ukraine, which determined the relevance of the work. In the traditional understanding of energy balance is the ratio between the extraction (production) and consumption of different types of energy resources.

At the heart of the development of fuel and energy balance is a set of strategic statements of economic development, the definition of forecast volumes of energy consumption, based on adopted policies to increase energy efficiency, the development of fuel and energy complex and evaluating opportunities extraction and

production of fuel and energy, as well as the formation of areas of import- export policy and determine the volume of purchase and sale of energy.

One of the mathematical methods of forecasting is group method of data handling, which allows you to build adequate predictive models of energy consumption in the system of Ukraine's energy balance.

With the help of a group method of data handling and by using modern software were built predictive models of coal consumption in the system of Ukraine's energy balance:

1. Forecasting System Model 2 lags:
$$Y(1)=0{,}37837*Y1(-1)+ 0{,}576431*Y1(-2)+0{,}13327*Y2(-2)$$
$$Y(2)=0{,}135461*Y2(-1)+1{,}52816*Y2(-2)+11{,}8371*Y3(-1)-18{,}2873*Y3(-2)+0{,}590244*Y4(-1) \quad (1)$$
$$Y(3)=1{,}41627*Y3(-1)-0{,}849706*Y3(-2)+0{,}155252*Y4(-1)$$
$$Y(4)=-0{,}00552574*Y1(-1)+0{,}00517918*Y1(-2)+1{,}35122*Y4(-1)-0{,}356013*Y4(-2)$$

Initial data for forecasting coal consumption are shown in Table 1

Table 1 - Initial data of coal consumption

Year	Coal production, total, mln t	Consumption of coal, total, mln t	Imports of coal, total, mln t	Ash content of coal shipped, %
	Y1	Y2	Y3	Y4
2006	79,5	61,8	7,9	24,8
2007	81,8	63,1	8,1	24,4
2008	84,3	68,8	8,5	24,0
2009	88,5	72,4	8,9	23,8
2010	90,9	78,9	9,2	23,6
2011	94,7	81,4	9,0	23,4
2012	99,1	83,7	8,6	23,1
2013	103,9	85,1	8,1	22,8
2014	107,5	92,2	7,4	22,5
2015	110,3	98,7	7,0	22,3

1. Forecasting System Model 2 logs:
$$Y(1)=0{,}37837*Y1(-1)+ 0{,}576431*Y1(-2)+0{,}13327*Y2(-2)$$
$$Y(2)=0{,}135461*Y2(-1)+1{,}52816*Y2(-2)+11{,}8371*Y3(-1)-18{,}2873*Y3(-2)+0{,}590244*Y4(-1) \quad (2)$$
$$Y(3)=1{,}41627*Y3(-1)-0{,}849706*Y3(-2)+0{,}155252*Y4(-1)$$
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Results of approximation and forecast for the next 5 years

The first indicator Y1 - Coal production, everything million tons given in Table 2

Table 2 - Coal production, total, mln t

Year	2006	2007	2008	2009	2010	2011	2012	2013
Initial data	79,5	81,8	84,3	88,5	90,9	94,7	99,1	103,9
Forecast			85,01	87,73	91,37	94,87	99,08	102,89

Continuation of Table 2

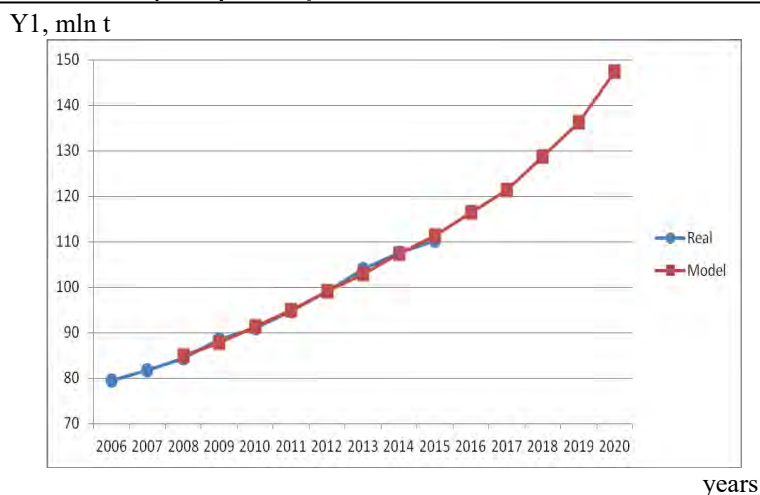| Year	2014	2015	2016	2017	2018	2019	2020
Initial data	107,5	110,3					
Forecast	107,299	111,26	116,4	121,4	128,6	136,3	147,4

Y1, mln t

Fig. 1 Predictive model of coal production, mln t,
built by group method of data handling

The second indicator Y2 - coal consumption, mln t is given in Table. 3

Table 3 - Consumption of coal, total, mln t

Year	2006	2007	2008		2009	2010	2011	2012	2013	2014
Initial data	61,8	63,1	68,8		72,4	78,9	81,4	83,7	85,1	92,2
Forecast			68,8		73,02	78,9	80,37	84,48	85,202	93,14

Continuation of Table 3

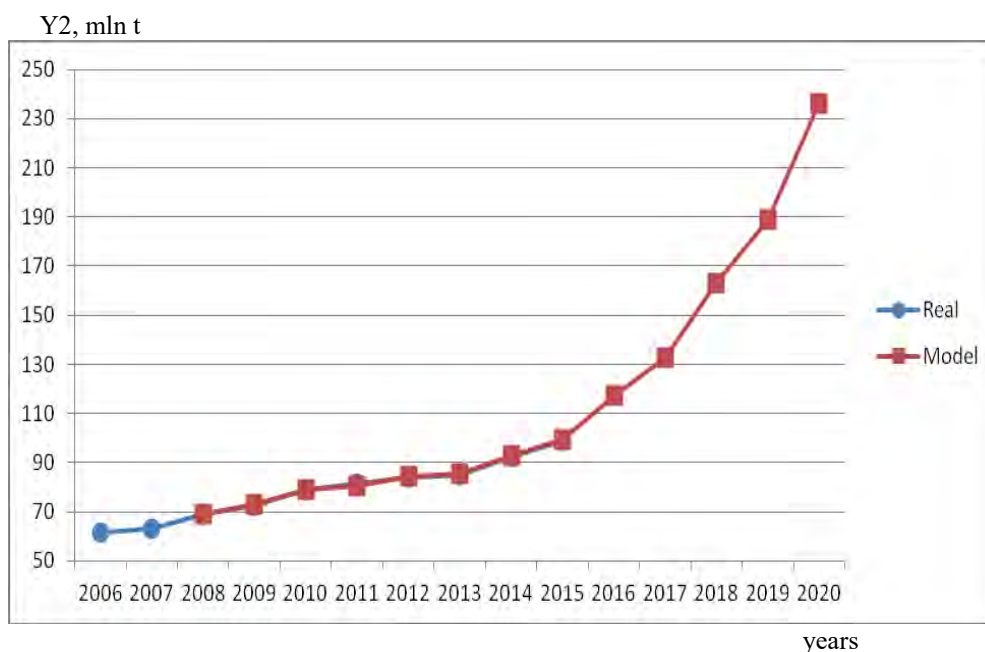| Year	2015	2016	2017	2018	2019	2020
Initial data	98,7					
Forecast	99,46	117,2	132,6	162,8	189,1	236,2

Y2, mln t

Fig. 2 Predictive model of coal consumption, mln t,
built by group method of data handling

The third indicator Y3 – Imports of coal , total, mln t is given in Table. 4

Table 4 - Imports of coal, total, mln t

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Initial data	7,9	8,1	8,5	8,9	9,2	9	8,6	8,1	7,4
Forecast			8,547	8,96	9,13	8,98	8,58	8,099	7,725

Continuation of Table 4

Year	2015	2016	2017	2018	2019	2020
Initial data	7					
Forecast	7,56	7,606	7,77	7,92	7,96	7,83

The fourth indicator Y4 - Ash content of coal shipped,% is given in Table 5

Table 5 - Ash content of coal shipped,%

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Initial data	24,8	24,4	24	23,8	23,6	23,4	23,1	22,8	22,5
Forecast			24,10	23,83	23,58	23,32	23,07	22,814	22,557

Continuation of Table 5

Year	2015	2016	2017	2018	2019	2020
Initial data	22,3					
Forecast	22,3	22,04	21,78	21,5	21,2	20,9

Conclusions. The basic method of building predictive models for coal consumption has been selected the group method of data handling, because through this unique method was possible to build a multidimensional multifactor forecasting model of coal consumption in the system of energy balance in Ukraine, which will take into account all important energy data for the coal sector in the complex. Using the group method of data handling to build predictive scenarios of coal sector made it possible to see promising options for the future development of the sector of coal industry of Ukraine for the next 5 years and made it possible to see clearly at that scenario can develop the coal industry of Ukraine were forecasted important key indicators.

Through analysis of the dynamics of coal consumption in Ukraine, and such important indicators as coal production, consumption, imports, ash coal shipped - were built predictive models in coal consumption using the group method of data handling, on the above indicators and obtained the following results:
- forecasted the growth of coal production from 79,5 mln t in 2006 to 147,4 mln t in 2020.
- forecasted the growth of coal consumption of 61,8 mln t in 2006 to 236,2 million tons in 2020.
- forecasted the decreasing of the imports of coal from 7, 9 mln t in 2006 to 7,83 mln t in 2020.
- forecasted the decreasing of ash coal shipped from 24,8% in 2005 to 20,9% in 2020.

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МОДЕЛИРОВАНИЕ ПОТРЕБЛЕНИЯ УГЛЯ В УКРАИНЕ С ИСПОЛЬЗОВАНИЕМ МЕТОДА ГРУППОВОГО УЧЕТА АРГУМЕНТОВ

В данной работе рассмотрены проблемные вопросы потребления угля по Украине. Проанализирована динамика потребления угля, и предложены методические рекомендации по эффективной добыче, потреблению и использованию угля по всей Украине в целом. Построены и разработаны прогнозные модели потребления угля в Украине с использованием современного программного обеспечения и путем использования метода группового учета аргументов, который позволил построить адекватные прогнозные модели потребления энергоресурсов в системе энергетического баланса Украины. Исследованы и спрогнозированы сценарии потребления угля в целом по Украине.

Ключевые слова: энергосбережение, энергоэффективность, энергобаланс, энергетическая статистика.

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МОДЕЛЮВАННЯ СПОЖИВАННЯ ВУГІЛЛЯ В УКРАЇНІ З ВИКОРИСТАННЯМ МЕТОДУ ГРУПОВОГО УРАХУВАННЯ АРГУМЕНТІВ

У даній роботі розглянуто проблемні питання споживання вугілля по Україні. Проаналізовано динаміку споживання та запропоновано методичні рекомендації щодо ефективного видобування, споживання та використання вугілля по всій Україні в цілому. Побудовано та розроблено прогнозні моделі споживання вугілля в Україні з використанням сучасного програмного забезпечення та методу групового урахування аргументів, який дозволив побудувати адекватні прогнозні моделі споживання енергоресурсів у системі енергетичного балансу України. Досліджено та спрогнозовано сценарії споживання вугілля загалом по Україні.

Ключові слова: енергозбереження, енергоефективність, енергобаланс, енергетична статистика.