ENERGY SECURITY THREAT SCENARIOS FOR REDUCING LOAD CHP-1 AND CHP -2 MOLDAVIAN POWER SYSTEM

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REZUMAT.Această lucrare prezintă modelarea de scenarii de ameninţări de securitate energetică pentru sistemul energetic al Moldovei, care apar în timpul off-CET 1 şi CET-2 de reducere a şi-o singură etapă a sarcinii.

Cuvinte cheie: Securitatea energetică, amenințare, reducând sarcina, CHP

ABSTRACT. The article performed results of simulations threats to energy security for the Moldovan energy system, which arise when disconnecting or step load reduction of CHP-1 and CHP-2.

Keywords: energy security, threats ,load reduction, CHP.

1. INTRODUCTION

The problem of energy security is relevant for each country (region) and is associated with the task of sustainable development [1]. During the last several years research in the field of energy security is conducting in Moldova [2-3] . One of tasks is to develop a computer system for analysis and monitoring of energy security, which currently covers of electricity, thermal and the fuel sectors as well as some of the economic, environmental and social aspects of energy. The complex includes a set of applications, including "economic security", "environmental security", "forecast", "scenarios".

The modular structure gives flexibility and future expansion of the complex as needed.

Modeling threats to energy security by means of computer system for analysis and monitoring of energy security in the Annex "Scenarios." This application includes a simplified version of each block, in which there are pages of "Description", "Calculation and Scenarios," "Background". On the "Calculation and Scenarios", there are special tables for substitution variable data for each scenario or groups of scenarios and table summary scores, which use the same algorithm as indicative of analysis, which is based. The total score for all blocks (a total of 10 blocks, which include 40 indicators) is determined in a separate file and construct a graph of total state. This graph includes the results (in points) to monitor the actual status of energy security for a number of previous years, the reference point (eg, 2007) and scores the state level of energy security for each scenario. The scenarios examined groups, for example, such as a definite step change any parameter or indicator, which is studied from the standpoint of growing threats to energy security.

On the basis of the analysis are corrected measures to prevent the development of these threats and improve energy security.

To date, several groups have considered scenarios in which simulated the most heavy threat to the energy sector in Moldova and the Moldovan power system . This article presents the results of the analysis of two groups of scenarios that reflect the state of energy security is disabled and under-loading of the largest sources of generation of the Right Bank of Moldova - Combined Heat Power plant Chishinau's CHP -1 and CHP-2.

Brief description of power system of Moldova

Moldovan energy system consists of the following sources: the Moldavian Thermo Electric Power Plant (2520 MW), Chisinau CHP-1 (66 MW) and CHP-2 (240 MW), Balti CHP (24 MW) hydroelectric power plant (HPP) Dubosari (48 MW), Kostesti HPP(16 MW) and 9 little block combined power plants of sugar plants (total installed capacity 98 MW). Transport and distribution of electricity is carried on the networks of 330 kV, 110 kV, 35 kV, 10 kV, 0,4 kV. Chisinau CHP-1 and CHP-2, the Balti CHP and HPP Costesti are on Right Bank territories. The average consumption of the Right Bank for a number of recent years is 3.5-4 billion kWh. The maximum load of the Right Coast is at a level of 800-900 MW in winter. Transport of electricity is high voltage electricity companies, distribution - the distribution companies RED-Nord (Northern networks), RED-NORD-VEST (Northwest networks), a private Spanish company Union Fenosa, which since 2000 belongs to the former state-owned enterprises of the South, Central and Chisinau electricity networks.

2.THREAT MODELING, WHICH ARISE FROM LOAD REDUCTION ON THE CHP-1 (GROUP SCENARIOS L1-L5)

Formulation of the problem.

To determine the level of energy security of the Right Bank of Moldova, with full disabled and under partial load CHP-1, as well as the growth of its installed capacity on 25 MW. The installed electrical capacity of CHP-1 is 66 MW, the heat-254 Gcal / h. Production of electricity and heat for the period 1990-2010 he CHP-1 is given in Table 1.

Table 1.

Production of electricity and heat in CHP-1

Production	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
electricity mln kWh	162	161	155	117	103	76	88	72	111	92
Heat, thousands Gcal	1239	1339	1978	715	628	525	488	396	600	448

Production	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
electricity mln kWh	83	117	142	138	136	154	148	152	140	135	94
Heat, thousands Gcal	387	408	386	405	335	375	378	329	319	271	245

Description of scenarios

The first group consists of 5 scenarios (L1-L5), which differ in terms of installed power CHP-1:

L1-P_{inst} CHP-1 = 0 MW (completely disabled);
L2- P_{inst} CHP-1 = 12 MW;
L3- P_{inst} CHP-1 = 34 MW;
L4- P_{inst} CHP-1 = 66 MW;
L5- P_{inst} CHP-1 = 91 MW (up to 25 MW).

Initial data taken on the fact of 2007 (reference point, checkpoint)

Electricity Sector

Electricity consumption - 4029,74 mln kWh;
Imports of electricity - 2622,21 mln kWh;
Production of electrical energy on internal own sources – 1 084,433 mln kWh, including the CHP-1: 152 mln kWh;
Electricity exports to Romania - 315 million kWh;
P_{inst} (Right Bank) = 444 MW, P_{inst} (CHP-1) = 66 MW.

Heat sector

The total production of heat CHP -3094 thous. Gcal. The consumption of heat from CHP - 2554 thous. Gcal.

Fuel Sector

Total fuel consumption is 2934 thous. tone, the total consumption of natural gas in 1526 thousand tone or 1.323 billion cubic meters . Fuel consumption for electricity and heat are737 thousand tone or 638 million cubic meters of natural gas (used only natural gas). Specific fuel consumption to produce 1 kWh of electricity -0.235 gram of fuel coal equivalent. / KWh and for 1 Gcal of heat-0.154 tone of fuel coal equivalent / Gcal.

Variable input data for the scenarios

Since there is a change of installed capacity, indicators of production and consumption of electricity and heat, the fuel consumption are change. These indicators are then used to calculate the block number 1 (fuel supply, the block number 2 (production of electricity and heat), the block number 6 (the consumption of electricity and heat), as follows:

X11 is the total fuel consumption, thous. tone;
X12 is the total natural gas consumption, then thousand tone, and (or) million cubic meters;
X13 is total fuel consumption for the production of electricity and heat, thous. tone;
X21 is production electricity, million kWh;
X22 is production of heat energy, thousand Gcal;
X23 is production of electricity on own sources, million kWh, or %;

X61 is consumption of electricity, million kWh;
X62 is consumption of heat, thousand Gcal.

The values of electrical and thermal installed capacity, as primary indicators that are involved in calculating the number of indicators, although the individual indicators are not.The values indicated in each scenario are calculated on the basis of the installed power is off, the number of hours of work stations Th (similar to the actual accepted in 2007 and is 2300 hours). There is also a consideration the coefficients of the restrictions in access to public electricity and heat, and fuel while reducing the production of both types of energy (Table 2,3).

Table 2.

The calculation of variable values for the scenarios L1-L5

Indicators		**Checkpoint (2007)**	**L1**	**L2**	**L3**	**L4**	**L5**
Electricity							
Available capacity of CHP-1	MW	66	0	12	34	66	91
Th	hours	2300	2300	2300	2300	2300	2300
Production of electricity in the CHP-1	Mln kWh	152	0	27	78	152	209
non-produced energy (-), additional production (+)	Mln kWh	0	-152	-125	-74	0	+57
The total electricity production in the Right Bank to the account non-produced energy or additional production nedootpuska	Mln kWh	1084	932	959	1010	1084	1141
Total electricity consumption in the Right Bank to the account non-produced energy or additional production nedootpuska	Mln kWh	4029	3877	3904	3955	4029	4086
Heat							
Production of heat of CHP-1	Thous.Gcal	190	0	34	97	190	262
non-produced energy (-), additional production (+)	Thous.Gcal	0	-190	-156	093	0	+72
Total electricity consumption in the Right Bank to the account non-produced energy or additional production nedootpuska	Thous.Gcal	3094	2904	2938	3001	3094	3166
Total electricity consumption in the Right Bank to the account non-produced energy or additional production nedootpuska	Thous.Gcal	2554	2364	2398	2461	2554	2626
Fuel							
Fuel consumption for electricity production at CHP-1	thousands of tons of coal equivalent	35,72	0	6,3	18,3	35,72	49,15
Natural gas consumption for **electricity** production CHP-1	Mln cubic meters	31	0	5,5	15,9	31	42,7
Non-using of fuel	thousands of tons of coal equivalent	0	-35,72	-29,3	- 17,39	0	+13,4
Non-using of Natural gas	Mln cubic meters	0	-31	-25,5	- 15,12	0	+11,6
Fuel consumption for the **heat** production at CHP-1	thousands of tons of coal equivalent	29,26	0	5,2	14,9	29,26	40,34
Consumption of natural gas to heat produce at CHP-1	Mln cubic meters	25,44	0	4,55	12,98	25,44	35,07
Non-using of fuel	thousands of	0	-29,26	-24	-	0	+11

	tons of coal equivalent				14,32		
Non-using of Natural gas	Mln cubic meters	0	-25,44	-20,86	-12,45	0	+9,64
The **total fuel** consumption at CHP-1	thousands of tons of coal equivalent	64,98	0	11,5	33,26	64,98	89,45
The **total consumption of gas** at CHP-1	Mln cubic meters	56	0	10,3	28,92	56	77,78
Non-using of fuel	thousands of tons of coal equivalent	0	-64,98	-53,3	-31,71	0	+24,4
Non-using of Natural gas	Mln cubic meters	0	-56	-46,41	-27,57	0	+22,18

3.THREAT MODELING, WHICH ARISE AT LOAD REDUCTION ON THE CHP-2 (GROUP SCENARIOS M1-M8)

Scenarios M1 ÷ M8 for CHP-2 include cases P_{inst} = 0, 40, 80, 120, 160, 200, 240 MW and increasing up 512 MW.Initial data are the same as for a group of scenarios L1 ÷ L5. CHP-2 operates 3 units of 80 MW. In 2007, CHP-2 has generated a 2805,413 million kWh.

Table 3.

Final scores on the state by scenarios L1-L5

	Checkpoint	L1	L2	L3	L4	L5
Score without coefficient restrictions	4,23	4,37	4,25	4,30	4,29	4,20
Score with coefficient restrictions	4,23	4,91	4,68	4,56	4,29	4,02

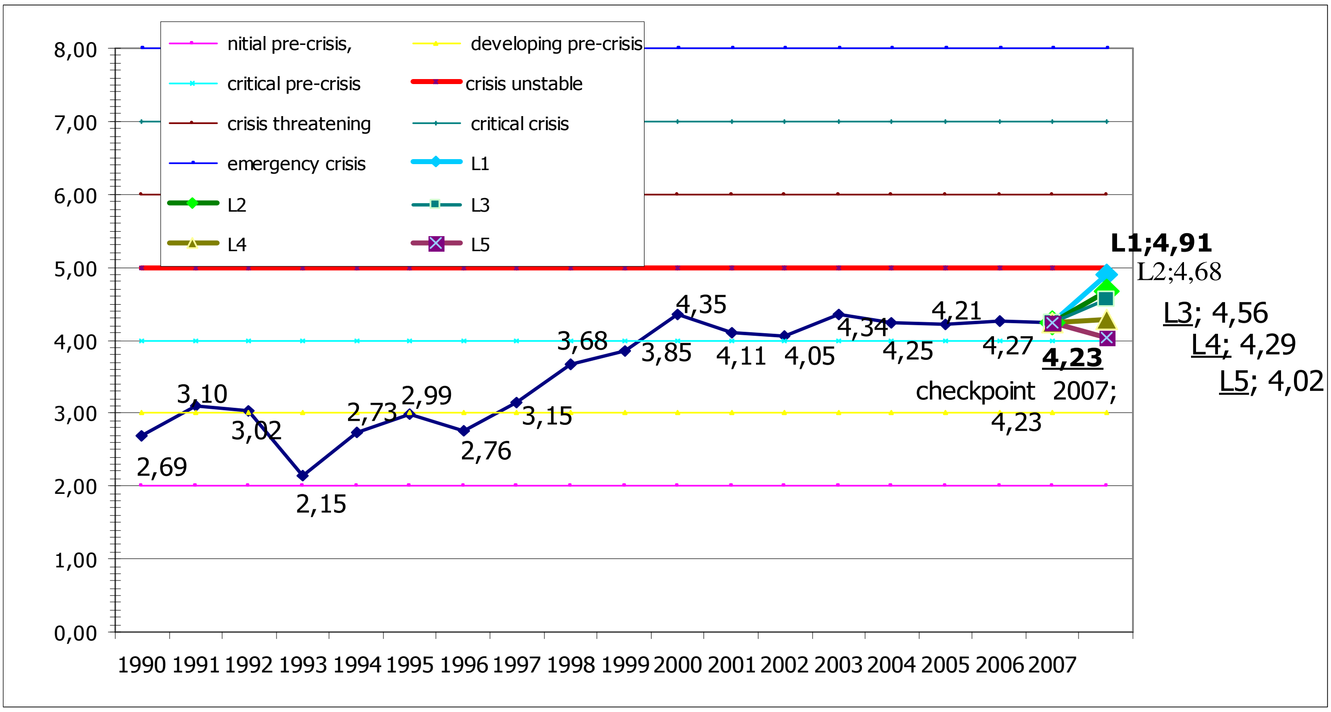

Fig. 1. The final score of crisis in the energy security by scenarios L1-L5

Table. 4

Calculation of the initial data for scenarios M1-M8 for electricity

CHP-2	**Checkpoint**	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Production at the check point, million kWh	805,4	0	134,2	268,4	402,6	536,8	671	805,4	1717
Pinst, MW	240	0	40	80	120	160	200	240	512
Th (fact 2007), hours	3355	3355	3355	3355	3355	3355	3355	3355	3355
Reducing production of electricity, million kWh	0	-805	-671,2	-537	-402,8	-268,6	-134,4	0	+911,6
Total production of electricity on the Right Coast	1084	279	412,8	547	681,2	815,4	949,6	1084	1995,6
Total consumption of electricity on the Left Coast, million kWh	4029	3224	3558	3492	3626,2	3760	4	3894,6	4940,6
Pinst, MW, on the Right Coast	444	204	244	284	324	364	404	444	512
Without CHP-2	204	204	204	204	204	204	204	204	204
With CHP-2	240	0	40	80	120	160	200	240	512
Pinst, MW	444	204	244	284	324	364	404	444	716

Table.5.

The calculation of the initial data for scenarios M1-M8 for heat energy

	Checkpoint	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Qinst, Gcal/h	1200	0	200	400	600	800	1000	1200	2520
Th(fact 2007), hours	2355	2355	2355	2355	2355	2355	2355	2355	2355
Q production, thous.Gcal	1159,331	0	193	386	579	772	965	1159	2434
Reduced production of heat by the value, thous.Gcal	0	-1159	-966	-733	-580	-387	-194	0	+1275
The total production of heat on the right bank, thous.Gcal	3094	1935	2128	2361	2514	2707	2900	3094	4369
The total consumption of heat, thous.Gcal	2554	1395	1588	1821	1974	2167	2360	2554	3829

*)0,154 tone/Gcal· 1159 thous. Gcal = 178,486 thous.tone.

Table 6.

The resulting score for scenarios M1-M8

	Checkpoint	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
The final score	4,23	4,42	4,31	4,34	4,29	4,27	4,28	4,33	4,04

Table 7.

The resulting score for scenarios M1-M8, taking into account coefficient constraints for scenarios M1-M8

	Checkpoint	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Fuel	1	1	1	1	1	1	1	1	1
Electricity	1	0,8	0,83	0,87	0,9	0,93	0,97	1	1,23
Heat	1	0,63	0,69	0,76	0,81	0,87	0,94	1	1,41
The final score	4,23	8,78	7,52	6,57	5,88	5,27	4,70	4,33	2,33

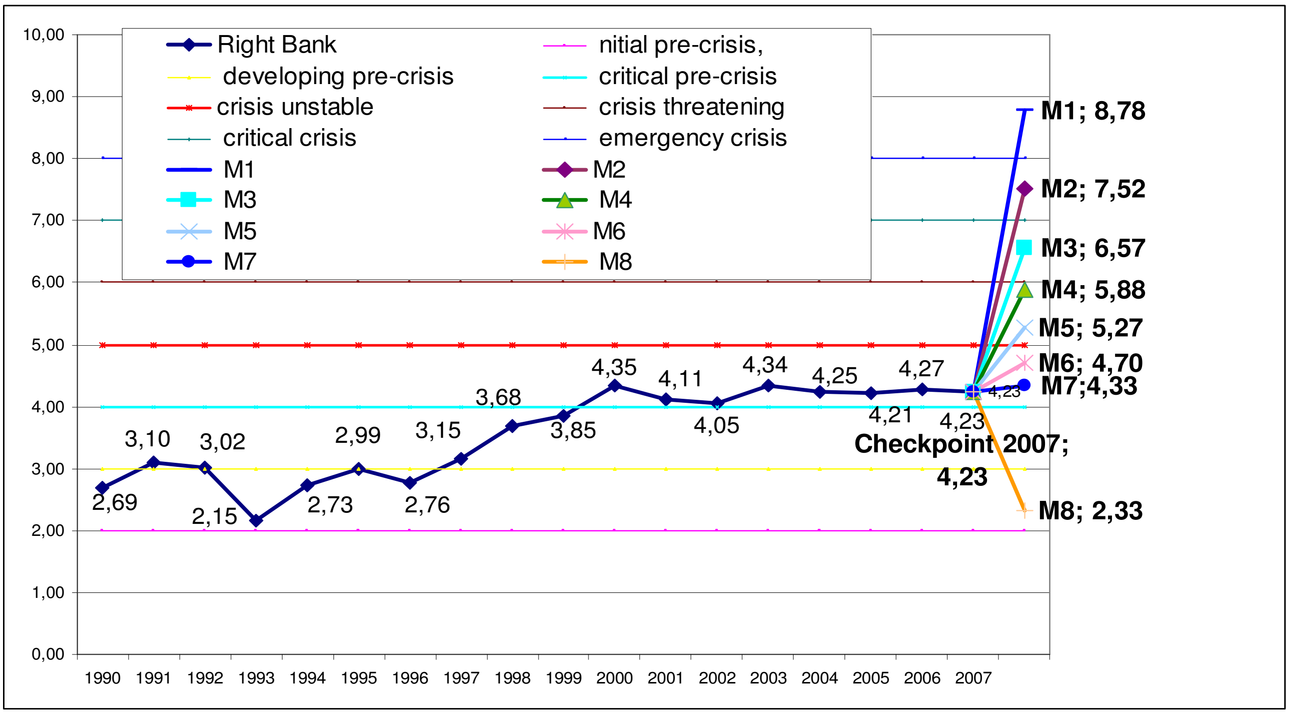

Fig. 2. The final score for the state energy security by scenarios M1-M8

The results of calculations of fuel consumption in the implementation scenarios M1-M8. show that the full disconnected CHP-2 fuel consumption for energy production will decrease by 12%. However, fuel consumption is reduced as a whole, that the population will spend the same (or even large) amounts of different fuels to cover the demand for heat. This will be used, or are not the most eco-friendly fuels or the use will not be the most economical mode. In any case, will increase the load on the environment and reduced living standards. On the other hand, if the power station will increase to 512 MW, the fuel consumption will increase by only 13%. Thus, the work of CHP is beneficial in all respects and to increase its power installation.

4.CONCLUSION

Computer system for monitoring and analyze energy security is designed, which include modules: initial date (database of energy sector in Excel and Access), calculating, analysis and forecasting. Modeling risks (threats) is carried out in application "Scenarios." With it, the analysis of the energy levels of security scenarios, L1-L5 and M1-M8, associated with an incremental decrease in load (up to complete shutdown) Chisinau CHP -1 and CHP-2, which have the largest installed capacity on the right bank Moldova. Found that the most heavy scenario is to completely turn off the stations. The state of the energy security is crisis in this case.

The development of these scenarios is actually extremely undesirable, since it would create a large deficit of electricity and heat, as well as disruptions to the electricity consumers. Measures to maintain the work is necessary, the timely repair and expansion of the mentioned plants to improve the reliability of power system and energy security.

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