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CITY OF KOROSTEN
SUSTAINABLE ENERGY ACTION PLAN
UNTIL 2020

Korosten
2015

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INTRODUCTION

The problem of global warming and the annual climate change trend towards worsening of the environmental situation made the European Community research the situation and set ambitious goals in the form of the 20-20-20 Initiative until 2020.

Considering the importance of this problem the city of Korosten signed the Covenant of Mayors on 20 October 2010 – the initiative by the European Commission aimed to unite Europe's local government bodies into a voluntary association for counteraction of the global warming. Having signed the Covenant, the city of Korosten set the goal to reduce its own CO_2 emission by at least 20% until 2020, thus, contributing to the development of the ecologically oriented economy and improvement of the quality of life. Within the framework of the Covenant of Mayors and in pursuance of the declared goals, Korosten City Council developed the Sustainable Energy Action Plan of the City of Korosten until 2020 (hereinafter - SEAP) as a guide for planning of the city's energy policy and a basis for the formation of priorities and measures with the aim of energy saving.

The Sustainable Energy Action Plan of the City of Korosten until 2020 consists of four Sections:

1. The preconditions (Descriptive and Analytical Part) for development of the SEAP and description of the relevant regulatory framework;
2. Current status of the city's energy infrastructure, analysis of production, supply and consumption of energy resources;
3. Baseline Emission Inventory and major CO_2 emission sources in the city;
4. Description of specific measures with a breakdown by programs and projects, the administrative unit for SEAP implementation, expected funding sources, information campaigns in the area of energy saving, protection of climate and environment.

Section 1. DESCRIPTIVE AND ANALYTICAL PART

Korosten is a city of Oblast significance located on the river Uzh (tributary of the Prypyat) 87 km north of the Oblast Capital, Zhytomyr, 150 km from the Capital of Ukraine, Kyiv, and 60 km from the border with Belarus.

1.1 General desctiption of the city

1.1.1. Geographical position and climate conditions

The city is located at 150-190 m above the sea level. The river Uzh divides it into two parts from south-west to north-east, and the left-bank part is almost twice as big as the right bank.

Of the energy mineral resources, there is only turf in Korosten Raion in several deposits of the total area over 2,000 hectares. More than half of these deposits have been already exhausted and the extraction of turf at the remaining deposits is complicated due to irrational extractions in the past.

Korosten is located at the crossing of international highways: Kyiv-Kovel-Warsaw (E 373/M 07) and Minsk-Izmail (E 583/P 10).

The city is an important railroad hub at the crossing of trunk lines: Korosten-Shepetivka, Korosten-Kovel, Odesa-St. Petersburg, Kyiv-Kovel, Kyiv-Lviv-Uzhgorod, Lviv-Luhansk, Korosten-Zhytomyr, Korosten-Mozyr.

The city area is 4,230.84 ha.

Korosten's climate is moderate continental. The main factors that influence the formation of climate in this territory are: solar radiation, circulation of air masses, partial woodiness and swampiness.

Korosten is located in the moderate illumination zone of the Northern hemisphere.

The city's geographic coordinates are 50°57' of Northern latitude and 28°37' of Eastern longitude and it is located almost in the center of Korosten Raion. Therefore, the angle of solar beams on the days of vernal and autumn equinoxis is approximately 34°, its maximum is on 22 June - 57°, and minimum on 22 December – about 11°. Total solar radiation is close to 95 Kcal per 1 cm^2.

The average annual temperature is approximately + 6 degrees. The average temperature in winter is - 3.7 °C. The average temperature in summer is + 19.3 °C. During the heating season, the average temperature is - 6° C. The frost-free season lasts about 170 days a year with the temperature above 0° – about 245 days and with the temperature above +10° – about 105 days. The highest temperature during the last 100 years was +37°, and the lowest -34°. Ground frost in spring may be sometimes observed even in the end of May and ground frost in autumn may start in the middle of September.

The average annual precipitation is 500-600 mm, most of which occurring in the summer months – about 240 mm, and the least in winter – about 80 mm.

During a year, north-west, west and north winds are dominant in the area of Korosten. There are 8-10 days in a year when the wind strength exceeds 15-20 meters per second. The number of days with atmospheric drought and hotwinds fluctuates between 3 to days 40 per year.

Relative humidity of the air ranges between 70-95%, and the average annual humidity is about 85%. Within the raion, the number of cloudless days during a year is approximately 80-85.

1.1.2. Human capital and household income

Korosten has 65,700 residents and 22,100 households.

At the same time, a positive migration balance and growth of births have been observed in the last 8 years.
It may be forecast that the number of population in Korosten by 2020 will be about the same as today ±2-3 percent.

The city's economy sectors employ almost 22,000 people. The number of unemployed in the city fluctuates up to 1,500 people. In 2015-2020, no sharp variations are expected in the labor force quantity.

In Korosten, the average wage is higher than the oblast's average but lower than Ukraine's national indicators. It would be fair to say that the above parameters will be preserved until 2020.

1.1.3. Economic potential of the city

Korosten has multi-industry small and medium business with an emphasis on transport and manufacturing. The city's developed industries represent machine-building, food, mining, chemical and processing sectors.

Utility services in Korosten including housing maintenance, water, heating, gas, electricity supply and waste removal are provided by: Korosten Municipal Heating Supply Company, Korosten Municipal Water and Sewerage Company, Municipal Production and Maintenance Company, Municipal Production and Repair/Operation Companies Nos. 1-4 and Private Enterprise Korosten Residential Service No.5.
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1.1.4. City budget overview

To some extent, the city budget satisfies the city's needs but it is not sufficient considering inflation, unsatisfactory condition of buildings and wear-and-tear of engineering networks.

Section 2. ANALYSIS OF PRODUCTION, SUPPLY AND CONSUMPTION OF ENERGY RESOURCES

2.1. Energy balance by types of energy resources

2.1.1. Heating

District heating in Korosten is provided by Municipal Heating Supply Company. The city does not have any centralized hot water supply.

During 2008-2014, the average production volume of heat was 155,000 GCal/year. Depending on the weather conditions, this indicator fluctuated from 130,000 GCal to 177,000 GCal.

Within the structure of heat consumption, 72% attributes to households, 12% - public

sector, 9% - network losses, 2% - supplier's own needs, and 5% - other consumers.

The heating supply system consists of 27 boiler stations working on natural gas and 7 others on alternative fuels. In the boiler stations, there are 95 boilers with the total installed capacity of 131.122 GCal/hour and the connected heat capacity of 81.723 GCal/hour.

The service life of 46 boilers is over ten years, 31 boilers - over five years and 18 boilers - less than five years.

Heat is transported via external heating networks laid mainly in underground channels of reinforced concrete. Only an insignificant part of heating networks is arranged above the earth. Heating pipes are covered with bitumen and heat insulation: mineral wool plates or slag wool, foil insulation or ruberoid. The systems of heat supply from all boiler stations are of the closed type.

In one of the city's districts (Kyivsky District), 23 individual heating units have been installed with the heat meters, separates heat exchangers and regulation of temperature.

In general, the following conclusion may be made with regard to the city's district heating system. The city managed to preserve the system of district heating: the coverage of population by the service has been stable for the last 7 years - 80%. On the other hand, the degree of wear and tear of centralized heating networks is about 35%, and causes an increase in accidents and loss of heating energy.

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2.1.2. Gas supply

Gas is supplied to Korosten by a regional gas company - ZhytomyrGas PJSC. Gas is delivered to consumers through 21 gas control units (GCU) and 60 cabinet-type regulation points (CTRP) via gas pipelines of high, medium and low pressure.

The total length of gas networks was 261 km.

Main gas consumers are households (52%) and the heat generating company (36%), as well as industrial and non-industrial enterprises (11%) and public sector (1%).

2.1.3. Electricity

Electricity is supplied to the city by Electricity Supplying Company ZhytomyrOblEnergo PJSC. Electric power is delivered via 3 transformer substations (110 kV) and 5 distribution points (6-10 kV). The total length of power transmission lines (КЛ-10 kV) is about 857 km.

Main consumers of electricity are industrial enterprises and other businesses – 59%, households – 31%, utility companies – 6%, public institutions – 4%.

2.1.4. Water supply

Water supply and sewerage services are provided by two water and sewerage companies (a municipal company and the Railroad Directorate).

Within the structure of water consumption, the share of households is 72%, industrial enterprises and other businesses – 21%, public institutions – 7%. The situation with the sewerage structure is similar.

The length of sewerage networks is 15% shorted than that of water supply.

Installed productive capacity of each water station, the municipal water system and each treatment facility is 20,000 m^3/day, and the total installed capacity of the city's sewerage system is 14,500 m^3/day.

However, the level of wear-and-tear of the water supply network is 51.5%, leakages and unaccounted losses of water keep growing and amount to 22.5 % of the total volume of water supplied to the city.

The costs of water supply and sewerage services grow from year to year.

2.2. Major consumers of energy resources in the city

2.2.1. Public institutions

In Korosten, there are 58 public buildings. All of them have low energy efficiency and require high costs for maintenance and energy resources. The main expenses are those for heating (69%) and electricity (23%). These expenses grow ever year primarily due to growth of tariffs.

2.2.2. Residential stock

The city's residential stock consists of 8,637 buildings (617 multi-storied blocks) of the total area of 1,301,700 sq. m.

Most buildings were constructed in 1960s-1980s and have major losses of heat through the building envelope. Buildings are made of silica bricks or concrete panels, and the wall thickness is insufficient.

Only 7.5% multi-storied buildings with district heating are equipped with heat meters and 66% apartments with centralized water supply have cold water meters.

2.2.3. Automobile transport

The total length of motor roads in the city is 210 km.

Public transport services in Korosten are provided by fixed-route taxis and normal taxies. There are five transport companies operating on 14 city routes of the total length of 104 km. Total density of bus routes is 2.5 km/sq. km.

Municipal buses have diesel (20 vehicles) and gas engines (27 vehicles).

The average age of vehicles engaged in transportation is 8-10 years.

Since 2011, Korosten has had a system of centralized control of city transport using GPS surveillance equipment.

The city is serviced by 6 taxi companies with about 140 cars. Also, there are 100 private taxi drivers.

In the city, 2,800 private automobiles are registered.

2.2.4. Street lighting

Out of 263 streets in Korosten, only 153 have street lighting and 7 others are partially lighted. The total length of the street lighting networks is 139 km (126 km of overhead lines and 13 km of cable lines).

In total, the city has 3,161 lighting points: 78% with sodium lamps, 19% with mercury lamps, 3% with incandescent lamps. The city's street lighting system is equipped with 32 separate electricity meters covering 100% of electricity consumption accounting.

There is an individual weekly schedule for switching the system of street lighting, which makes it possible to use budget funds economically and efficiently.

Section 3. BASELINE EMISSION INVENTORY

3.1. Definition and justification of key sector selection

The Baseline Emission Inventory (BEI) determines the volume CO_2 released in connection with energy consumption within the city during the baseline year.

The main criterial for inclusion of a sector into BEI are:

- importance for the municipal community (social importance);
- volume of expenses from the city budget (financial component);
- existing or planned energy efficiency projects;
- regulatory influence on the sector by the city administration;
- possibility for the city to control energy consumption by the sector.

Based on the priority analysis, the following sectors have been included into SEAP:

- public buildings funded from the city budget;
- residential sector;

- passenger transportation (public transport in Korosten);
- street lighting;
- heating supply;
- water supply.

3.2. Consumption of energy resources in key sectors

For calculation of the Baseline Emission Inventory, the database was created on consumption of major energy resources that includes the main CO_2 emission sources as a result of different activities in Korosten during 2008-2014. Energy consumption in 2008-2014 in the selected sectors is shown in physical terms in Table 3.1.

For the purpose of estimation of CO_2 emissions for the energy resources consumed indicators for all energy resources have been converted in physical terms into a single measuring unit - MW*hour.

The following coefficients were used for the conversion of consumption volumes in natural terms into MW*hour:

Energy resource	Conversion coefficient
Heat ……. 1.163	MW*hour/ 1 GCal
Liquefied gas…… 6.765	MW*hour/1000 l
Coal ……7.2	MW*hour/t
Wood ……3.484	MW*hour/t
Diesel fuel ……10.00	MW*hour/1000 l

Table 3.1.

Consumption of energy resources in 2008-2014

#	Sectors included into BEI	2008	2009	2010	2011	2012	2013	2014
1. Municipal buildings, equipment/facilities								
1.1.	Natural gas, thousand m3	250,10	226,10	227,80	155,20	31,60	79,90	60,90
1.2.	Electricity, MW*hour	2 434,80	2 524,60	2 268,30	2 345,70	2 230,60	2 036,40	2 179,40
1.3.1	Water supply, thousand m3	108,70	110,60	96,30	93,80	75,10	78,40	79,20
1.3.2	Sewerage, thousand m3	117,43	119,69	105,50	97,05	78,43	81,94	84,74
1.4.	Heat, GCal	15 500,00	14 000,00	16 222,00	15 520,00	14 979,00	15 617,00	11 629,00
1.5.	Coal, tons	0,00	0,00	174,90	4,90	5,00	5,20	5,00
1.6.	Wood, tons	0,00	0,00	10,00	0,00	10,00	0,00	5,00
2. Residential buildings								
2.1.	Natural gas, thousand m3	26 098,4	25 499,3	25 681,7	25 391,6	26 478,0	25 952,1	24 129,4
2.2.	Electricity, MW*hour	41 574,0	43 624,0	49 659,0	46 848,0	52 199,0	54 257,0	53 771,0
2.3.1.	Cold water, thousand m3	1 646,5	1 611,6	1 669,5	1 606,6	1 594,0	1 603,6	1 590,2
2.3.2.	Sewerage, thousand m3	1 587,6	1 520,4	1 562,4	1 507,8	1 495,9	1 506,1	1 492,8
2.4.	Heat, GCal	88 157,3	98 505,6	112 993,4	108 544,5	123 457,9	111 517,2	93 935,3
3. Municipal street lighting								
3.1.	Electricity, MW*hour	1132,9	1131,7	1323,9	1476,4	1423,8	1156,5	1118,2
4. Transport								
4.3.	Liquefied gas, thousand l	108,5	162,8	190,0	217,1	217,1	366,3	366,3
4.4.	Diesel fuel, thousand l	494,9	439,9	439,9	417,9	417,9	219,9	219,9
5. Industries outside ETS								
	Heating							
5.1.	Heat, GCal	15 674,8	18 009,7	20 449,0	19 654,6	20 868,5	18 857,1	14 822,9
	Water and sewerage							
5.2.	Water supply and sewerage, thousand m3	608,9	638,2	625,4	652,5	648,3	640,7	608,1

Table 3.2.

Consumption of energy resources by selected sectors in 2008-2014, in aggregated units, MW*hour

#	Sectors included into BEI	2008	2009	2010	2011	2012	2013	2014
1. Municipal buildings, equipment/facilities								
1.1.	Natural gas	2 325,2	2 102,7	2 144,5	1 443,4	296,1	746,3	579,2
1.2.	Electricity	2 434,8	2 524,6	2 268,3	2 345,7	2 230,6	2 036,4	2 179,4
1.3.	Water supply and sewerage	162,5	207,1	170,4	166,9	131,0	147,7	159,2
1.3.1.	Water supply	81,7	123,8	103,7	102,8	77,3	86,9	89,4
1.3.2.	Sewerage	80,8	83,3	66,7	64,1	53,7	60,7	69,8
1.4.	Heat	18 026,5	16 282,0	18 866,2	18 049,8	17 420,6	18 162,6	13 524,5
1.5.	Coal	0,00	0,00	1 259,28	35,28	36,00	37,44	36,00
1.6.	Wood	0,00	0,00	34,84	0,00	34,84	0,00	17,42
Subtotal		**22 949,0**	**21 116,4**	**24 743,5**	**22 041,0**	**20 149,1**	**21 130,3**	**16 495,7**
2. Residential buildings								
2.1.	Natural gas	242 637,0	237 143,1	241 767,2	236 141,9	248 099,3	242 392,5	229 471,1
2.2.	Electricity.	41 574,0	43 624,0	49 659,0	46 848,0	52 199,0	54 257,0	53 771,0
2.3	Water supply and sewerage	2 330,4	2 861,6	2 785,5	2 756,0	2 664,9	2 894,4	3 025,4
2.3.1	Water supply	1 238,2	1 803,4	1 798,1	1 760,8	1 640,2	1 778,4	1 795,3
2.3.2	Sewerage	1 092,3	1 058,2	987,4	995,1	1 024,7	1 116,0	1 230,1
2.4.	Heat	102 526,9	114 562,0	131 411,3	126 237,3	143 581,5	129 694,5	109 246,8
Subtotal		**389 068,4**	**398 190,7**	**425 623,0**	**411 983,2**	**446 544,8**	**429 238,4**	**395 514,2**
3. Municipal street lighting								
3.1.	Electricity	1 132,90	1 131,70	1 323,90	1 476,40	1 423,80	1 156,50	1 118,20
Subtotal		**1 132,90**	**1 131,70**	**1 323,90**	**1 476,40**	**1 423,80**	**1 156,50**	**1 118,20**
4. Transport								
4.1.	Liquefied gas	734,3	1101,5	1285,0	1468,6	1468,6	2478,3	2478,3
4.2.	Diesel fuel	4948,6	4398,7	4398,7	4178,8	4178,8	2199,4	2199,4
Subtotal		**5682,9**	**5500,2**	**5683,8**	**5647,4**	**5647,4**	**4677,6**	**4677,6**
5. Industries outside ETS								
5.1.1	Heat	18 229,8	20 945,3	23 782,2	22 858,3	24 270,1	21 930,8	17 239,0
5.1.2	Water supply	457,9	714,1	673,6	715,1	667,1	710,5	686,5
	Subtotal	**18 687,73**	**21 659,40**	**24 455,78**	**23 573,46**	**24 937,20**	**22 641,37**	**17 925,59**
	Total	**437 520,92**	**447 598,38**	**481 829,98**	**464 721,37**	**498 702,26**	**478 844,26**	**435 731,40**

3.3. Analysis of CO_2 emissions for selected years in selected sectors

Based on the data of consumption of key energy resources, calculation of CO_2 emissions in 2008-2014 was made. Based on the analysis of the data obtained. As well as available calculation methodologies, we accept the method of standard coefficients. In the methodology of baseline inventory calculations, we take into account only CO_2 emissions.

Values of the coefficients applied during calculation of the emission baseline inventory:

Energy resource	CO_2 emission coefficient (t/MW·hour)
Natural gas……....	0,202
Coal ……..……..…….	0,341
Liquefied gas…….……	0,231
Diesel fuel……	0,267
Wood.....……..	0,00

Table 3.3.

IPCC national emission coefficients for electricity

Years	2008	2009	2010	2011	2012	2013	2014
CO_2 emission coefficients for electricity, t/MW·hour	0,924	0,931	0,88	0,899	0,912	0,912	0,912

Table 3.4.

Results of calculations of CO_2 emissions in selected sectors

#	Sectors included into BEI	2008	2009	2010	2011	2012	2013	2014
1. Municipal buildings, equipment/facilities								
1.1.	Natural gas	469,7	424,8	433,2	291,6	59,8	150,7	117,0
1.2.	Electricity	2 249,8	2 350,4	1 996,1	2 108,8	2 034,3	1 857,2	1 987,6
1.3.	Water supply and sewerage	150,2	192,8	149,9	150,0	119,5	134,7	145,2
1.5.	Heat	4 395,8	3 959,8	4 424,9	4 164,4	4 006,7	4 158,8	3 128,5
1.6.	Coal	0,0	0,0	429,4	12,0	12,3	12,8	12,3
1.7.	Wood	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Subtotal		**7 265,4**	**6 927,7**	**7 433,5**	**6 726,8**	**6 232,6**	**6 314,2**	**5 390,6**
2. Residential buildings								
2.1.	Natural gas	49 012,7	47 902,9	48 837,0	47 700,7	50 116,1	48 963,3	46 353,2
2.2.	Electricity.	38 414,4	40 613,9	43 699,9	42 116,4	47 605,5	49 482,4	49 039,2
2.3.	Water supply and sewerage	2 153,3	2 664,1	2 451,2	2 477,6	2 430,4	2 639,7	2 759,2
2.5.	Heat	25 001,5	27 861,4	30 821,3	29 125,0	33 023,8	29 696,9	25 271,2
Subtotal		**114 581,9**	**119 042,4**	**125 809,4**	**121 419,7**	**133 175,7**	**130 782,2**	**123 422,7**
3. Municipal street lighting								
3.1.	Electricity	1 046,80	1 053,61	1 165,03	1 327,28	1 298,51	1 054,73	1 019,80
Subtotal		**1 046,80**	**1 053,61**	**1 165,03**	**1 327,28**	**1 298,51**	**1 054,73**	**1 019,80**
4. Transport								
4.3.	Liquefied gas	169,6	254,4	296,8	339,2	339,2	572,5	572,5
4.4.	Diesel fuel	1321,3	1174,5	1174,5	1115,7	1115,7	587,2	587,2
Subtotal		**1490,9**	**1428,9**	**1471,3**	**1455,0**	**1455,0**	**1159,7**	**1159,7**
5. Industries outside ETS								
Heating								
5.1.1	Heat	4 445,4	5 093,9	5 577,9	5 273,8	5 582,1	5 021,6	3 987,8
	Water supply and sewerage							
5.1.2	Water supply and sewerage	423,1	664,9	592,7	642,9	608,4	648,0	626,1
	Subtotal	**4 868,49**	**5 758,74**	**6 170,62**	**5 916,71**	**6 190,5**	**5 669,63**	**4 613,91**
	Total	**129 253,49**	**134 211,29**	**142 049,91**	**136 845,41**	**148 352,3**	**144 980,48**	**135 606,77**

3.4. Justification of selection of the baseline year

The baseline year selected for assessment of the current level of CO_2 emissions in Korosten is 2012, which is explained by the availability of complete and reliable information for that period with regard to consumption of all types of energy resources, and the period is most representative concerning the specific economic situation.

During the baseline year, the Baseline Emission Inventory for selected sectors in Korosten amounts to 148,374.15 tCO_2 in the absolute terms, or 2.26 tCO_2 per resident.

The breakdown of emissions by CO_2 emission sources in the baseline year of 2012 is as follows: 90% - residential buildings, 4% - municipal buildings and industry (each), 1% - municipal street lighting and transport (each).

The largest share of emissions of hazardous substances into the air is attributed to residential buildings, which is due to the growing development of residential areas and energy intensity of residential buildings in general.

The highest CO_2 emissions are produced from the use of natural gas and electricity – 34% (each), as well as heat – 29%. Water supply with sewerage and coal take 2% and 1% respectively.

SECTION 4. SUSTAINABLE ENERGY ACTION PLAN (SEAP)

4.1. Strategy, goals and commitments until 2020

The goals of this Plan are in line with the strategic choice of Korosten's community stated in the Strategic Plan of Development of the City of Korosten until 2025 and comply with the Strategic Goal 2.2 - to improve the level of energy and environmental security of the city.

The strategic mission of Korosten's SEAP is to ensure comfortable life of its residents due to improved quality of services combined with reduction of energy consumption by the municipal infrastructure and increase of the share of renewable energy.

SEAP goals are:

- reduction of CO_2 emissions until 2020 in the selected sectors by 20.77 %;
- increase of the share of renewable energy by 12.6 %;
- increase of the expedience of the use of fuel and energy resources by heating and water supplying organizations;
- improvement of consciousness and responsibility of residents for rational use of fuel and energy resources;
- attraction of investments for energy saving projects.

The planned distribution of emission reduction by sectors is shown in Table 4.1.

Table 4.1.

Calculation of CO_2 emission reduction until 2020 by sectors

#	Sectors included into BEI	Total emissions in the baseline year 2012, tons/year	Emission reduction, tons/year	CO_2 emission reduction, %
1.	Municipal buildings, equipment/facilities	6 232,60	2 380,03	38,19
2.	Residential buildings	133 175,71	24 238,01	18,20
3.	Municipal street lighting	1 298,51	459,31	35,37
4.	Transport	1 454,98	336,60	23,13
5.	Industries outside ETS	6 190,51	3 401,30	54,94
	Total	148 352,30	30 815,24	20,77

4.2. Description of the planned energy saving projects and measures

SEAP objectives are divided into measures aimed to change the attitude towards consumption of energy resources and technical measures that require investments and are aimed to:

- reduction of CO_2 emissions;
- economical consumption of the key energy resources: natural gas, heat, electricity, water, diesel fuel, coal, etc.;
- increase of the share of alternative energy sources;
- change of the residents' mentality towards rational use of energy resources;
- creation of conditions for attraction of investments for implementation of energy saving measures and programs.

4.3 Main activities of the SEAP

Table 4.2.

Main activities of the SEAP

#	Project/measure	Content	Total cost of implementation, (thousand UAH)	Expected energy saving, MW-hour/year	Renewable energy generation, MW-hour/year	CO2 emission reduction (tons/year)
	1. Municipal buildings, equipment/facilities		**42 049.95**	**8 904.57**	**2 860.41**	**2 380.03**
1.1.	Introduction of the energy management system in public buildings	Improvement of the energy management system, setting limits for the fuel and energy consumption, software procurement, staff training	535.500	2012.5	0	623.47
1.2.	Installation of energy saving lighting equipment at public institutions	Replacement of existing lamps with energy saving lamps	629.000	223.06	0	203.43
1.3.	Improvement of energy efficiency in public buildings	Installation of balancing equipment and renovation of heat insulation on pipelines, flushing of the heating system, installation of individual heating units, installation of heat reflecting screens between external walls and radiators, replacement of windows and entrance doors with metal and plastic sets	9 188.053	2605	0	702.75
1.4.	Deep thermal modernization of selected buildings	Installation of balancing equipment and renovation of heat insulation on pipelines, flushing of the heating system, installation of individual heating units, installation of heat reflecting screens between external walls and radiators, replacement of windows and entrance doors with metal and plastic sets, heat insulation of facades, roofs, basements, installation of local ventilation systems with heat recovery	27 532.725	1203.6	0	264.6
1.5.	Use of renewable energy sources in public buildings	Use of heat pumps for heating of the premises in public buildings	1 383.333	207.8	207.8	47.82
1.6.	Use of renewable energy sources in public buildings	Installation of the solar system (pilot project) for hot water preparation in a preschool institution	1 424.219	85.55	85.55	18.8
1.7.	Transfer of public institutions into heating with alternative fuel	Reconstruction of the heating system at a preschool institution with installation of modular equipment using alternative energy sources	440.116	1540.2	1540.2	311.5

№ з/п	Project/measure	Content	Total cost of implementation, (thousand UAH)	Expected energy saving, MW-hour/year	Renewable energy generation, MW-hour/year	CO2 emission reduction (tons/year)
	2. Residential buildings		**163 316.20**	**84 956.89**	**15 891.88**	**24 238.01**
2.1.	Motivation of residents to use energy saving devices and domestic appliances in their households	Replacement of incandescent lamps with energy saving lamps at staircases and in private apartments	1 202.76	6 698.17	0	1 997.89
2.2.	Implementation of energy saving measures in private premises (apartments)	Replacement of windows and doors, installation of balancing valves, insulation of walls in single-family houses	24 350.00	46 557.32	0.00	13 590.06
2.3.	Deep thermal modernization of pilot residential buildings (OSBBs)	Heat insulation of façade, roof, basement, replacement of windows and doors, installation of individual heating units, flushing, hydraulic balancing of the system, replacement of windows in staircases, restoration of insulation on pipelines, roof repair, rehabilitation of engineering networks	93 675.39	11 344.08	0	4 107.98
2.4.	Replacement of natural gas with alternative fuels in residential buildings	Replacement of gas boilers in residential buildings with solid fuel boilers	16 500.00	12 404.97	12 404.97	2 505.80
2.5.	Transition of boiler stations into alternative fuels	Technical re-equipment of boiler stations for combustion of biofuel	26 986.67	3 486.91	3 486.91	704.36
	3. Municipal street lighting		**4 326.56**	**503.63**	**0.00**	**459.31**
3.1.	Reconstruction and repair of street lighting networks	Replacement of luminaires with incandescent lamps with LED luminaires, installation of regulation equipment	4 326.56	503.63	0	459.31
	4. Transport		**2 347.84**	**1 260.68**	**0.00**	**336.60**
4.1.	Optimization of urban traffic schemes	Development of the new scheme for public transport traffic, transition of transport into liquefied gas	2 347.84	1 260.68	0.00	336.60
	5. Industries outside ETS		**10 063.70**	**15 625.72**	**0.00**	**3 401.30**
5.1.	Modernization of the heating supply system	Capital renovation of the heating networks: ТК3-ТК5; ТК26- ТК42; ТК46-ТК49-ТК 59; ТК1А-ТК10	2 232.23	581.5	0	117.5
5.2.	Reconstruction of the heating supply system	Reconstruction of the boiler station with installation of equipment for automatic combustion of fuel	4 435.07	14521.3	0	2933.3
5.5.	Reconstruction of the water supply and sewerage system	Reconstruction of the sewerage pumping stations Nos. 1, 2 and 4	665.326	0.613	0	0.6

№ з/п	Project/measure	Content	Total cost of implementation, (thousand UAH)	Expected energy saving, MW-hour/year	Renewable energy generation, MW-hour/year	CO2 emission reduction (tons/year)
5.6.	Improvement of the energy management system at the Municipal Heating Company	Installation of meters with automatic reading, reduction of non-productive losses, software procurement	508.4	185.27	0	42.6
5.7.	Improvement of the energy management system at the Municipal Water Supply and Sewerage Company	Installation of meters with automatic reading, development of the scheme for optimized water supply and a hydraulic model for water supply network, reduction of non-productive losses by replacement of valves	921.398	86.58	0	79.0
	Total		**222 104.24**	**111 251.50**	**18 752.29**	**30 815.24**

4.4. Information campaigns in the areas of energy saving, climate protection and ecology

When the set of measures was formed with the aim to change the residents' mentality with regard to rational use of energy resources, the emphasis was made on the sectors that comprise the Baseline Emission Inventory.

A mandatory tool envisaged by the Covenant of Mayors is Sustainable Energy Days aimed to increase awareness of the community on the modern ways of efficient use of energy, broader utilization of renewable energy sources and counteraction of the global climate change in line with the general European policy.

The tentative list of activities during the Sustainable Energy Days is rather broad and may include the following measures:

1) Demonstration measures: doors open days, exhibition, trade fairs, technology festivals, fests, contents on environmental topics, demonstration of specialized video clips;

2) Education measures: conferences, seminars, round tables, training games and sessions, presentations of school programs on energy saving and climate protection, energy audits of school buildings made by students, presentations of the students' own research results;

3) Cultural measures: theatrical and puppet shows on environmental topics, drawing, photo or literal work competitions on efficient use of energy and climate protection;

4) Sport measures: "clean air" bicycle and roller skate races; "health" running competitions;

5) Formal measures: ceremonies of opening and closing Sustainable Energy Days, public hearings on the planned activities and relevant investment packages, honoring the winners of contests and competitions, meetings of management and business circles to combine the efforts towards reduction of the hazardous impact of the energy sector on the environment.

4.5. Role and planned activities in the area of use of alternative energy sources

In addition to the comprehensive development and application of energy saving technologies, equipment, materials and production processes, an important issue in the set of energy saving measures is involvement of renewable and non-traditional (alternative) energy sources into the city's fuel and energy balance.

Improvement of Korosten's provision with energy due to introduction of non-traditional and renewable energy technologies and sources, as well as alternative fuels, considerably contributes to the reduction of the city's dependence upon organic fuels.

This concerns the use of solar radiation to heat water in the heating and hot water supply systems using solar collectors allowing to heat the water to 40-50 ºC, as well

as the use of silicon solar cells for power generation and use of geothermal water energy for heating purposes.

Calculations of solar radiation for Korosten's geographic latitude shows that the annual volume of heat that can be obtained per 1 sq. m of solar collectors is not more than 1150 kW.hour, which is 141 kg of oil equivalent. Wood has much larger potential for use. The energy potential of forestry products in Zhytomyr Oblast is estimated as 39,500 tons of oil equivalent. Thus, the forestry wastes may compensate at least 10% of the fuel need for the district heating system.

The city has launched the process of using wood waste (biofuel) as a renewable energy sources for generation of thermal energy.

Analysis of experience of operation of the energy facilities where renewable or alternative energy sources are used, as well as the world's experience in this area, proves that under current conditions the development and implementation priority is given to combined generation of heat and electricity (cogeneration) in small-scale energy generation, which allows obtaining additional volumes of electricity without additional use of organic fuel. Installation of cogeneration plants has been launched in the city, and there are plans of their further use.

4.6. Organizational structure

For the purposes of coordination of actions of the players at the local energy market, ensuring sustainable energy development of Korosten's community and prevent climate changes, the Advisory Committee for Sustainable Energy Development has been established with the tasks to:

- formulate the concept of the city's energy policy;
- develop proposal for improvement of the energy management system in the city;
- analyze functioning of the city's energy sector;
- ensure control of implementation of necessary measures for implementation of the sustainable energy action plan of Korosten;
- involve companies, institutions and organizations of all forms of ownership into the city's energy management system;
- inform the citizens of the issues pertinent to energy efficiency.

In order to inform the Office of the Covenant of Mayors of the progress of SEAP preparation and implementation, a person in charge of communication was appointed (Municipal Energy Manager) who ensures ongoing control, information exchange between interested parties and coordination of actions of all participants. Within structural units of the city's Executive Committee and municipal companies, officials in change of energy management have been appointed.

4.7. Monitoring and reporting

SEAP monitoring with the use of various relevant indicators is used in order to assess the probability of achievement of the planned goals and take corrective measures if necessary. The following stages of monitoring are set:

- activity report (every two years after adoption);
- General Strategy Monitoring envisages any changes in the general strategy and presents updated data on redistribution of labor force and financial resources;
- monitoring of planned measures describes their progress, problems that arose and, accordingly, their influence on achievement of SEAP goals.
- the full report, which is submitted four years after adoption of the SEAP, among other things, provides for preparation of the Monitoring Emission Inventory.

For the purposes of achievement of the above goals, the system of ongoing monitoring of consumption of the fuel and energy resources is established.

Monitoring of FER consumption in the transport sector is performed on an annual basis.

Monitoring of FER consumption in the budget-funded sector, street lighting system and utilities is performed on a monthly basis.

At the facilities administered by the city administration, monthly and annual limits are set for consumption of all types of energy resources.

The system of monitoring of FER consumption together with the system of energy management will allow:

- determining the effectiveness of energy efficiency measures;
- making effective analysis of data on energy consumption and implementation of relevant activities;
- improving the system of communications and information exchange with municipal utility companies in order to create a coordinated energy policy in the city;
- forming a single municipal register of energy efficiency projects and performing ongoing monitoring of their implementation;
- monitoring expenses for procurement of FER from the municipal budget;
- performing information and awareness activities aimed to change people's attitude to the FER consumption, as well as explanation of the efficiency of specific measures aimed to reduce consumption of energy resources;
- implementing the system of annual CO_2 monitoring.

4.8 SEAP funding sources

SEAP financial component is determining for the process of implementation of energy efficiency projects.

To ensure SEAP implementation in Korosten, the following funding sources have been identified:

1. Companies' own funds.
2. Governmental targeted programs (State Budget).
3. Local targeted programs (municipal budget).
4. Donor grants.
5. Loans from banks including international.
6. Trade credit (supplier's credit).
7. Borrowings (bonds).
8. Targeted contributions of co-owners of multi-family buildings.
9. Financial leasing.
10. Involvement of private capital.

The key guaranteed sources of funding of energy saving measures in Korosten in the recent years have been the state budget and the municipal budget. At the moment, considering the tough economic situation in the country and difficulties with replenishment of the budget revenues the emphasis on the sources for funding of energy efficiency projects should be considerably shifted towards attraction of loans and grants.

Possible options for cooperation in the implementation of future energy efficiency projects appear to be presented by the following international financial institutions: NEFCO (Nordic Environment Finance Corporation), UNDP (United Nations Development Program in Ukraine), IFC (International Financial Corporation), EBRD (European Bank for Reconstruction and Development), E5P (Eastern Europe Energy Efficiency and Environmental Partnership), WB (World Bank) and others.

In the public sector, the key funding source appears to be loans and grants with co-funding from the municipal budget. For residential buildings, the structure of funding sources is supplemented with residents' contributions (about 30-50% of co-funding depending on the complexity of energy efficiency measures). In addition, it is also possible to take bank loans for implementation of energy efficiency measures. For other sectors, the determining funding source in addition to loans and grants are the funds of the companies that supply energy resources, as well as other institutions and organizations.

The planned amount needed for implementation of energy efficiency projects in the SEAP's selected sectors is UAH 222,100,000.

CONCLUSION

The Sustainable Energy Action Plan of the city of Korosten is a strategic document aimed to improve energy efficiency in public institutions and facilities, residential buildings, public transport, municipal street lighting and municipal utility companies.

Based on the results of SEAP preparation, analysis and evaluation have been made as to the current status of generation and consumption of FER in the city. The dynamics of consumption of energy resources have been analyzed for 7 years (2008 - 2014) with the breakdown by key sectors (municipal buildings, equipment/ facilities, residential buildings, municipal street lighting, transport, industries outside ETS (utility companies)). Based on the data obtained, the CO_2 emission inventory was prepared with the year 2012 as a baseline, against which it is planned to reach in 2020 the reduction of CO_2 emission by **30,815.24 tons/year** or **20,77%**. Also, it is planned to reduce consumption of all major energy resources by **111,251.50 MW*hour/year** and increase the RES share to **18,752.29 MW*hour/year**.

The readiness of the organizational and management structure of Korosten City Council to the implementation and monitoring of the SEAP and efficient energy management system in the city has been evaluated.

In the context of the proposed measures and financial resources necessary for their implementation, the capacity of Korosten's municipal budget has been estimated with the view of funding (co-funding) of the measures aimed to reduce CO2 emissions. It was determined that the key funding sources for energy efficiency projects should be loans, grants and other financing sources that are not prohibited by effective legislation. As to the funds of the municipal budget, those should rather be used for co-funding of energy saving measures.

The list of measures offered for reduction of the emissions of greenhouse gases and their cost may be reviewed and updated in the course of SEAP implementation due to development of new technologies, needs, changes of the market conjuncture, management decisions, etc.