

Intelligent Energy  Europe



NIMSEC
Novel and Integrated Model of
Sustainable Energy Communities

Project NIMSEC

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3-pronged strategy for SEC model

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1. Introduction.

The purpose of this study is to develop a model for sustainable energy community for Municipality of Karlovo based on the 3-pronged strategy. The stress in this strategy is to analyze the current situation and elaboration of realistic and economically-efficient measures for energy efficiency (EE) and to promote utilization of renewable energy (RES) as alternative to the mineral fuels which currently are being used. These measures will affect the following sectors: residential sector, local administrations, industry and agriculture. Each of these sectors has its own specific features with specific priorities in the area of EE measures and implementation of RES. The obstacles before realization of energy efficiency measures and implementation of RES are also different. This implies development of different approaches for each sector in order to overcome these obstacles. An important element from the model is the identification and analysis of RES potential in Municipality of Karlovo. The summary, which is structured mainly in a tabular format, shows the current energy consumption in the above mentioned sectors and measures for EE and RES implementation. The study is actually one realistic and economically-efficient model for conversion of Municipality of Karlovo into a sustainable energy community.

2. Analysis of the RES potential which exists in Municipality of Karlovo.

The following RES potential exists on the municipal territory: forest biomass, hydro, solar, and wind energy, energy from agricultural wastes.

Table 1.1 shows data of the existing RES potential on the territory of Municipality of Karlovo:

Table 2.1

| Type of RES | Annual potential, MWh |
|-----------------------------------|-----------------------|
| Wood residues (forest biomass) | 25 276 |
| Hydro energy | 10 800 |
| Wind energy | 16 902 |
| Solar electricity (PV) | 38 400 |
| Solar heating energy (collectors) | 26 280 |
| TOTAL: | 117 658 |

3. Residential sector.

There are 24 715 households in Municipality of Karlovo. Energy is being consumed mainly for heating purposes, private transport vehicles, preparation of food, sanitary-hygienic needs, etc. Table 3.1 shows the annual energy quantities consumed by households by energy-carriers.

Table 3.1

| Type of energy-carrier | Dimension | Quantity | Energy content, MWh |
|------------------------|----------------|-----------|---------------------|
| Electricity | MWh | 59 316.00 | 59 316.00 |
| Wood | m ³ | 61 787.50 | 123 575.00 |
| Coal | Tons | 49 430.00 | 346 010.00 |
| Petrol | Tons | 4 943.00 | 69 004.28 |
| Propane-butane | Tons | 1 952.49 | 25 968.05 |
| Diesel | Tons | 4 943.00 | 58 821.70 |
| | | ОБЩО: | 682 695.03 |

Energy-saving measures and implementation of RES:

Table 3.2

| № | Description of energy-saving measure | Expected savings, MWh |
|---|--|-----------------------|
| 1 | Energy refurbishment. The energy audits performed so far, and the actual results from refurbished buildings determine a saving potential of 40% in heating energy. For panel flats this parameter reaches 55%. | 187 834 |
| 2 | Solar collectors for hot water. The climate conditions in Municipality of Karlovo allow full preparation of hot water for five months of the year. In the other months this parameter varies between 0% and 60% depending on the season. | 11 863 |
| 3 | Energy-saving household appliances Class A and A+ | |
| 4 | Heating with thermo-pumps "air-air". They have a wide application, providing a transformation coefficient 3:1. | 7 850 |
| 5 | Heating with thermo-pumps "ground-water". They have a limited application due high investment costs, but they can provide a transformation coefficient up to 10:1. | |
| 6 | Gradual shift of old automobiles by new ones. Old automobiles consume more energy and have higher maintenance costs. | |
| 7 | Awareness-raising campaign among citizens for avoidance of own vehicles when moving in short distances and use of public transport. | |

Table 3.2 describes all possible measures. Most realistic and economically-efficient from them are measures №: 1, 2, 3, 4, and 5 because implementation of these measures foresees

some legal preferences. Several popular banks in the country provide the so called “energy efficiency” credit which has a 20% deduction of the credit principle for energy-saving measures which cost is above 500 €. All energy refurbished buildings, which have an energy certificate A, are tax-exempted for a ten-year period.

4. Local administrations sector

Tables 4.1, 4.2 and 4.3 show data for consumption of boiler oil fuel and electricity as well as total heated area of buildings and specific energy cost for one square meter of this area. Analyzing this data, it shows that there is a considerable consumption of boiler oil-fuel which is the most expensive energy-carrier – the price for one 1 MWh heating energy produced by this type of fuel is 237,68 levs. The consumption of this fuel in municipal buildings was 714,14 tons in 2008 amounting to 1 571 108 levs. The specific energy consumption is also considerable as in most of the public buildings currently this rate is twice bigger than the rate fixed by the legal regulations. On the other hand, this considerable consumption is a result of enormous heat losses through fencing elements of buildings. All this data shows a very low efficiency state of this sector: buildings with considerable heat losses are being heated with the most expensive fuel. Combustion of the above mentioned fuel causes a CO₂ emission of 2159 tons in the atmosphere.

Table 4.1

| № | Municipal schools | Heated area m ² | Boiler oil fuel, tons | Boiler oil fuel, MWh | Electricity, MWh | Total, MWh | kWh.y/m ² |
|----|---------------------------------------|----------------------------|-----------------------|----------------------|------------------|------------|----------------------|
| 1 | High school V. Levski | 6 050 | 58.30 | 674.53 | 134.88 | 809.41 | 133.79 |
| 2 | High school Hr. Prodanov | 8 722 | 138.60 | 1 603.60 | 112.16 | 1 715.77 | 196.72 |
| 3 | Secondary school Kalofer | 4 235 | 26.22 | 303.41 | 52.54 | 355.95 | 84.05 |
| 4 | Secondary school Kiril and Metodii | 3 183 | 43.56 | 503.99 | 21.03 | 525.02 | 164.95 |
| 5 | Secondary school Raino Popovich | 3 311 | 26.40 | 305.45 | 71.11 | 376.56 | 113.73 |
| 6 | Municipal school center | | | 0.00 | 9.94 | | |
| 7 | Secondary school Klissura | 2 236 | 22.18 | 256.58 | 0.00 | 256.58 | 114.75 |
| 8 | Secondary school Bania | 5 660 | 25.08 | 290.18 | 35.46 | 325.63 | 57.53 |
| 9 | НУ КЛИМЕНТ | 1 570 | | 0.00 | 6.10 | | |
| 10 | Secondary school Rozino | 2 530 | 71.02 | 821.66 | 0.00 | 821.66 | 324.76 |
| 11 | Secondary school Karnare | 1 155 | 18.04 | 208.72 | 3.82 | 212.55 | 184.02 |
| 12 | Secondary school Karavelovo | 1 534 | | 0.00 | 10.88 | | |
| 13 | Secondary school Bogdan | 1 617 | | 0.00 | 0.64 | | |
| 14 | Secondary school Voyniagovo | 1 250 | | 0.00 | 0.76 | | |
| 15 | Secondary school Dabene | 1 300 | | 0.00 | 29.25 | | |
| 16 | Secondary school Vedrare | 3 173 | 39.82 | 460.72 | 32.32 | 493.03 | 155.38 |
| 17 | Secondary school in village V. Levski | 2 098 | 20.33 | 235.19 | 16.16 | 251.36 | 119.81 |

| | | | | | | | |
|---------------|--|---------------|---------------|-----------------|---------------|-----------------|---------------|
| 18 | Secondary school in village Hr. Danovo | 2 072 | 18.04 | 208.72 | 8.82 | 217.54 | 104.99 |
| 19 | Primary school Slatina | 1 488 | | 0.00 | 3.09 | | |
| 20 | Primary school Stoletovo | 648 | | 0.00 | 1.61 | | |
| 21 | Primary school Iganovo | 478 | | 0.00 | 4.48 | | |
| 22 | Primary school Gorni Domlian | | | 0.00 | 1.38 | | |
| TOTAL: | | 54 310 | 507.58 | 5 872.75 | 556.44 | 6 429.19 | 118.38 |

Table 4.2

| № | Kindergartens | Heated area, m2 | Boiler oil fuel, tons | Boiler oil fuel, MWh | Electricity, MWh | Total, MWh | kWh.y/m2 |
|---------------|-----------------------------------|-----------------|-----------------------|----------------------|------------------|------------|----------|
| 1 | Kindergarten № 1 Karlovo | 1 331 | 17.16 | 198.54 | 45.54 | 244.08 | 183.38 |
| 2 | Kindergarten № 4 Karlovo | 1 138 | 23.58 | 272.87 | 41.89 | 314.75 | 276.59 |
| 3 | Kindergarten № 6 Karlovo | 1 666 | 21.82 | 252.50 | 40.05 | 292.56 | 175.60 |
| 4 | Kindergarten № 7 Karlovo | 1 666 | 13.20 | 152.72 | 45.48 | 198.20 | 118.97 |
| 5 | Kindergarten № 8 Karlovo | 2 900 | 26.22 | 303.41 | 20.63 | 324.04 | 111.74 |
| 6 | Kindergarten Karlovo | 425 | | | 16.69 | | |
| 7 | Kindergarten Kalofer | 1 672 | 37.84 | 437.81 | 38.02 | 475.83 | 284.59 |
| 8 | Kindergarten Klissura | 1 138 | | | 42.60 | | |
| 9 | Kindergarten Vedrare | 800 | | | 26.39 | | |
| 10 | Kindergarten Bania | 519 | | | 69.46 | | |
| 11 | Kindergarten village Vasil Levski | 325 | | | 27.51 | | |
| 12 | Kindergarten Voyniagovo | 521 | | | 49.76 | | |
| 13 | Kindergarten Dabene | 325 | | | 26.40 | | |
| 14 | Kindergarten Kliment | 325 | 5.46 | 63.13 | 9.86 | 72.98 | 224.56 |
| 15 | Kindergarten Bogdan | 907 | | | 23.54 | | |
| 16 | Kindergarten Karavelovo | 1 145 | | | 21.30 | | |
| 17 | Kindergarten Karnare | 325 | | | 58.29 | | |
| 18 | Kindergarten Rozino | 325 | | | 53.78 | | |
| 19 | Kindergarten Hr. Danovo | 678 | | | 31.20 | | |
| 20 | Kindergarten Sushica | 325 | | | 27.49 | | |
| 21 | Kindergarten Sokolitza | 325 | | | 5.08 | | |
| 22 | Kindergarten Prolom | 248 | | | 7.76 | | |
| TOTAL: | | 19 029 | | 1 680.98 | 827.22 | | |

Table 4.3

| № | Municipal administrative buildings | Heated area, m2 | Boiler oil fuel, tons | Boiler oil fuel, MWh | Electricity, MWh | Total, MWh | kWh.y/m2 |
|---------------|------------------------------------|-----------------|-----------------------|----------------------|------------------|---------------|---------------|
| 1 | Municipal administration - Karlovo | 2 670 | 15.29 | 176.93 | 438.60 | 615.53 | 230.53 |
| 2 | Local administration - Kliment | 368 | 1.76 | 20.36 | 0.00 | 20.36 | 55.33 |
| TOTAL: | | 3 038 | 17.05 | 197.29 | 438.60 | 635.89 | 209.31 |

Table 4.4 shows data for electricity consumption of municipal buildings in 2008 by target groups:

Table 4.4

| Target groups | Consumption, kWh |
|----------------------------------|------------------|
| Municipal schools | 555 062 |
| Kindergartens | 908 779 |
| Administrative buildings | 438 597 |
| Street lightning | 1 707 207 |
| Cleaning services | 131 191 |
| Sports facilities | 117 024 |
| Cultural and historic activities | 57 388 |
| Social activities | 32 680 |
| Municipal market | 15 085 |
| Other activities | 4 365 |
| TOTAL: | 3 967 378 |

The table above show very high consumption of electricity for street lightning.

Table 4.5 shows the specific energy consumption in municipal buildings by target groups.

Again, it shows the big exceeding above the consumptions which are required by law.

Table 4.5

| Target groups in municipal sector | Specific energy consumption, kWh.y/m ² | |
|-----------------------------------|---|------------------|
| | Actual | Required by law* |
| Municipal schools | 118,32 | 50,1 |
| Municipal kindergartens | 179,70 | 70,0 |
| Administrative buildings | 209,31 | 62,1 |

*Data for climate zone № 7 from State Regulation № 18 “Energy performance of buildings”.

Energy saving measures and implementation of RES:

| № | Description of measure | Expected results |
|---|---|--|
| 1 | Energy refurbishment. Fitting insulation on side-walls and roofs. Substitution of depreciated doors and windows by new ones, in conformity with regulative requirements. | Saving of 4 892 MWh heating energy. |
| 2 | Substitution of boiler oil fuel by a fuel produced from wood biomass. This measure is not energy saving measure but it will sharply decrease the heating expenditures and thus shortens the pay-back period for costs needed to implement Measure № 1. Price of 1 MWh heating energy produced from wood chips is 46,14 levs, i.e. it is 5,15 times lower than the price of the same amount heating energy produced from boiler oil fuel. In the combustion process, one ton of boiler oil fuel emits 2,66 tons of CO ₂ . Wooden fuel is practically neutral towards CO ₂ emissions. The quantity of wood chips needed for the municipal buildings that would substitute the whole quantity of boiler oil fuel is 3 285 tons. According to statistics from State Forestry Administration of Karlovo, the annual extraction of forest biomass on the municipal territory is 9 912 tons. | Heating expenditures will decrease by 1 242 608 levs or by 79%. 2 159 tons of CO ₂ emissions will be saved. |
| 3 | Heating process automation. This measure is reasonable only if Measure № 1 is executed. It would ensure maintenance of a temperature, required by law. | |
| 4 | Substitution of ordinary mercurial lamps used in street lightning by new, energy-saving ones (sodium lamps with high pressure and LED lightning). Automated control of street lightning. | |

| | | |
|---|--|---|
| 5 | Introduction of intensive utilization of vacuum-piping solar collectors for production of hot water in kindergartens and social houses. The measure is similar to the one proposed for the residential sector. | Provides 100% of the hot water needed between May-September, and from 0% to 60% of the hot water during rest of the year. |
|---|--|---|

5. Industry and agriculture.

5.1. Agriculture.

Two companies possess the bigger part of arable land in the municipality – 13 009,90 ha. They are: SD “Itali – Trifonof i SIE”, from village of Vedrare, and ZP “Nenko Angelov Trifonov”, from town of Bania. These two companies used 819 623,70 liters or 721,30 tons of diesel for tillage, sowing, harvesting, and irrigation in 2007.

Energy saving measures and implementation of RES:

| № | Description of measure | Expected results |
|---|--|-------------------|
| 1 | Production of biogas in animal farms thus obtaining hot water needed for operation activities. | |
| 2 | Gradual substitution of mineral diesel fuel used in agricultural activities by biodiesel. | Ecological effect |

5.2. Industry.

Table 5.1 provides actual data for energy consumption of eight determinant industrial enterprises operating on the municipal territory:

Table 5.1

| Name of Company | Year | Electricity, kWh | Wood, m ³ | Diesel fuel, tons | Black oil (mazut), tons | Propane-butane, tons | Coal, tons |
|-------------------------------------|------|------------------|----------------------|-------------------|-------------------------|----------------------|------------|
| “Baneks” SA, Karlovo | 2005 | 4 173 492 | 118 | 33 | 0 | 10 | 0 |
| | 2006 | 3 350 789 | 102 | 37 | 0 | 10 | 0 |
| | 2007 | 3 233 658 | 250 | 40 | 0 | 6 | 0 |
| “Elektrostomana” SA, Karlovo | 2005 | 2 820 600 | 0 | 230 | 0 | 130 | 0 |
| | 2006 | 2 710 300 | 0 | 250 | 0 | 115 | 0 |
| | 2007 | 2 769 100 | 0 | 270 | 0 | 105 | 0 |
| “Agrotehnika” SA, Karlovo | 2005 | 550 000 | 20 | 1 | 0 | 0 | 0 |
| | 2006 | 490 000 | 20 | 1 | 0 | 0 | 0 |
| | 2007 | 450 000 | 20 | 1 | 0 | 0 | 0 |
| ”Messokombinat Karlovo” SA, Karlovo | 2005 | 3 787 | 0 | 54 | 559 | 0 | 0 |
| | 2006 | 3 482 | 0 | 72 | 500 | 0 | 0 |
| | 2007 | 4 156 | 0 | 196 | 500 | 0 | 0 |
| “Balgarska Roza” SA, Karlovo | 2005 | 340 000 | 0 | 142 | 444 | 0 | 0 |
| | 2006 | 243 000 | 0 | 44 | 603 | 0 | 0 |
| | 2007 | 440 000 | 0 | 93 | 682 | 0 | 0 |
| „VMZ” SA, Sopot | 2005 | 16 957 999 | 0 | 0 | 4 119 | 0 | 0 |
| | 2006 | 17 769 409 | 0 | 0 | 4 396 | 0 | 0 |
| | 2007 | 22 801 533 | 0 | 0 | 3 421 | 0 | 0 |
| „VRZ Karlovo” SA | 2005 | 977 104 | 0 | 57 | 0 | 0 | 9 |
| | 2006 | 830 657 | 0 | 12 | 0 | 0 | 10 |

| | | | | | | | |
|---|------|---------|---|----|---|---|----|
| | 2007 | 723 464 | 0 | 12 | 0 | 0 | 14 |
| „Bonner” Ltd., village of Vedrare | 2005 | 60 000 | 0 | 15 | 0 | 0 | 0 |
| | 2006 | 185 000 | 0 | 22 | 0 | 0 | 0 |
| | 2007 | 211 000 | 0 | 36 | 0 | 0 | 0 |

Energy saving measures and implementation of RES:

| No | Description of measure | Expected results |
|----|--|---|
| 1 | Frequency controlled electro-motions. This measure is implemented at inconstant machine revs ensuring a considerable save of electricity. Enabling an easy revolution of the mechanism in motion, a longer life and less maintenance costs are provided. | Up to 50% save of electricity. |
| 2 | Substitution of mercurial lamps for lightning industrial premises by energy-efficient ones, equipped with electronic starters. Automated control of lightning. | Up to 45% decrease in electricity for lightning. |
| 3 | Substitution of black oil (mazut) by a fuel produced from wood residues (pellets or wood chips). This measure is similar to the one proposed for the public sector. | Up to 4 times lower expenditures for heating. Eliminates emission of sulfur-oxides in the atmosphere. |
| 4 | Cancellation of warming up the black-oil tanks in the mills, which produce industrial steam through steam black-oil heaters. The measure predicts this warming will be performed by self-regulated, electrically-heated conductors. This will ensure the needed temperature not only in tanks but also in the pipelines which connect them with the steam station. | Saving of at least 20% industrial steam. |
| 5 | Substitution of old insulation of pipelines for hot water and steam. | Up to 25% savings of heating energy. |
| 6 | Energy refurbishment of industrial premises and other heated premises controlled by enterprises. This measure is similar to the one proposed for the municipal sector. | Up to 50% savings of heating energy. |
| 7 | Introduction of a system for energy monitoring and training of managerial staff how to use it. Even the simplest type of monitoring: switching off unnecessary lighting, and idle-running machines, may leads to remarkable results. | |
| 8 | Use of powerful technological units, which would work on electricity only in the night shifts (from 10p.m. to 6p.m.) should the specificity of work allow this. This measure is not an energy-saving measure, but it would enable use of cheaper electricity through night exploitation of machines. | Up to 30% savings of electricity costs. |

Implementation of the above proposed measures will lead to energy savings between 40 – 60 % in the sectors, i.e. the expected savings will be around 318 658 – 477887 MWh / year. The structure of fuels which are used will also be changed, mainly in the public sector. The mineral oil fuels will be substituted by wood residues fuel which would be produced from local sources of forest biomass described above. All these measures are serious precondition for converting Municipality of Karlovo into a sustainable energy community.

6. Barriers before EE measures and implementation of RES.

Main barrier before implementation of RES and energy-saving is the lack of preferences and incentives with one exception: buildings are tax-exempted for 10 years when an energy refurbishment as a result of energy audit has been performed. Another preference is also the higher price paid for electricity produced by PV and wind generators. Unfortunately, the purchase and installation of equipment which operates with RES is not being stimulated. Substitution of old vehicles by new ones is not being stimulated either. The insufficient promotion and popularization of RES implementation in households is also a huge barrier. Recently, some schools introduced in their programs a subject for training on energy efficiency. Its purpose is to teach the youngest citizens on renewable energy and energy-saving issues, but unfortunately these are only incidental initiatives led by NGOs. Such educational policy does not exist yet at state level.

7. Data source.

- Municipal administration of Karlovo.
- A report from EnCon Services International ltd., USA.
- State Forestry Administration of Karlovo
- Regional Energy Agency of Pazardjik (REAP).
- An offer for gasification of Karlovo by CNG Trakia, Plovdiv.
- National statistics year-book.