

MunEM:
Sustainable energy management on municipal level

WP 3: Improvement of energy consumption situation

Measures catalogue on public buildings

(Draft report)

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by
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on behalf of
**Ministry of Science, Economic Affairs and Transport
of the state Schleswig-Holstein**

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1 Introduction

The following report was elaborated in the framework of Work package 3 “Improvement of energy consumption situation”. It provides the result of the work task “elaboration of measure catalogues” which was carried out within the Milestone 3 of the project.

In this work task the wide experience of Energy Agency in elaborating measure catalogues for energy saving measures in public buildings in the meaning of schools and Kindergartens from energy management projects in Schleswig-Holstein was transferred to the regional partners in Kaliningrad Oblast.

2 Aim and Structure of Measures catalogues

The aim of a measures catalogue for a public building which is elaborated within the framework of the municipal energy management is to identify energy saving potentials. These potentials shall be roughly estimated and evaluated due to costs and savings. Basing on this evaluation first decision about the prioritisation of measures and the further planning steps can be carried out. The measure catalogue do not replace detailed engineering it gives advice about saving potentials and measure to be executed in short time. For these reasons the measures in the measure catalogue are split into three categories:

Category A

Non investment measures or measures with low investment which can be carried out with own personnel resources within the framework of daily operation of the building. The investment will be repaid by cost saving in short time.

Category B

Measures with a remarkable investment which need a detailed engineering and a planning of financial resources. The investment will be paid back through cost savings within the technical lifetime of invested asset.

Category C

Energetic measures which have to be executed in combination with measures which has to be carried out for other reasons (basic-measure). As a single measure these energetic measures will not be economical. But under consideration of costs of the basic-measure which has to carried out for other reasons the more costs for energetic part can be paid back by energy costs savings

The more-investment is paid back by more-cost savings within the lifetime of invested asset.

Example:

The roof of a building has to be renovated because it has reached the end of its lifetime and it is leaky. The costs for the refurbishment of the roof gasket (basic-measure) have to be spent for reasons of maintenance.

If this measure is combined with an energetic optimisation by additional insulation only the more costs for the insulation have to be accounted to the energetic measure. The more-costs can be covered by the savings due to insulation.

3 Basics of Measures catalogues

The measures catalogues base on common personal site visit. Within the site visit the constructive situation of the buildings have been investigated.

Additionally data about yearly energy consumption have been evaluated and compared with similar building types. Instrument for this evaluation was the energy mirror which has been implemented in municipalities. A third instrument was the monitoring of monthly energy consumption. The comparison with data from other months and the same month last year gave important indication for measures.

The following data about the framework were provided by the regional partners or were adjusted with regional partner as realistic basing on assumptions:

<u>Economic framework</u>		
Heat costs (Svetly only)	33,00 €/MWh	1.188 RUB/MWh
Coal costs	7,70 €/MWh	277 RUB/MWh
Electricity costs	0,05 €/kWh	1,80 RUB /kWh
Potable water costs	0,30 €/m ³	10,80 RUB/m ³
Sewage water costs	0,16 €/m ³	5,80 RUB/m ³
<u>Technical framework</u>		
Costs for replacement of windows or doors	155 €/m ²	5.600 RUB/m ²
Costs for insulation of external wall	23 €/m ² (5 cm) 28 €/m ² (7cm)	854 RUB/m ² (5cm) 1.040 RUB/m ² (7cm)
Costs for replacement of electric bulb	3,5 €/piece	126 RUB/piece
Costs for replacement of lighting fixture	50 €/piece*	1.856 RUB/piece
Costs for replacement of heating boiler	51 €/kW	1890 RUB/kW
Cost per working our of own personnel	3 €/h	108 RUB/h

<u>Ecologic framework**</u>		
CO2 emissions of district heat without chp basing on coal	408 kg/MWh	
CO2 emissions of district heat with chp basing on coal	312 kg/MWh	
CO2 emission of district heat with chp basing on natural gas	129 kg/MWh	
CO2 emissions of coal	439 kg/MWh	
CO2 emissions of electricity	647 kg/MWh	
CO2 emission of natural gas	249 kg/MWh	

*: own assumption

** : basing on GEMIS 4.3

4 Results of Measures catalogues

4.1 Mamonovo

For the two buildings in Mamonovo 13 measures could be identified. The measures are divided in four measures Category A, four measures category B and five measures category C.

The execution of the proposed measure could save yearly 5.689 € (204.804 RUB) energy costs and 180 t CO2 emissions. The amortisation times are between 0 and 44 years.

Some of the measures are not economically under current conditions of energy prices. But it is expectable that energy prices will increase and reach world market level in a few years. Than these measures will become economically as well. To the principles of the measure catalogue these measures are mentioned in the catalogue even if they not economically yet.

Measure Cat.	No.	Description	cost of basic measure	costs of energy saving measure	savings					efficiency	
					kWh el / a	kWh therm / a	m³/a	€ / a	kg CO2 / a	amortization time a	€ invest/ kg CO2 a
A	A.1	energy saving project		30 €	4.500	40.000	0	534	18.681	0,1	0,00
	A.2	measure based accounting of water demand		12 €			1.098	505	0	0,0	
B	B.1	replacement of existing lighting fixture in sports hall		2.400 €	7.272			364	1.811	6,6	1,33
	B.2	ΔT-Controlling unit for heat water pumps		5.000 €	6.570	0	0	329	1.636	15,2	3,06
C	C. 1	replacement of windows	144.305 €	13.965 €		106.879		827	46.920	16,9	0,00
	C. 2	Insulation of external walls	34.753 €	7.555 €	0	29.616	0	827	46.920	9,1	0,16
	C. 3	Insulation of roof	55.752 €	12.120 €	0	35.633	0	276	15.643	44,0	0,00
		Sum Measures energy management		41.082 €	18.342	212.127	1.098	3.660 €	131.610	11,2	0,31

Table: Overview measures Mamonovo school

Measure Cat.	No.	Description	cost of basic-measure	costs of energy saving measure	savings					efficiency	
					kWh el / a	kWh therm / a	m³/a	€ / a	kg CO2 / a	amortization time a	€ invest/ kg CO2 a
A	A.1	energy saving project		30 €	3.100	8.750	0	223	4.613	0,1	0,01
	A.2	measurement based accounting of water demand		12 €			1.952	898	0	0,0	
B	B.1	replacement of electric bulbs		175 €	3.180			159	792	1,1	0,22
	B.2	Insulation of upper ceiling		9.821 €		42.490		329	18.653	29,9	0,53
C	C.1	replacement of windows	31.310 €	3.030 €		21.406		166	9.397	18,3	0,00
	C.2	Insulation of external walls	33.557 €	7.295 €		32.996		255	14.485	28,6	0,50
Sum Measures energy management				20.363 €	6.280	105.641	1.952	2.029 €	47.940	10,0	0,42

Table: Overview measures Mamonovo kindergarten

Detailed description of measures please find in the Annex.

4.2 Svetly

For the building in Svetly seven measures could be identified. The measures are divided in two measures Category A, two measures category B and three measures category C.

The execution of the proposed measure could save yearly 8.776 € (315.936 RUB) energy costs and 69 t CO2 emissions.

The amortisation times are between 0 and 15 years

Some of the measures are not economically under current conditions of energy prices. But it is expectable that energy prices will increase and reach world market level in a few years. Than these measures will become economically as well. To the principles of the measure catalogue these measures are mentioned in the catalogue even if they not economically yet.

Measure Cat.	No.	Description	cost of basic-measure	costs of energy saving measure	savings					efficiency	
					kWh el / a	kWh therm / a	m³/a	€ / a	kg CO2 / a	amortization time a	€ invest/ kg CO2 a
A	A.1	energy saving project		30 €	6.000	54.661	0	2.104	18.548	0,0	0,00
	A.2	adjustment of heat controlling system to avoid heat consumption in summer		6 €		30.221		997	9.429	0,0	
B	B.1	replacement of existing lighting fixture in sports hall		2.400 €	7.272			364	1.811	6,6	1,33
	B.2	ΔT-Controlling unit for heat water pumps		5.000 €	6.570	0	0	329	1.636	15,2	3,06
C	C.1	replacement of windows	197.625 €	19.125 €		92.444		3.051	23.019	6,3	0,83
	C.2	Insulation of external walls	29.371 €	6.385 €	0	15.808	0	522	3.936	12,2	1,62
	C.3	Insulation of roof	52.946 €	11.510 €	0	42.745	0	1.411	10.643	8,2	1,08
Sum Measures energy management				44.456 €	19.842	235.878	0	8.776 €	69.022	5,1	0,64

Table: Overview measures Svetly school

Detailed description of measures please find in the Annex.

5 Conclusion and next steps

The catalogues should be the basis for further investigations about the mentioned tasks to ensure a detailed planning and the execution of the mentioned measures. The measures of category A should be executed as soon as possible. The measures of category B should be executed in the next budget period. The measures of category C should be carried out when the necessary basic-measure is executed.

Furthermore the results of the measures catalogues will be considered in the “energy report” which will be elaborated for each municipality end of 2008.

The measures catalogues shall be updated at regular intervals as an everlasting task of municipal energy management.

6 Annex

6.1 Measures catalogue for Mamonovo school

Measure Cat.	No.	Description	cost of basic-measure	costs of energy saving measure	savings				efficiency		
					kWh el / a	kWh therm / a	m³/a	€/a	kg CO2 / a	amortization time a	€ invest/kg CO2 a
A	A.1	energy saving project		30 €	6.000	54.661	0	2.104	18.548	0,0	0,00
	A.2	adjustment of heat controlling system to avoid heat consumption in summer		6 €		30.221		997	9.429	0,0	
B	B.1	replacement of existing lighting fixture in sports hall		2.400 €	7.272			364	1.811	6,6	1,33
	B.2	ΔT-Controlling unit for heat water pumps		5.000 €	6.570	0		329	1.636	15,2	3,06
C	C. 1	replacement of windows	197.625 €	19.125 €		92.444		3.051	23.019	6,3	0,83
	C. 2	Insulation of external walls	29.371 €	6.385 €	0	15.808	0	522	3.936	12,2	1,62
	C. 3	Insulation of roof	52.946 €	11.510 €	0	42.745	0	1.411	10.643	8,2	1,08
Sum Measures energy management				44.456 €	19.842	236.878	0	8.776 €	69.022	5,1	0,64

MunEM Suitable energy management on municipal level Measures catalogue for Mamonovo school

basic data for building

total heated area 3.850 m²

Basic data for calculation of economic efficiency

yearly heat demand 800.000 kWh/a

yearly electricity demand 90.000 kWh/a

yearly accounted water demand 3.600 m³/a

electricity average price 0,05 €/kWh

heat price €/kWh not applicable

price natural gas €/kWh Hu not applicable

coal price 0,0077 €/kWh applicable

price potable water 0,3 €/m³

sewage water price 0,16 €/m³

hour rate own personnel 3 €/h

CO2 emissions

Electricity 647 kg/MWh

heat 312 kg/MWh

natural gas 249 kg/MWh

LFO 303 kg/MWh

coal 439 kg/MWh

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo school

Measure name	energy saving project
Measure description	Execution of a school project about "energy saving". Target of the project is to reduce the user dependent part of energy demand. Experiences show that the users can save up to 10% of energy demand by changing their behavior

basic data:

yearly heat demand	800.000 kWh/a
yearly electricity demand	90.000 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price
1	effort for organisation of project	hours	10	3 €	30 €
2					0 €
Sum:					30 €

Savings

Expected savings by changing user behavior	5%	
Expected heat energy savings by changing user behavior	40.000 kWh/a	17.560 kg CO2 / a
Expected electricity savings by changing user behavior	4.500 kWh/a	1.121 kg CO2 / a
cost savings	534 €/a	Total 18.681 kg CO2 / a

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo school

Measure name replacement of existing lighting fixture in sports hall

Measure description The sports hall is equipped with lighting fixtures with 2x 65W installed electrical power. Including control gear the total electrical power has got a value of 156 W per piece. The equipment has reached the end of its lifetime and has to be replaced by modern lighting fixtures with electronic control gears with much lower installed electrical power by same light output. The measure can be financed by cost savings within the technical lifetime of new equipment.

basic data:

amount of lighting fixtures 48 pieces

installed electrical power 0,1560 kW per piece

new electrical power 0,055 kW per piece

hour of operation 1.500 hours per year

investment costs

No.	Description	unit	amount	price p.u.	total price
1	replacement of lighting fixtures	piece	48	50 €	2.400 €
Sum:					2.400 €

Savings

reduction of installed electrical power 0,1010 kW per piece

reduction of installed electrical power 4,8480 kW total

Savings electrical energy 7.272 kWh/a 1.811 kg CO2 / a

cost savings 364 €/a

payback time for investment 7 years

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo school

Measure name	ΔT-Controlling unit for heat water pumps
Measure description	The heat water pumps in the hot water heating system are without any control and regulation system. With the installation of a delta T control unit an operation adjusted to the need will be possible. This will save electrical energy.

basic data:

installed electrical power of pumps	1,500 kW
annual operation time	8.760 h/a
total electricity demand	13.140 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price
1	Installation of delta T controlling unit for heat water pump	lump sum	1	5.000 €	5.000 €
				Sum:	5.000 €

savings

saving of electrical energy for pumping operation	50%	
new annual consumption of electrical energy	6.570 kWh/a	
savings of electrical energy	6.570 kWh/a	
cost savings	329 €/a	1.636 kg CO2 / a
payback time for investment	15 years	

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo school

Measure name replacement of windows

Measure description The school is equipped with windows from the construction year of the building. The windows are partly defective and have reached the end of their technical live time. The windows have to be replaced by reasons of maintenance. This necessary measure has to be executed in a energetically optimized way. The U-value has to be reduced compared to a standard execution of the measure

basic data

area of windows 931 m²

existing U-value 5,6 W/m²K

U-value in case of standard refurbishment 1,8 W/m²K

utilisation ratio of heat boiler 0,6

factor for restrained heating 0,7

Heat demand from transmission by standard refurbishment 164.228 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price standard measure	additional costs for energetically optimisation
1	Replacement of windows as a complete performance with all axillary services	m ²	931	155 €	144.305 €	
2	Additional effort for improvement of U-Value in glazing and Frame	m ²	931	15 €		13.965 €
Sum:					144.305 €	13.965 €

Savings by optimization

optimized U-Value 1,2 W/m²K

Heat demand from Transmission by optimized refurbishment 57.350 kWh/a

Heat demand savings 106.879 kWh/a 46.920 kg CO₂ / a

cost savings 827 €/a

Pay back time of optimization 17 a

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo school

Measure name	Insulation of external walls
Measure description	The external walls are in a bad condition and have to be renovated. The renovation has to be combined with a insulation of walls. This necessary measure has to be executed in a energetically optimized way. The U-value has to reduced compared to a standard execution of the measure

basic data

area of fassade	1511 m ²
existing U-value	1,25 W/m ² K
U-value in case of standard refurbishment	0,45 W/m ² K
utilisation ratio of heat boiler	0,6
factor for restrained heating	0,7

Heat demand from transmission by standard refurbishment 66.635 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price standard measure	additional costs for energetically optimisation
1	Refurbishment of external walls as standard refurbishment	m ²	1.511	23 €	34.753 €	
2	Additional effort for improvement of U-Value	m ²	1.511	5 €		7.555 €
Sum:					34.753 €	7.555 €

Savings by optimization

optimized U-Value 0,25 W/m²K

Heat demand from Transmission by optimized refurbishment 37.020 kWh/a

Heat demand savings 29.616 kWh/a 13.001 kg CO2 / a

cost savings 229 €/a

Pay back time of optimization 33 a

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo school

Measure name	Insulation of roof
Measure description	The roof is in a bad condition and has to be renovated. The renovation has to be combined with a additional insulation of the roof. This necessary measure has to be executed in a energetically optimized way. The U-value has to reduced compared to a standard execution of the measure

basic data

area of roof	2424 m ²
existing U-value	1,00 W/m ² K
U-value in case of standard refurbishment	0,25 W/m ² K
utilisation ratio of heat boiler	0,6
factor for restrained heating	0,7

Heat demand from transmission by standard refurbishment 59.388 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price standard measure	additional costs for energetically optimisation
1	Refurbishment of roof as standard refurbishment	m ²	2.424	23 €	55.752 €	
2	Additional effort for improvement of U-Value	m ²	2.424	5 €		12.120 €
Sum:					55.752 €	12.120 €

Savings by optimization

optimized U-Value 0,10 W/m²K

Heat demand from Transmission by optimized refurbishment 23.755 kWh/a

Heat demand savings 35.633 kWh/a 15.643 kg CO₂ / a

cost savings 276 €/a

Pay back time of optimization 44 a

6.2 Measures catalogue for Mamonovo kindergarten

MunEM Suitable energy management on municipal level											
measures catalogue for:											
Mamonovo kindergarten											
Measure Cat.	No.	Description	cost of basic measure	costs of energy saving measure	savings			efficiency			
					kWh el / a	kWh therm / a	m³/a	€/a	kg CO2 / a	amortization time a	€ invest / kg CO2 a
A	A.1	energy saving project		30 €	3.100	8.750	0	223	4.613	0,1	0,01
	A.2	measurement based accounting of water demand		12 €			1.952	898	0	0,0	
B	B.1	replacement of electric bulbs		175 €	3.180			159	792	1,1	0,22
	B.2	Insulation of upper ceiling		9.821 €		42.490		329	18.653	29,9	0,53
C	C.1	replacement of windows		3.030 €		21.406		166	9.397	18,3	0,00
	C.2	Insulation of external walls		7.295 €		32.996		255	14.486	28,6	0,50
Sum Measures energy management				20.363 €	6.280	105.641	1.952	2.029 €	47.940	10,0	0,42

MunEM Suitable energy management on municipal level Measures catalogue for Mamonovo kindergarten

basic data for building

total heated area 1.459 m²

Basic data for calculation of economic efficiency

yearly heat demand 175.000 kWh/a

yearly electricity demand 62.000 kWh/a

yearly accounted water demand 2.900 m³/a

electricity average price 0,05 €/kWh

heat price €/kWh not applicable

price natural gas €/kWh Hu not applicable

coal price 0,0077 €/kWh applicable

price potable water 0,3 €/m³

sewage water price 0,16 €/m³

hour rate own personnel 3 €/h

CO2 emissions

Electricity 647 kg/MWh

heat 312 kg/MWh

natural gas 249 kg/MWh

LFO 303 kg/MWh

coal 439 kg/MWh

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo kindergarten

Measure name	energy saving project
Measure description	Execution of a school project about "energy saving". Target of the project is to reduce the user dependent part of energy demand. Experiences show that the users can save up to 10% of energy demand by changing their behavior

basic data:

yearly heat demand	175.000 kWh/a
yearly electricity demand	62.000 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price
1	effort for organisation of project	hours	10	3 €	30 €
2					0 €
Sum:					30 €

Savings

Expected savings by changing user behavior	5%	
Expected heat energy savings by changing user behavior	8.750 kWh/a	3.841 kg CO2 / a
Expected electricity savings by changing user behavior	3.100 kWh/a	772 kg CO2 / a
cost savings	223 €/a	Total 4.613 kg CO2 / a

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo kindergarten

Measure name	measurement based accounting of water demand
Measure description	The water demand is accounted according to theoretical values and not according to measured demand. The comparison to other objects shows that the measured water consumption is lower than the theoretical value. The water supply contract has to be changed in the way that the water is accounted to the real measured consumption.

basic data:

yearly accounted water demand	2.900 m ³ /a
	1.988 l/m ² a

investment costs

No.	Description	unit	amount	price p.u.	total price
1	effort for change in water supply contract	hours	4	3 €	12 €
2					0 €
				Sum:	12 €

Savings

Expected measured water demand due to comparison with similar objects	650 l/m ² a
Expected measured water demand due to comparison with similar objects	948 m ³ /a
Expected reduction of accounted water amount	1.952 m ³ /a
cost savings for water and sewage water	898 €/a

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo kindergarten

Measure name replacement of electric bulbs

Measure description

basic data:

amount of electric bulbs 50 pieces
 installed electrical power 0,0600 kW per piece
 new electrical power 0,007 kW per piece
 hour of operation 1.200 hours per year

investment costs

No.	Description	unit	amount	price p.u.	total price
1	replacement of electric bulbs	piece	50	3,50	175 €
Sum:					175 €

Savings

reduction of installed electrical power 0,0530 kW per piece
 reduction of installed electrical power 2,6500 kW total

Savings electrical energy 3.180 kWh/a

792 kg CO2 / a

cost savings 159 €/a

payback time for investment 1,10 years

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo kindergarten

Measure name	Insulation of upper ceiling
Measure description	The upper ceiling against the unheated loft is unisolated. It should have been isolated with a poured isolation so that resulting U-value is appr. 0,15 W/m²K

basic data

area of ceiling	427 m²
existing U-value	1,25 W/m²K
utilisation ratio of heat boiler	0,65
factor for restrained heating	0,7
Existing heat demand from transmission	48.284 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price
1	Refurbishment of upper ceiling as standard refurbishment	m²	427	23 €	9.821 €
Sum:					9.821 €

Savings by optimization

new U-Value	0,15 W/m²K	
Heat demand from Transmission after isolation	5.794 kWh/a	
Heat demand savings	42.490 kWh/a	18.653 kg CO2 / a
cost savings	329 €/a	
Pay back time of measure	30 a	

MunEM Suitable energy management on municipal level
Measures catalogue for Mamonovo kindergarten

Measure name	replacement of windows
Measure description	The school is equipped with windows from the construction year of the building. The windows are partly defective and have reached the end of their technical live time. The windows have to be replaced by reasons of maintenance. This necessary measure has to be executed in a energetically optimized way. The U-value has to be reduced compared to a standard execution of the measure

basic data

area of windows	202 m ²
existing U-value	5,6 W/m ² K
U-value in case of standard refurbishment	1,8 W/m ² K
utilisation ratio of heat boiler	0,65
factor for restrained heating	0,7
Heat demand from transmission by standard refurbishment	32.892 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price standard measure	additional costs for energetially optimisation
1	Replacement of windows as a complete performance with all axillary services	m ²	202	155 €	31.310 €	
2	Additional effort for improvment of U-Value in glazing and Frame	m ²	202	15 €		3.030 €
Sum:					31.310 €	3.030 €

Savings by optimization

optimized U-Value	1,2 W/m ² K
Heat demand from Transmission by optimized refurbishment	11.486 kWh/a
Heat demand savings	21.406 kWh/a
cost savings	166 €/a
	9.397 kg CO2 / a

6.3 Measures catalogue for Svetly School

MunEM Suitable energy management on municipal level												
measures catalogue for:												
Svetly school												
Measure Cat.	No.	Description	cost of basic-measure	costs of energy saving measure	savings			efficiency				
					kWh el / a	kWh therm / a	m³/a	€/a	kg CO2 / a	amortization time a	€ invest/ kg CO2 a	
A	A.1	energy saving project		30 €	6.000	54.661	0	2.104	18.548	0,0	0,00	
	A.2	adjustment of heat controlling system to avoid heat consumption in summer		6 €		30.221		997	9.429	0,0		
B	B.1	replacement of existing lighting fixture in sports hall		2.400 €	7.272			364	1.811	6,6	1,33	
	B.2	ΔT-Controlling unit for heat water pumps		5.000 €	6.570	0	0	329	1.636	15,2	3,06	
C	C.1	replacement of windows	197.625 €	19.125 €		92.444		3.051	23.019	6,3	0,83	
	C.2	Insulation of external walls	29.371 €	6.385 €	0	15.808	0	522	3.936	12,2	1,62	
	C.3	Insulation of roof	52.946 €	11.510 €	0	42.745	0	1.411	10.643	8,2	1,08	
Sum Measures energy management				44.456 €	19.842	235.878	0	8.776 €	69.022	5,1	0,64	

MunEM Suitable energy management on municipal level
Measures catalogue for Svetly school

basic data for building

total heated area 5.548 m²

Basic data for calculation of economic efficiency

yearly heat demand 1.093.220 kWh/a

yearly electricity demand 120.000 kWh/a

yearly accouted water demand 4.129 m³/a

electricity average price 0,05 €/kWh

heat price 0,033 €/kWh applicable

price natural gas €/kWh Hu not applicable

coal price €/kWh not applicable

price potable water 0,3 €/m³

sewage water price 0,16 €/m³

hour rate own personnel 3 €/h

CO2 emisssions

Electricity 647 kg/MWh

heat 312 kg/MWh

natural gas 249 kg/MWh

LFO 303 kg/MWh

coal 439 kg/MWh

MunEM Suitable energy management on municipal level
Measures catalogue for Svetly school

Measure name	energy saving project
Measure description	Execution of a school project about "energy saving". Target of the project is to reduce the user dependent part of energy demand. Experiences show that the users can save up to 10% of energy demand by changing their behavior

basic data:

yearly heat demand	1.093.220 kWh/a
yearly electricity demand	120.000 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price
1	effort for organisation of project	hours	10	3 €	30 €
Sum:					30 €

Savings

Expected savings by changing user behavior	5%	
Expected heat energy savings by changing user behavior	54.661 kWh/a	17.054 kg CO2 / a
Expected electricity savings by changing user behavior	6.000 kWh/a	1.494 kg CO2 / a
cost savings	2.104 €/a	Total 18.548 kg CO2 / a

MunEM Suitable energy management on municipal level
Measures catalogue for Svetly school

Measure name replacement of existing lighting fixture in sports hall

Measure description The sports hall is equipped with lighting fixtures with 2x 65W installed electrical power. Including control gear the total electrical power has got a value of 156 W per piece. The equipment has reached the end of its lifetime and has to be replaced by modern lighting fixtures with electronic control gears with much lower installed electrical power by same light output. The measure can be financed by cost savings within the technical lifetime of new equipment.

basic data:

amount of lighting fixtures 48 pieces

installed electrical power 0,1560 kW per piece

new electrical power 0,055 kW per piece

hour of operation 1.500 hours per year

investment costs

No.	Description	unit	amount	price p.u.	total price
1	replacement of lighting fixtures	piece	48	50 €	2.400 €
Sum:					2.400 €

Savings

reduction of installed electrical power 0,1010 kW per piece

reduction of installed electrical power 4,8480 kW total

Savings electrical energy 7.272 kWh/a 1.811 kg CO2 / a

cost savings 364 €/a

payback time for investment 7 years

MunEM Suitable energy management on municipal level
Measures catalogue for Svetly school

Measure name	ΔT-Controlling unit for heat water pumps
Measure description	The heat water pumps in the hot water heating system are without any control and regulation system. With the installation of an delta T control unit an operation adjusted to the need will be possible. This will save electrical energy.

basic data:

installed electrical power of pumps	1,5 kW
annual operation time	8.760 h/a
total electricity demand	13.140 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price
1	Installation of delta T controlling unit for heat water pump	lump sum	1	5.000 €	5.000 €
Sum:					5.000 €

savings

saving of electrical energy for pumping operation	50%	
new annual consumption of electrical energy	6.570 kWh/a	
savings of electrical energy	6.570 kWh/a	
cost savings	329 €/a	1.636 kg CO2 / a
payback time for investment	15 years	

MunEM Suitable energy management on municipal level
Measures catalogue for Svetly school

Measure name replacement of windows

Measure description The school is equipped with windows from the construction year of the building. The windows are partly defective and have reached the end of their technical live time. The windows have to be replaced by reasons of maintenance. This necessary measure has to be executed in a energetically optimized way. The U-value has to be reduced compared to a standard execution of the measure

basic data

area of windows 1.275 m²

existing U-value 5,6 W/m²K

U-value in case of standard refurbishment 1,8 W/m²K

utilisation ratio of heat exchanger 0,95

factor for restrained heating 0,7

Heat demand from transmission by standard refurbishment 142.048 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price standard measure	additional costs for energetically optimisation
1	Replacement of windows as a complete performance with all axillary services	m ²	1.275	155 €	197.625 €	
2	Additional effort for improvment of U-Value in glazing and Frame	m ²	1.275	15 €		19.125 €
Sum:					197.625 €	19.125 €

Savings by optimization

optimized U-Value 1,2 W/m²K

Heat demand from Transmission by optimized refurbishment 49.604 kWh/a

Heat demand savings 92.444 kWh/a 23.019 kg CO₂ / a

cost savings 3.051 €/a

MunEM Suitable energy management on municipal level
Measures catalogue for Svetly school

Measure name	Insulation of external walls
Measure description	The external walls are in a bad condition and have to be renovated. The renovation has to be combined with a insulation of walls. This necessary measure has to be executed in a energetically optimized way. The U-value has to reduced compared to a standard execution of the measure

basic data

area of fassade	1277 m ²
existing U-value	1,25 W/m ² K
U-value in case of standard refurbishment	0,45 W/m ² K
utilisation ratio of heat exchanger	0,95
factor for restrained heating	0,7
Heat demand from transmission by standard refurbishment	35.568 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price standard measure	additional costs for energetically optimisation
1	Refurbishment of external walls as standard refurbishment	m ²	1.277	23 €	29.371 €	
2	Additional effort for improvement of U-Value	m ²	1.277	5 €		6.385 €
Sum:					29.371 €	6.385 €

Savings by optimization

optimized U-Value	0,25 W/m ² K
Heat demand from Transmission by optimized refurbishment	19.760 kWh/a
Heat demand savings	15.808 kWh/a
	3.936 kg CO2 / a
cost savings	522 €/a
Pay back time of optimization	12 a

MunEM Suitable energy management on municipal level
Measures catalogue for Svetly school

Measure name	Insulation of roof
Measure description	The roof is in a bad condition and have to be renovated. The renovation has to be combined with a insulation of roof. This necessary measure has to be executed in a energetically optimized way. The U-value has to reduced compared to a standard execution of the measure

basic data

area of roof	2302 m ²
existing U-value	1,00 W/m ² K
U-value in case of standard refurbishment	0,45 W/m ² K
utilisation ratio of heat exchanger	0,95
factor for restrained heating	0,7
Heat demand from transmission by standard refurbishment	64.117 kWh/a

investment costs

No.	Description	unit	amount	price p.u.	total price standard measure	additional costs for energetically optimisation
1	Refurbishment of roof as standard refurbishment	m ²	2.302	23 €	52.946 €	
2	Additional effort for improvement of U-Value	m ²	2.302	5 €		11.510 €
Sum:					52.946 €	11.510 €

Savings by optimization

optimized U-Value	0,15 W/m ² K
Heat demand from Transmission by optimized refurbishment	21.372 kWh/a
Heat demand savings	42.745 kWh/a
	10.643 kg CO2 / a
cost savings	1.411 €/a
Pay back time of optimization	8 a