



**PERMANENT
M&V Plan for
Energy Efficiency Project in A High School
*In Bulgaria***

Developed within the project Performance Risk Management for Energy Efficiency through
Training – PERMANENT – IEE/08/657/SI2.528420

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Hristo Enchev, EEE

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1. Situation

A 7 544 m² high school in Bulgaria was retrofitted with new windows, wall roof and pipe insulation, new heating valves and outdoor temperature control of the heating system. Before retrofit the building was unable to maintain comfortable indoor conditions in winter. The retrofits themselves will enable proper indoor temperatures to be maintained. The resultant higher indoor temperatures will increase the energy requirements, partially offsetting the savings of the retrofits.

2. M&V Option Selection

IPMVP Volume I, EVO 10000 – 1:2010, Option D, Calibrated Simulation was selected because baseline energy data was not available. Normal indoor temperatures would be an appropriate set of baseline conditions, but the school was not operated this way before retrofit. Therefore there was no utility information for the school operating with normal indoor temperatures. The “Baseline” condition had to be modeled by computer simulation.

3. Basis For Adjustment

Normalized savings will be reported for the first year after retrofit under long term average weather and 2005 occupancy conditions.

4. Simulation Approach

Whole facility energy simulations will be calibrated using actual diesel fuel and electricity data for the school. Electricity data comes directly from utility bills. Diesel fuel quantities before retrofit come from both shipment records and monthly oil inventory estimates for the underground tank. After retrofit diesel fuel quantities come from a diesel flow meter.

The simulation will be performed by Mr xxxx, long experienced in the use of ENSI® Key Number Software v7.12. He will assemble key facts about the building for the simulation.

Simulations already prepared while preparing this M&V Plan are shown in the Appendix. Key facts are summarized below.

Savings will be reported relative to the energy use of a school that is not under-heated. The baseline for this situation was created by:

1. Preparing an actual “Condition Model” of the school building and its operations in 2005, using long term average weather, and recognizing there was under-heating of the school.
2. Modifying the Condition Model until it came within 648 kWh of the actual 889 652 kWh of energy use for 2005 (after correcting 2005 heating data for degree day differences with the long term average). The difference of less than 0.1% was excellent. This modified Condition Model was called the “Calibrated Condition Model.” All input and output data is in the Appendix.
3. Adjusting the Calibrated Condition Model to assume proper heating of the school. This adjustment brought school energy up by 217 700 kWh, to 1 108 000 kWh, a 24% increase. The input and output data of this “Baseline Model” is in the Appendix.

As part of the retrofit planning, the Baseline Model was rerun with each of the proposed retrofits added in sequence. The input and output data of this “Retrofit Model” was documented, showing a total post retrofit energy requirement of 490 412 kWh. The savings predicted for each retrofit were determined by comparing progressive Retrofit Models against the Baseline Model, and are shown in Table 1.

Table 1. Predicted Savings

	ECM	Annual Savings (kWh)
M1	Insulation of walls	222 517
M2	New PVC windows	147 486
M3	Insulation of roof	176 364
M4	Automatic control of heating supply temperature, and insulation of pipes	71 221
	Total	617 588

A year after retrofit, the validity of the predicted savings in Table 1 will be assessed by:

- a) Creating a “**Post-Retrofit Condition Model**,” reflecting the retrofits as actually implemented, current occupancy and weather, and any other changes made to the school.
- b) Comparing the Post Retrofit Condition Model to actual measured energy use over the first year after retrofit, and modifying the model until it is reasonably close to measured data. The modified simulation is called the “**Calibrated Post-Retrofit Condition Model**.”
- c) Modifying the Calibrated Post-Retrofit Condition Model to 2005 occupancy and long term weather. The resultant “**After ENCON Model**” will be compared to the **Retrofit Model** of Step 3 above, to assess how well actual results compare to predicted results.
- d) Modifying the *predicted* savings shown in Table 1 to reflect the total differences found in step c). The allocation of excesses or shortfalls to the individual retrofits will be justified and the final numbers reported for each retrofit as the Achieved Normalized Savings.

5. Marginal Price

The school’s diesel supply contract has a marginal unit price of 1.87 BGN/l including VAT, or 0.19 BGN/kWh.

6. Accuracy

The accuracy of the savings report will be determined when conducting step c), described in Section 3, above.

7. M&V Budget

The owner required the development of a notional baseline and predicting of savings in Table 1, before deciding to proceed with the project. Therefore the only M&V effort was in preparing this M&V Plan and the actions a) through d) shown in Section 3, above. The engineering services for determining the achieved Normalized Savings will cost 10 000 lev

Key Number Software Computer Screens

Project name	Permanent SOU Vasil Levski
Country	Bulgaria
Climatic data	Clim. zone 3 - Ruse, Vidin
Reference building	School
Reference conditions	1987 r.
Holiday table	School
<input checked="" type="checkbox"/> Detailed calculations	

Settings - climatic data		Settings - reference data		Settings - holiday data			
Building data		Heating		Domestic hot water			
Country	България	U - wall	W/m ² K	1,00	Sanitary installations	l/m ²	0,0
Reference building	Училище	U - window	W/m ² K	2,65	Kitchen	l/m ²	0,0
Condition	1987 r.	U - roof	W/m ² K	0,60	Distribution losses	%	5,0
h/day with setback	8,0	U - floor	W/m ² K	0,30	Autom. contr. - modern	%	97,0
External wall	m ² 3 129	Total solar gain		0,54	Autom. control - poor	%	94,0
Total window area	m ² 1 517	Infiltration	1/h	0,50	Autom. control - man.	%	92,0
Window area north	m ² 320	Indoor temperature	°C	18,5	O & M / EM	%	96,0
Window area east	m ² 465	Setback temperature	°C	13,5	Energy supply efficiency	%	89,0
Window area south	m ² 379	Distribution losses	%	5,0	Simultaneous power	W/m ²	8,00
Window area west	m ² 353	Autom. contr. - modern	%	97,0	Lighting		
Roof area	m ² 2 722	Autom. control - poor	%	94,0	Operation period	h/week	30,0
Floor area	m ² 2 722	Autom. control - man.	%	92,0	Simultaneous power	W/m ²	1,0
Heated area	m ² 7 544	O & M / EM	%	96,0	Fans and pumps		
Gross volume	m ³ 31 364	Energy supply efficiency	%	89,0	Operation period	h/week	40,0
Net heated volume	m ³ 29 757	Window area	%	20,1	Fans, power	W/m ²	0,30
Thermal capacity	Medium	Ventilation			Pumps ventilation	W/m ²	0,00
Form - factor	0,32	Operation period	h/week	0,0	Pumps heating	W/m ²	0,00
		Ventilation rate	m ³ /m ² h	0,00	Pumps cooling	kWh/m ²	0,0
		Supply temperature	°C	18,5	O & M / EM	%	96,0
		Heat recovery	%	0,0	Various exploitable		
		Autom. contr. - modern	%	97,0	Operation period	h/week	40,0
		Autom. control - poor	%	94,0	Simultaneous power	W/m ²	1,80
		Autom. control - man.	%	92,0	Various unexploitable		
		Humidification	%	0,0	Operation period	h/week	40,0
		O & M / EM	%	96,0	Simultaneous power	W/m ²	0,20
		Energy supply efficiency	%	89,0	Persons		
					Number		590

Settings - climatic data Settings - reference data Settings - holiday data

Climatic data Clim. zone 3 - Ruse, Vidin

Clim. zone 3 - Ruse, Vi Solar Radiation W/m²

	Tavg °C	Horizonta	North	East	South	West
January	0,1	45,5	21,2	36,8	66,3	36,8
February	0,0	77,6	33,5	56,9	93,0	56,9
March	5,9	105,9	46,2	67,0	87,1	67,0
April	12,5	147,1	62,4	84,3	83,8	84,3
May	17,4	191,6	76,8	106,9	90,2	106,9
June	21,4	215,4	83,4	120,4	96,7	120,4
July	24,0	223,8	82,7	124,9	104,7	124,9
August	23,4	217,0	74,5	125,2	127,9	125,2
September	19,2	164,0	58,7	104,1	136,5	104,1
October	13,3	93,9	38,9	66,6	104,3	66,6
November	6,7	54,0	24,4	42,8	75,8	42,8
December	0,8	39,1	18,4	32,6	60,3	32,6

Heating season

DOT -17,0 Start month 10 Stop month 4

Start day 23 Stop day 15

Exit

Settings - climatic data Settings - reference data Settings - holiday data

School

Holidays per month

January	3	July	23
February	0	August	22
March	1	September	11
April	9	October	0
May	3	November	1
June	10	December	7

Saturdays and Sundays are weekends

School

Heated area	m ²	<input type="text" value="7 544"/>	External wall	m ²	<input type="text" value="3 129"/>
Gross volume	m ³	<input type="text" value="31 364"/>	Total window area	m ²	<input type="text" value="1 517"/>
Net heated volume	m ³	<input type="text" value="29 757"/>	Roof area	m ²	<input type="text" value="2 722"/>
Thermal capacity		<input type="text" value="Medium"/>	Floor area	m ²	<input type="text" value="2 722"/>

Number of persons		<input type="text" value="590"/>
Occupancy schedule h/day		
Weekday h/day	<input type="text" value="8"/>	
Saturday h/day	<input type="text" value="0"/>	
Sunday h/day	<input type="text" value="0"/>	
Heating schedule h/day		
Weekday h/day	<input type="text" value="8"/>	
Saturday h/day	<input type="text" value="0"/>	
Sunday h/day	<input type="text" value="0"/>	

External walls and windows

North	Northeast	East	Southeast	South	Southwest	West	Northwest	Roof	Floor
Opaque parts		Windows							
A	U	A	U	g	n				
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-	-				
877,31	1,64	143,82	2,63	0,51	1				
87,45	2,67	88,31	2,63	0,59	1				
		57,07	2,63	0,51	1				
		31,05	6,66	0,59	1				
Total facade area									
1 285,01	[m ²]								
Opaque parts		Transparent parts							
A (net)	U (equiv)	A (net)	U (equiv)	g (equiv)					
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-					
964,76	1,73	320,25	3,02	0,54					
After ENCON									
877,31	0,49	143,82	2,00	0,51	1				
87,45	0,48	88,31	2,00	0,51	1				
		57,07	2,00	0,51	1				
		31,05	2,00	0,51	1				
A (net)	U (equiv)	A (net)	U (equiv)	G (equiv)					
964,76	0,49	320,25	2,00	0,51					

North	Northeast	East	Southeast	South	Southwest	West	Northwest	Roof	Floor
Opaque parts		Windows							
A	U	A	U	g	n				
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-	-				
563,36	1,64	203,40	2,63	0,51	1				
46,91	2,67	7,88	5,88	0,59	1				
3,20	2,63	32,48	2,63	0,51	1				
		220,74	6,66	0,59	1				
Total facade area									
1 077,97		[m ²]							
Opaque parts		Transparent parts							
A (net)	U (equiv)	A (net)	U (equiv)	g (equiv)					
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-					
613,47	1,72	464,50	4,60	0,55					
After ENCON									
563,36	0,49	203,40	2,00	0,51	1				
46,91	0,48	7,88	2,00	0,51	1				
3,20	2,00	32,48	2,00	0,51	1				
		220,74	2,00	0,51	1				
A (net)	U (equiv)	A (net)	U (equiv)	G (equiv)					
613,47	0,50	464,50	2,00	0,51					

North	Northeast	East	Southeast	South	Southwest	West	Northwest	Roof	Floor
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Opaque parts		Windows			
A	U	A	U	g	n
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-	-
828,84	1,64	338,98	2,63	0,51	1
46,71	2,67	40,32	2,63	0,51	1
Total facade area					
1 254,85 [m ²]					
Opaque parts		Transparent parts			
A (net)	U (equiv)	A (net)	U (equiv)	g (equiv)	
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-	
875,55	1,69	379,30	2,63	0,51	
After ENCON					
828,84	0,49	338,98	2,00	0,51	1
46,71	0,48	40,32	2,00	0,51	1
A (net)	U (equiv)	A (net)	U (equiv)	G (equiv)	
875,55	0,49	379,30	2,00	0,51	

North	Northeast	East	Southeast	South	Southwest	West	Northwest	Roof	Floor
-------	-----------	------	-----------	-------	-----------	------	-----------	------	-------

Opaque parts		Windows			
A	U	A	U	g	n
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-	-
623,77	1,64	189,54	2,63	0,51	1
51,48	2,67	27,29	2,63	0,51	1
		136,26	6,66	0,59	1
Total facade area					
1 028,34 [m ²]					
Opaque parts		Transparent parts			
A (net)	U (equiv)	A (net)	U (equiv)	g (equiv)	
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-	
675,25	1,72	353,09	4,19	0,54	
After ENCON					
623,77	0,49	189,54	2,00	0,51	
51,48	0,48	27,29	2,00	0,51	
		136,26	2,00	0,51	
A (net)	U (equiv)	A (net)	U (equiv)	G (equiv)	
675,25	0,49	353,09	2,00	0,51	

Floor

North	Northeast	East	Southeast	South	Southwest	West	Northwest	Roof	Floor
-------	-----------	------	-----------	-------	-----------	------	-----------	------	-------

Floor data			
Before ENCON		After ENCON	
A	U	A	U
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]
2 722,0	0,40	2 722,0	0,40

Roof

North	Northeast	East	Southeast	South	Southwest	West	Northwest	Roof	Floor
-------	-----------	------	-----------	-------	-----------	------	-----------	------	-------

Opaque parts		Windows				
A	U	A	U	g	Declination	
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-	deg	
1 115,0	2,49					North
1 607,0	1,02					East
						South
						West
						NE/NW
						SE/SW

Total roof area	
2 722,00	[m ²]

Opaque parts		Transparent parts		
A (net)	U (equiv)	A (net)	U (equiv)	g (equiv)
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-
2 722,00	1,62			

After ENCON					
A	U	A	U	g	Declination
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-	deg
1 115,0	0,52				North
1 607,0	0,49				East
					South
					West
					NE/NW
					SE/SW

A (net)	U (equiv)	A (net)	U (equiv)	G (equiv)
[m ²]	[W/m ² K]	[m ²]	[W/m ² K]	-
2 722,00	0,50			

Fans and Lighting

Parameter	Reference	Condition	Baseline	Sensitivity	kWh/m ² y	ENCON measure	After ENCON
4. Fans and pumps		0,4	kWh/m²y				
Operation period	40 h/week	40	40	+5 h/week = 0,04		40	
Fans	0,3 W/m ²	0,3	0,3	+1 W/m ² = 1,17		0,3	
Pumps ventilation	0,0 W/m ²	0,00	0,00	+1 W/m ² = 1,04		0,00	
Pumps heating	0,0 W/m ²	0,00	0,00	+1 W/m ² = 4,35		0,00	
Pumps cooling	0,0 kWh/m ² y	0,00	0,00			0,00	
Sum 1	kWh/m²y	0,3	0,3			0,3	
O & M / EM	96 %	96,0	96,0			96,0	
4. Fans and pumps corrected	kWh/m²y	0,4	0,4			0,4	
5. Lighting		1,6	kWh/m²y				
Utilisation period	30 h/week	30	30	+1 h/week = 0,05		30	
Simultaneous power	1,00 W/m ²	1,00	1,00	+1 W/m ² = 1,56		1,00	
5. Lighting corrected	kWh/m²y	1,6	1,6			1,6	

Miscellaneous electrical equipment generating (“exploitable”) internal heat gain.

Parameter	Reference	Condition	Baseline	Sensitivity	kWh/m ² y	ENCON measure	After ENCON
6.1 Various exploitable		3,8	kWh/m²y				
Utilisation period	40 h/week	40	40	+5 h/week = 0,47		40	
Simultaneous power	1,80 W/m ²	1,80	1,80	+1 W/m ² = 2,09		1,80	
6.1 Various ex. corrected	kWh/m²y	3,8	3,8			3,8	
6.2 Various unexploitable		0,4	kWh/m²y				
Utilisation period	40 h/week	40	40	+5 h/week = 0,01		40	
Simultaneous power	0,20 W/m ²	0,20	0,20	+1 W/m ² = 2,09		0,20	
6.2 Various unex. corrected	kWh/m²y	0,4	0,4			0,4	

Three terms are used to describe the various simulations:

- “**Condition**” describes the existing situation in the building in 2005
- “**Baseline**” describes the building as if indoor conditions were acceptable
- “**After ENCON**” shows energy consumption after implementation of the energy conservation retrofits.

Actual Condition - Calibration:

Parameter	Reference	Condition	Baseline	Sensitivity	kWh/m ² y	ENCON measure	After ENCON
1. Heating		74,1 kWh/m²y					
U - wall	1,00 W/m ² K	1,72 >	1,72	+ 0,1 W/m ² K = 2,61	1,72	>	
U - window	2,65 W/m ² K	3,68 >	3,68	+ 0,1 W/m ² K = 1,26	3,68	>	
U - roof	0,60 W/m ² K	1,62 >	1,62	+ 0,1 W/m ² K = 2,27	1,62	>	
U - floor	0,30 W/m ² K	0,40 >	0,40	+ 0,1 W/m ² K = 2,27	0,40	>	
Form - factor	0,32 -	0,32	0,32		0,32		
Window area	20,1 %	20,1	20,1		20,1		
Total solar gain	0,54 -	0,54 >	0,54		0,54	>	
Infiltration	0,50 1/h	0,56	0,56	+ 0,1 1/h = 8,44	0,56		
Indoor temperature	18,5 °C	12,7	12,7	+ 1 °C = 3,47	12,7		
Setback temperature	13,5 °C	12,7	12,7	+ 1 °C = 12,66	12,7		
Contribution from							
Ventilation	kWh/m ² y	0,00 ...	0,00 ...		0,00 ...		
Lighting	kWh/m ² y	0,42 ...	0,42 ...		0,42 ...		
Various equipment	kWh/m ² y	1,02 ...	1,02 ...		1,02 ...		
Sum 1	kWh/m²y	81,4	81,4		81,4		
Distribution losses	5,0 %	8,1	8,1		8,1		
Automatic control	97,0 %	Manual	Manual	Poor +3 %, Manual +5 %	Manual		
Sum 2	kWh/m²y	96,3	96,3		96,3		
O & M / EM	96,0 %	96,0	96,0		96,0		
Sum 3	kWh/m²y	100,3	100,3		100,3		
Energy supply efficiency	89,0 %	85,0	85,0		85,0		
1. Heating corrected	kWh/m²y	118,0	118,0		118,0		

Energy Budget | Power Budget | ENCON Measures | ET curve | Annual consumption

Project

Permanent СОУ Васил Левки

Reference building Училище

Reference conditions 1987 г.

Climatic zone Клим. зона 3 - Русе, Видин

Heating season 23.10 - 15.4

Budget item	Reference kWh/m ²	Baseline before ENCON		After ENCON	
		kWh/m ²	kWh/y	kWh/m ²	kWh/y
1. Heating	74,1	118,0	890 300	118,0	890 300
2. Ventilation	0,0	0,0	0	0,0	0
3. DHW	0,0	0,0	0	0,0	0
4. Fans and pumps	0,4	0,4	2 646	0,4	2 646
5. Lighting	1,6	1,6	11 801	1,6	11 801
6. Various	4,2	4,2	31 469	4,2	31 469
7. Cooling	0,0	0,0	0	0,0	0
Total	80,1	124,1	936 217	124,1	936 217
8. Outdoor			0		0

Baseline Model

The school is under-heated, so to create the Baseline Model indoor temperature is adjusted upwards. As a result the energy consumption for heating increases.

Parameter	Reference	Condition	Baseline	Sensitivity	kWh/m ² y	ENCON measure	After ENCON
1. Heating		74,1 kWh/m²y					
U - wall	1,00 W/m ² K	1,72 >	1,72	+ 0,1 W/m ² K = 2,61	1,72	>	
U - window	2,65 W/m ² K	3,68 >	3,68	+ 0,1 W/m ² K = 1,26	3,68	>	
U - roof	0,60 W/m ² K	1,62 >	1,62	+ 0,1 W/m ² K = 2,27	1,62	>	
U - floor	0,30 W/m ² K	0,40 >	0,40	+ 0,1 W/m ² K = 2,27	0,40	>	
Form - factor	0,32 -	0,32	0,32		0,32		
Window area	20,1 %	20,1	20,1		20,1		
Total solar gain	0,54 -	0,54 >	0,54		0,54	>	
Infiltration	0,50 1/h	0,56	0,56	+ 0,1 1/h = 8,44	0,56		
Indoor temperature	18,5 °C	12,7	18,5	+ 1 °C = 3,47	18,5		
Setback temperature	13,5 °C	12,7	13,5	+ 1 °C = 12,66	13,5		
Contribution from							
Ventilation	kWh/m ² y	0,00 ...	0,00 ...		0,00 ...		
Lighting	kWh/m ² y	0,42 ...	0,50 ...		0,50 ...		
Various equipment	kWh/m ² y	1,02 ...	1,20 ...		1,20 ...		
Sum 1	kWh/m²y	81,4	101,3		101,3		
Distribution losses	5,0 %	8,1	8,1		8,1		
Automatic control	97,0 %	Manual	Manual	Poor +3 %, Manual +5 %	Manual		
Sum 2	kWh/m²y	96,3	119,8		119,8		
O & M / EM	96,0 %	96,0	96,0		96,0		
Sum 3	kWh/m²y	100,3	124,8		124,8		
Energy supply efficiency	89,0 %	85,0	85,0		85,0		
1. Heating corrected	kWh/m²y	118,0	146,9		146,9		

Energy Budget	Power Budget	ENCON Measures	ET curve	Annual consumption
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Project
Permanent COУ Васил Левки

Reference building Училище
 Reference conditions 1987 г.
 Climatic zone Клим. зона 3 - Русе, Видин
 Heating season 23.10 - 15.4

Budget item	Reference kWh/m ²	Baseline before ENCON		After ENCON	
		kWh/m ²	kWh/y	kWh/m ²	kWh/y
1. Heating	74,1	146,9	1 108 000	146,9	1 108 000
2. Ventilation	0,0	0,0	0	0,0	0
3. DHW	0,0	0,0	0	0,0	0
4. Fans and pumps	0,4	0,4	2 646	0,4	2 646
5. Lighting	1,6	1,6	11 801	1,6	11 801
6. Various	4,2	4,2	31 469	4,2	31 469
7. Cooling	0,0	0,0	0	0,0	0
Total	80,1	153,0	1 153 916	153,0	1 153 916
8. Outdoor			0		0

After retrofit:

Parameter	Reference	Condition	Baseline	Sensitivity	kWh/m ² y	ENCON measure	After ENCON
1. Heating							
		74,1			kWh/m²y		
U - wall	1,00 W/m ² K	1,72 >	1,72	+ 0,1 W/m ² K = 2,61		0,49 >	-29,50
U - window	2,65 W/m ² K	3,68 >	3,68	+ 0,1 W/m ² K = 1,26		2,00 >	-19,55
U - roof	0,60 W/m ² K	1,62 >	1,62	+ 0,1 W/m ² K = 2,27		0,50 >	-23,38
U - floor	0,30 W/m ² K	0,40 >	0,40	+ 0,1 W/m ² K = 2,27		0,40 >	
Form - factor	0,32 -	0,32	0,32			0,32	
Window area	20,1 %	20,1	20,1			20,1	
Total solar gain	0,54 -	0,54 >	0,54			0,51 >	
Infiltration	0,50 1/h	0,56	0,56	+ 0,1 1/h = 8,44		0,56	
Indoor temperature	18,5 °C	12,7	18,5	+ 1 °C = 3,47		18,5	
Setback temperature	13,5 °C	12,7	13,5	+ 1 °C = 12,66		13,5	
Contribution from							
Ventilation	kWh/m ² y	0,00 ...	0,00 ...			0,00 ...	
Lighting	kWh/m ² y	0,42 ...	0,50 ...			0,47 ...	
Various equipment	kWh/m ² y	1,02 ...	1,20 ...			1,13 ...	
Sum 1	kWh/m²y	81,4	101,3			48,2	
Distribution losses	5,0 %	8,1	8,1			6,4	-2,46
Automatic control	97,0 %	Manual	Manual	Poor +3 %, Manual +5 %		Modern	-6,98
Sum 2	kWh/m²y	96,3	119,8			53,0	
O & M / EM	96,0 %	96,0	96,0			96,0	
Sum 3	kWh/m²y	100,3	124,8			55,3	
Energy supply efficiency	89,0 %	85,0	85,0			85,0	
1. Heating corrected	kWh/m²y	118,0	146,9			65,0	

Energy Budget | Power Budget | ENCON Measures | ET curve | Annual consumption

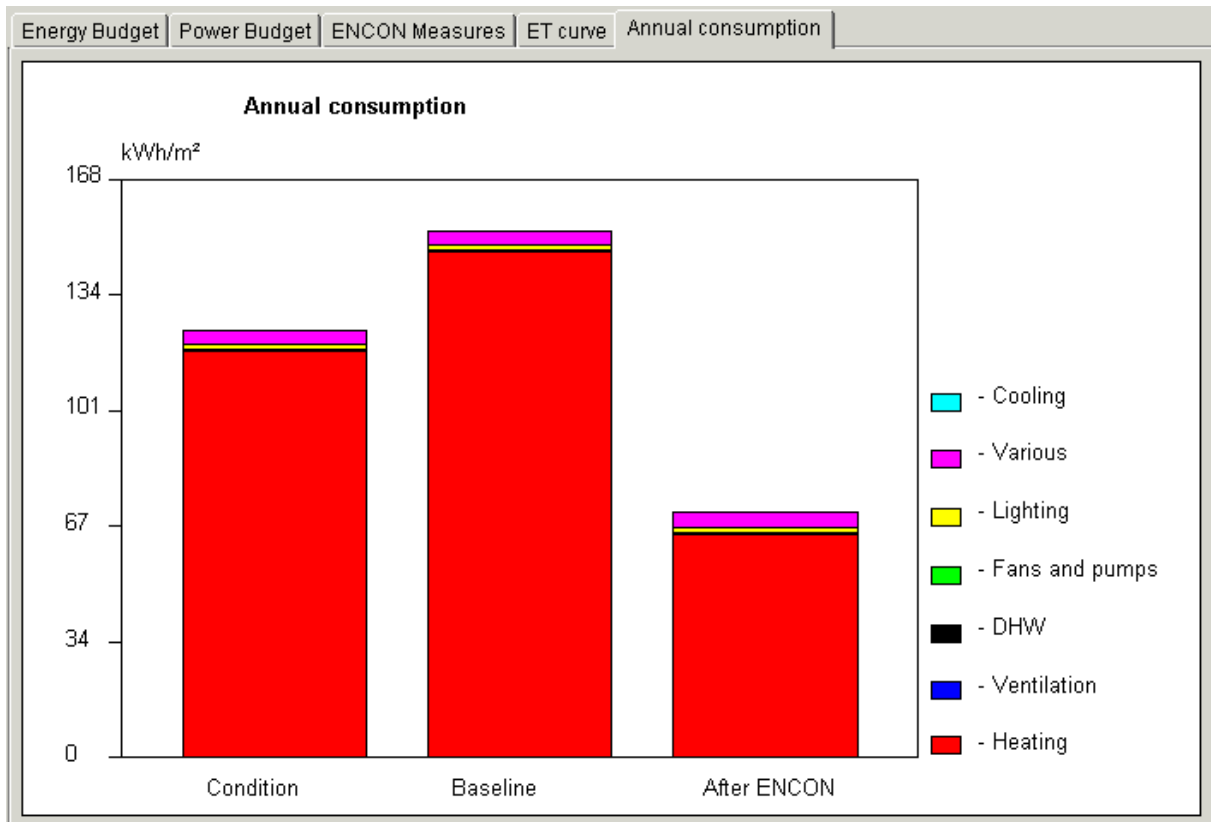
Project
Permanent SOU Vasil Levski

Reference building School
 Reference conditions 1987 r.
 Climatic zone Clim. zone 3 - Ruse, Vidin
 Heating season 23.10 - 15.4

Budget item	Reference kWh/m ²	Baseline before ENCON		After ENCON	
		kWh/m ²	kWh/y	kWh/m ²	kWh/y
1. Heating	74,1	146,9	1 108 000	65,0	490 412
2. Ventilation	0,0	0,0	0	0,0	0
3. DHW	0,0	0,0	0	0,0	0
4. Fans and pumps	0,4	0,4	2 646	0,4	2 646
5. Lighting	1,6	1,6	11 801	1,6	11 801
6. Various	4,2	4,2	31 469	4,2	31 469
7. Cooling	0,0	0,0	0	0,0	0
Total	80,1	153,0	1 153 916	71,1	536 328
8. Outdoor			0		0

Predicted savings from individual retrofits:

Energy Budget	Power Budget	ENCON Measures	ET curve	Annual consumption
Project Permanent COУ Васил Левки		Reference building	Училище	
		Reference conditions	1987 г.	
		Climatic zone	Клим. зона 3 - Русе, Видин	
		Heating season	23.10 - 15.4	
Parameter	kWh/m ²	kWh		
1. Heating: U - wall	-29.50	-222 517		
1. Heating: U - window	-19.55	-147 486		
1. Heating: U - roof	-23.38	-176 364		
1. Heating: Distribution losses	-2.46	-18 556		
1. Heating: Automatic control	-6.98	-52 665		
Total		-81,86	-617 587	



8. Energy Savings Report

Energy Efficiency Project In A High School In Bulgaria

Reporting Period: January 1 - December 31, 2009

Normalized Savings were determined, following the M&V Plan dated February 2, 2008, to be 600 000 kWh, worth 110 000 lev.

These numbers were developed as presented below.

- a) A “**Post-Retrofit Condition Model**,” was assembled reflecting the retrofits as actually implemented, 2009 occupancy and weather, and all other changes made to the school since 2005.
- b) The Post-Retrofit Condition Model was modified until it came close to actual measured energy use after retrofit (499 713 kWh). The final input and output of this “**Calibrated Post-Retrofit Condition Model**” is documented in the files supplied with this report.
- c) Modified the Calibrated Post-Retrofit Condition Model to 2005 occupancy and long term weather. The resultant “**After ENCON Model**” showed a predicted energy use of 491 852 kWh. This result is within 1 440 kWh (0.3%) of the **Retrofit Model** developed in the M&V Plan for the same conditions. The small difference indicates that the actual post retrofit performance matches prediction very well.
- d) Since the post-retrofit performance matches prediction, Achieved Normalized Savings are those shown in Table 1 of the M&V Plan, repeated below:

Achieved Normalized Savings

ECM		Annual Savings (kWh)
M1	Insulation of walls	222 517
M2	New PVC windows	147 486
M3	Insulation of roof	176 364
M4	Automatic control of heating supply temperature, and insulation of pipes	71 221
Total		617 588

At the school’s marginal cost for heating fuel of 0.19 BGN/kWh, the first year’s achieved normalized savings under 2005 occupancy and long term average weather conditions is 117 341 lev.

The energy and cost savings number shown at the top of this report are conservatively rounded down to 2 significant digits.