Serbian Energy Efficiency Project

Public Buildings Retrofit
First phase
Implementation 2005-2006
Expected and Realized Outcomes

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by

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Main Features

- Public sector project with four participating ministries – energy, health, education and social welfare - with involvement of municipalities
- IDA Credit of $21 million supplements and/or complements GoS budget for various building improvement measures
- Stakeholders extend to population – care givers (doctors, nurses, etc), patients, students, teachers, etc.
- Has strong energy saving incentive as wells as pollution abatement flavor
- Tackles energy use principally, but also energy supply at select sites (e.g. Clinical centers)
- Serbian Energy Efficiency Agency (SEEA) and an inter-ministerial PIU carryout implementation
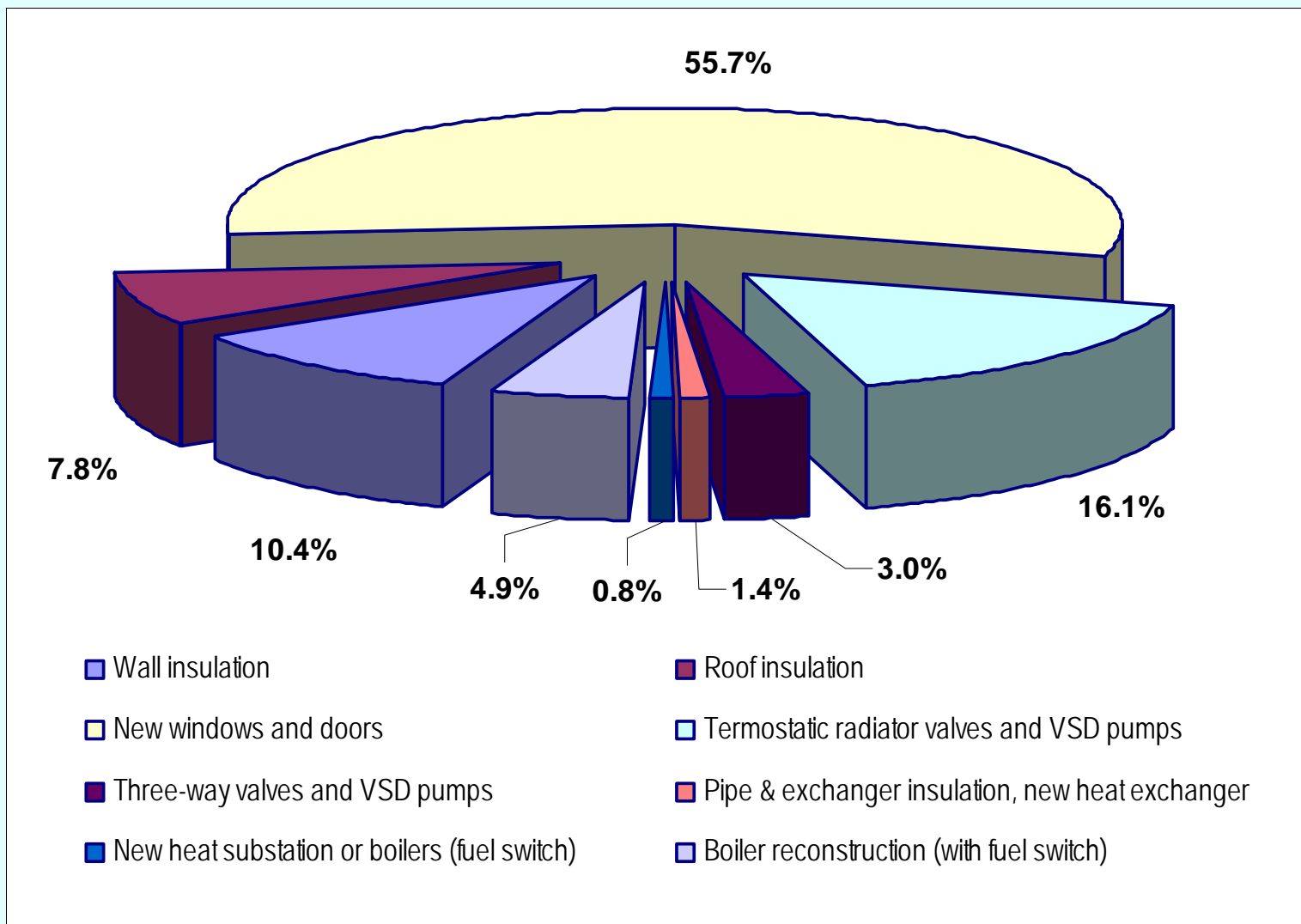
Buildings retrofit summary

- Total number / heated area of buildings in first phase : 27 sites - 11 hospitals and 16 schools covering an area 104,969 m^2

- Total first phase investment approx €3.5 million

- Annual consumption for space heating (MWhe/y)
  - before 27,915 --> after 16,994 **(-39.12%)**
  - **Estimated savings 10,921** MWhe/y $\cong$ **940 toe per year**

- Specific heat consumption for space heating
  - before 266 кWh/m^2/y -> after 162 кWh/ m^2/ y

- CO_{2e} reduction
  - before 7971 t/y - after 4945 t/y **(-38%) = 3026** t/y

- Specific investment
  - Average **34.2** €/m^2 (in range of **19 to 97** €/m^2)

Hospitals - summary

- Total number of hospital buildings: 11 / 50,934 m^2

- Annual heat for space heating (MWhe/y)
  - before 16,747 -> after 10,673 = reduction of **36.3%**

    (before 13,447 -> after 8695 = reduction of 43.8%)

- Specific heat consumption
  - Before **329** кWh/ m^2,y -> after **210** кWh/ m^2,y **(-36.3%)**

- CO$_2$ emission
  - Before 4,668 t/y -> after 3,101 t/year **(-33.6%)**

- Specific investments
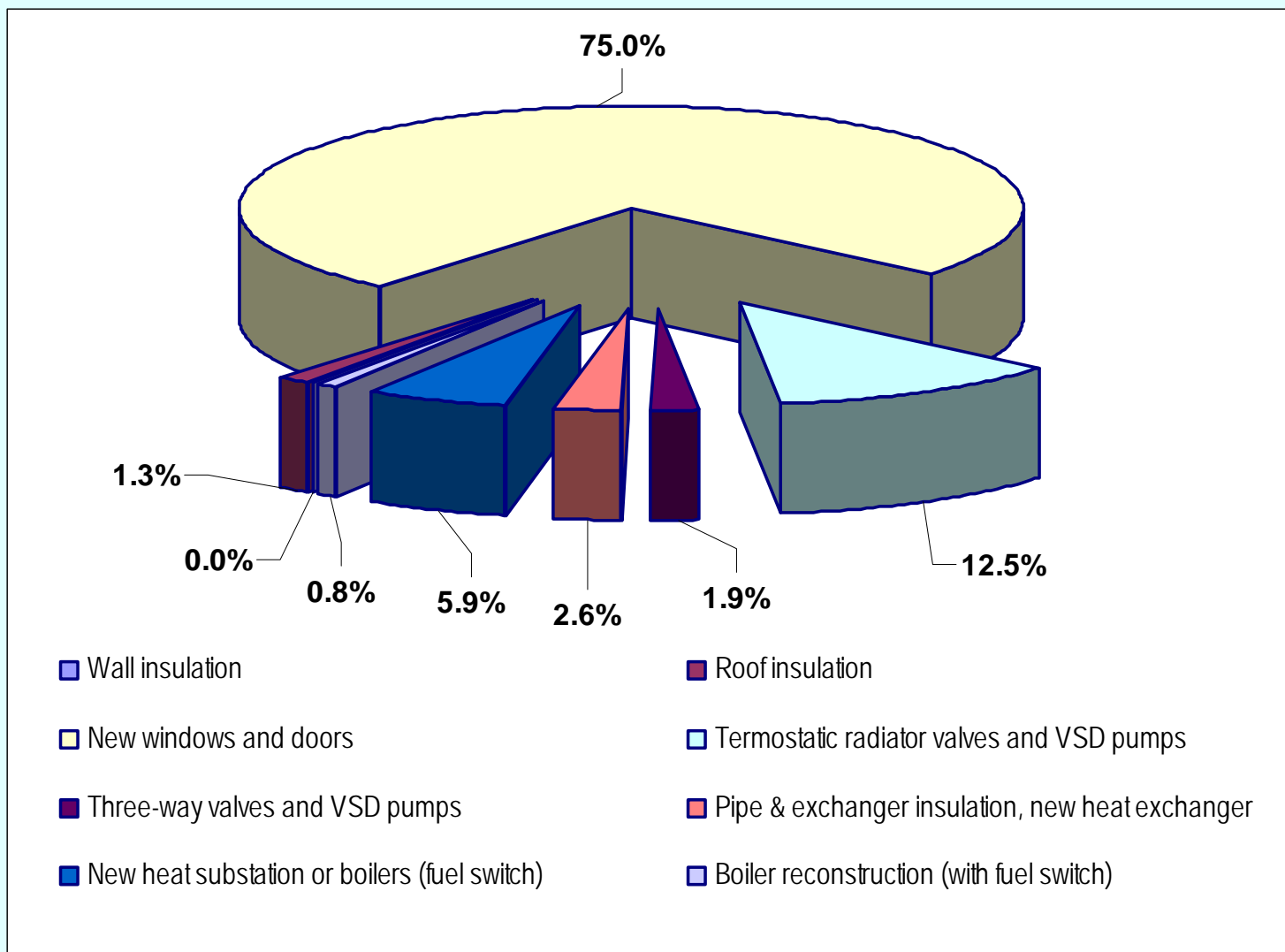 - Average 29.23 €/m^2 ; range 19 to 58.8 €/m^2

Hospitals – Heat saving structure

Pie chart – Heat saving structure:
- 55.7%
- 16.1%
- 3.0%
- 1.4%
- 0.8%
- 4.9%
- 10.4%
- 7.8%

Legend:
- ☐ Wall insulation
- ■ Roof insulation
- ☐ New windows and doors
- ☐ Termostatic radiator valves and VSD pumps
- ■ Three-way valves and VSD pumps
- ■ Pipe & exchanger insulation, new heat exchanger
- ■ New heat substation or boilers (fuel switch)
- ☐ Boiler reconstruction (with fuel switch)

Schools - Summary

- Total number of schools : 16 / 54,035 м^2

- Heat for space heating (MWhe/y)
  - before 11,168 -> after 6,321 **(-43.4%)**

- Average specific heat consumption for space heating
  - before **207** кWh/ m²/y -> after **117** кWh/ м²/y

- CO_2 emission reduction
  - before 3,303 t/y -> after 1,844 t/y **(-44.2%)**

- Specific investments
  - Average **38.8 €/m²** in range **18.1 to 97.4** €/m^2

Schools – Heat saving structure

75.0%

1.3%

0.0%

0.8%

5.9%

2.6%

1.9%

12.5%

- Wall insulation
- Roof insulation
- New windows and doors
- Termostatic radiator valves and VSD pumps
- Three-way valves and VSD pumps
- Pipe & exchanger insulation, new heat exchanger
- New heat substation or boilers (fuel switch)
- Boiler reconstruction (with fuel switch)

Summary results from 4 buildings (completed) - 1

Building		Bačka Palanka School		Čonoplja School		Odžaci School		Senta Hospital	
Heated Area [m²]		4,521		2,066		2,102		3,656	
Annual Degree Hours		49,755		49,997		49,997		64,724	
Annual Degree Days		2,073		2,083		2,083		2,697	
Results		Measuring Results	Evaluation Report	Measuring Results	Evaluation Report	Measuring Results	Evaluation Report	Measuring Results	Evaluation Report
BEFORE	Annual Heating Energy Consumption [MWh]	1008	800	938	559	316	413	1155	1235
BEFORE	Annual Heating Energy Consumption per m² [kWh/m²]	223	177	454	271	150	196	316	338
BEFORE	Annual CO_2 Emission [t]	252	200	281	168	82	107	300	321
AFTER	Annual Heating Energy Consumption [MWh]	596	451	291	306	211	196	714	695
AFTER	Annual Heating Energy Consumption per m² [kWh/m²]	132	100	141	148	100	93	195	190
AFTER	Annual CO_2 Emission [t]	149	113	87	92	55	51	186	181
SAVINGS — Absolute	Annual Heating Energy Consumption [MWh]	412	349	647	253	105	217	441	540
SAVINGS — Absolute	Annual CO_2 Emission [t]	103	87	194	76	27	56	115	140
SAVINGS — In percentage terms	Annual Heating Energy Consumption [MWh]	41%	44%	69%	45%	33%	53%	38%	44%
SAVINGS — In percentage terms	Annual CO_2 Emission [t]	41%	44%	69%	45%	33%	53%	38%	44%

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- Average investment € 125k

- Average annual savings 400 MWhe or € 15k to 20k; very attractive to municipalities

- Simple payback 6 to 8+ years

- Ave annual CO_2 avoided 110 tons or € 650 to 700
  - Cost efficiency of emission reduction 1 ton / 1000 €
  - Too low ERs and high transaction costs for CDM
  - Justifies bundling; programmatic CDM anticipated
  - Combining with supply improvement a better way (e.g. the CCS in Belgrade)

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Secondary School
"Radivoje Uvalić" Bačka Palanka

WORKS COMPLETED

Gross Area	5650 m²
Year of construction	1965/1971
Fuel type	Gas / District Heating
Investment EUR	≅ 130.000

Energy efficiency measures

1. Outer Windows and Doors Replacement on Building with Gym
2. Outer Windows and Doors Replacement on Single floor Building
3. Central Hall Single Glazing Replacement with Double Glazing
4. Piping Insulation
5. Thermostatic Radiator Valves and Variable Flow Pumps Installation

Backka Palanka School - 2

			Measuring Results	Evaluation Report
		Heated Area (m²)	4.521	
		Annual Degree Hours	5.176	
		Results	Measuring Results	Evaluation Report
BEFORE		Annual Heating Energy Consumption (MWh)	835	800
		Annual Heating Energy Consumption per m² (MWh/m²)	185	177
		Annual CO₂ Emission (t)	209	200
AFTER		Annual Heating Energy Consumption (MWh)	596	451
		Annual Heating Energy Consumption per m² (MWh/m²)	132	100
		Annual CO₂ Emission (t)	149	113
SAVINGS	Absolute	Annual Heating Energy Consumption (MWh)	239	349
		Annual CO₂ Emission (t)	60	87
	In percentage terms	Annual Heating Energy Consumption (MWh)	29%	44%
		Annual CO₂ Emission (t)	29%	44%

Conoplja school data -1

Elementary School Čonoplja

WORKS · COMPLETED

Gross Area	2350 m²
Year of construction	1969/1982
Fuel type	Coal
Investment EUR	≅ 100.000

Energy efficiency measures

1. Outer Windows and Doors Replacement
2. Three Way Valve Installation with Controls
3. Installment Venetian blinds in gym
4. Thermostatic Radiator Valves and
   Variable Flow Pumps Installation

Conoplja school data -2

			Measuring Results	Evaluation Report
		Heated Area (m²)	2.066	
		Annual Degree Hours	56.701	
		Results	Measuring Results	Evaluation Report
BEFORE		Annual Heating Energy Consumption (MWh)	1129	559
		Annual Heating Energy Consumption per m² (MWh/m²)	546	271
		Annual CO_2 Emission (t)	339	168
AFTER		Annual Heating Energy Consumption (MWh)	291	306
		Annual Heating Energy Consumption per m² (MWh/m²)	141	148
		Annual CO_2 Emission (t)	87	92
SAVINGS	Absolute	Annual Heating Energy Consumption (MWh)	838	253
		Annual CO_2 Emission (t)	251	76
	In percentage terms	Annual Heating Energy Consumption (MWh)	74%	45%
		Annual CO_2 Emission (t)	74%	45%

Odzaci school data - 1

Elementary School
"Miroslav Antić" Odžaci

Gross Area	2750 m²
Year of construction	1895/1927/1963
Fuel type	Light Fuel Oil

Investment EUR ≅ 130.000

Energy efficiency measures

1. Outer Wooden Windows Replacement (Openings on Building from 1895)
2. Outer Wooden Windows Replacement (Openings on Building from 1927)
3. Outer Wooden Windows Replacement (Openings on Building from 1963)
4. Three Way Valve Installation with Controls
5. Thermostatic Radiator Valves and Variable Flow Pumps Installation

Odzaci school data - 2

			Measuring Results	Evaluation Report
		Heated Area (m²)	2.102	
		Annual Degree Hours	56.701	
		Results	Measuring Results	Evaluation Report
BEFORE		Annual Heating Energy Consumption (MWh)	316	413
		Annual Heating Energy Consumption per m² (MWh/m²)	150	196
		Annual CO$_2$ Emission (t)	82	107
AFTER		Annual Heating Energy Consumption (MWh)	211	196
		Annual Heating Energy Consumption per m² (MWh/m²)	100	93
		Annual CO$_2$ Emission (t)	55	51
SAVINGS	Absolute	Annual Heating Energy Consumption (MWh)	105	217
		Annual CO$_2$ Emission (t)	27	56
	In percentage terms	Annual Heating Energy Consumption (MWh)	33%	53%
		Annual CO$_2$ Emission (t)	33%	53%

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Senta Hospital

Gross Area	3650 m²
Year of construction	1950
Fuel type	Light Fuel Oil
Investment EUR	≡ 140.000

Energy efficiency measures

1. Outer Windows and Doors Replacement
2. Three Way Valve Installation with Controls
3. Thermostatic Radiator Valves and Variable Flow Pumps Installation
4. Basement Pipework Insulation Replacement

Senta hospital data - 2

			Measuring Results	Evaluation Report
		Heated Area (m²)	3.656	
		Annual Degree Hours	76.587	
		Results	Measuring Results	Evaluation Report
BEFORE		Annual Heating Energy Consumption (MWh)	1062	1235
		Annual Heating Energy Consumption per m² (MWh/m²)	290	338
		Annual CO_2 Emission (t)	276	321
AFTER		Annual Heating Energy Consumption (MWh)	842	1062
		Annual Heating Energy Consumption per m² (MWh/m²)	230	290
		Annual CO_2 Emission (t)	219	276
SAVINGS	Absolute	Annual Heating Energy Consumption (MWh)	220	173
		Annual CO_2 Emission (t)	57	45
	In percentage terms	Annual Heating Energy Consumption (MWh)	21%	14%
		Annual CO_2 Emission (t)	21%	14%

Majdenpek school lighting

- Old lighting in library 50 to 90 lux

- New windows and lighting in class room 350 lux (EAR funded demo project)

Key drivers of success

- Highly and broadly distributed benefits among strong constituents
- visible benefits from projects – comfort, aesthetics, health, lower bills, etc.
- no-load policy conditions; projects attractive even at low energy prices
- local population and mayors driving the project
- investments borne by GoS, and cash flow benefits to local communities and municipalities
- sustained non-partisan political support
- high local skill and knowledge
- well motivated PIU and SEEA staff
- project scaled up with another $28 million from World Bank – scope for CDM built-in

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