



Co-funded by the Intelligent Energy Europe
Programme of the European Union



ZEMedS: Case studies





Case study:

25th Primary School & Kindergarten Athens, Greece

The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.

August 2015



General data

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Name of the school

25th Primary School & Kindergarten



Type of school



Kindergarten and Primary school (5-12 years old)

Number of pupils



220

Owner



public

Location

Municipality of Peristeri, Athens, Greece

Year of construction



1982



General data

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Building typology



1 building

Heated area m2

1030 m²

Climate

Mediterranean

Site



High Density

Heating degree days (base 18): 994

Cooling degree days (base 26): 403





Current situation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Renovation needs

The school was built after the entry of the Basic Building Standard on Thermal Conditions (1979). However, insulation was not fully applied according the standards. It must be renewed globally. The main objectives are to improve user comfort, comply with new regulations and optimize energy consumption.

Utilization rate

20% (average use), from 16th of September till 16th of June, approx. 160 school days, 8 hours per day.



Building use

Schedule for Primary School and kindergarten: 08:00 to 16:00

Building surroundings

Urban dense but low-height surroundings. Limited greenery





Current situation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Building envelope: Walls

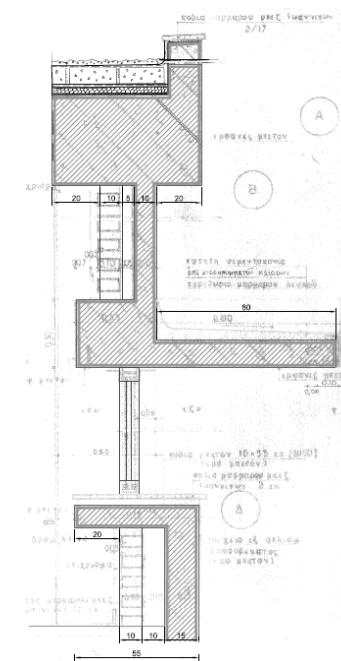
Concrete and Brick wall with in between cavity. No insulation

$$U = 1.7 \text{ W/m}^2\cdot\text{K}$$

Building envelope: Roof

Asphalt covered flat roof. Limited EPS insulation

$$U = 0.9 \text{ W/m}^2\cdot\text{K}$$



Building envelope: Groundfloor

Ground floor consists of concrete slab with mosaic finish. No insulation.

$$U = 3.1 \text{ W/m}^2\cdot\text{K}$$

Building envelope: Windows

Single-glazed windows with aluminum frames

$$U_w = 5.7 \text{ W/m}^2\cdot\text{K}$$



Current situation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Airtightness:	No measurements (poor performance)
Heating and cooling:	1 Oil boiler (256 kW) supplying radiators. Central heating system. Manual control. Heat pumps for cooling only at the teachers' offices
Ventilation:	No mechanical ventilation Ventilation by opening windows (classrooms)
Lighting:	Mainly, T8 2x26 W and T8 2x58 fluorescent tubes controlled by users
Appliances:	Electronic boards and computer equipment in classrooms and computer lab Office equipment in teachers' offices
DHW:	No DHW
Cooking:	No cooking
Current final energy consumption kWh/m² conditioned area (from bills, metering etc.):	*30 kWh/m ² y for heating *15 kWh/m ² y for electricity *Total =45 kWh/m ² per year



Current situation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Health and Comfort:

Summer comfort:	Complaints of thermal discomfort were reported from the teachers, at the start and the end of school year
Interior air quality:	No studies carried out about indoor quality. No problems observed. Air change is manual and related to user choices about the window opening
Visual comfort:	Gloomy classes Due to the use of electronic boards and with the low Winter southern sun, the curtains usually are kept shut most of the day
Running cost:	Energy: 3,234 €/y for heating, no other data Water: no data Maintenance: no data



NZEB renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Design approach:

Deep renovation towards ZEMedS nZEB Schools requirements.

ZEMedS Goals:

- Requirement 1: $C_{PE} - \text{Prod}_{RES} \leq 0$

Primary energy consumption yearly (heating, cooling, ventilation, DHW and lighting) is produced by local renewable energies.

- Requirement 2: $C_{FE} \leq 25 \text{ kWh/m}^2 \text{ y}$

FE consumption yearly (heating, cooling, ventilation and lighting) per conditioned area

- Requirement 3: Indoor air quality guaranteed ($\text{CO}_2 \leq 1000 \text{ ppm}$) and temperature above $28^\circ\text{C} \leq 40$ hours yearly during occupancy

National factors for conversion in energy and CO_2 have been taken into account (data 2014).

Methodology in energy simulations:

Steps considered:

➤ First step: 3 proposals (variant A, B and C) in envelope renovation: from less insulated to more insulated

➤ Second step: 2 proposals for each variant:

➤ Renovation in lighting system

➤ Renovation in lighting system, heating and DHW system + installation of PV system + use of natural ventilation

➤ Renovation in lighting system, heating and DHW system + installation of PV system + use of mechanical ventilation without heat recovery

➤ Renovation in lighting system, heating and DHW system + installation of PV system + use of mechanical ventilation with heat recovery



NZEB renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

➤ **First step:** 3 proposals (variant A, B and C) in envelope renovation: from less insulated to more insulated.



		Variant A	Variant B	Variant C	
Step 1	Uwindows and exterior doors	1.8	1.5	1.4	Replacement of existing single glazing for: Variant A: low-e double glazing, 16mm(air) and aluminium frame (with thermal break) . Ug=1.6 Uf= 2.2 Variant B: low-e double glazing, 16mm(argon) and aluminium frame (with thermal break) . Ug=1.3 Uf= 2.2 Variant C: low-e double glazing, 16mm(argon) and aluminium frame . Ug=1.3 Uf= 2.2
	Solar protection	Interior Curtains			-
	Uroof	0.3	0.22	0.15	Variant A: 3cm roof tiles with cool material coating and 7.5cm EPS attached Variant B: 3cm roof tiles with cool material coating and 10.5cm EPS attached Variant C 3cm roof tiles with cool material coating and 145m EPS attached
	Uwall	0.4	0.3	0.2	Variant A: External wall insulation 6cm EPS & plaster with cool coating Variant B: External wall insulation 10cm EPS & plaster with cool coating Variant C: External wall insulation 12cm EPS & plaster with cool coating
	Ugroundfloor	current			-



NZEB renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

➤ **Second step:** 2 proposals for each variant A, B and C:

- Step 2: Renovation in lighting system
- Step 2.1: Renovation in lighting system, heating system + installation of PV system + use of natural ventilation
- Step 2.2: Renovation in lighting system, heating system + installation of PV system + use of mechanical ventilation without heat recovery
- Step 2.3: Renovation in lighting system, heating system + installation of PV system + use of mechanical ventilation with heat recovery

Step 2	Lighting	led lamps efficiency 66lm/W and dimmer
Step 2.1	Natural Ventilation	Windows open sceario (0,008 m3/sec/person)
	Heating system	Boiler (COP 2)
	Cooling system	current cooling system
	PV system	9 kWh/m2/ 32 m ² PV panels
Step 2.2	Mechanical Ventilation	Ventilation systems without heat recovery (control when occupancy) 6.5 l/s person
	Heating system	Boiler (COP 2)
	Cooling system	current cooling system
	PV system	11 kWh/m2/ 38 m ² PV panels
Step 2.3	Mechanical Ventilation	Ventilation systems without heat recovery (control when occupancy) 6.5 l/s person, 70% heat recovery
	Heating system	Boiler (COP 2)
	Cooling system	current cooling system
	PV system	8 kWh/m2/ 27 m ² PV panels



NZEB Renovation

13th-33th Primary School, Municipality of Peristeri, Athens, Greece

Greek Regulation:

Schedule	Hours	8
	Days	5
	Months	8 (October till May)
Envelope	U wall	0,4
	U roof	0,4
	U floor	0,75
Internal Gains, Ventilation and Setpoints	Ventilation	11m ³ /h/m ²
	Lighting	9,6 W/m ²
	Equipment	5 W/m ²
	Heating / Cooling	20°C / 26°C



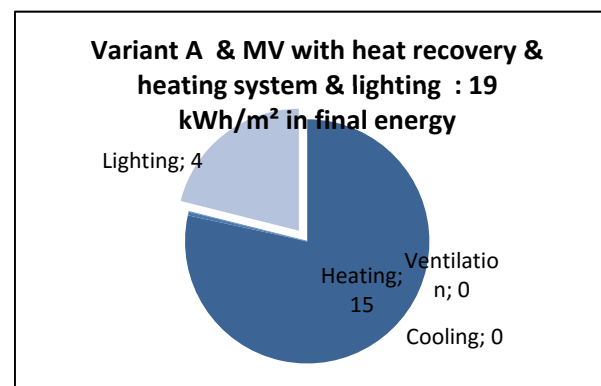
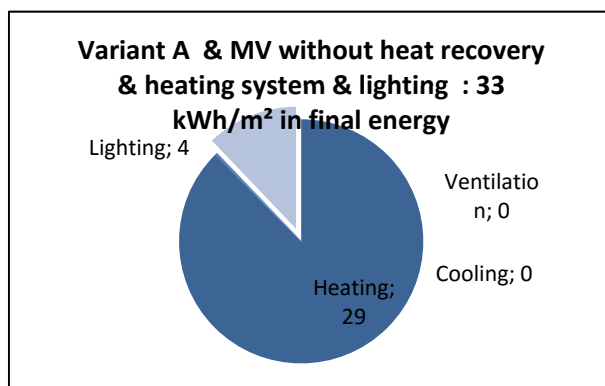
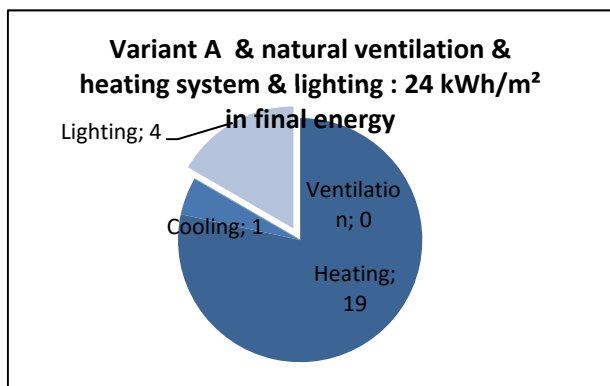
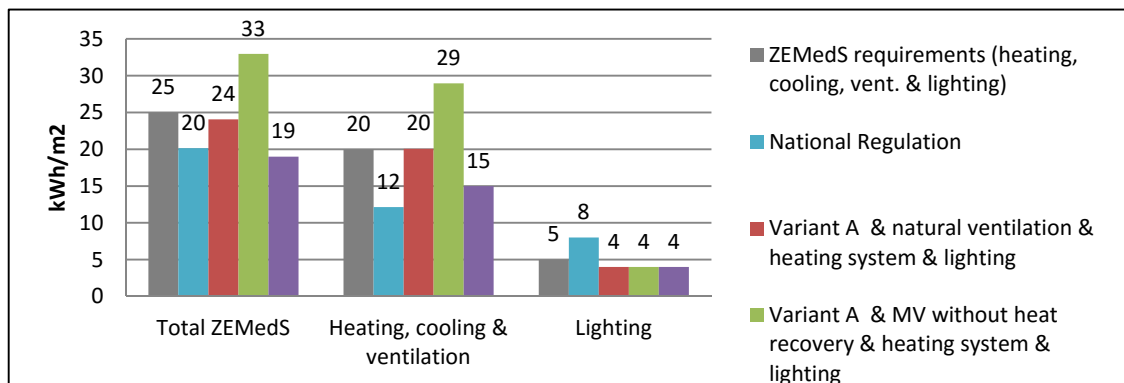
NZEB renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

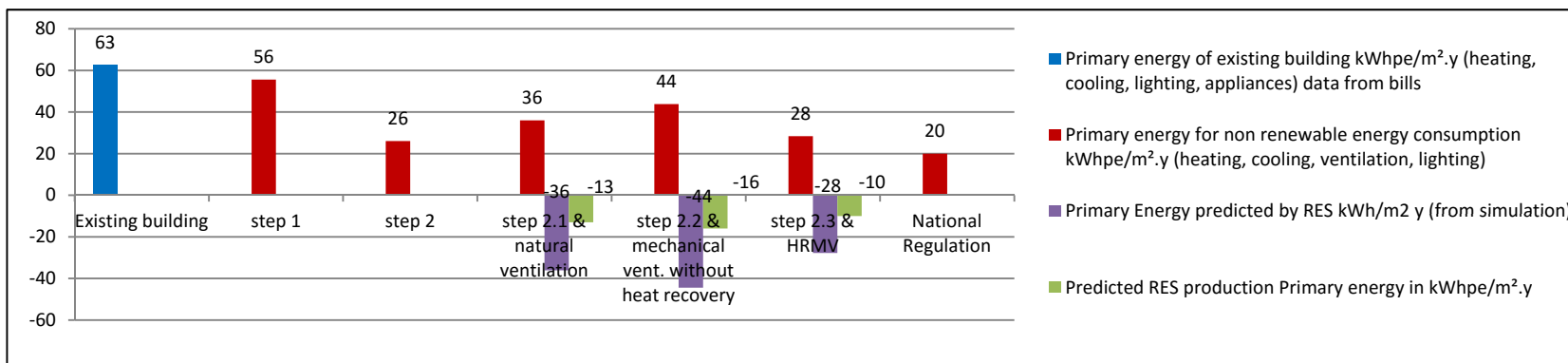


VARIANT A

FINAL ENERGY:



PRIMARY ENERGY:





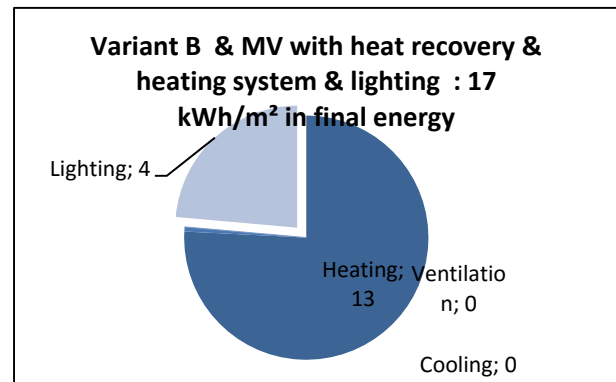
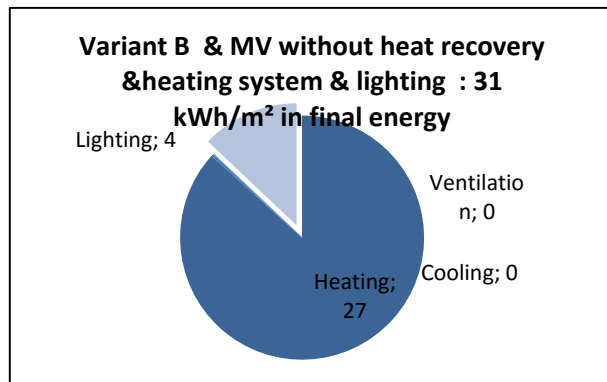
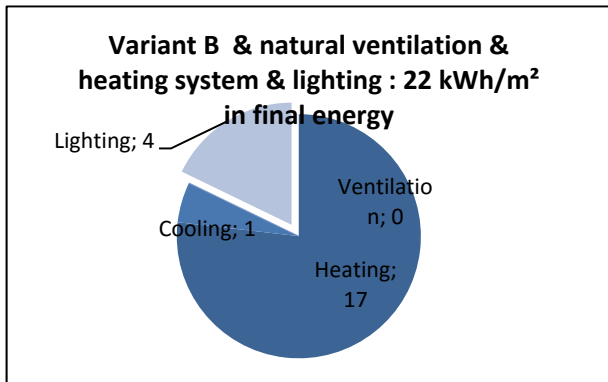
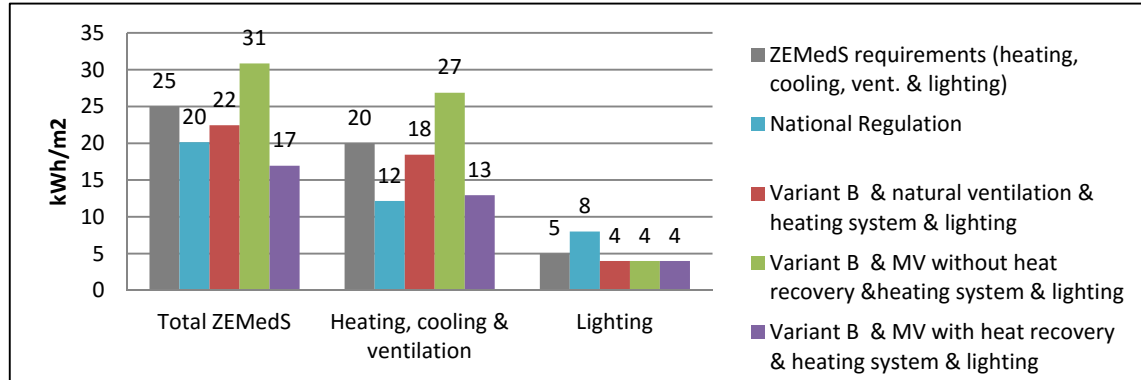
NZEB renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

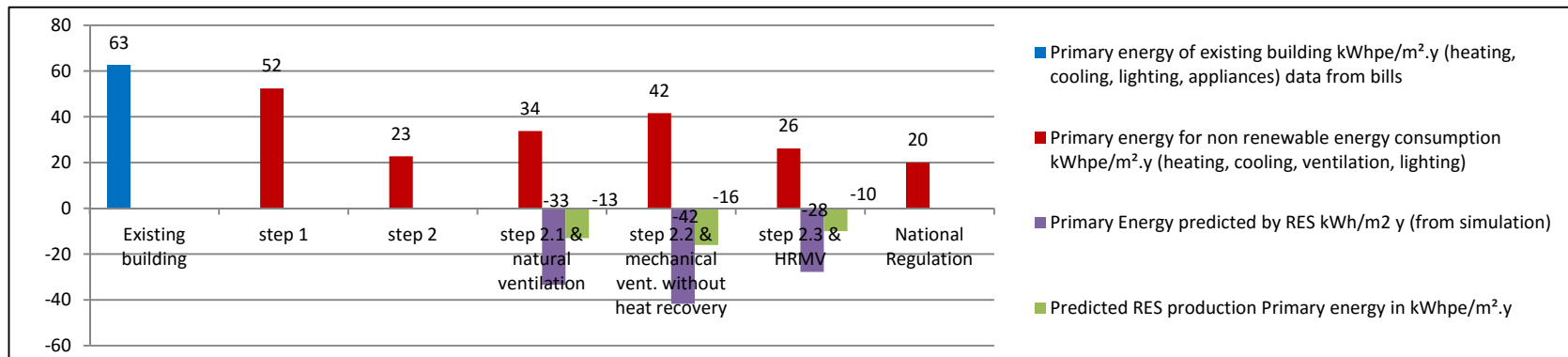


VARIANT B

FINAL ENERGY:



PRIMARY ENERGY:





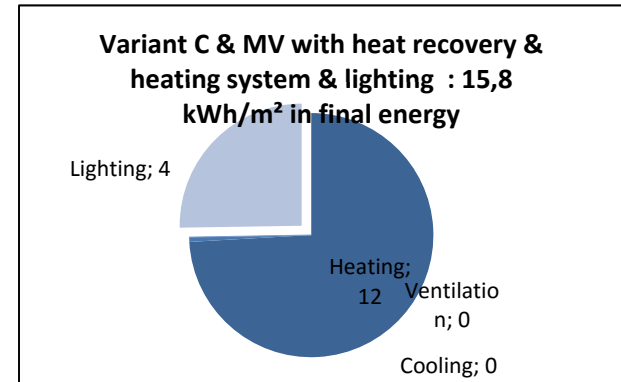
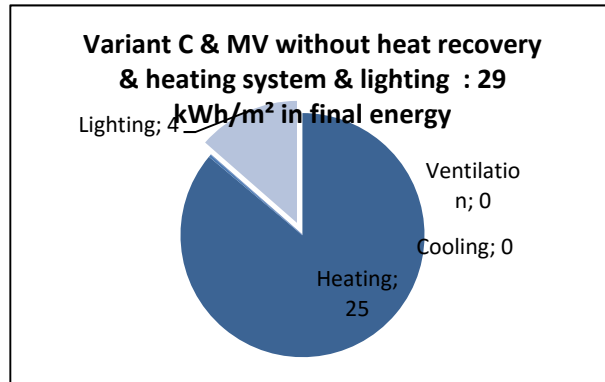
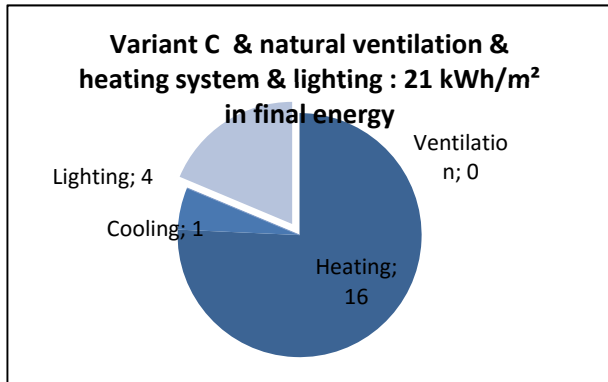
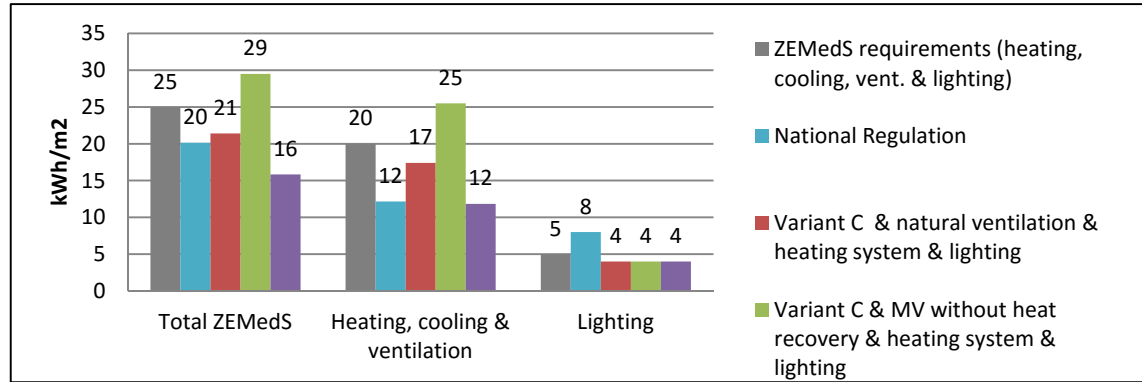
NZEB renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

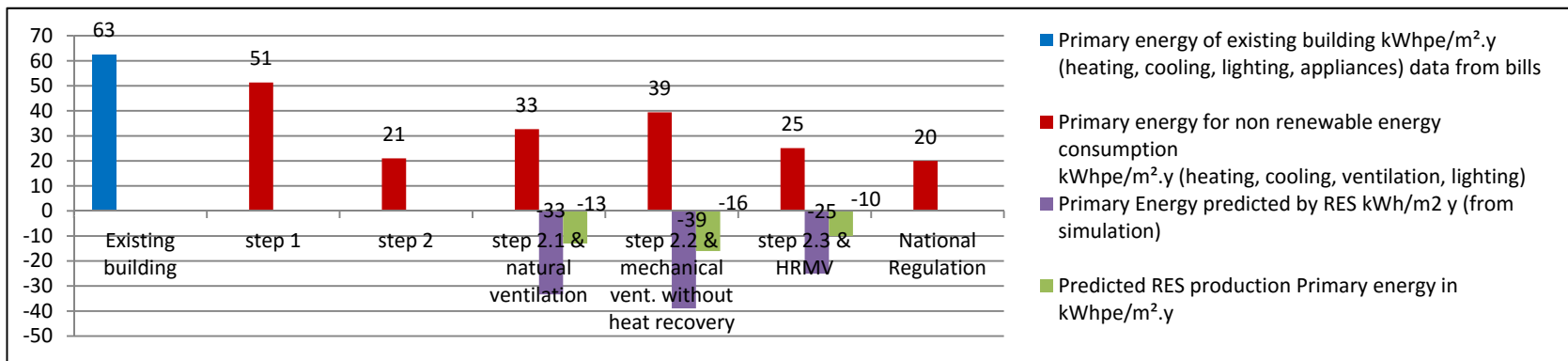


VARIANT C

FINAL ENERGY:



PRIMARY ENERGY:





NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Global cost and paybacks for the renovation scenarios:

Calculations based on:

- Average yearly increase in diesel price: 8 % (data from 2004-2005 to 2013-14)
- Average yearly increase in electricity price*: 10,8% (data from 2003 to 2014)

- Overall cost of diesel: 3,234 €/year
- Overall cost of electricity: no data available; it is supposed 1,133 €/year
- Considered an overall maintenance cost of the renovation scenarios (yearly percentage of the total cost of the renewals) in 0.5% (envelope measures), 2% (heating systems and PV)
- Replacement assumed in lighting (15-20 years lifetime)

- Average inflation considered in 2% (from 10 years average data)

Prices of investments at 2014. All construction costs in the renovation scenarios include 13% of overall costs over the execution cost of material and 6% of industrial profit over the execution cost of materials. VAT included.

Sources for cost data are gathered from using of existing cost database which have been derived from market-based data gathering, evaluating of recent projects, and analyzing of standard offers of construction companies.

Assembling, disassembling and daily amortization of scaffold are included in wall insulation costs.

* Source: <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=ten00118>



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Paybacks for the renovation implemented in steps (every 4 years):

	Expected savings in diesel	Expected savings in electricity	Overall cost of gas €/year	Overall cost of electricity €/year	Investment in €	Overall maintenance cost €/year	Cost of replacement in €	Items to be replaced	Payback (years)
step 1 - envelope (var A)	64%	0%	1.156 €	1.133 €	249.050 €	322 €	0 €	-	30
step 1 - envelope (var B)	77%	0%	746 €	1.133 €	303.615 €	322 €	0 €	-	30
step 1 - envelope (var C)	82%	0%	581 €	1.133 €	413.485 €	322 €	0 €	-	33
step 2 - lighting (var A)	-75%	56%	1.307 €	495 €	28.091 €	281 €	28.091 €	led tubes (lifetime 15-20 years)	36
step 2 - lighting (var B)	-104%	56%	1.525 €	495 €	28.091 €	281 €	28.091 €	led tubes (lifetime 15-20 years)	40
step 2 - lighting (var C)	-123%	56%	1.660 €	495 €	28.091 €	281 €	28.091 €	led tubes (lifetime 15-20 years)	43
step 2.1 - boiler + nat. vent. + PV system (var A)	-43%	38%	2.188 €	309 €	16.200 €	304 €	4.230 €	inversors PV (15 years lifetime)	>50
step 2.1 - boiler + nat. vent. + PV system (var B)	-74%	38%	2.655 €	309 €	14.700 €	304 €	4.060 €	inversors PV (15 years lifetime)	>50
step 2.1 - boiler + nat. vent. + PV system (var C)	-93%	38%	2.942 €	309 €	14.700 €	304 €	4.060 €	inversors PV (15 years lifetime)	>50
step 2.2 - boiler + mechanical vent. + PV system (var A)	-119%	38%	3.347 €	309 €	39.800 €	388 €	4.570 €	inversors PV (15 years lifetime)	>50
step 2.2 - boiler + mechanical vent. + PV system (var B)	-170%	38%	4.120 €	309 €	38.300 €	388 €	4.400 €	inversors PV (15 years lifetime)	>50
step 2.2 - boiler + mechanical vent. + PV system (var C)	-202%	38%	4.609 €	309 €	38.300 €	388 €	4.400 €	inversors PV (15 years lifetime)	>50
step 2.3 - boiler + MVHR + PV system (var A)	-13%	38%	1.727 €	309 €	38.950 €	385 €	18.000 €	inversors PV (15 years lifetime)	>50
step 2.3 - boiler + MVHR + PV system (var B)	-30%	38%	1.979 €	309 €	38.950 €	385 €	18.000 €	inversors PV (15 years lifetime)	>50
step 2.3 - boiler + MVHR + PV system (var C)	-40%	38%	2.130 €	309 €	37.450 €	385 €	18.000 €	inversors PV (15 years lifetime)	>50

Total payback (step 1+ step 2 + step 2.1) and (step 1+ step 2 + step 2.2) and (step 1+ step 2 + step 2.3) in all variants is expected in > 50 years.

Overall maintenance yearly percentage of the total cost of the investment.

All construction costs (prices at 2014) in the renovation scenarios include 13% of overall costs over the execution cost of material and 6% of industrial profit over the execution cost of materials. Assembling, disassembling and daily amortization of scaffold are included in wall insulation costs. VAT included.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Paybacks for the renovation implemented in steps (every 4 years):

Values in m2 conditioned area

	Expected savings in diesel	Expected savings in electricity	Overall cost of gas €/year m2	Overall cost of electricity €/year m2	Investment in €/m2	Overall maintenance cost €/year m2	Cost of replacement in €/m2	Items to be replaced	Payback (years)
step 1 - envelope (var A)	64%	0%	1 €	1 €	242 €	0 €	0 €	-	30
step 1 - envelope (var B)	77%	0%	1 €	1 €	295 €	0 €	0 €	-	30
step 1 - envelope (var C)	82%	0%	1 €	1 €	401 €	0 €	0 €	-	33
step 2 - lighting (var A)	-75%	56%	1 €	0 €	27 €	0 €	27 €	led tubes (lifetime 15-20 years)	36
step 2 - lighting (var B)	-104%	56%	1 €	0 €	27 €	0 €	27 €	led tubes (lifetime 15-20 years)	40
step 2 - lighting (var C)	-123%	56%	2 €	0 €	27 €	0 €	27 €	led tubes (lifetime 15-20 years)	43
step 2.1 - boiler + nat. vent. + PV system (var A)	-43%	38%	2 €	0 €	16 €	0 €	4 €	inversors PV (15 years lifetime)	>50
step 2.1 - boiler + nat. vent. + PV system (var B)	-74%	38%	3 €	0 €	14 €	0 €	4 €	inversors PV (15 years lifetime)	>50
step 2.1 - boiler + nat. vent. + PV system (var C)	-93%	38%	3 €	0 €	14 €	0 €	4 €	inversors PV (15 years lifetime)	>50
step 2.2 - boiler + mechanical vent. + PV system (var A)	-119%	38%	3 €	0 €	39 €	0 €	4 €	inversors PV (15 years lifetime)	>50
step 2.2 - boiler + mechanical vent. + PV system (var B)	-170%	38%	4 €	0 €	37 €	0 €	4 €	inversors PV (15 years lifetime)	>50
step 2.2 - boiler + mechanical vent. + PV system (var C)	-202%	38%	4 €	0 €	37 €	0 €	4 €	inversors PV (15 years lifetime)	>50
step 2.3 - boiler + MVHR + PV system (var A)	-13%	38%	2 €	0 €	38 €	0 €	17 €	inversors PV (15 years lifetime)	>50
step 2.3 - boiler + MVHR + PV system (var B)	-30%	38%	2 €	0 €	38 €	0 €	17 €	inversors PV (15 years lifetime)	>50
step 2.3 - boiler + MVHR + PV system (var C)	-40%	38%	2 €	0 €	36 €	0 €	17 €	inversors PV (15 years lifetime)	>50

Total payback (step 1+ step 2 + step 2.1) and (step 1+ step 2 + step 2.2) and (step 1+ step 2 + step 2.3) in all variants is expected in > 50 years.

Overall maintenance yearly percentage of the total cost of the investment.

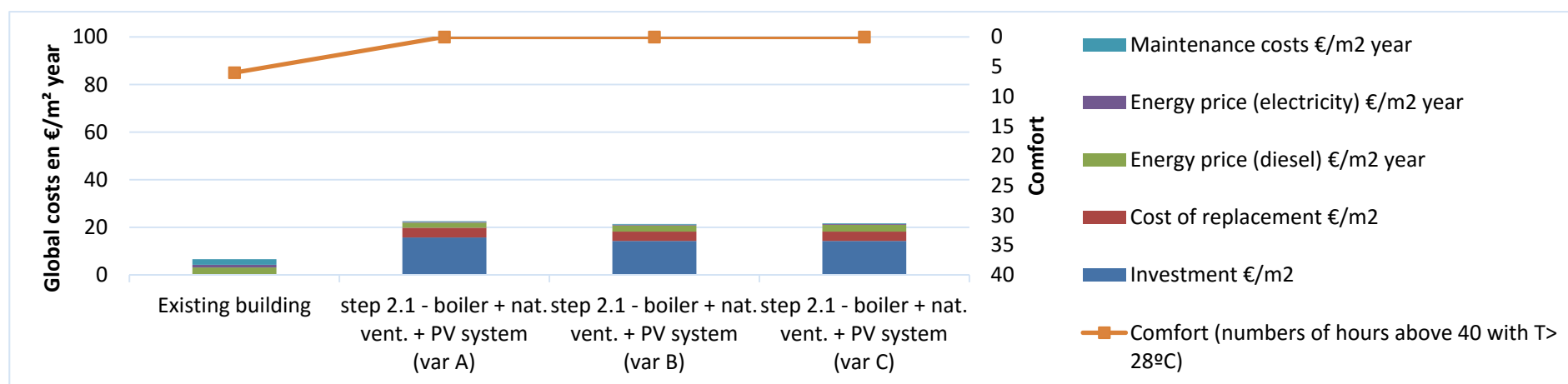
All construction costs (prices at 2014) in the renovation scenarios include 13% of overall costs over the execution cost of material and 6% of industrial profit over the execution cost of materials. Assembling, disassembling and daily amortization of scaffold are included in wall insulation costs. VAT included.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

In graphics, global cost of step 2.1:



In general, it is expected no problems of overheating ($T > 28^{\circ}\text{C}$) in classrooms.

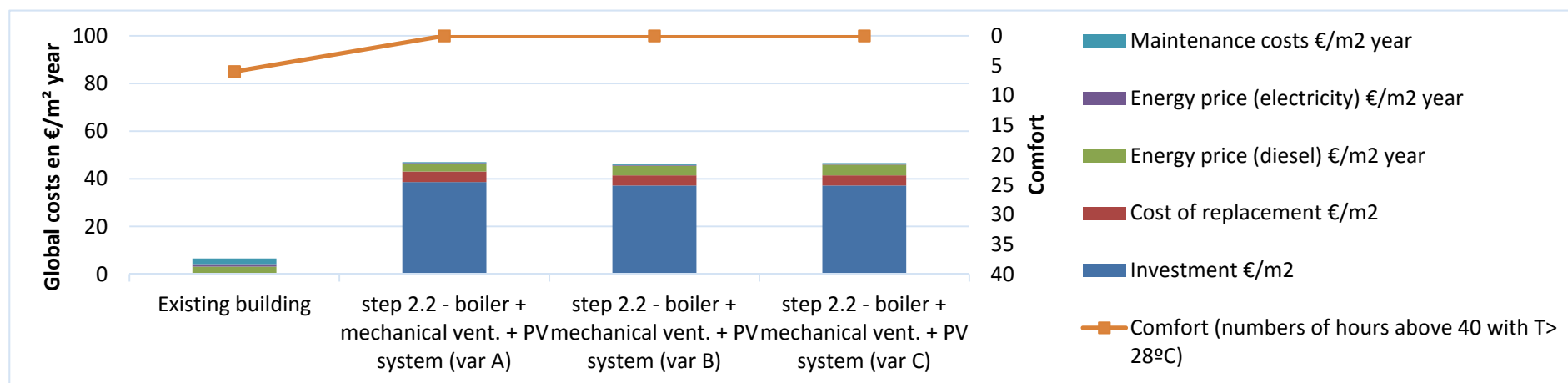
There is no information of the costs in maintenance and replacements concerning the existing building.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

In graphics, global cost of step 2.2:



It is expected no problems of overheating ($T > 28^{\circ}\text{C}$) in classrooms.

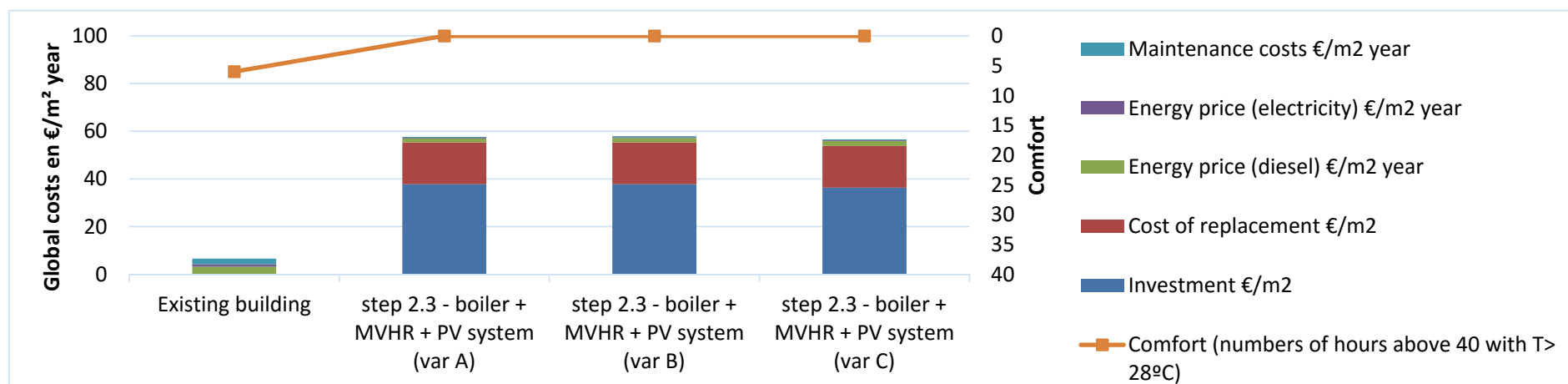
There is no information of the costs in maintenance and replacements concerning the existing building.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

In graphics, global cost of step 2.3:



It is expected no problems of overheating ($T > 28^{\circ}\text{C}$) in classrooms.

There is no information of the costs in maintenance and replacements concerning the existing building.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Paybacks for the renovation implemented **all at once (step 1 + step 2 + step 2.1/2.2/ 2.3)**:

	Expected savings in diesel	Expected savings in electricity	Overall cost of gas €/year	Overall cost of electricity €/year	Investment in €	Overall maintenance cost €/year	Cost of replacement in €	Items to be replaced	Payback (years)
step 1+ step 2 + step 2.1 (var A)	10%	73%	2.904 €	309 €	293.341 €	1.827 €	32.321 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	39
step 1+ step 2 + step 2.1 (var B)	18%	73%	2.655 €	309 €	346.406 €	1.827 €	32.151 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	39
step 1+ step 2 + step 2.1 (var C)	23%	73%	2.496 €	309 €	456.276 €	1.827 €	32.151 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	41
step 1+ step 2 + step 2.2 (var A)	-37%	73%	4.443 €	309 €	316.941 €	1.945 €	32.661 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	52
step 1+ step 2 + step 2.2 (var B)	-27%	73%	4.120 €	309 €	370.006 €	1.945 €	32.491 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	50
step 1+ step 2 + step 2.2 (var C)	-21%	73%	3.911 €	309 €	479.876 €	1.945 €	32.491 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	50
step 1+ step 2 + step 2.3 (var A)	29%	73%	2.292 €	309 €	316.091 €	1.943 €	31.981 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	36
step 1+ step 2 + step 2.3 (var B)	39%	73%	1.979 €	309 €	370.656 €	1.943 €	31.981 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	36
step 1+ step 2 + step 2.3 (var C)	44%	73%	1.808 €	309 €	479.026 €	1.943 €	31.811 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	38

Total payback (step 1+ step 2 + step 2.1) and (step 1+ step 2 + step 2.2) and (step 1+ step 2 + step 2.3) in all variants is expected in 39-41 years, 52-50 years, and 36-38 years, respectively.

Overall maintenance yearly percentage of the total cost of the investment.

All construction costs (prices at 2014) in the renovation scenarios include 13% of overall costs over the execution cost of material and 6% of industrial profit over the execution cost of materials. Assembling, disassembling and daily amortization of scaffold are included in wall insulation costs. VAT included.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Paybacks for the renovation implemented **all at once (step 1 + step 2 + 2.1/2.2/ 2.3):**

Values in m2 conditioned area

	Expected savings in diesel	Expected savings in electricity	Overall cost of gas €/year	Overall cost of electricity €/year	Investment in €	Overall maintenance cost €/year	Cost of replacement in €	Items to be replaced	Payback (years)
step 1+ step 2 + step 2.1 (var A)	10%	73%	2,8 €	0,3 €	285 €	2 €	31 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	39
step 1+ step 2 + step 2.1 (var B)	18%	73%	2,6 €	0,3 €	336 €	2 €	31 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	39
step 1+ step 2 + step 2.1 (var C)	23%	73%	2,4 €	0,3 €	443 €	2 €	31 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	41
step 1+ step 2 + step 2.2 (var A)	-37%	73%	4,3 €	0,3 €	308 €	2 €	32 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	52
step 1+ step 2 + step 2.2 (var B)	-27%	73%	4,0 €	0,3 €	359 €	2 €	32 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	50
step 1+ step 2 + step 2.2 (var C)	-21%	73%	3,8 €	0,3 €	466 €	2 €	32 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	50
step 1+ step 2 + step 2.3 (var A)	29%	73%	2,2 €	0,3 €	307 €	2 €	31 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	36
step 1+ step 2 + step 2.3 (var B)	39%	73%	1,9 €	0,3 €	360 €	2 €	31 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	36
step 1+ step 2 + step 2.3 (var C)	44%	73%	1,8 €	0,3 €	465 €	2 €	31 €	lighting LED tubes (15-20 years lifetime)/invertors PV (15 years lifetime)	38

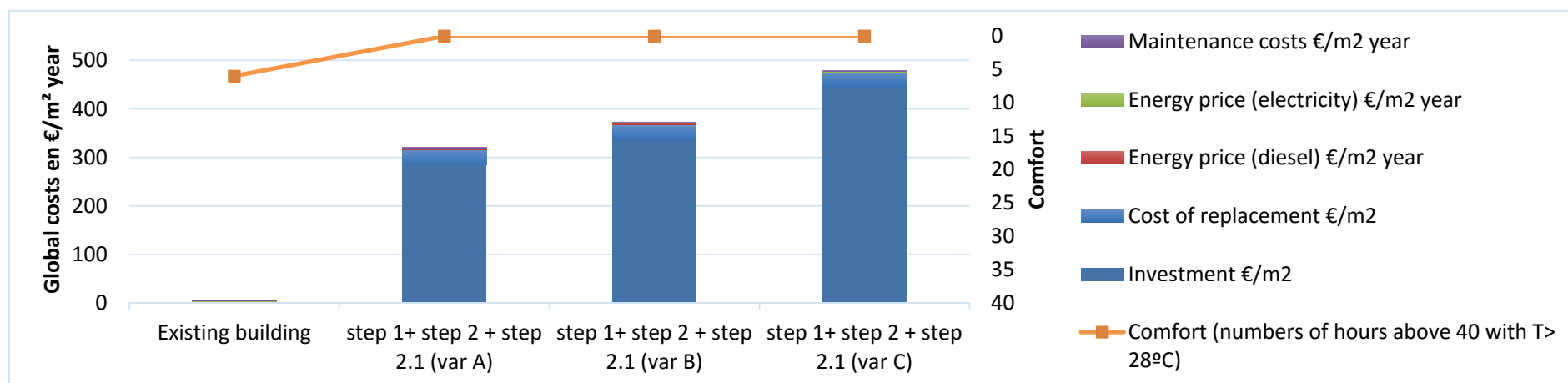
Total payback (step 1+ step 2 + step 2.1) and (step 1+ step 2 + step 2.2) and (step 1+ step 2 + step 2.3) in all variants is expected in 30-33 years, 40-41 years, and 29-32 years, respectively.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

In graphics, global cost of renovation all at once of step 1+ step2 + step 2.1:



It is expected no problems of overheating ($T > 28^{\circ}\text{C}$) in classrooms.

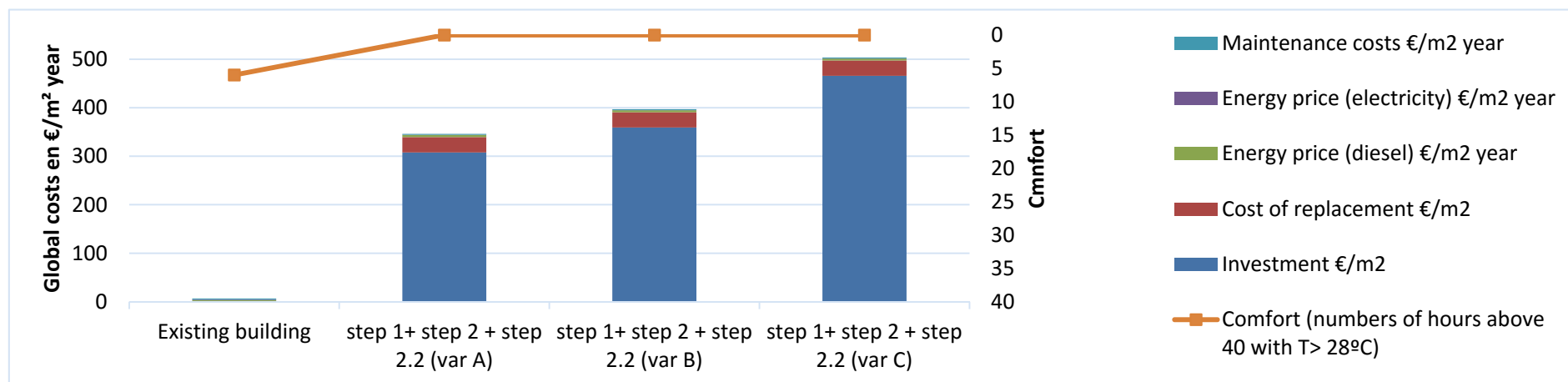
The replacement of the 1 gas boilers of heating system have been considered in the cost of replacement of the existing building. There is no information of the costs in maintenance and replacements concerning the existing building.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

In graphics, global cost of renovation all at once of step 1+ step2 + step 2.2:



It is expected no problems of overheating ($T > 28^{\circ}\text{C}$) in classrooms.

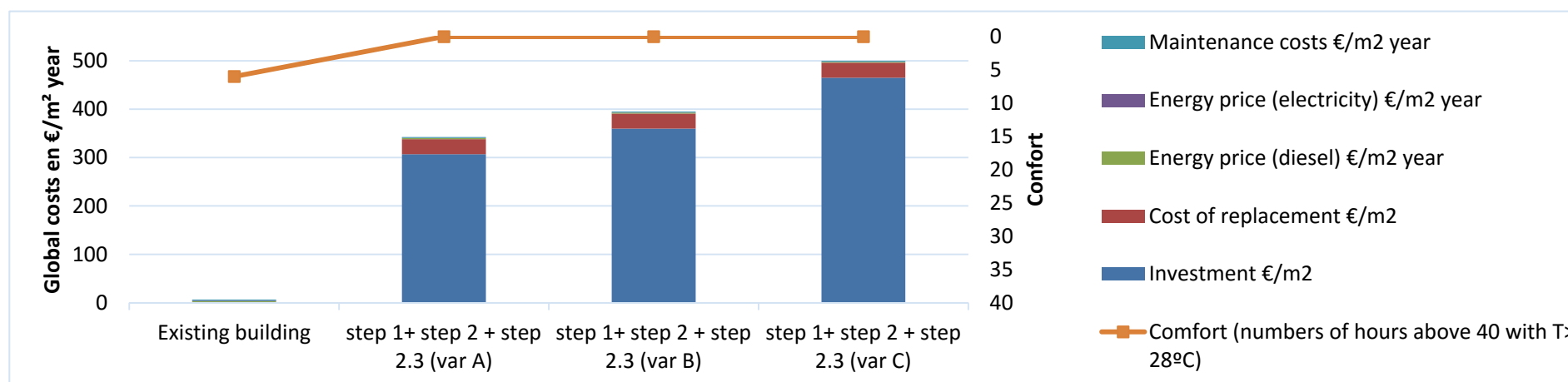
The replacement of the 1 gas boilers of heating system have been considered in the cost of replacement of the existing building. There is no information of the costs in maintenance and replacements concerning the existing building.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

In graphics, global cost of renovation all at once of step 1+ step2 + step 2.3:



It is expected no problems of overheating ($T > 28^{\circ}\text{C}$) in classrooms.

The replacement of the 1 gas boilers of heating system have been considered in the cost of replacement of the existing building. There is no information of the costs in maintenance and replacements concerning the existing building.



NZEB Renovation

25th Primary School & Kindergarten, Municipality of Peristeri, Athens, Greece

Current situation:



	diesel		electricity	
	consumption (kWh)	Ratio (kWh/m2)	consumption (kWh)	Ratio (kWh/m2)
Real (bills)	30900	30	15450	15
Simulation (Open studio+Energyplus)	21630	21	23690	23

Results of nZEB renovation under ZEMedS goals:

		result 1		result 2		result 3	
Renovation implemented with energy efficiency measures in		envelope + lighting + ventilation with natural ventilation + heating system (boiler)+ PV system covering (heating, cooling, lighting, ventilation)		envelope + lighting + ventilation with mechanical ventilation + heating system (boiler)+ PV system covering (heating, cooling, lighting, ventilation)		envelope + lighting + ventilation with mechanical ventilation with heat recovery + heating system (boiler)+ PV system covering (heating, cooling, lighting, ventilation)	
Energy balance in PE (kWh/m2 y) (heating, cooling, vent., & lighting) and RES production (kWh and kWh/m2 conditioned area) (ZEMedS requirement 1) (simulations)	Var A	0	13390/13	-1	16480/16	1	10300/10
	Var B	0	12360/12	0	15450/15	-2	10300/10
	Var C	-1	12360/12	1	14420/14	0	9270/9
Energy result in FE (kWh/m2 y) (heating, cooling, vent. & lighting) per conditioned area (ZEMedS requirement 2) (simulations)	Var A	24		33		19	
	Var B	22		31		17	
	Var C	21		29		16	
Goal of (ZEMedS requirement 3)		- natural ventilation by opening windows (no indoor quality guaranteed) - predicted temperatures above 28°C in less than 40 hours/year		- indoor quality guaranteed by mechanical ventilation - predicted temperatures above 28°C in less than 40 hours/year		- indoor quality guaranteed by mechanical ventilation - predicted temperatures above 28°C in less than 40 hours/year	
Paybacks (years) step by step implementation		> 50		> 50		> 50	
Paybacks (years) all at once implementation		30-33		40-41		29-32	