Interreg CENTRAL EUROPE
European Union European Regional Development Fund

BOOSTEE-CE

DELIVERABLE T1.3.3

D.T1.3.3 – Estimation of heating losses from thermal data / PA6

03/2020

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A.T1.3 Estimation of PV potential and heating losses

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1. Introduction and aims

The deliverable T1.3.3 belongs to the activities related to estimation of PV potential and heating losses (A.T1.3). In particular for each Pilot Action, a report has been created reporting some information gathered from onsite thermal acquisitions or data owned by local energy agencies. The overall idea is to report the heating loss situation in the pilot buildings and, if possible, the improvement after the investment activities. According to Application Form, the quantification of D.T1.3.3 is 7 but we created 8 documents corresponding to the 8 locations of the Pilot Actions (one cross-border). The various deliverables reports information and graphical results of thermal analyses in all PAs with (public or internal) and without investments. In this latter case, despite the lack of investment, thermal and energetic analyses were performed in any case to provide useful material to the local municipalities and inform them of possible energy efficiency actions they could undertake to improve the energy performance of buildings.
In the following section the activities related to PA6 in Koprivnica, Croatia (REAN and CoK) are reported.

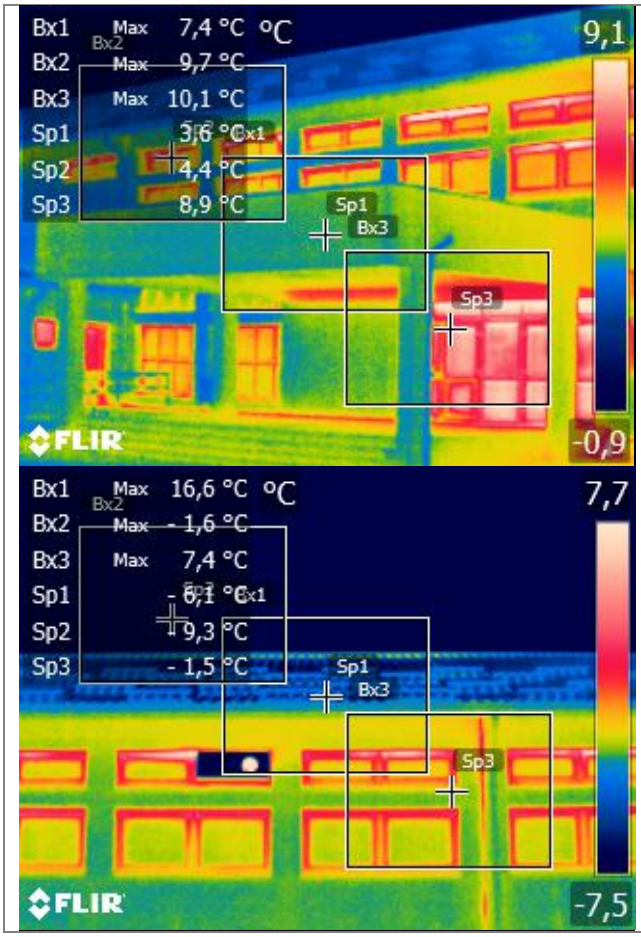
2. Thermal acquisitions in the BOOSTEE-CE pilot action #6

In the following tables we present some thermal analyses on two buildings located in the municipality of Koprivnica. The images are acquired in two successive winter seasons to evaluate whether some energy performance improvement was visible or not.

Building #1 – Primary school Braca Radic – 2018/19

Acquisition date	07.01.2019
Time and ext. temperature	16:30, 8 deg
Distance from building [m]	15
Applied thermography camera system	Manufacturer: FLIR Type: E60 IR resolution: 320 × 240 Lens: FOL 18 mm
Pictures of the equipment	 
Type of building	Primary school

Owner	Primary school Braca Radic
Description of the composition of the outer wall	Inside-out (before renovation): Lime-cement plaster – brick block – thermo plaster
Description of the roof or ceiling to the exposed roof	Half-hipped roof with 20° slope, layers: wooden board – rock wool – wooden board – air pocket – roof tile
Coefficient of heat passing through the outer walls [W/m2K]	1,24 (before renovation)
Coefficient of heat passing through windows (openings) [W/m2 K]	1,1 and 1,4
Coefficient of heat passing through the ceiling [W/m2 K]:	/
Coefficient of heat passing through floors [W/m2 K]	0,68
Coefficient of heat passing through walls to unheated spaces [W/m2 K]	/
Transmission coefficient of heat loss per unit of surface area of heated buildings, HT' [W/m2 K]	1,12 (before renovation)
Annual thermal energy needed for heating [kWh]	214.527,60
General remarks on the outer envelope and building state	The building is in relatively solid condition in terms of maintaining the basic requirements for the building, except for the elements that affect the fulfillment of the basic requirement of "energy management and heat conservation". Regarding the basic requirement of "energy management and heat conservation", the building is in rather poor condition and urgent refurbishment of the outer envelope is required.

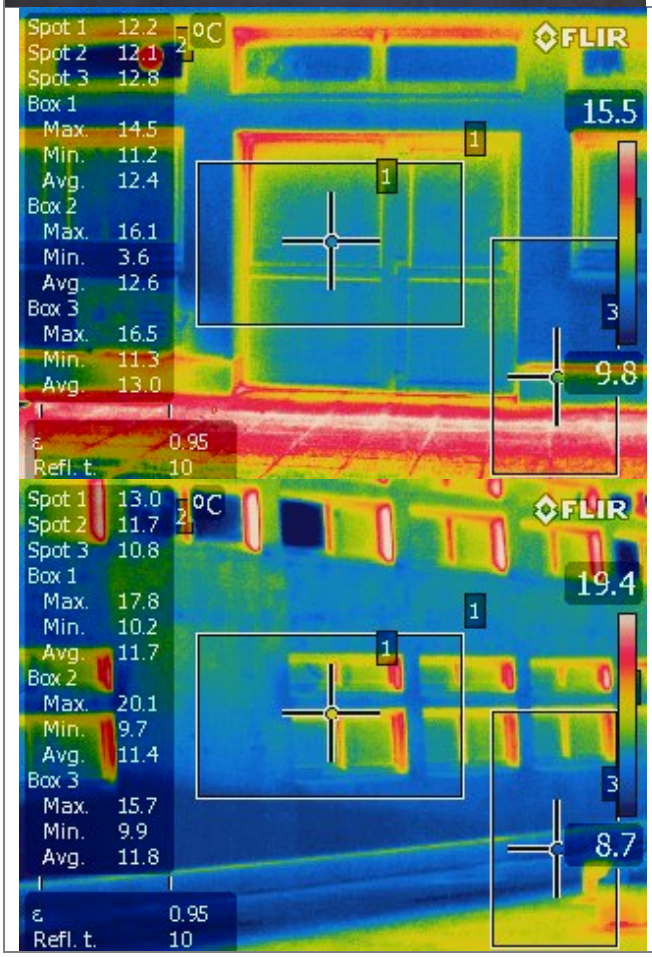
	In the first thermographic image we can see uninsulated canopy which creates a thermal bridge. In the second image windows are mostly well installed, except in the upper part of the frame where, due to the very likely poor fitting of the windows, there are thermal losses in the upper parts of the windows.

Building #1 - Primary school Braca Radic – 2019/20

Acquisition date	10.02.2020
Time and ext. temperature	7:30, 1 deg
Distance from building [m]	15
Applied thermography camera system	Manufacturer: FLIR Type: E60 IR resolution: 320 × 240 Lens: FOL 18 mm

Pictures of the equipment	 

Type of building	Primary school
Owner	Primary school Braca Radic
Description of the composition of the outer wall	Inside-out (after renovation): Lime-cement plaster – brick block – rock wool – silicate plaster
Description of the roof or ceiling to the exposed roof	Half-hipped roof with 20° slope, layers: wooden board – rock wool – wooden board – air pocket – roof tile
Coefficient of heat passing through the outer walls [W/m2K]	*0,21 (after renovation)*
Coefficient of heat passing through windows (openings) [W/m2 K]	*1,1 and 1,4*
Coefficient of heat passing through the ceiling [W/m2 K]:	*/*
Coefficient of heat passing through floors [W/m2 K]	*0,68*
Coefficient of heat passing through walls to unheated spaces [W/m2 K]	*/*
Transmission coefficient of heat loss per unit of surface area of heated buildings, HT' [W/m2 K]	*0,34 (after renovation)*
Annual thermal energy needed for heating [kWh]	*62.179,49*
General remarks on the outer envelope and building state	*Since the renovation was carried out in the meantime, building is in good condition in relation to "energy management and heat conservation requirements".*

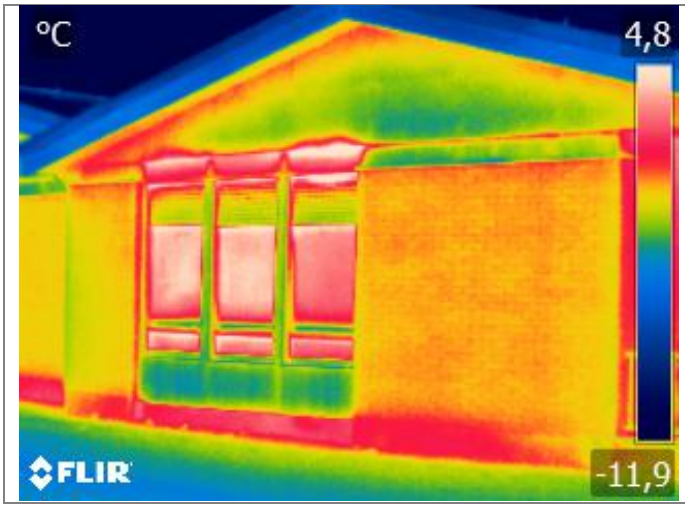


In the first and second image windows are mostly well installed, except in the upper part of the frame where, due to the very likely poor fitting of the windows, there are thermal losses in the upper parts of the windows. Also, in the first image we can see heat losses along the entire length of the plinth (socle). Facade surface is uniform, there are no point thermal bridges.

Building #2 – Kindergarten Loptica – 2018/19

Acquisition date	07.01.2019
Time and ext. temperature	14:00, 9 deg
Distance from building [m]	10
Applied thermography camera system	Manufacturer: FLIR Type: E60 IR resolution: 320 × 240 Lens: FOL 18 mm
Pictures of the equipment	 
Type of building	Kindergarten
Owner	Kindergarten Tratincica (central building)
Description of the composition of the outer wall	a) Inside-out: Lime- cement plaster - brick block – thermo plaster b) Inside-out: Gypsum cardboard - OSB board - PE foil - Rock wool - OSB board – EPS - Acrylic plaster
Description of the roof or ceiling to the exposed roof	Gable roof with 17° slope, layers: wooden board – roof foil – air pocket – roof tile
Coefficient of heat passing through the outer walls [W/m2K]	*a)* 0,83 *b)* 0,35
Coefficient of heat passing through windows (openings) [W/m2 K]	3,6
Coefficient of heat passing through the ceiling [W/m2 K]:	1,23
Coefficient of heat passing through floors [W/m2 K]	1,23
Coefficient of heat passing through walls to unheated spaces [W/m2 K]	/
Transmission coefficient of heat loss per unit of surface area of heated buildings, HT' [W/m2 K]	0,65

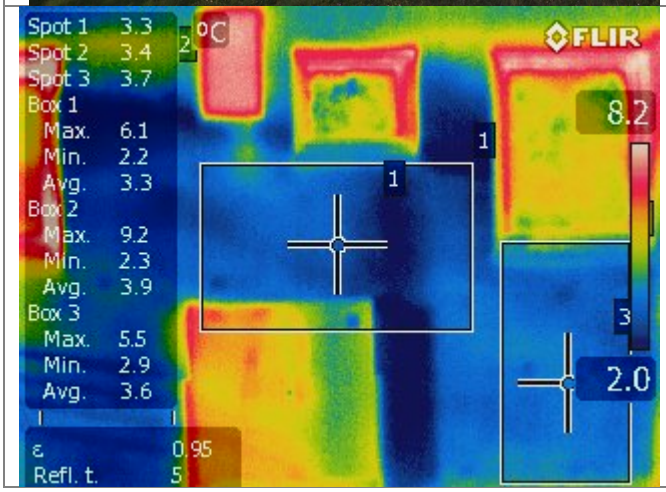
Annual thermal energy needed for heating [kWh]	107.904,00
General remarks on the outer envelope and building state	The building is in relatively solid condition in terms of maintaining the basic requirements for the building, except for the elements that affect the fulfillment of the basic requirement of "energy management and heat conservation". Regarding the basic requirement of "energy management and heat conservation", the building is in rather poor condition and urgent refurbishment of the outer envelope is required.
	
	On both images you can see heat losses through windows and through outer walls due to poor quality windows and uninsulated facade.



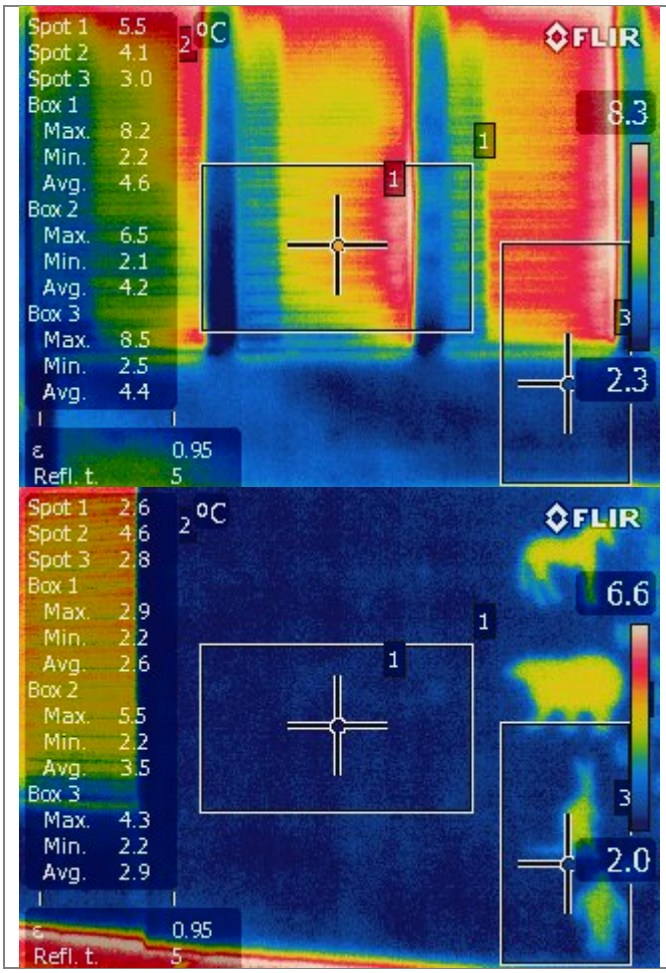
Building #2 – Kindergarten Loptica – 2019/20

Acquisition date	11.02.2020
Time and ext. temperature	8:00, 2 deg
Distance from building [m]	10
Applied thermography camera system	Manufacturer: FLIR Type: E60 IR resolution: 320 × 240 Lens: FOL 18 mm
Pictures of the equipment	 
Type of building	Kindergarten
Owner	Kindergarten Tratincica (central building)
Description of the composition of the outer wall	a) Inside-out: Lime- cement plaster - brick block – thermo plaster – rock wool – silicate plaster b) Inside-out: Gypsum cardboard - OSB board - PE foil - Rock wool - OSB board – EPS - Acrylic plaster – rock wool – silicate plaster

Description of the roof or ceiling to the exposed roof	Gable roof with 17° slope, layers: wooden board – roof foil – air pocket – roof tile Insulated ceiling to the exposed roof: Gypsum cardboard - vapor barrier – rock wool
Coefficient of heat passing through the outer walls [W/m2K]	*a)* 0,22 *b)* 0,13
Coefficient of heat passing through windows (openings) [W/m2 K]	1,4
Coefficient of heat passing through the ceiling [W/m2 K]:	0,19
Coefficient of heat passing through floors [W/m2 K]	1,23
Coefficient of heat passing through walls to unheated spaces [W/m2 K]	/
Transmission coefficient of heat loss per unit of surface area of heated buildings, HT' [W/m2 K]	0,36
Annual thermal energy needed for heating [kWh]	12.355,57
General remarks on the outer envelope and building state	Since the renovation was carried out in the meantime, building is in good condition in relation to "energy management and heat conservation requirements".



Thermal bridges in energy-renovated building could not be completely avoided, but have been reduced to minimum by correct handling of structural details. There are minor thermal bridges present around the windows and also on connection of the outer wall and slab.


Spot 1 5.5
Spot 2 4.1
Spot 3 3.0
Box 1
Max. 8.2
Min. 2.2
Avg. 4.6
Box 2
Max. 6.5
Min. 2.1
Avg. 4.2
Box 3
Max. 8.5
Min. 2.5
Avg. 4.4
ε 0.95
Refl. t. 5
°C
FLIR
8.3
2.3
Spot 1 2.6
Spot 2 4.6
Spot 3 2.8
Box 1
Max. 2.9
Min. 2.2
Avg. 2.6
Box 2
Max. 5.5
Min. 2.2
Avg. 3.5
Box 3
Max. 4.3
Min. 2.2
Avg. 2.9
ε 0.95
Refl. t. 5
°C
FLIR
6.6
2.0