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Mere energetske efikasnosti (EE) i smernice za njihovo sprovođenje- program obuke za građevinske kompanije i nadzorne organe

Rezultati analize javnog građevinarstva i utvrđene mere

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Sadržaj

- Razmatrane EE & RE mere
- O energetskoj reviziji
- Utvrđene mere
- Pregled rezultata energetske revizije

Razmatrane EE & RE mere

- GRAĐEVINARSKE MERE
  - Izolacija spoljašnjih zidova
  - Krovna izolacija
  - Podna izolacija (na prizemlju) – posebni slučajevi
  - Zamena prozora i vrata

Razmatrane EE & RE mere

- MAŠINSKE MERE
  - Poboljšanje sistema grejanja
    - Montaža TRV
    - Zamena pumpi
    - Zamena, popravka i čišćenje postojećih grejnih distributivnih sistema
    - Zamena goriva – gradsko grejanje, biomasa, pumpe za grejanje
  - Priprema sanitarne tople vode – solarni grejni sistemi

Razmatrane EE & RE mere

- ELEKTROTEHNIČKE MERE
  - Sistem osvetljenja
    - Poboljšanje postojećih sistema osvetljenja
    - Zamena postojećih sistema osvetljenja
  - Ostali aparati
    - Pumpe, električni aparati, itd. (zavisno od situacije)
    - Uklanjanje električnih grejalica

O energetskoj reviziji…

- Energetska revizija :

…je provera, pregled i analiza tokova energije, radi očuvanje energije u objektu, proces ili sistem smanjenja dotoka energije u sistem bez negativnih posledica po izlaz (e).

Wikipedia

- <u>Za pripremu energetske revizije, potrebne su:</u>
  - Opšte informacije o objektu
  - Informacije o obrascima potrošnje u objektu
    - Zauzetost/naseljenost objekta
    - Režimi rada grejanja/hlađenja
    - Obrasci upotrebe električnih sistema

O energetskoj reviziji…

- Nacrt i plan objekta
  - Građevinski/arhitektonski
  - Mašinski
  - Elektrotehnički
  - Ostali (ako su od koristi)
- Informacije o energetskoj potrošnji u objektu
  - Nosilac potrošnje grejne energije i troškovi
  - Potrošnja i troškovi električne energije
- Informacije/potvrda o ugrađenim električnim aparatima u objektu
  - HVAC
  - SHW sistem
  - Električni potrošači

O energetskoj reviziji …

- TOK RADA
  - Priprema
    - Prikupljanje dostupnih informacija o objektu (-ima)
      - Nacrti, obrasci upotrebe, potrošnja, troškovi,itd.
    - Planiranje obilaska lokacije
    - Dogovor o obilasku lokacije
  - Obilazak lokacije
    - Prikupljanje informacija na licu mesta o opremljenosti objekta
    - Prikupljanje informacija od tehničkog osoblja
    - Potvrda/provera informacija o pripremnoj fazi
    - Prikupljanje ostalih bitnih informacija

O energetskoj reviziji …

- TOK RADA
  - Kancelarijski posao
  - Priprema svih informacija za izveštaj
    - … karakteristike omota
    - … karakteristike HVAC sistema
    - … karakteristike električnih sistema
  - Priprema za analizu potrošnje energije
  - Priprema za analizu troškova energije
  - Priprema modela energije u objektu
  - Uspostavljanje referentne potrošnje
  - Utvrđivanje mera EE
  - Procena mogućih posledica EE mera
  - Potrošnja energije
    - Troškovi energije

O energetskoj reviziji…

5. BUILDING STATE DESCRIPTION

The following chapter details the existing condition of the building including envelope constructions, mechanical and electrical systems, and general condition. The energy consumption data, both reported and calculated, are presented in Chapter 6.

5.1. BUILDING LOCATION

The building is located in the center of Vushtrri with good access for pedestrians and vehicles. It is surrounded with other buildings with different characteristics in architecture and period of construction. According to interviews with the staff and according to the list of buildings with historical value issued by Ministry of Culture, the Dormitory for Men building doesn't have any historical value and therefore no restrictions for renovation works.

Figure 2 – Building location

5.2. GENERAL CONSTRUCTION DESCRIPTION

Audited building Date of auditing Interviewed person	Dormitory Men 15.11.2014 Hajrip Zeneli		
Year of construction	1936		
Type of construction	Massive construction		
No of floors	4 (basement, ground floor, 2 floors)		
Gross area [m²]	5,530.2	Heated area	5,0973
Volume [m³]	11,355.5	Heated volume	10,654.1
Occupants	500	Heating season	15 Oct. – 15 Apr.

Table 2 – General description

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The floor usage is similar for all other floors which are mostly residential rooms. The basement comprises the substation, storage and training rooms.

Building floor	Space type	Height m	Heated area m²	Non-heated m²	Total area m²	Heated volume m³
Basement	Substation, storage, training room.	2.6	200.0	360.0	560.0	520.0
Ground floor	Rooms, hallways.	3.5	955.8	275	960.0	3,345.1
First floor	Rooms, hallways.	3.5	955.8	275	960.0	3,345.1
Second floor	Rooms, hallways.	3.5	955.8	275	960.0	3,345.1
TOTALS			3,067.5	1,195.0	3,520.0	10,735.3

Table 3 – Usage by floor

5.2.1. Building layout

The building layouts were obtained. The building is spread along the main axis. The shape of building is simple as it only has one central corridor and rooms concentrated on both sides of the corridor.

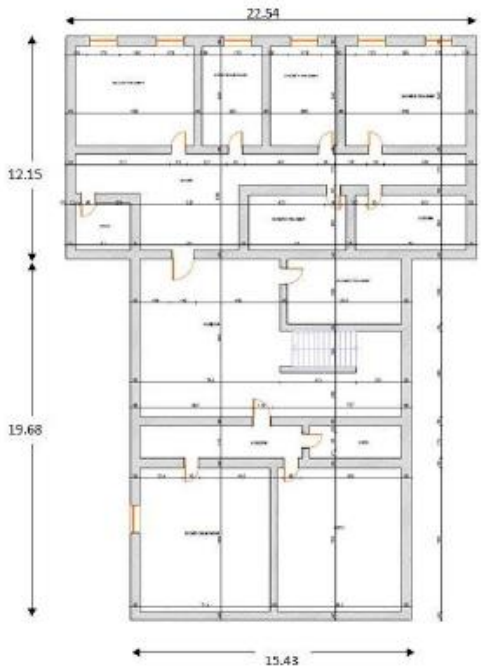

Figure 3 – Basement layout

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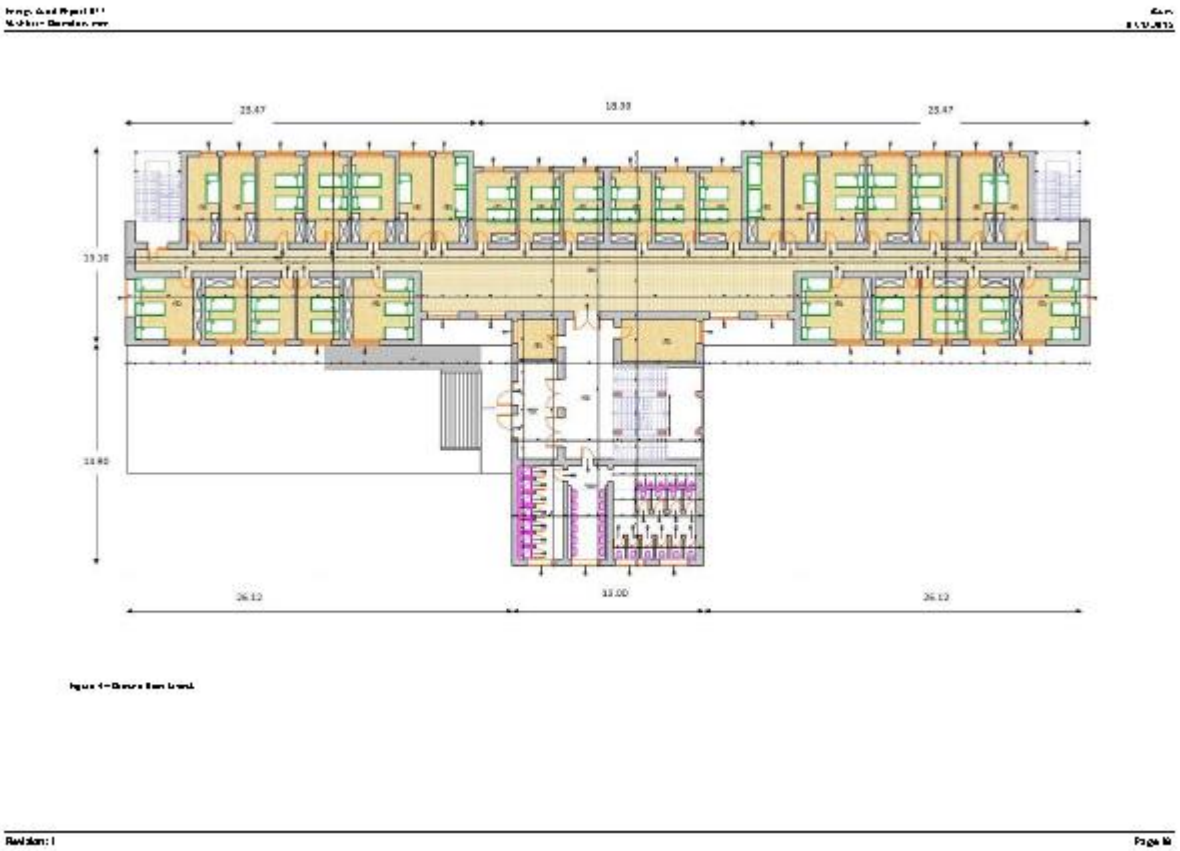
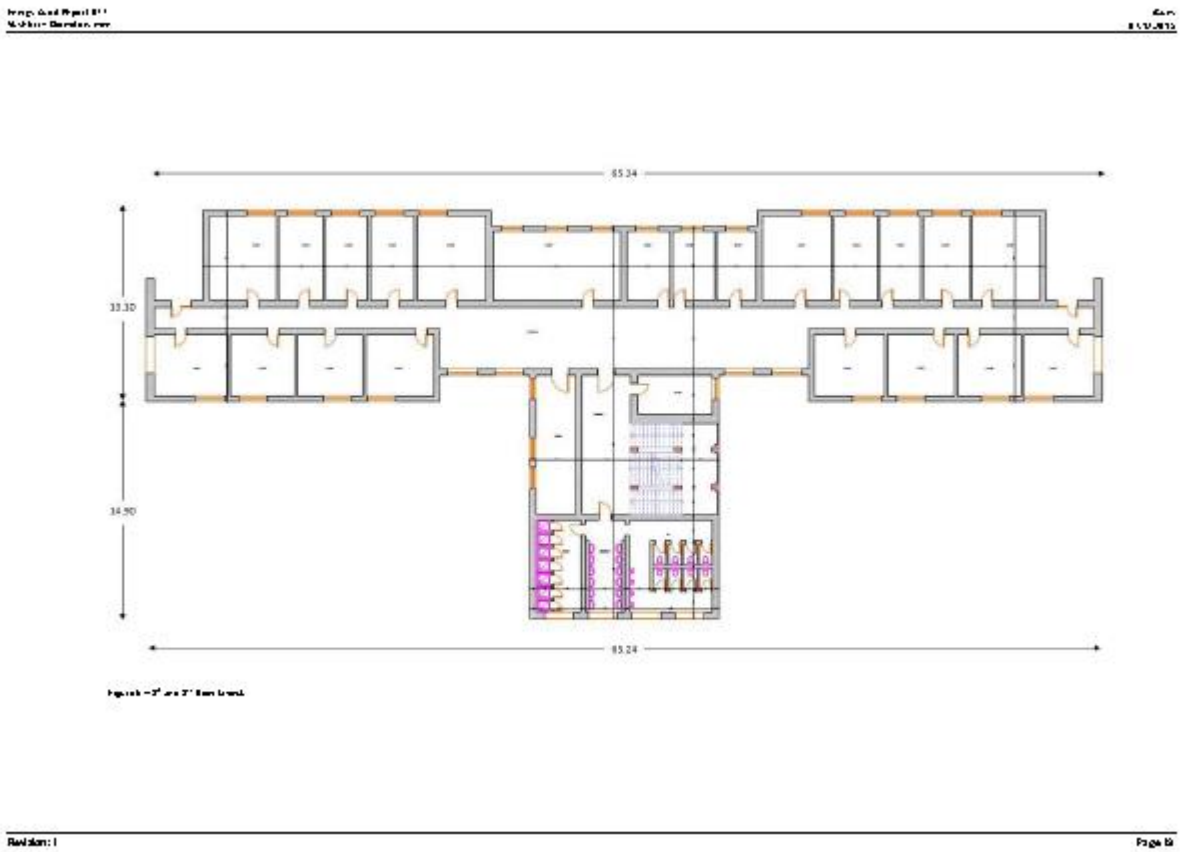


O energetskoj reviziji …



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5.2.2. Building Physical Characteristics

All building elements were examined during the site visit. During the examination, certain deficiencies which cause large thermal losses were found. The following tables present the characteristics of each building element, including:

- year of renovation
- existing layers of the element (where applicable)
- overall element thicknesses (where applicable)
- assessment of the element condition in order to evaluate whether construction measures are necessary prior to application of energy efficiency measures
- visible damage on each building element

The most important result apart from the condition assessment, is the elaboration on building element areas, orientations and U-values of each element.

5.2.2.1. Walls

Building was constructed during 1936, structurally it consists of walls made out of full brick and concrete with a thickness of 35 cm and plaster from both sides. Outside walls are assessed to be in quite a good condition from the structural point of view with some minor damages in plaster. It is recommended to install thermal insulation on the facade but minor damages have to be treated prior to EPS installation.

The existing layers are presented in Table 5. Existing wall can be seen in photos, Figure 6.

		Area (m²)					Existing "U" value	Proposed "U" value
Type	Description	h	W	S	E	Total	(W/m²K)	(W/m²K)
Wall type 1	Plaster, brick, plaster	268.6	512.1	221.7	488.7	1492.1	1.659	0.222
Total wall		268.6	512.1	221.7	488.7	1492.1		

Table 4 – Walls summary

Wall type 1 1492.1 m²

Baseline

Layer name	d	λ	R
	(mm)	(W/mK)	(m²K/W)
Plaster	25	0.80	0.031
Brick	300	0.81	0.370
Plaster	25	0.80	0.031
	U-value	(W/m²K)	1.659

Renovated

Layer name	d	λ	R
	(mm)	(W/mK)	(m²K/W)
Plaster	25	0.80	0.031
Brick	300	0.81	0.370
Plaster	25	0.80	0.031
EPS	100	0.04	2.500
Facade plaster	5	0.80	0.006
	U-value	(W/m²K)	0.222

Table 5 – Wall U-value calculation

Figure 6 – Walls

5.2.2.2. Windows and External Doors

In 2000, most of the old metallic frame windows were replaced with new PVC windows. New windows are double glazed with PVC frame but some minor deficiencies were noticed during inspection since some PVC windows cannot be closed properly. It is recommended to fix the closing mechanism on windows. This measure is considered to have a slight improvement in reducing the infiltration heat losses. It is also recommended to replace the remaining old windows. The table below describes the window area and U-value.

	Description	Area (m²)		Existing "U" value	Proposed "U" value
Type		South	non-south	(W/m²K)	(W/m²K)
Windows 1 - PVC frame	Double glazing	0.0	369.9	1.900	1.900
Windows 2 - Metal frame	Double glazing	67.6	0.0	4.500	1.400
Total windows		440.6			

Table 6 – Windows description

Doors were also inspected. Doors were replaced during 2000 when new aluminum frame and double glazed doors were installed. According to the visual inspection doors are assessed as good material and it is not recommended to replace them.

The table below describes door characteristics.

	Description	Area (m²)		Existing "U" value	Proposed "U" value
Type		South	non-south	(W/m²K)	(W/m²K)
Doors 1 - Aluminum frame	Double glazing	0.0	25.5	1.900	1.900
Total doors		25.5			

Table 7 – Doors description

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Figure 7 – Windows/doors

5.2.2.3. Floor

The floor is in a relatively good condition, but it has bad thermal properties. Despite that, it is not recommended to insulate the floor since this measure is in general expected to have a large investment for a small benefit compared to other elements of the envelope. However if a renovation is going to take place in future then it is recommended to implement EE measures along with other refurbishment works.

The basement floor U-value and areas are presented in Table 8 and Table 9.

Basement type 2 — 933.8 m²
Baseline

layer name	d	λ	R
	[mm]	[W/mK]	[m²K/W]
Ceramic	20	1.60	0.015
Screed	30	1.65	0.030
Wood tiles	20	0.13	0.155
Hydro-insulation	10	0.16	0.065
Concrete slab	150	2.60	0.058
	U-value	[W/m²K]	1.975

Table 8 – Basement floor U-value calculation

Basement floor	Area	Average 'U' value	Proposed 'U' value
Description	[m²]	[W/m²K]	[W/m²K]
Ceramic, screed and concrete slab	933.8	1.975	1.975

Table 9 – Floor description

5.2.2.4. Roof

According to the visual inspection, the roof has a solid wooden structure forming a regular geometric shape. Roof is assesed to be structurally sound. However, it is covered with asbestos corrugated plates which need to be removed and handled carefully by professionals. New covering should include wooden planks, vapor barrier and metallic corrugated sheets. It is recommended to install thermal insulation on the roof with a rock wool layer to be laid on the slab and covered with a protective layer of screed, but only after construction works are completed.

The layers and U-value calculation for the existing and proposed roof are presented in Table 10 and Table 11.

Roof type 1 — 933.8 m²

Baseline

layer name	d	λ	R
	[mm]	[W/mK]	[m²K/W]
Plaster	20	0.80	0.03
Concrete slab	200	2.6	0.08
	U-value	[W/m²K]	4.154

Renovated

layer name	d	λ	R
	[mm]	[W/mK]	[m²K/W]
Plaster	20	0.80	0.03
Concrete slab	200	2.6	0.08
Rockwool	120	0.04	3.00
Screed	50	1.65	0.03
	U-value	[W/m²K]	0.306

Table 10 – Roof U-value calculation

	Roof	Area	Average 'U' value	Proposed 'U' value
Type	Description	[m²]	[W/m²K]	[W/m²K]
Roof type 1	Pitched roof	933.8	4.154	0.306

Table 11 – Roof description


Figure 8 – Roof

5.3. SANITARY HOT WATER

A solar thermal heating system was investigated and study of a solar thermal system for SHW preparation was done in order to assess the currently installed system.

Sanitary hot water is produced in the Main heating plant with a diesel boiler and is supplied to buildings according to demand. However, currently it is not functioning and SHW is prepared locally in each building.

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In addition to this, Dormitory for men has installed solar panels with a total of 22 panels (1.2x2 m) and 4 water storage tanks of 1000 l each. The tanks are also connected to the electrical system for water preparation when solar panels are not supplying to full requirement, but currently they are turned off due to high energy expenses. SHW substation is located in the basement of the Dormitory and no major deficiencies were noted.

Sanitary hot water consumption is estimated to around 1314 m^3/a, meaning 77 MWh energy (calculated with 10°C average annual cold water temperature and 60°C desired SHW temperature).

Type	Description	Quantity
Solar panels	- D = 1.2x2.0 m	22
Hot water tank	- V = 1,000 l each	4
Expansion vessel	- V = 100 l each	2
Pumps	- Wilo, Ion 350/10	1

Table 12 – Installed equipment for Sanitary Hot water production and distribution


Figure 9 – SHW preparation

5.4. SPACE HEATING

Kosovo Academy for Public Safety campus has a centralized heating system with one heating plant serving all buildings within campus. Heating plant runs on diesel boilers. Entire heating system was refurbished during 2000-2002. The water is distributed through an underground pipeline system. Site visit revealed that the underground piping system was recently replaced (in 2014) (Dormitory men, Dormitory women, Administration, New Dormitory, and Range shooting). The old pipes were replaced with new pipes insulated with glass wool and laid into concrete trenches. The interview revealed that second phase of the project is expected to be finalized during 2015 when pipes that supply Sports Hall and School building will be replaced with new. This was already implemented in the second half of 2015 according to information that was received. Every building (besides Steve Benet building, Healthcare building and Building 14) has its own substation, where the hot water enters into the hot water header and then through the circulating pumps to upper floors.

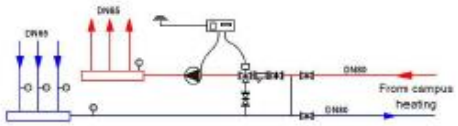

Figure 10 – Technological scheme of heating

5.4.1. Hot Water Preparation and Distribution

Substation is located in the basement covering an area of 12 m^2, which is sufficient for the current heating system and storages around it would allow placement of potential additional equipment.

Heating substation has been renovated in 2000 when new pumps, valves and piping were installed. Heating hot water is circulated with one Wilo pump without VFD. A three way valve is installed and working properly. The distribution pipes within the substation are well insulated with some minor deficiencies caused during some construction works. However, personnel didn't report any leakages in the system.

The installed equipment for heating preparation and distribution is listed below:

Type	Description	Quantity
Pumps	- Ion 340/2, type Wilo	1

Table 13 – Installed equipment for heating preparation and distribution


Figure 11 – Substation

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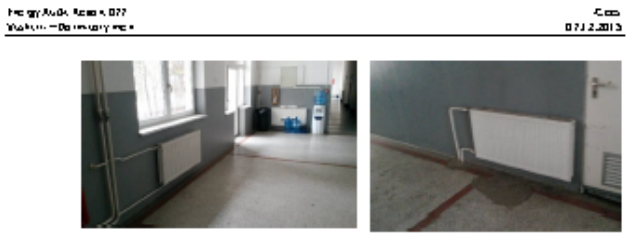

Figure 12 – Radiators installed in the building

Radiators

Basic Info

TYPE	Dimensions	No.	Capacity	Total
			W	kW
PCLP	600x1000	21	2,259	47.4
PCLP	600x1200	80	2,259	178.8
PCLP	600x1400	20	5,126	62.3
PCLP	600x1600	8	5,571	28.6
PCLP	600x1800	5	4,017	12.1
PCLP	500x1200	2	5,704	7.4
	TOTAL	154	43,944	455

Table 14 – Specification of radiators

Internal temperature was measured in different places and the results show 19-22°C in most of the rooms. However there was a higher fluctuation in hallways where the measured temperature range was between 12-18°C.

The calculated system power for the baseline scenario is 422 kW (see Annex 2 for calculation details) which is above the total installed radiator capacity of 336 kW, and the comfort conditions are not met due to low capacity of radiators compared to heat losses.

After introducing EE measures, heat demand will drop significantly (200 kW), which means radiators capacity will be oversized. Therefore, it is recommended to install TRVs on each radiator.

5.5. AIR CONDITIONING

There is no central cooling system in the building.

5.6. SPACE VENTILATION

There is no central ventilation system installed.

5.7. ELECTRICAL SYSTEM

There are no data regarding the internal electricity distribution network. In general, the lighting is in a poor condition in terms of EE and there are no replacement parts

available. Fixtures are T8 linear fluorescent lamps operated by conventional control gear (COG) which has placed under reflecting grill for soft light distribution and incandescent 100 W lights. Lighting measurements accounted for 150-200lux in most of the rooms and approximately the same in hallways. It is recommended to replace the lighting system with a more efficient one which will also ensure higher lighting levels which will meet the national standards. A lighting simulation of one characteristic room is provided on the figure below.

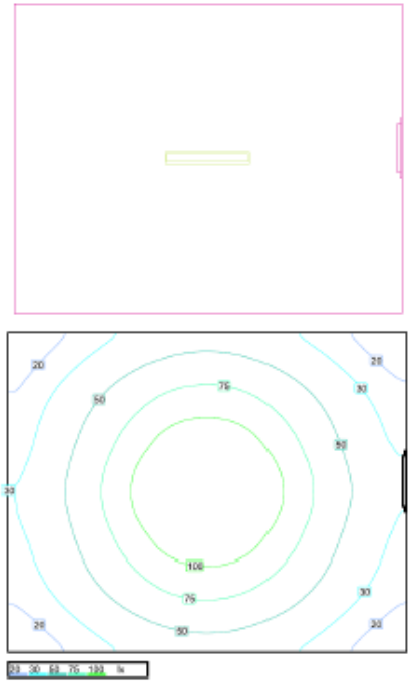

Figure 13 – Lighting simulation of one characteristic room

Since the baseline is calculated for the condition where all the lamps are in place and operating, the new lamps to be installed are only included in the Table of the Investment.

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Table below describes identified lighting fixtures and their rated power.

Lighting
Baseline

TYPE	No.	Bulbs	Watts	Ballast	kWh/a
T8 Fluorescent 2x58W	4	2	56	13%	531.1
T8 Fluorescent 1x58W	127	1	56	13%	3,375.5
T8 Fluorescent 2x58W	11	2	56	13%	965.4
Headlamps 100W	25	1	100	0%	2,438.0
TOTAL	165		2018		9,527.8

Table 15 – Lighting specification

Figure 14 – Lighting fixtures

Electric equipment is mostly PCs, TV, and technical equipment.

Equipment
Baseline

TYPE	No.	Watts	kWh/a
PC	10	350	3,065
TV	1	350	742
Kettle	2	2,000	5,130
Printer	2	350	702
Fan	6	1,300	5,310
TOTAL		4,040	15,669.0

Table 16 – Electric equipment specification

6. ENERGY CONSUMPTION

The dormitory buildings are a part of a larger academy center campus including three dormitories, School, Administration building, Logistic building, Steve Benet, Building 14, Sport hall, Healthcare building, Kitchen. According to the interview there is no energy meter (heat or electrical) for each separate building. In order to obtain an orientation figure for metered consumption of each building, the total consumption is distributed according to ratios of total calculated consumption. The results are presented in the following section.

The results are presented in the following section.

6.1. REPORTED/ MEASURED ENERGY CONSUMPTION

The results are presented in the tables below.

Audit no.	Total measured consumption	Calculated consumption	%	Measured
	MWh	MWh	-	MWh
076-VUD-CRP3_School	2,654.2	970.7	30.7%	800.0
077-VUD-CRP3_Dormitory_area		625.5	19.8%	521.1
078-VUD-CRP3_Dormitory_area		515.9	10.0%	265.5
079-VUD-CRP3_Healthcare_building		74.6	2.4%	62.2
080-VUD-CRP3_Logistic_building		197.9	6.3%	164.9
081-VUD-CRP3_Sports_Hall		516.6	16.3%	430.5
082-VUD-CRP3_Heating Plant-Technical office		8.0	0.3%	6.7
083-VUD-CRP3_Steve_Benet_building		86.0	2.7%	71.7
Not included VUD-CRP3_Building_no_14		30.2	1.0%	25.2
Not included VUD-CRP3_Kitchen		105.0	5.3%	88.8
Not included VUD-CRP3_Administration		65.4	2.1%	54.5
Not included VUD-CRP3_Laundry		47.6	1.5%	39.7
Not included VUD-CRP3_Storeroom		8.6	0.3%	7.2
Not included VUD-CRP3_Police		33.0	1.0%	27.5
Not included VUD-CRP3_other		78.5	2.5%	65.4
TOTAL		3,161.2	100%	2,634.7

Table 17 – Estimated measured consumption of diesel

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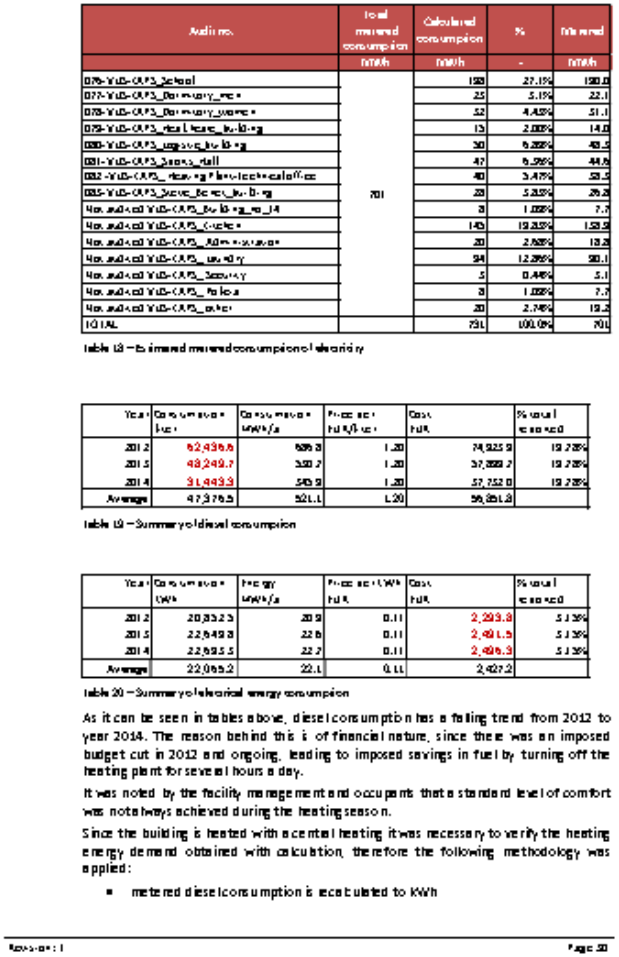


Audit no.	Total metered consumption	Calculated consumption	%	Metered
	MWh	MWh	-	MWh
076-VUD-CRPS_School	701	190	27.1%	190.0
077-VUD-CRPS_Dormitory_west		35	5.1%	32.1
078-VUD-CRPS_Dormitory_south		32	4.6%	31.1
079-VUD-CRPS_Medical Care_building		15	2.0%	14.0
080-VUD-CRPS_Workshop_building		50	6.8%	43.5
081-VUD-CRPS_Sports_Hall		47	6.5%	44.6
082-VUD-CRPS_Heating Plant+technical office		40	5.4%	38.5
083-VUD-CRPS_Service Center_building		28	3.8%	26.8
Non-audited VUD-CRPS_Building_no_14		8	1.0%	7.7
Non-audited VUD-CRPS_Outside		145	19.8%	139.5
Non-audited VUD-CRPS_Administration		20	2.8%	18.8
Non-audited VUD-CRPS_Laundry		94	12.8%	90.1
Non-audited VUD-CRPS_Security		5	0.6%	5.1
Non-audited VUD-CRPS_Police		8	1.0%	7.7
Non-audited VUD-CRPS_Other		20	2.7%	19.2
TOTAL		731	100.0%	701

Table 18 – Estimated metered consumption of electricity

Year	Consumption liter	Consumption MWh/a	Price per EUR/liter	Cost EUR	% annual reduced
2012	62,436.6	636.8	1.20	74,923.9	19.28%
2013	48,249.7	550.7	1.20	57,899.7	19.28%
2014	31,443.3	540.9	1.20	37,732.0	19.28%
Average	47,376.5	521.1	1.20	56,851.8	

Table 19 – Summary of diesel consumption

Year	Consumption GWh	Energy MWh/a	Price per GWh EUR	Cost EUR	% annual reduced
2012	20,853.3	20.9	0.11	2,293.8	5.13%
2013	22,649.8	22.6	0.11	2,491.5	5.13%
2014	22,993.5	22.7	0.11	2,496.3	5.13%
Average	22,065.2	22.1	0.11	2,427.2	

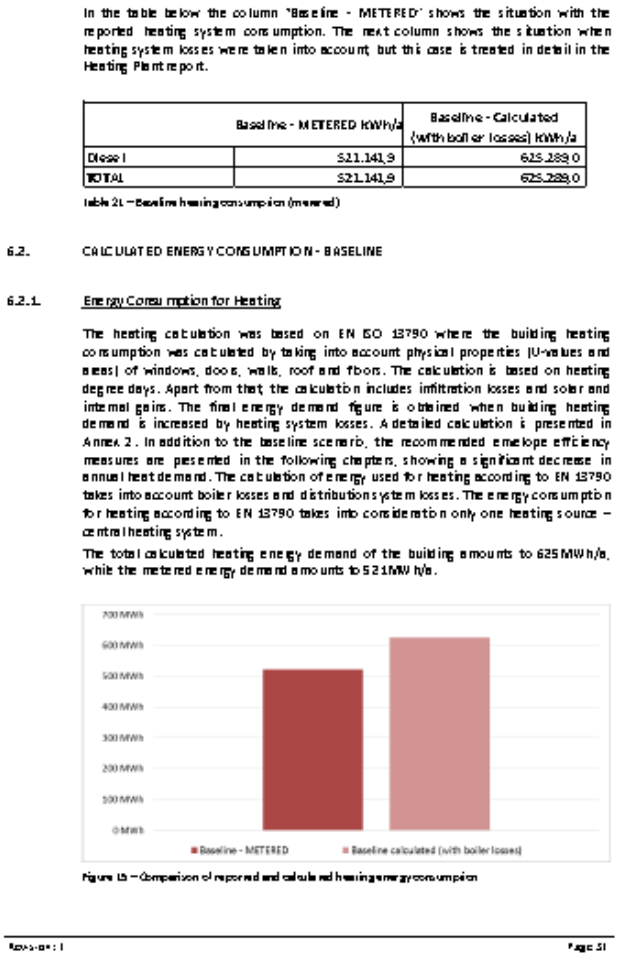
Table 20 – Summary of electrical energy consumption

As it can be seen in tables above, diesel consumption has a falling trend from 2012 to year 2014. The reason behind this is of financial nature, since there was an imposed budget cut in 2012 and ongoing, leading to imposed savings in fuel by turning off the heating plant for several hours a day.

It was noted by the facility management and occupants that a standard level of comfort was not always achieved during the heating season.

Since the building is heated with a central heating it was necessary to verify the heating energy demand obtained with calculation, therefore the following methodology was applied:

- metered diesel consumption is recalculated to kWh



In the table below the column "Baseline - METERED" shows the situation with the reported heating system consumption. The next column shows the situation when heating system losses were taken into account, but this case is treated in detail in the Heating Plant report.

	Baseline - METERED kWh/a	Baseline - Calculated (with boiler losses) kWh/a
Diesel	521.141,9	625.288,0
TOTAL	521.141,9	625.288,0

Table 21 – Baseline heating consumption (metered)

6.2. CALCULATED ENERGY CONSUMPTION - BASELINE

6.2.1. Energy Consumption for Heating

The heating calculation was based on EN ISO 13790 where the building heating consumption was calculated by taking into account physical properties (U-values and areas) of windows, doors, walls, roof and floors. The calculation is based on heating degree days. Apart from that, the calculation includes infiltration losses and solar and internal gains. The final energy demand figure is obtained when building heating demand is increased by heating system losses. A detailed calculation is presented in Annex 2. In addition to the baseline scenario, the recommended envelope efficiency measures are presented in the following chapters, showing a significant decrease in annual heat demand. The calculation of energy used for heating according to EN 13790 takes into account boiler losses and distribution system losses. The energy consumption for heating according to EN 13790 takes into consideration only one heating source – central heating system.

The total calculated heating energy demand of the building amounts to 625 MWh/a, while the metered energy demand amounts to 521 MWh/a.

Figure 15 – Comparison of reported and calculated heating energy consumption

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The calculated baseline is approximately 104 MWh/a higher than the reported baseline value. As discussed above, the heating comfort inside the building is not always met.

6.2.2. Electrical Energy Consumption

The calculated electrical energy for the baseline scenario was consumed for lighting, cooling and office equipment as presented in Table 22. The calculation is derived from a count of all electrical devices in the building and an estimate of usage throughout the year.

Uses	Lighting	Equipment	Total
kWh/a	9,527.8	13,499.0	23,026.8
MWh/a	9.5	13.7	23.0

Table 22 – Calculated electrical energy usage

7. ENERGY EFFICIENCY MEASURES

7.1. BUILDING ENVELOPE

Table 23 summarizes the above renovation cases for the entire building envelope. The UA value is the U value of each element multiplied by the area of each element, indicating how much heat is transferred per unit of temperature difference between the external and internal air. Implementing the above measures increases the envelope performance (as measured by the total UA value) by 63%.

	Baseline			Renovated			Improvement
	U [W/m²K]	A [m²]	UA [W/K]	U [W/m²K]	A [m²]	UA [W/K]	%
Wall 1	1.85	1,492.1	2,475.0	0.327	1,492.1	488.0	80.61%
Windows 1	1.800	372.9	671.0	1.800	372.9	671.0	0.00%
Windows 2	4.500	67.9	305.1	1.400	67.9	94.9	68.89%
Doors 1	1.800	25.5	45.9	1.800	25.5	45.9	0.00%
Roof	4.124	955.9	3,950.6	0.306	955.9	292.1	92.61%
Basement	1.975	955.9	1,887.6	1.975	955.9	1,887.6	0.00%
Total			9,205.4			3,471.6	62.91%

Table 23 – Envelope efficiency improvements

This increased envelope performance leads to savings in the heat load which is to be met by the heating plant. The heat load by element for the baseline and renovated envelope is presented in Table 24 and Table 25 (absolute and specific per meter squared values respectively), showing a 62% decrease overall in the ideal calculated heating load due to increased thermal performance and reduced infiltration.

	Baseline heating load	Envelope upgrade heating load	Savings	Savings
	kWh/a	kWh/a	kWh/a	%
Walls	109,672.2	21,270.6	88,401.6	81%
Windows/doors	45,288.4	35,975.1	9,313.3	21%
Roof	175,057.5	12,942.4	162,115.1	93%
Basement	49,348.9	49,348.9	0.0	0%
Infiltration	102,606.2	78,927.9	23,678.4	23%
Ventilation	0.0	0.0	0.0	0%
Internal gains	-8,746.2	-8,746.2	0.0	0%
Solar gains	-23,019.9	-18,960.2	-4,059.7	-18%
Total heat load	450,208.1	170,758.4	279,448.6	62%

Total savings [kWh/a] 279,448.6

% savings. 62.1%

Table 24 – Absolute heating load envelope improvement

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	Baseline heating load	Envelope upgrade heating load	Savings	Savings
	kWh/m2/a	kWh/m2/a	kWh/m2/a	%
Walls	35.4	6.9	28.5	81%
Windows/doors	14.6	11.6	3.0	21%
Roof	56.5	4.2	52.3	93%
Basement	15.9	15.9	0.0	0%
Infiltration	33.1	25.5	7.6	23%
Ventilation	0.0	0.0	0.0	0%
Internal gains	-2.8	-2.8	0.0	0%
Solar gains	-7.4	-6.1	-1.3	-18%
Total heat load	145.3	55.1	90.2	62%
			% savings:	62.1%

Table 25 – Specific heating load envelope improvement

The final calculated heating load after implementation of energy efficiency measures amounts to 200 kW (see Annex 2 for calculation details) and the annual energy demand due to building losses drops from 450 MWh/a to 171 MWh/a. The drop occurs due to envelope insulation and reduction in infiltration losses due to enhanced window properties. Envelope insulation will serve as the basis for other calculations where various other heating sources will be considered.

7.2. HEATING SYSTEM

According to the baseline, energy demand due to heating system losses amounts to approx. 175 MWh/a with 72% heating system efficiency (includes heating distribution and regulation system efficiencies).

The heating demand, by taking into account the envelope renovation case, would amount to 237 MWh/a. If the building stays connected to the Central heating system and the internal distribution system is renovated the overall system efficiency would increase to 81%.

Financial parameters of each project are elaborated in section 8.

7.3. VENTILATION SYSTEM

No measures recommended.

7.4. COOLING SYSTEM

No measures recommended.

7.5. LIGHTING SYSTEM

A lighting system efficiency project was created as follows;

- Replacement of T8 fixtures 2x36W with HE T5 2x28W
- Replacement of T8 fixtures 1x36W with HE T5 2x14W
- Replacement of T8 fixtures 2x36W with HE T5 2x28W
- Replacement of incandescent lamps with CFL

Lighting renovation proposed replacement of incandescent lamps as the major energy saving measure regarding electrical energy. See Table 29 – Project 2 cost specification for the detailed line items of this project.

Lighting
Baseline

TYPE	No.	Bulbs	Watts	Ballast	kWh/a
T8 Fluorescent 2x36W	4	2	36	15%	531.1
T8 Fluorescent 1x36W	127	1	36	15%	3,375.5
T8 Fluorescent 2x36W	11	2	36	15%	980.4
Incandescent 100W	25	1	100	0%	2,438.0
TOTAL	165		208		9,527.2

Lighting
Renovation

TYPE	No.	Bulbs	Watts	Ballast	kWh/a
T5 Fluorescent 2x28W	4	2	28	0%	257.4
T5 Fluorescent 2x14W	127	2	14	0%	3,769.4
T5 Fluorescent 2x28W	11	2	28	0%	635.0
CFL 26W	25	1	26	0%	633.9
TOTAL	165		96		5,295.8

Table 29 – Comparison of baseline consumption and renovated consumption

7.6. SANITARY HOT WATER

Building is already connected to a SHW solar thermal system which is working properly. The system consists of solar thermal panels and uses electricity as backup. The solar system is currently overheating when there is no SHW demand, therefore it is strongly recommended to change the system to a drain back system, however before installing the system it should be checked whether the collectors are allowed to be emptied. The drain back system automatically drains the solar medium into a special tank and does not heat up the SHW when not needed.

7.7. OTHER ELECTRICAL EQUIPMENT

Electrical equipment within the building is mostly administrative. This equipment is considered necessary for normal operation of the teaching process; therefore the only EE measure in this section is the replacement of the pumps with new VFD pumps.

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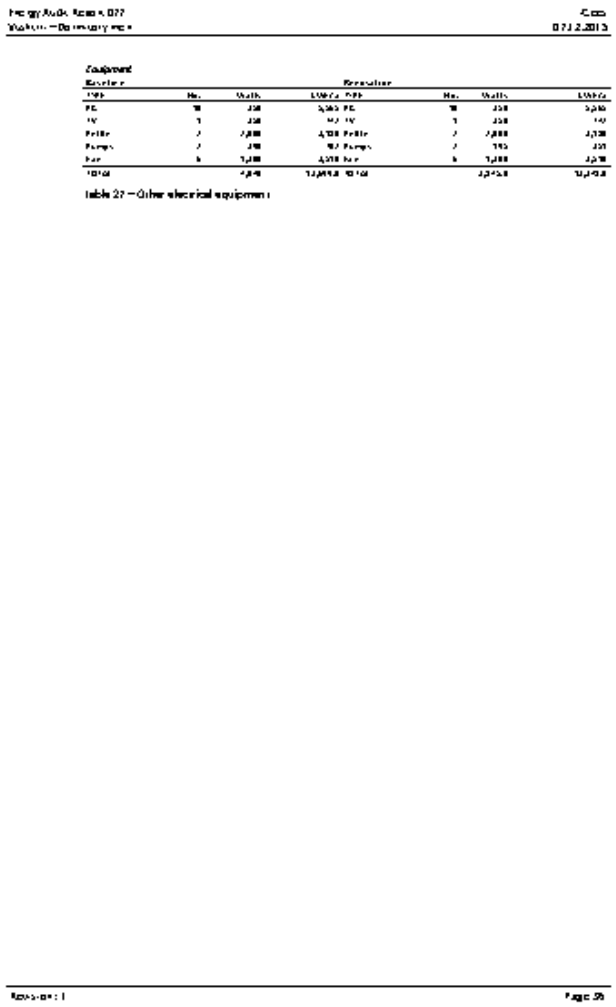
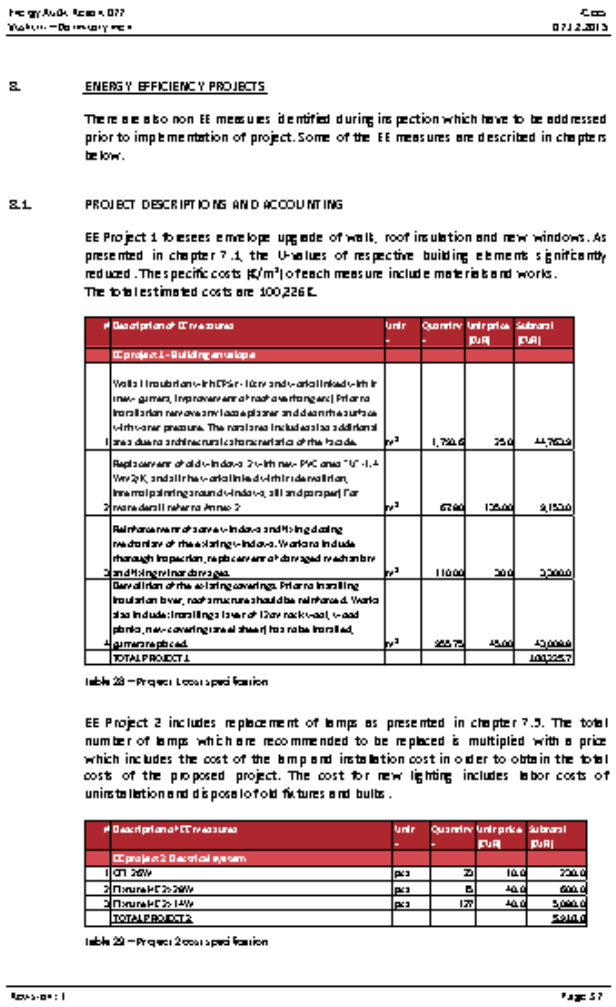


Equipment

Baseline				Renovation			
Item	No.	Watts	kWh/a	Item	No.	Watts	kWh/a
PC	18	250	3,240	PC	18	250	3,240
TV	1	250	90	TV	1	250	90
Boiler	2	2,000	4,000	Boiler	2	2,000	4,000
Pumps	2	190	190	Pumps	2	190	190
Fan	6	1,200	4,320	Fan	6	1,200	4,320
TOTAL		4,840	12,840	TOTAL		3,940	11,840

Table 27 – Other electrical equipment



8. ENERGY EFFICIENCY PROJECTS

There are also non EE measures identified during inspection which have to be addressed prior to implementation of project. Some of the EE measures are described in chapters below.

8.1. PROJECT DESCRIPTIONS AND ACCOUNTING

EE Project 1 foresees envelope upgrade of walls, roof insulation and new windows. As presented in chapter 7.1, the U-values of respective building elements significantly reduced. The specific costs (€/m²) of each measure include materials and works. The total estimated costs are 100,226 €.

#	Description of EE measures	Unit -	Quantity -	Unit price (EUR)	Subtotal (EUR)
	EE project 1 - Building envelope				
1	Walls Insulation - Inside EPS or - Outside and - external Inside - Inside new - gypsum, Improvement of roof overhang and Prior to installation new overall cleaning planar and clean the surface - Inside - over pressure. The renovated Included also additional area due to architectural characteristics of the facade.	m²	1,790.6	25.0	44,765.0
2	Replacement of old - Indoor 2 - layer new PVC ones "U" - 1.4 W/m2K, and all have - external Inside - Inside roller blind, Internal painting around - Indoor, sill and parapet (For more details refer to Annex 2)	m²	67.60	135.00	9,126.0
3	Reinforcement of observe - Indoor and Hinging closing mechanism of the shutters - Indoor. Works include thorough inspection, replacement of damaged mechanism and Hinging in damages.	m²	110.00	30.0	3,300.0
4	Demolition of the existing coverings. Prior to installing insulation layer, roof structure should be reinforced. Works also include: Installing layer of 12cm rock-wool, wood planks, new covering (metal sheet) has to be installed, gutters replaced.	m²	955.75	45.00	43,000.0
	TOTAL PROJECT 1				100,226.7

Table 28 – Project 1 cost specification

EE Project 2 includes replacement of lamps as presented in chapter 7.5. The total number of lamps which are recommended to be replaced is multiplied with a price which includes the cost of the lamp and installation cost in order to obtain the total costs of the proposed project. The cost for new lighting includes labor costs of uninstallation and disposal of old fixtures and bulbs.

#	Description of EE measures	Unit -	Quantity -	Unit price (EUR)	Subtotal (EUR)
	EE project 2 Electrical system				
1	CFL 26W	pcs	20	10.0	200.0
2	Fluorescent 2x26W	pcs	15	40.0	600.0
3	Fluorescent 2x14W	pcs	127	40.0	5,080.0
	TOTAL PROJECT 2				5,910.0

Table 29 – Project 2 cost specification

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EE Project 3 The additional cost in this case is the refurbishment of the existing substation distribution system, installation of TRVs on the radiators, as well as replacement of the existing pumps with new ones with VFD. The total costs are approx. 13,870 €.

#	Description of EE measures	Unit -	Quantity -	Unit price [EUR]	Subtotal [EUR]
	EE project 3 - Heating system renovation				
1	Installing self-operated thermostatic valves (no radiator cover with valves (radiator cover and TRV valve) where necessary)	ea	134,0	55,0	7,370,0
2	Partial replacement of pipes of distribution system	ea	1,0	1,000,0	1,000,0
3	Replacement of existing circulation pumps (5 kW) with new circulation pumps with VFD	ea	2,0	1,500,0	3,000,0
4	Creating general design of thermal heating network	u	1,0	2,500,0	2,500,0
	TOTAL PROJECT 3				13,870,0

Table 30 – Project 3 cost specification

8.2. NON-EE MEASURES

A monitoring system is recommended for proper accounting of energy consumption and to provide a baseline for future EE measures.

#	Description of non EE measures	Unit -	Quantity -	Unit price [EUR]	Subtotal [EUR]
	Monitoring				
1	Energy Monitoring (sensors, data logger, software, training)	u	1,0	12,000,0	12,000,0
	TOTAL MONITORING				12,000,0

Table 31 – Monitoring cost specification

Further measures include the internal painting, installing drain back equipment, check and fixing possible deficiencies in the solar thermal system.

#	Description of non EE measures	Unit -	Quantity -	Unit price [EUR]	Subtotal [EUR]
	Non EE measures				
1	Internal painting of mechanical rooms	u	1,0	3,725,0	3,725,0
2	Installing Drain back equipment in the existing solar thermal system	ea	1,0	3,500,0	3,500,0
3	Creating general design of solar thermal system by validating damages of installation and correcting deficiencies	u	1,0	2,000,0	2,000,0
	TOTAL NON EE MEASURES				14,725,0

Table 32 – Non-EE measures cost specification

8.3. FINANCIAL VIABILITY

Based on the costs and energy savings, a yearly cash flow analysis was performed. Fuel escalation was applied separately to baseline and proposed projects according to the fuel escalation rate of 2% per year. Table 33 presents an overview of the cash flow analysis, including the financial indicators net present value, internal rate of return, and the simple payback period.

		1. Envelope renovation	2. Lighting renovation	3. Heating system renovation *
Fuel savings	[EUR/a]	35,288,9	0,0	2,356,6
Electricity savings	[EUR/a]	0,0	484,1	42,1
Hot water cost savings	[EUR/a]	0,0	0,0	0,0
Total investment cost	[EUR]	-100,225,7	-5,910,0	-13,870,0
NPV	[EUR]	250,278,6	-2,638,6	10,346,0
Project life	[Years]	20,0	10,0	20,0
IRR	[%]	37,8%	-1,5%	19,1%
Simple payback	[Years]	2,84	12,21	5,89

Table 33 – Financial summary[7]

8.3.1. Energy Saving Potential

The table and figure below compare the reported and baseline energy consumption in kWh with the different scenarios of energy efficiency projects.

	Baseline scenario	1. Envelope renovation *	2. Lighting renovation	3. Heating system renovation * [1]
Heat consumption				
Heating energy source	Diesel	Diesel		Diesel
Heating consumption [kWh/a]	625,288,0	257,163,3		210,814,1
Specific consumption [kWh/a/m2]	201,9	79,6		65,1
Heating savings		59%		11%
Electricity consumption				
Electricity consumption [kWh/a]	25,026,8	25,026,8	18,582,6	22,675,8
Specific Consumption [kWh/a/m2]	7,4	7,4	5,1	7,5
Electrical load savings		0%	17,5%	2%
Total savings [kWh/a]		368,123,1	96,920,8	26,702,8
Total savings [%]		50%	14,2%	10%

Table 34 – Comparison of energy efficiency projects, baseline and reported energy consumption[8]

[7] The heating NPV and IRR consider the envelope as the new baseline for energy savings calculations
[8] The heating NPV and IRR consider the envelope as the new baseline for energy savings calculations

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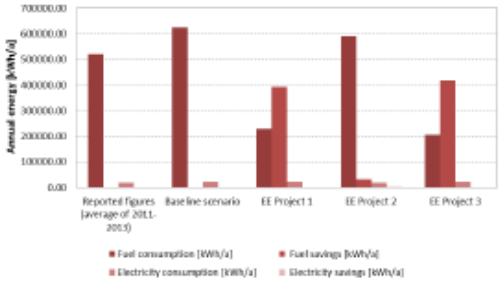

Figure 18 – Comparison of energy efficiency projects, baseline and reported energy consumption

8.4. RECOMMENDATIONS

8.4.1. EE-Project Summary

From the financial results in Table 33, a summary for each EE project can be drawn based on their highest NPV.

Project	NPV	Investment cost	IRR	Simple PB
	€	€	%	Year
1. Envelope renovation	290.279	100.226	37,8%	2,84
3. Heating system renovation *	10.346	13.870	19,1%	5,69
2. Lighting renovation	-2.638	5.910	-1,5%	12,21

Table 35 – Ranking based on highest NPV

In the above Table 35, the envelope project is considered a stand-alone project. The envelope upgrade is a precondition before any heating system upgrades. Therefore, the heating projects (Heating system renovation) are disaggregated as incremental to the envelope. The heating NPV and IRR consider the envelope as the new baseline for energy savings calculations. Heating system upgrade projects are then ranked as to their highest NPV.

8.4.2. Final Recommendations

Table 36 below summarizes the final package of energy efficiency measures and related general building improvements. The most economically feasible projects are selected based on the financial cut-off rate of return, 10%.

The baseline for comparison is the actual construction condition of the buildings and technical systems. The economic feasibility of each identified measure was evaluated based on the estimates of construction and installation. Operational energy savings were calculated using standard calculation methods for heating and electricity demand, and are compared to the baseline conditions.

Project	Heating Savings	Electricity Savings	Carbon Savings	Cash Savings	Investment cost	Simple payback
	kWh/a	kWh/a	non CO_2/a	€/a	€	Years
1. Envelope renovation	588.120	0	106	58.284	100.226	2,84
* Multi-year value, annualized. Heating savings are the incremental value of all replacement scenarios.						
3. Heating system renovation *	26.253	351	8	2.626	13.870	5,69
* Installing a boiler and thermostatic valves, the incremental value of all upgrades is considered, including the replacement of heat valves.						
Monitoring					12.000	
* Energy monitoring						
Total	614.479	351	113	57.660	126.096	2,25
Non CO2 measures					14.795	
* Internal painting of the total area						
* Installing Guar-Bankruptcy-proof or sealing valve thermal valves						
* Blinding and upgrading valve thermal valves by replacing average upper valve area with thermal valves						
* Replacement of existing lighting						

Table 36 – Recommended measures

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9. BUILDING CHARACTERISTICS WITH REGARD TO HAZARDOUS MATERIALS

9.1. OVERVIEW

Type of Use (Office, Educational, Hospital, etc.)	Dormitory
Year of construction:	1936
Year of significant reconstruction/refurbishing work:	Windows 2000
Partitioning of Building:	[illegible]
Type of Roof	Gable roof

Table 37 – Building properties

Existence	Yes	No	Comment	Likely
Central energy generation unit (e.g. steam production, heating boiler, oil tank)	X			ACM
Central ventilation / air conditioning system		X		ACM
Insulation applied	X			ACM
Facade with thermal insulation		X		ACM
Roof / facade with fiber cement sheets	X			ACM
Windows / PVC flooring with textural ACM glue layer		X		ACM
Night storage heaters / Accumulators		X		ACM
Special rooms for special medical use (e.g. surgery, radiology / X-ray)		X		used
Swimming pool		X		used
Compact fluorescent lamps / Energy Saving Bulbs Recycling	X		Residential waste containers	Mercury

Table 38 – Likelihood of hazardous materials existence (based on interview)

9.2. SUMMARY OF HAZARDOUS MATERIAL SURVEY

9.2.1. Suspect Hazardous Material

During the survey, the following products have been identified to be potentially a hazardous material:

#	Group	Suspect Product	Purpose	Location	Analysis Result	Amount (m³)
1	Asbestos	Sabestos	Roof	Roof	Visual inspection – ACM identified	933,8 m²
2	CFLs	Spent or charged CFLs	end of use / early failure	[illegible] building	–	137

Table 39 – Identified Hazardous Materials overview (in bold: evidenced materials)

The results of the visual and laboratory analysis are summarized in the following section.

9.2.2. Classification of Risk and Abatement Urgency

The subject building has got (as indicated with Y):

Y Strongly bound asbestos containing materials : Asbestos containing fiber cement panels (incl. "Salonit") and or other strongly bound asbestos products such as flange sealings
N Night storage heater
N Textile asbestos containing products (strings, mattresses)
N Friable asbestos products
N Deposits of lead-based paints
Y Spent Compact Fluorescent lamps

9.2.3. Identified Hazardous Material #1: Fiber Cement Panels

According to the Urgency Checklist (see Annex 2), the identified deposits of hazardous materials are deemed to be of small risk[1] and require professional abatement[2] not urgently (within 5 years).

9.2.4. Identified Hazardous Material #2: Spent Compact Fluorescent lamps

According to the Standard Operation Procedure for the Collection and Recycling of Compact Fluorescent lamps, which have to be generally considered to contain Mercury, the identified deposits of hazardous material are deemed to be of an issue that requires a territorial awareness raising campaign and the introduction of an incentive system for CFL recycling.

[1] (small/medium/high) risk is derived from the urgency, whereas risk = urgent (40 points)
[2] non urgently (within 5 years), urgently (within 2 years), immediately (within 0,5 years) according to the urgency table of Annex 2

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9.3. PROPOSED HAZARD MANAGEMENT

Referring to the environmental laws and regulations of the Kosovo, the appropriate EU directives and the World Bank requirements, the following mitigation measures are proposed in the course of EE measures are to be foreseen:

9.3.1. Proposed Hazard Management – Asbestos-Fiber Cement Panels

The general approach while handling this material is that contractors avoid crushing/destructing of asbestos plates from the roofs and or from the walls insulation and deposit them in an organized manner on the construction sites.

9.3.1.1. Maintenance

Prohibit any mechanical stress on fiber-cement panels (no drilling, cutting, smashing, cutting, dropping etc.)

9.3.1.2. Removal

Amount:	9 559,8 m²
Location:	Roof

The Removal of ACM containing Fiber-Cement Panels ("Eternit" / "Salonit" or other) belongs to the removal of so called strong bonded ACM, due to the fact that those panels consist of a lesser amount of asbestos, which is firmly embedded in a cement matrix.
However, whenever fiber-cement panels are mechanically damaged or destroyed, ACM dust is set free.
Best practice is to prevent or minimize dust release, resulting from a destruction free removal process.

Main Remediation WorkSteps

- Prohibit any mechanical stress on fiber-cement panels (no drilling, cutting, smashing, cutting, dropping etc.)
- Strive un-mounting procedure using lifting devices
- Wear appropriate respiratory protection FFP3 and disposable coveralls
- Moisten panels before uninstall;
- Collect panels without destruction
- Pack them plastic foil / e.g. panel big-bags with Asbestos Label
- Orderly Store in an interim storage until transport and disposal at appropriate disposal site.

Further hints are:

- Nails/rivets shall be removed with sharp tools
- If the fixing can't be released, small sheets can be pried out one by one
- Dismantling of asbestos cement panels shall happen in a work back way, for roofs from the ridge to the eaves, for walls from top to bottom

- When removing fixation materials, the product has to be secured against sliding off
- Whenever possible, products shall be lifted off rather than quarried out
- Encrustation or plant cover can be scraped off, using a wood scraper
- Broken bits and debris shall be wrapped in dust proof foil or bags
- The contaminated material has to be transported to the ground carefully
- The transportation of asbestos cement products has to take place in a way, that prevents asbestos dusts to be released (packaging)
- For cleaning use H-class vacuum cleaners only.
- Storage and transport of material has to happen in suited, closed containers

To be avoided:

- Breaking, cutting, throwing and milling of sheets
- Drilling, sawing, grinding with fast running machinery
- Cleaning with high pressure cleaners
- Shaking out of canvasses or undercover sheeting
- Usage of debris chutes

9.3.1.3. Supervision of Asbestos Abatement

Specifically due to the risk that abatement was performed contrary to above mentioned regulations, it is highly recommended that the mitigation works are to be guided by a specifically trained (certified) independent expert (e.g. chartered civil engineer with asbestos abatement knowledge).

9.3.1.4. Asbestos Transport and Disposal

The Ministry of Environment and Spatial Planning (MESP) is working towards the establishment of and (interim) storage facility for hazardous materials.
Contractors should liaise with MESP regarding final disposal and treatment options, licensing requirements and applicable local regulations on this issue.
The contractor has to prepare and to provide a coordinated transport and disposal concept as soon as the contract is signed. This concept has to include, based on the appointment with the MESP, a signed confirmation of the nearest suitable approved landfill to accept construction wastes.
The Contractor shall perform or carry out all transports in fully accordance with the international Statutory and Technical Rules (ADR) and/or corresponding national rules. According to this, the transport containers and equipment require certain danger marks depending on shipped masses. Vehicles and their drivers require specific ADR approval or an ADR license. Each driver has to carry documents, identifying origin and destination, mass and waste type of his way.
The contractor has to prepare and to provide a coordinated transport and disposal concept as soon as the contract is signed. This concept has to include a signed confirmation of the subcontracted transshipping to be all required licenses.
Removed ACM shall be packed in double-foil of at least 0.2 mm thickness and stored in Big-Packs clearly visibly signed with the Asbestos Logo. Whenever transported with fork lifter, Big Packs have to be set on wooden euro pallet in order not to damage the big-packs by the forks.

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9.3.2. Proposed Hazard Management – Lead Based Paint

There is no evidence of the presence of Lead-based paint.

9.3.3. Proposed Hazard Management – CFLs

9.3.3.1. Maintenance

Prohibit any mechanical stress on compact fluorescent lamps (no smashing, dropping etc.)

In case lamps are broken, follow the typical instructions[4]

Before Clean up

- Have people and pets leave the room.
- Air out the room for 5-10 minutes by opening a window or door to the outdoor environment.
- Shut off the central forced air heating/air-conditioning system, if you have one.
- Collect materials needed to clean up broken bulb:
  - stiff paper or cardboard;
  - sticky tape;
  - damp paper towels or disposable wet wipes (for hard surfaces); and
  - a glass jar with a metal lid or a sealable plastic bag.

During Clean up

- Do not use the Vacuum cleaner! Vacuuming is not recommended unless broken glass remains after all other clean up steps have been taken. Vacuuming could spread mercury-containing powder or mercury vapor.
- Be thorough in collecting broken glass and visible powder. Scoop up glass fragments and powder using stiff paper or cardboard. Use sticky tape, such as duct tape, to pick up any remaining small glass fragments and powder. Place the used tape in the glass jar or plastic bag. See the detailed clean up instructions for more information, and for differences in cleaning up hard surfaces versus carpeting or rugs.
- Place clean up materials in a sealable container.

After Clean up

- Promptly place all bulb debris and clean up materials, including vacuum cleaner bags, outdoors in a trash container or protected area until materials can be disposed of. Avoid leaving any bulb fragments or clean up materials indoors.
- Next, check with your local government about disposal requirements in your area, because some localities require fluorescent bulbs (broken or unbroken) be taken to a local recycling center. If there is no such requirement in your area, you can dispose of the materials with your household trash.
- If practical, continue to air out the room where the bulb was broken and leave the heating/air conditioning system shut off for several hours.

[4] (e.g. Instructions of the U.S. Environmental Protection Agency. http://www.epa.gov/cfl/cleanup-broken-cfl)

9.3.3.2. Recycling of spent CFLs

In Kosovo, spent CFLs, whereas all of them are containing small portions of Mercury and other hazardous materials emittable to atmosphere, water or soil, are currently neither separately collected, nor properly recycled or treated.
Thus, spent CFLs are mainly disposed on regional sanitary landfills in Kosovo.
Recently, the only possibility to treat such lamps properly, i.e. to separate Mercury and other gases from glass and scrap metal, is its export to foreign countries, where authorized companies are maintain CFL recycling centers (e.g. Altas SRB).
For the collection and undamaged transport CFLs have to be stored in certain grid shaped cardboard containers on Euro pallets and wrapped with stretch foil, while energy safety bulbs (rarely to be found during EE implementation works) have to be stored in sealable open-top UN bins (200 liter).

Method example Altas SRB[5]:

Interseroh, an ALBA Group company, provides a convenient service aimed at saving consumers a trip to the local recycling plant: the Interseroh collection box is designed especially for taking back illuminants in small and medium quantities. Retailers and manufacturers set up these inexpensive boxes in their sales and storage areas, allowing end users to dispose of used illuminants in-store when purchasing new ones. In addition to the collection of tubes, bulbs and other lamps, the service also covers their recycling and documentation.
Collection boxes are available for different types of illuminants. Once a box is full, a quick phone call is all that is needed to arrange for it to be picked up. The entire take-back and disposal process is handled by Interseroh, in close collaboration with service partners throughout Germany.

In the future, the residual mercury-containing phosphor powder (1-3 % of CFL weight, rest is recyclable glass and metal scrap) is due to lack of economic methods at least for part disposed as hazardous waste on suitable landfills. In the usual process the gaseous portion goes into the atmosphere.

9.4. COST ESTIMATE FOR ABATEMENT AND DISPOSAL OF SELECTED HAZARDOUS MATERIAL

Costs for the removal of Hazardous material apply in case that the implementation of energy efficiency measures requires the abatement of hazardous material.

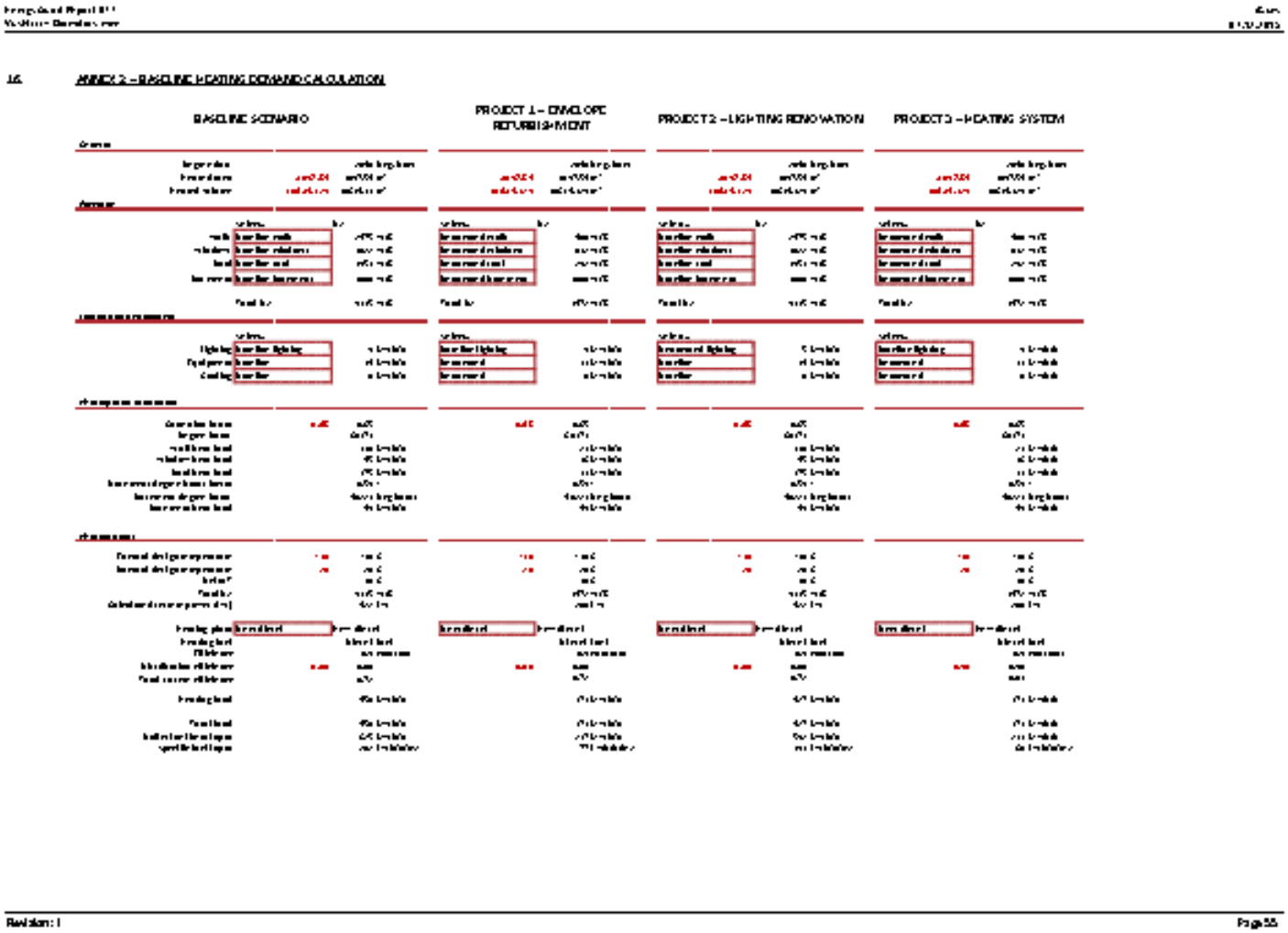
Asbestos containing material (ACM)

Based on similar ACM projects the following specific work amount has been estimated.

- Total amount approx. 9 558 m² of asbestos cement roof
- Estimated Weight (17 kg/m²): approx. 16 248,6 kg
- Product: Asbestos Cement (Salonit)

[5] Source: http://www.alba-group.com/de/recycling/alte-leuchtstoffroehren-und-energiesparlampen.html

O energetskoj reviziji …

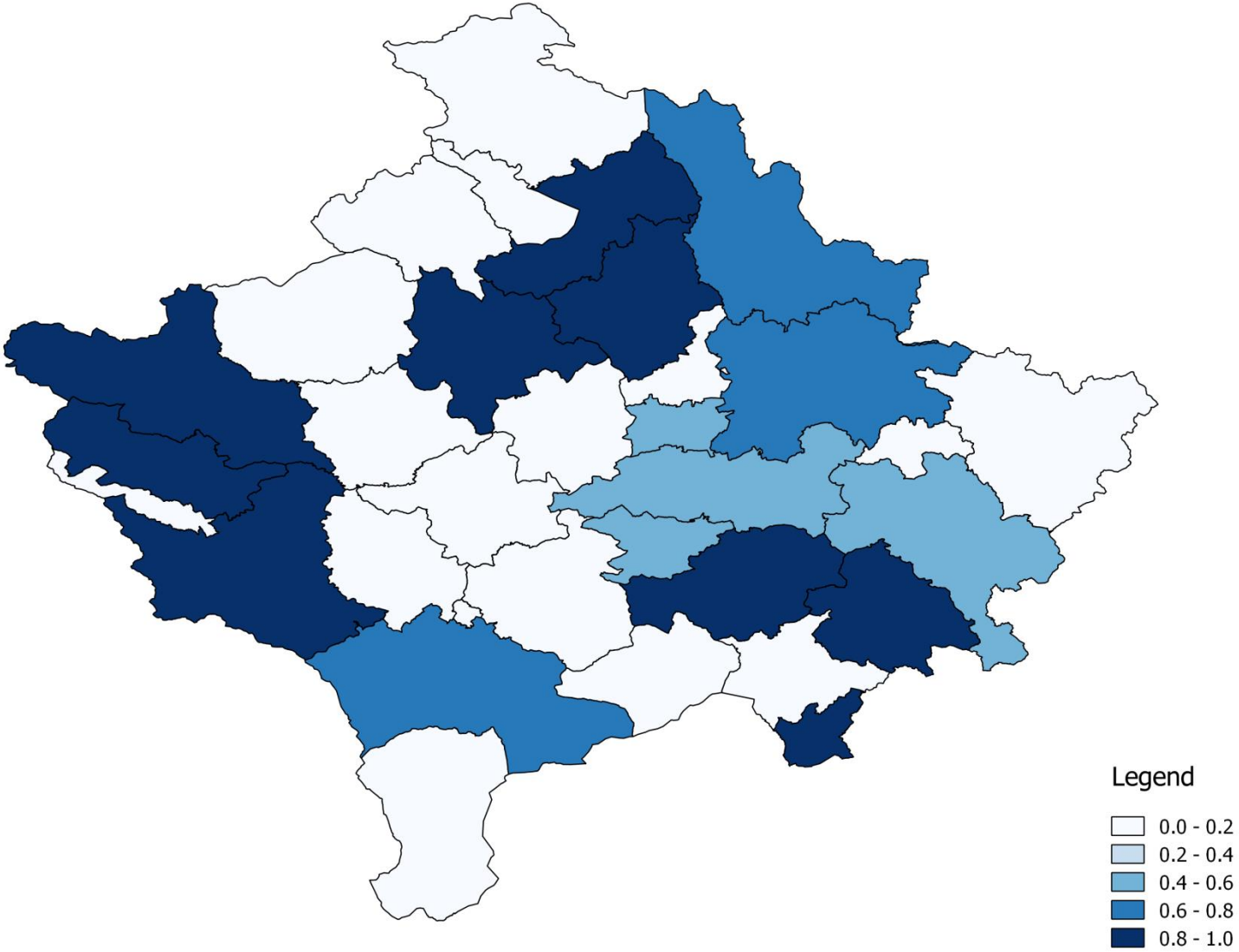


Utvrđene EE mere

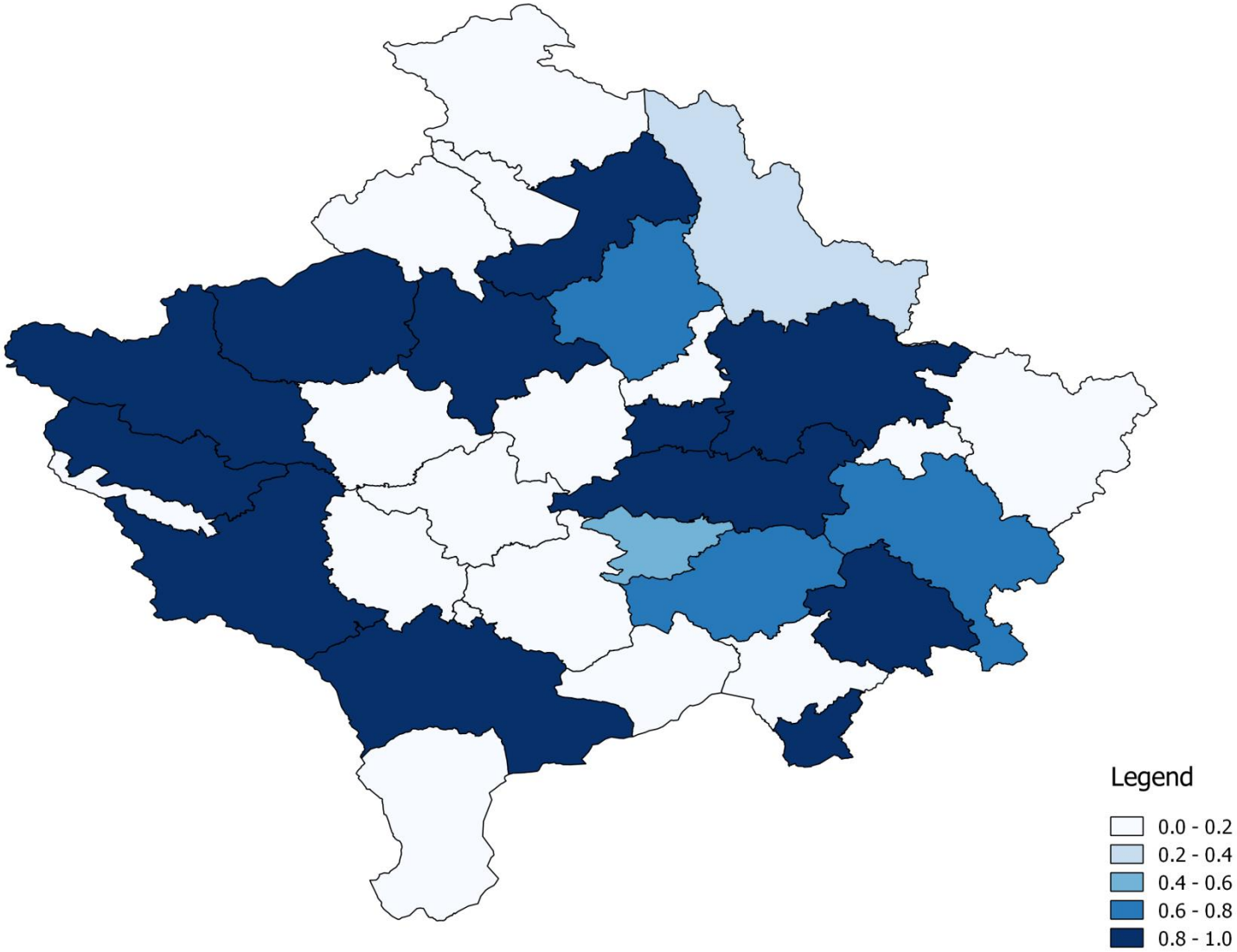
- Renoviranje zidova
- Renoviranje krova
- Zamena prozora i vrata
- Zamena goriva
- Poboljšanje sistema grejanja
- Popravka rasvete
- Solarno grejanje

- Sve brojke su prikazane u procentima:
  - Broj objekata u kojima su primenjene mere je podeljen sa ukupnim brojem objekata

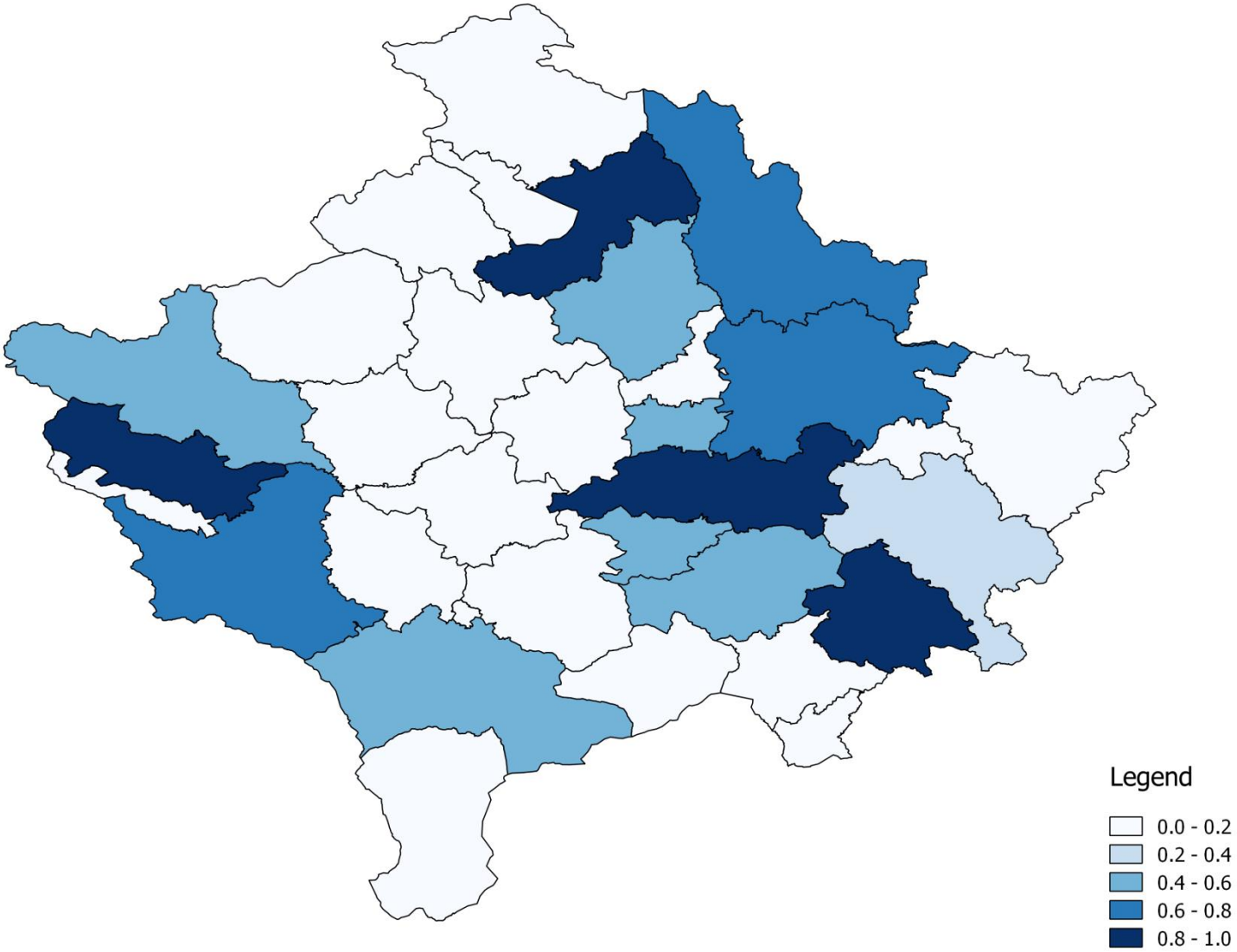
Utvrđene EE mere - renoviranje zidova



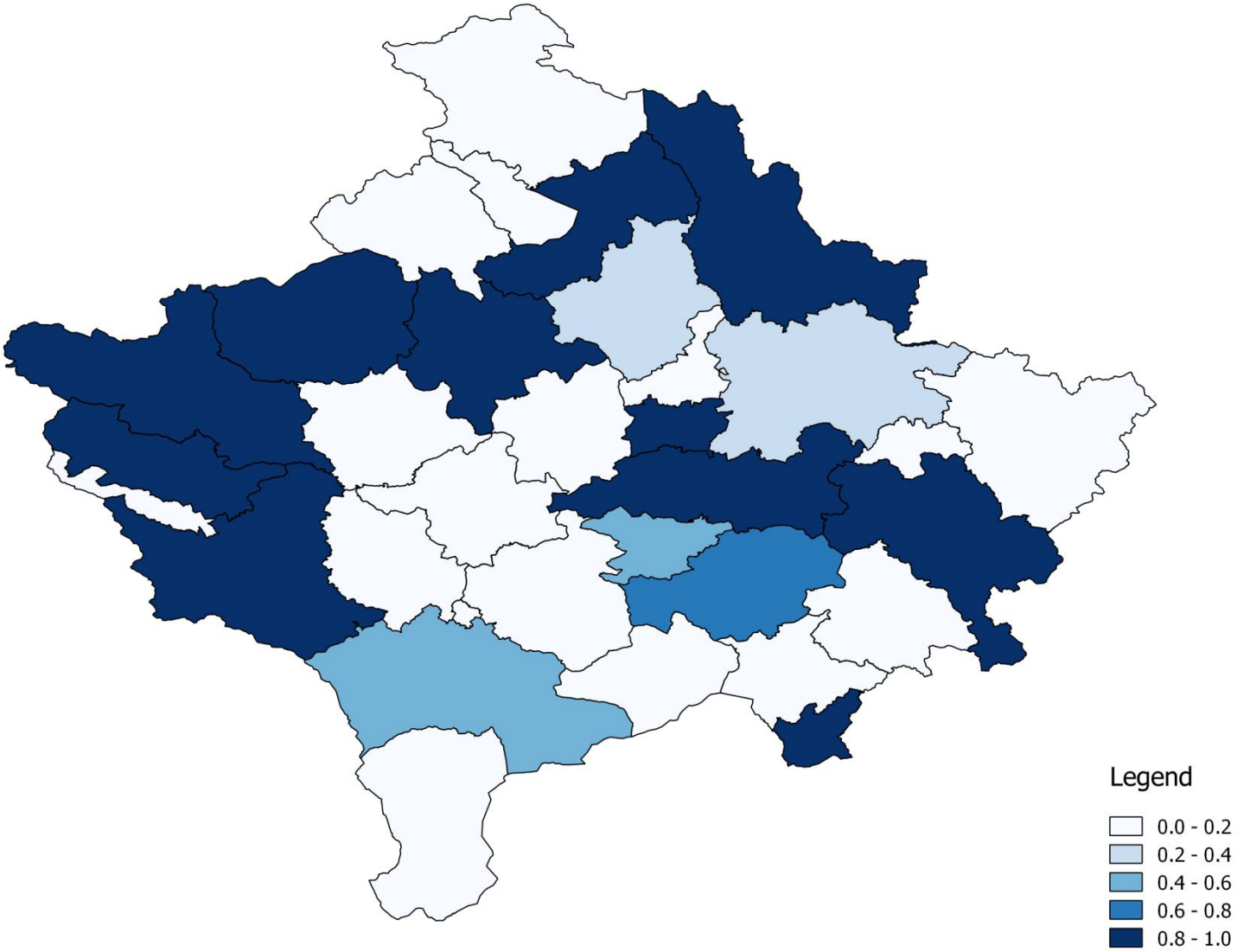
Utvrđene EE mere - renoviranje krova



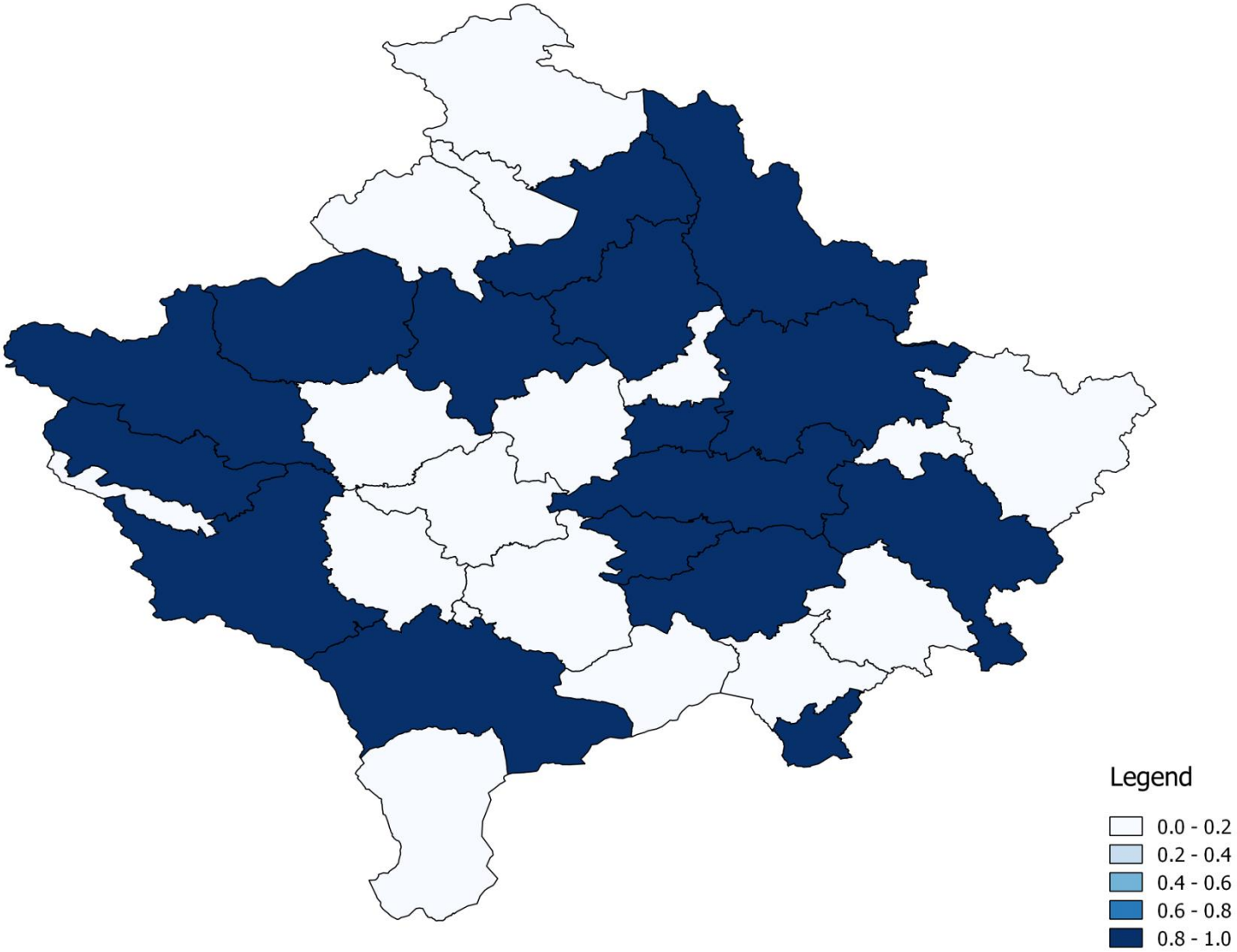
Utvrđene EE mere - renoviranje prozora



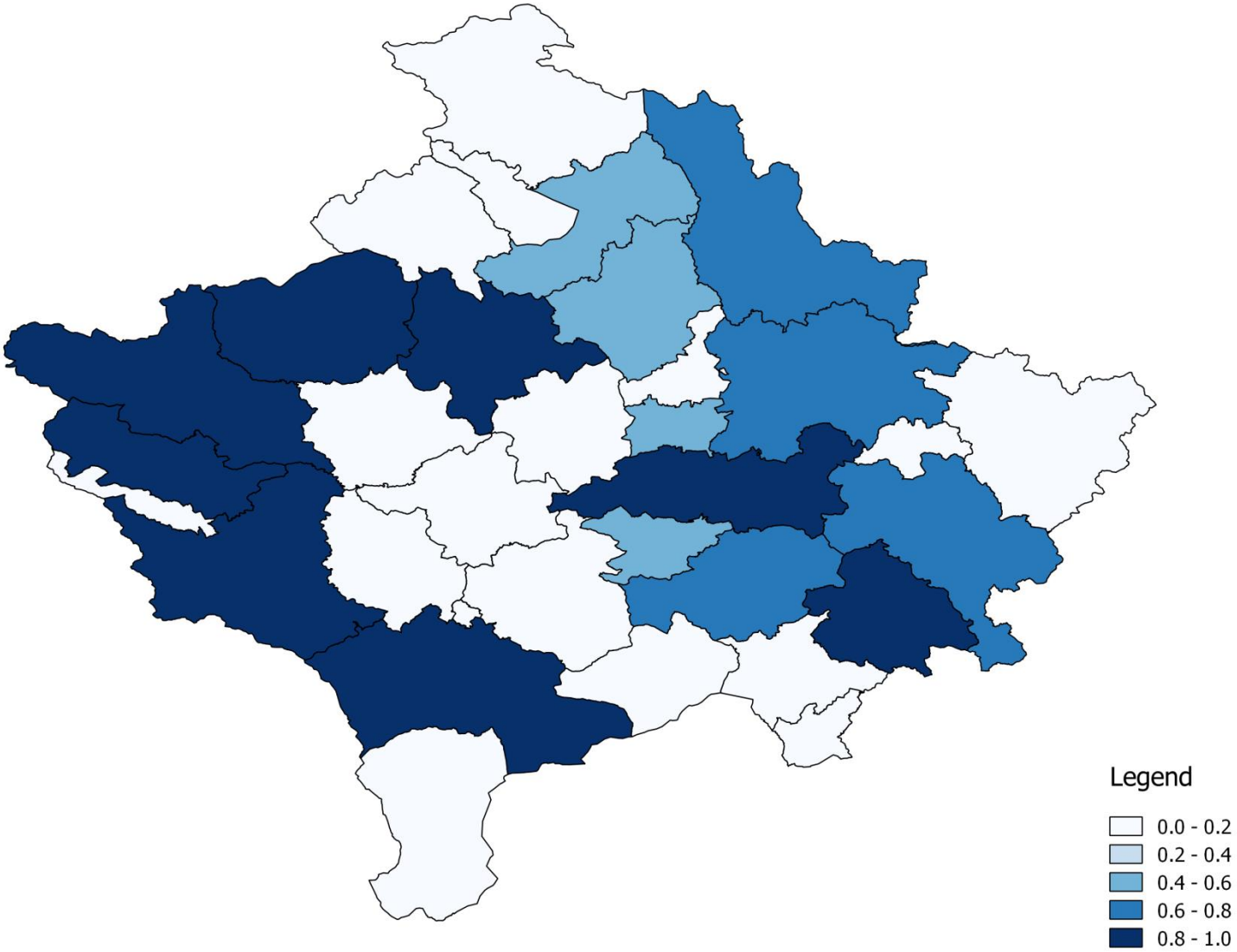
Utvrđene EE mere - zamena goriva



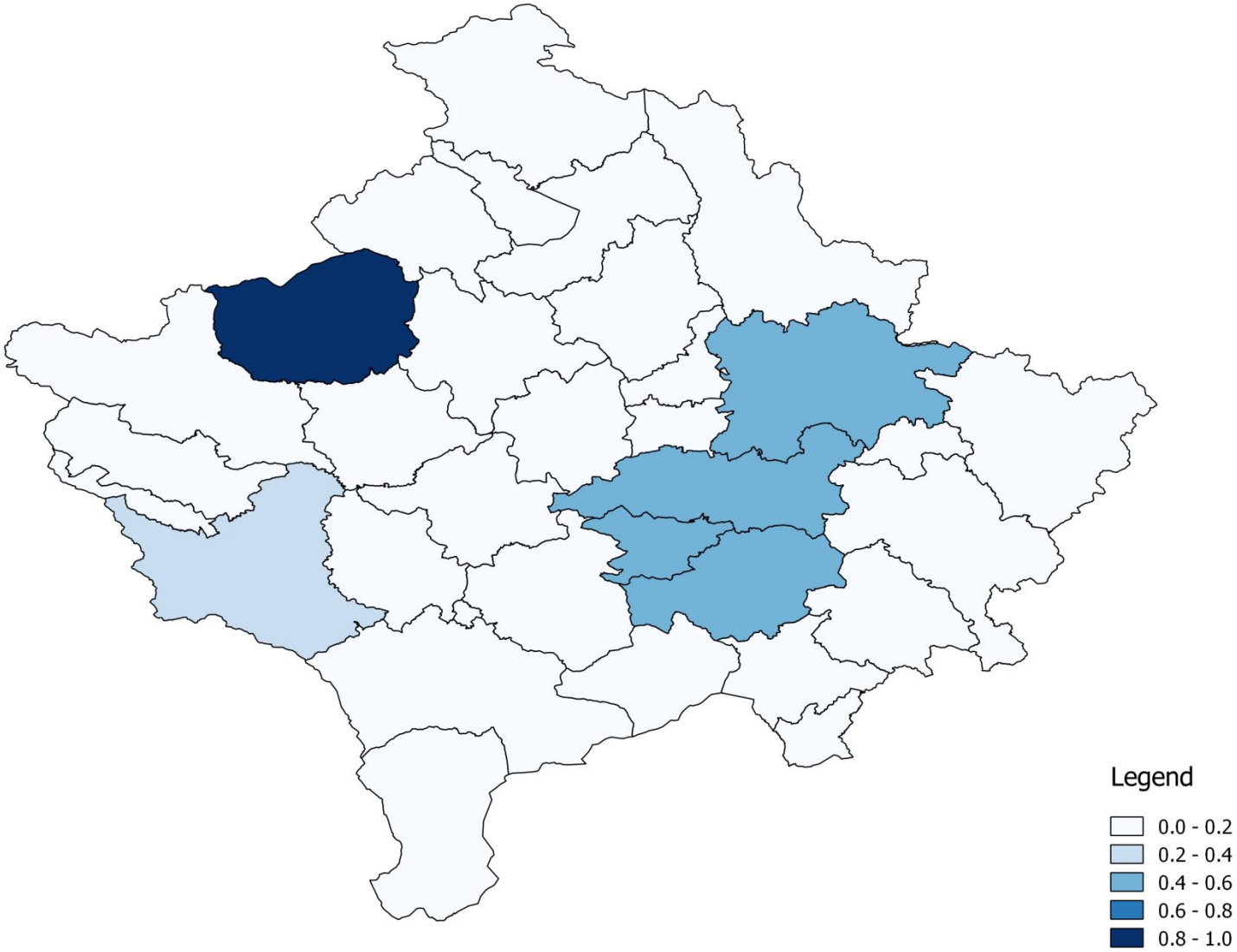
Utvrđene EE mere - sistem grejanja



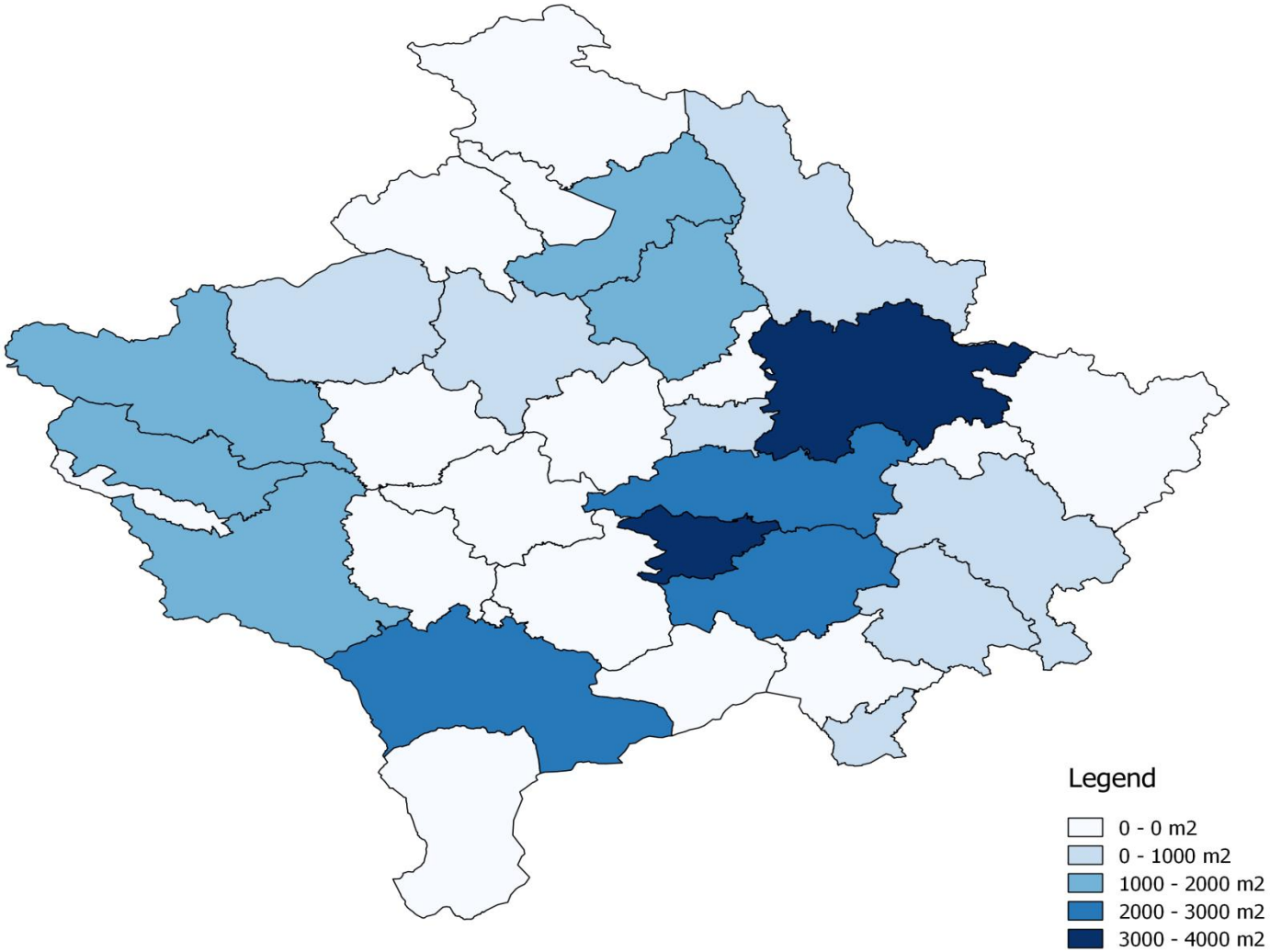
Utvrđene EE mere - sistem rasvete



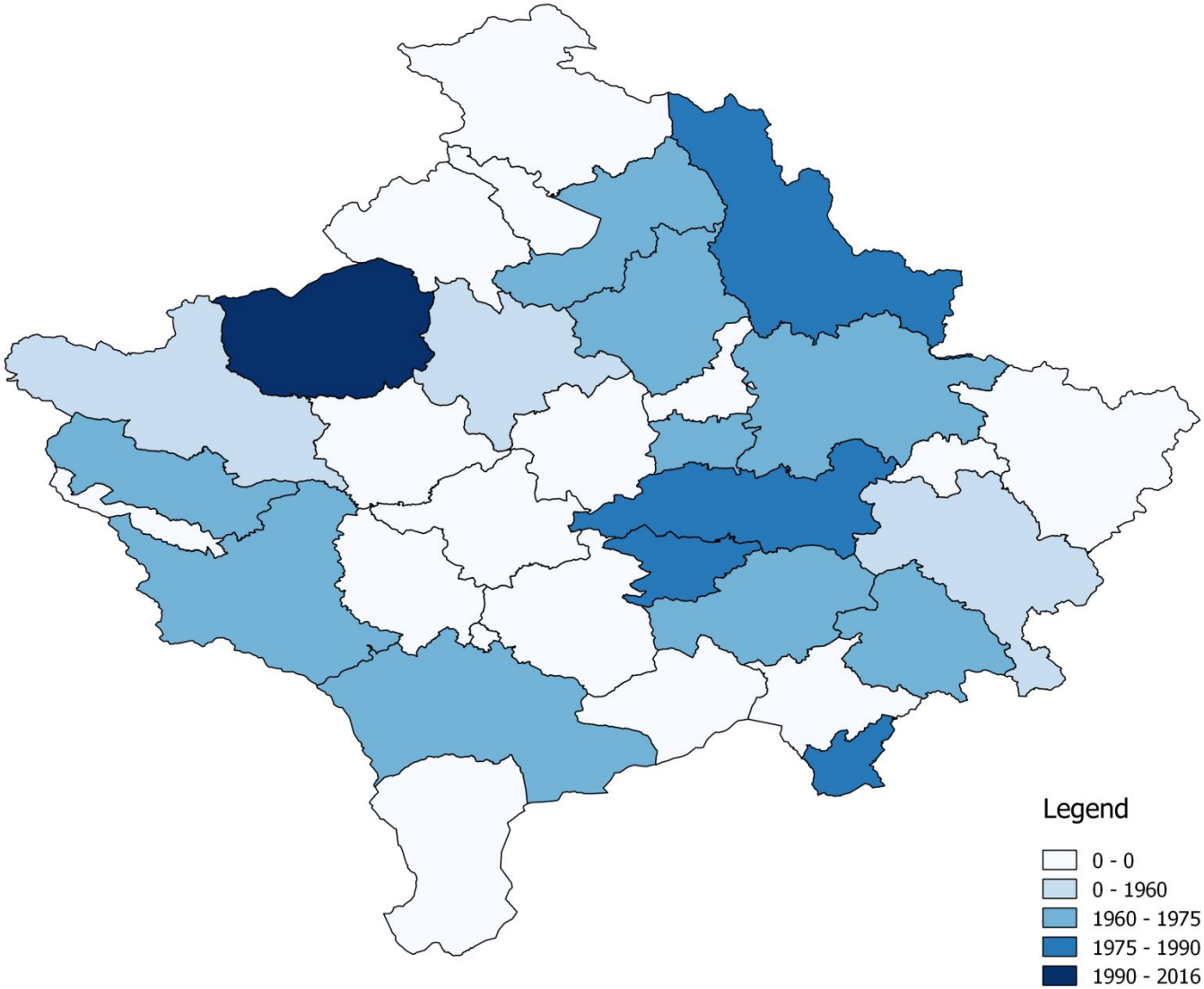
Utvrđene EE mere - solarno grejanje



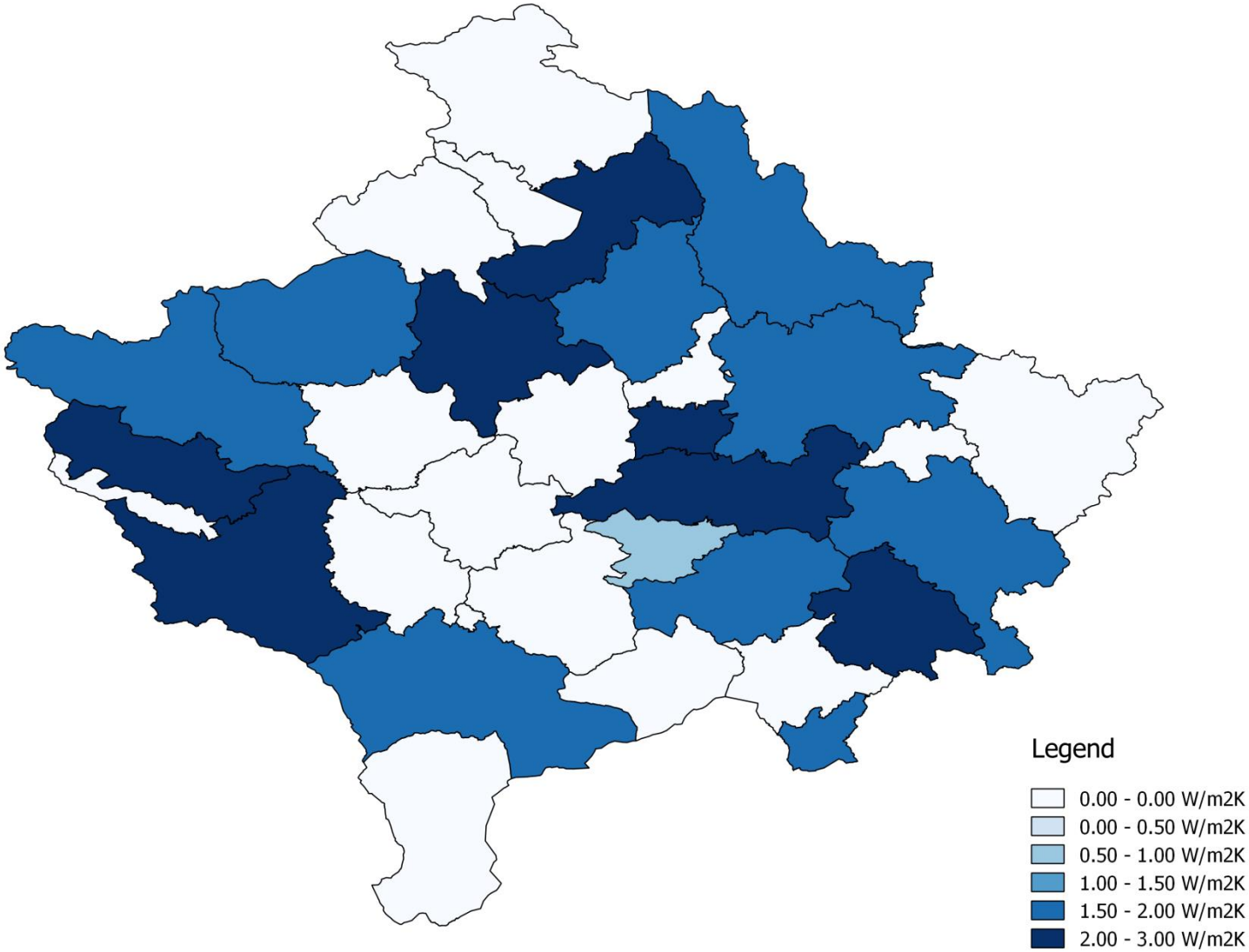
Sumirani rezultati - prosečna grejna površina objekta



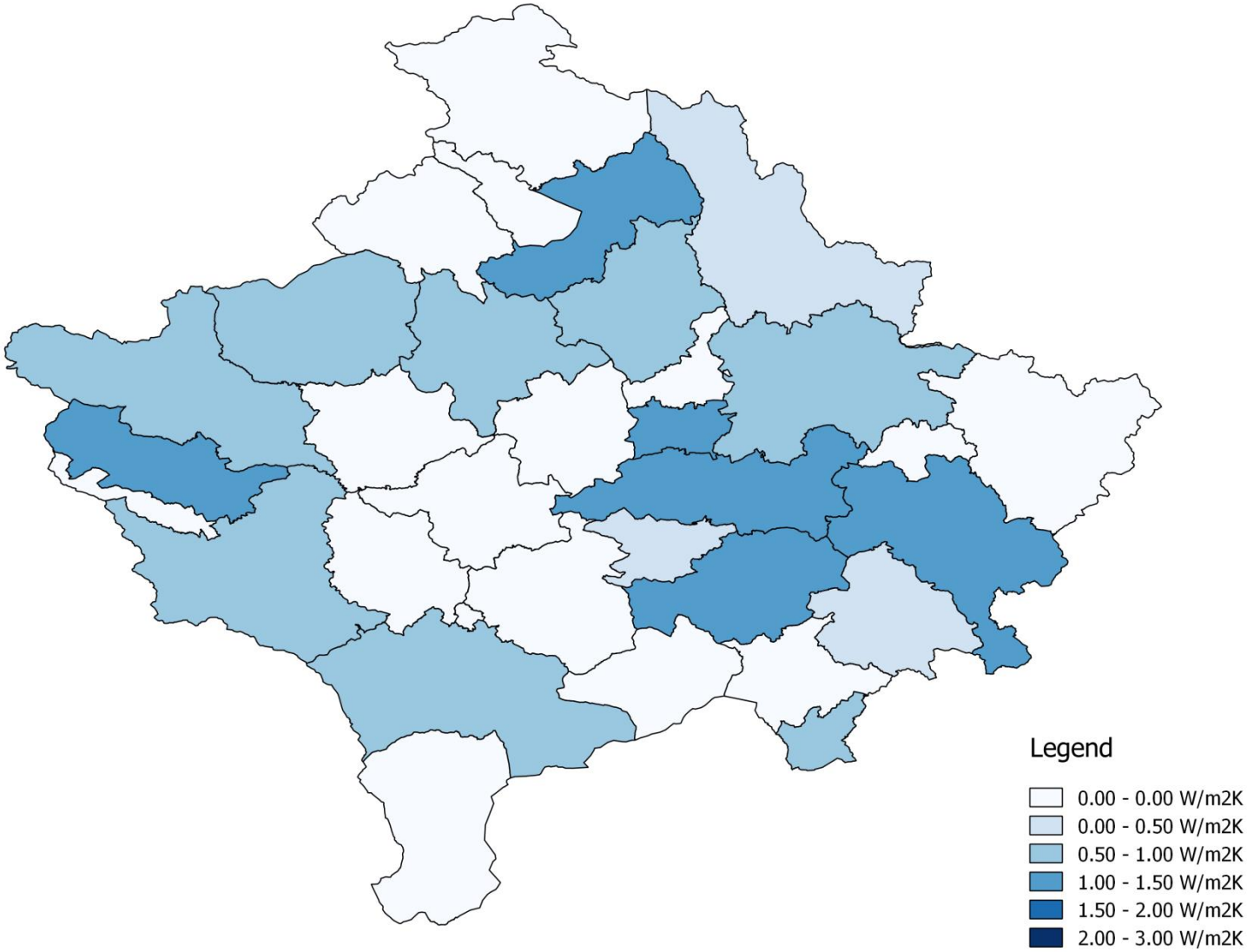
Sumirani rezultati - prosečna godina gradnje



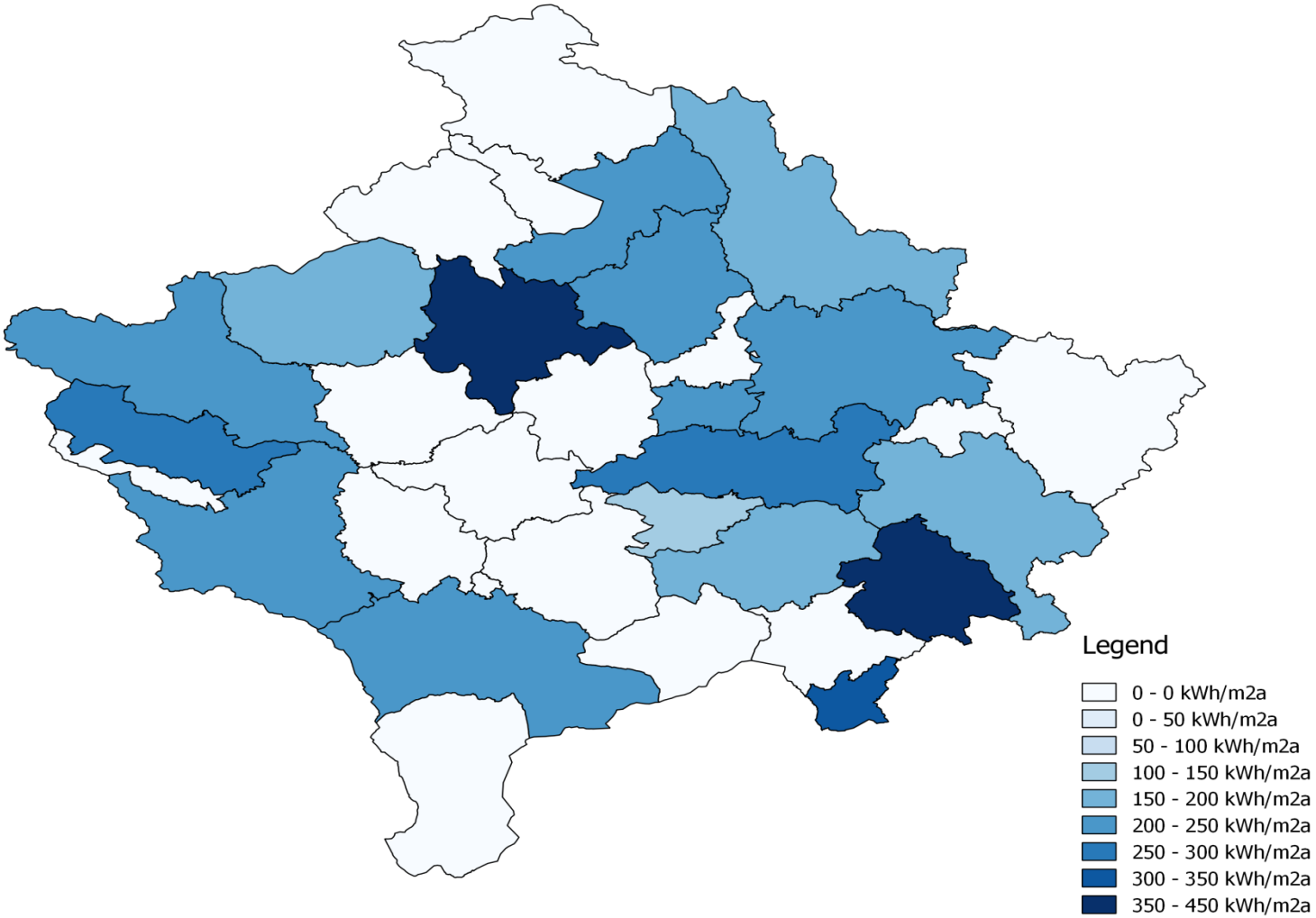
Sumirani rezultati - prosečne U-vrednosti pre



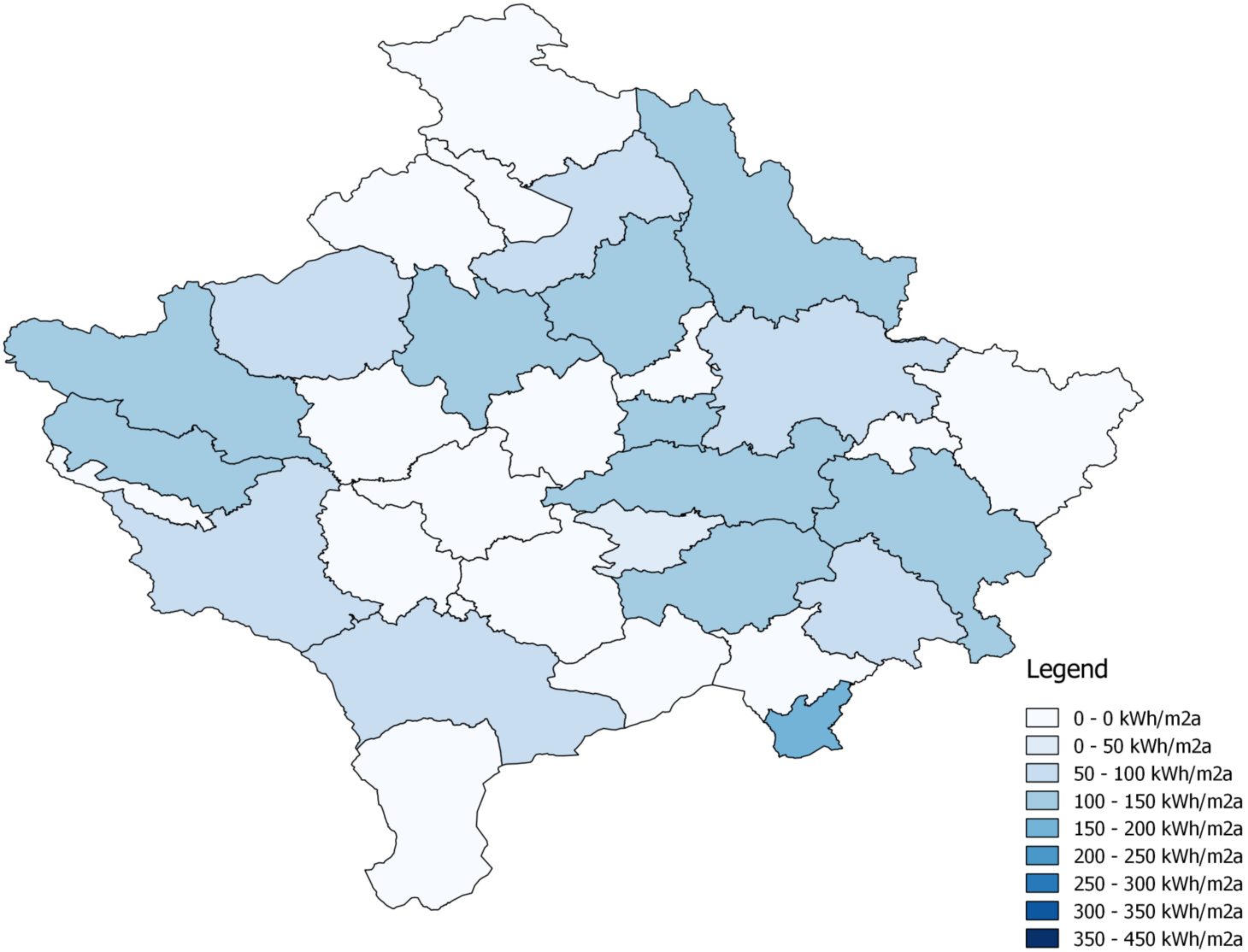
Sumirani rezultati - prosečne U-vrednosti posle



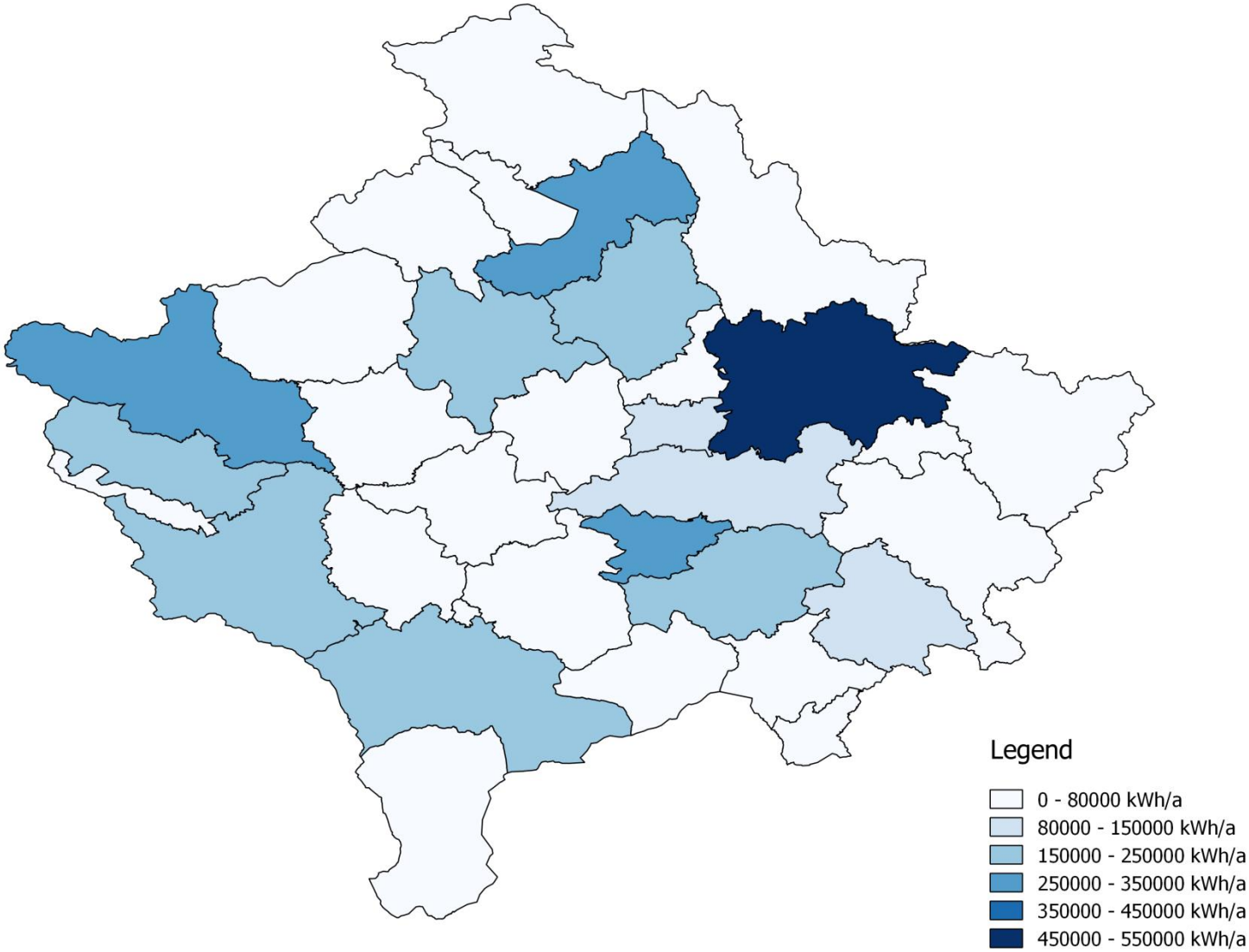
Sumirani rezultati - prosečna potrošnja grejanja pre



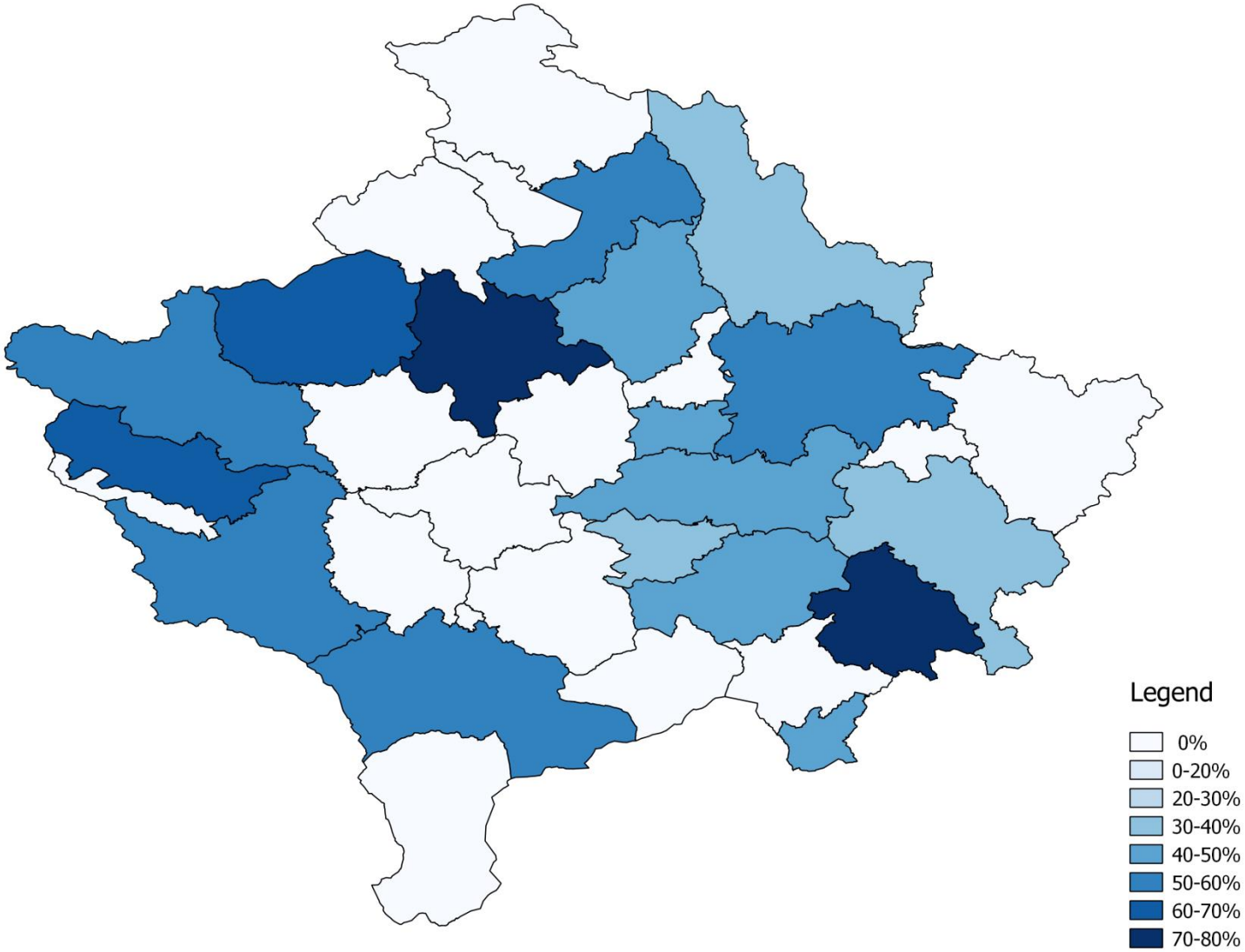
Sumirani rezultati - prosečna potrošnja grejanja posle



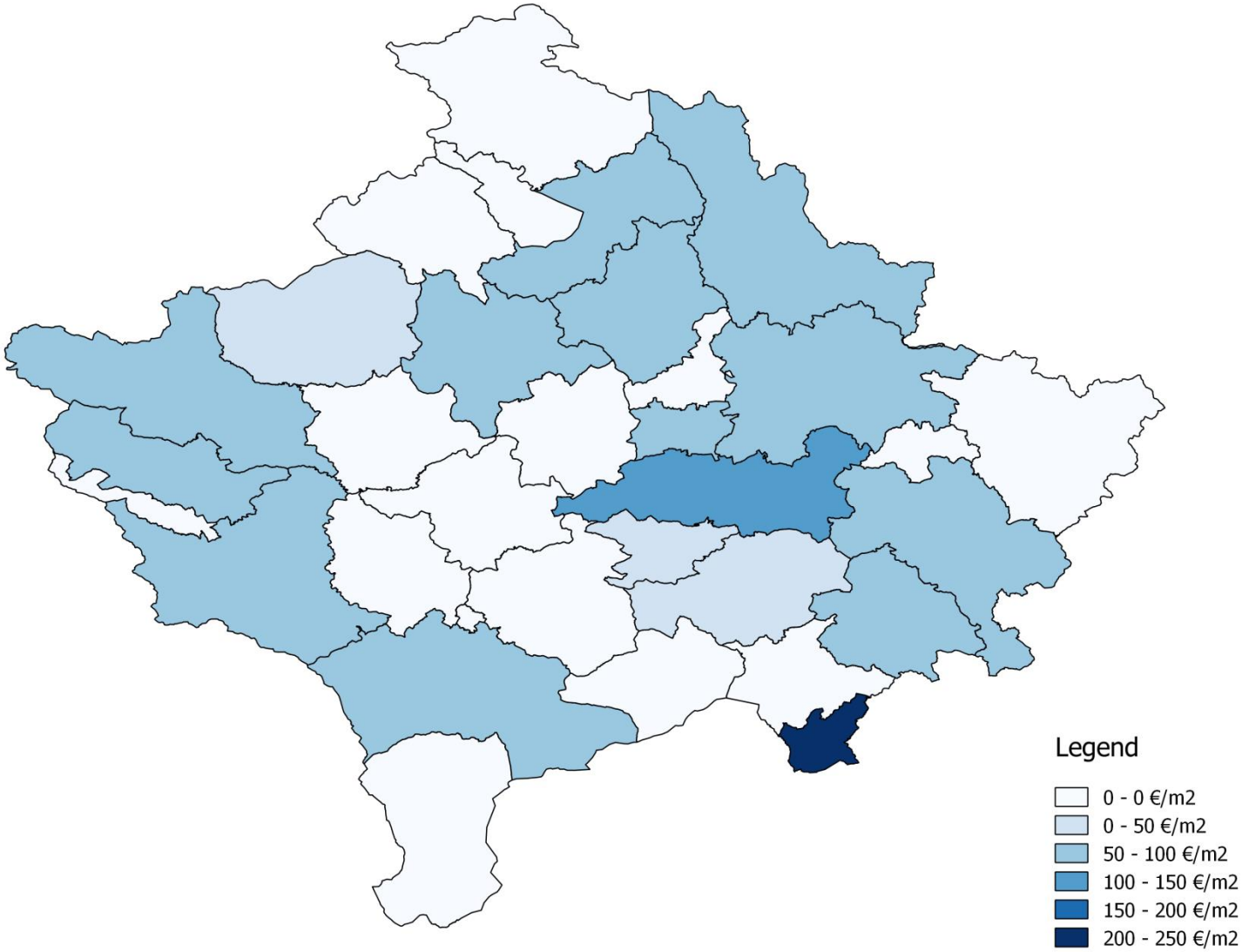
Sumirani rezultati - prosečna ušteda energije



Sumirani rezultati - prosečna ušteda energije %



Sumirani rezultati - prosečno spec. EE ulaganje



Profil

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Zlatko BAČELIĆ MEDIĆ

- Iskustvo u upravljanju timom i koordinaciji projektima energetske efikasnosti, obnovljivim energijama i primeni novih tehnologija
- Vođa tima za energetske revizije u javnom, privatnom i industrijskim sektoru
- Iskusto u obuci kadrova u zemljama u razvoju
- Izuzetno iskustvo u tehničkom oblikovanju i pripremi finansijskih analiza energetske efikasnosti i u projektima primene obnovljive energije
- Stručnost u optimizaciji i optimizovanju troškova u projektima energetske efikasnosti
- Stručnost u analizi i proceni energetskih sektora, uključujući energetsko planiranje
- Projektno iskustvo širom Jugoistočne Evrope

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to the future.
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Whenever!
With you.

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