Interreg Balkan-Mediterranean PRO-ENERGY

pro-energy-project.eu

PROJECT

PRO-ENERGY

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Interreg
Balkan-Mediterranean
PRO-ENERGY

1 DISCLAIMER:

The common challenge of PRO-ENERGY is to improve energy efficiency of public buildings (municipal/provincial/regional buildings, schools, universities, health centers, hospitals, museums, sports facilities etc.). This is a common problem faced by the territories participating in the project characterized by old facilities, outdated/degraded building façades, materials & equipment (insulation, electrical appliances, cooling/heating systems etc.), low energy consciousness & awareness, lack of skilled civil servants, etc. leading to high-energy consumption & CO_2 emissions.

2 IDENTIFICATION SHEET

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(Energy Audit)

Version 1.0

Koto Hoxhi School (Gjirokaster)

Executive Summary

PRO-ENERGY is to improve energy efficiency of public buildings (municipal/provincial/regional buildings, schools, universities, health centres, hospitals, museums, sports facilities etc.). This is a common problem faced by the territories participating in the project characterized by old facilities, outdated/degradated building façades, materials & equipment (insulation, electrical appliances, cooling/heating systems etc.), low energy consciousness & awareness, lack of skilled civil servants, etc. all leading to high energy consumption & CO2 emissions. Combined with the fact that participating territories are energy import dependent it is more than evident that there is room for improvements in energy consumption & more efficient use of energy.

The overall objective of the project is to strengthen the targets set for energy efficiency in Balkan Med area through strong cooperation and joint well-prepared interventions in the direction of reducing the energy consumption of energy-intensive public buildings at both target areas of this Programme. This overall objective is further supported by three (3) main objectives as follows: (i) a primary aim is to exploit the potential for energy savings and energy efficiency improvements in the building sector, with public sector buildings being an example for mobilizing the whole economy, (ii) a secondary objective is to stimulate cross-border knowledge exchange and awareness regarding energy efficiency in public buildings, and (iii) last, but not least, the partnership will seek to promote the joint involvement of various stakeholders in the sustainable energy planning and implementation towards a smart decarbonized building stock. The utilization of smart ICT and the creation of innovative interactive digital Pro-Energy that demonstrate sustainable energy applications will raise awareness among students that are using or visiting the schools where these investments will be implemented.

The joint effort for raising awareness will also be supported by the establishment of targeted events at the free spaces of the chosen building. In this sense, the project is fully aligned with the Priority Axis (1), the Thematic Priority (b) as well as the Specific Objective (1.3) of the Programme by carrying out actions, such as: (i) small scale investments in energy efficiency and use of RES in public buildings, (ii) smart energy saving by using advanced ICT, and (iii) joint public awareness initiatives for energy efficiency and the use of RES in residences and businesses. Regarding the indicator "Energy Efficiency Awareness Barometer", the target is set on 6,5. This is because in the planned events for the presentation of Pro-Energy, it is expected that 30 people will participate in each event in Greece, 40 in the respective Albanian events and also that a core-group of those participants will form, which will follow these events in each country.

“Small-scale Investments in the Pilot Public Buildings” of the public building school "Koto Hoxhi" at Gjirokastër will fix the extent of energy efficiency improvements they have to make in the selected buildings to maximize energy saving. These small-scale investments will be based on the prefeasibility studies recently conducted and on available certificates for the existing pilot buildings. At first will prepare studies and designers of installation of thermal Insulation at the Outside Walls, double-glazed windows, Introducing inside doors and new air -tied doors, thermal Insulation at the roof, solar system for hot water and heating, replacement or new installation of LED lighting, other non- EE measures and Rehabilitation/replacement of heating supply equipment. The expert will prepare technical specifications for BMS components and conceptual design for installation, configuration and optimization. Second, the tender documents and launch the invitation to tenders so as all preparatory works and installations will be completed by the end of the 15th month of the project at the latest. Third, supervision of investment.

3 Contents

ANNEX: 38 Monitoring Report

STANDARTS&REGULATIONS

EN ISO 10077 (2006) - Thermal transmittance of windows, doors and shutters- Calculation of thermal transmittance;

DIN V 18599-2:2007-02 - Energy efficiency of buildings

EN ISO 13790 20078 Thermal performance of buildings- Calculation of energy use for space

EN- ISO 13789 (2007) Thermal performance of buildings - Transmission and ventilation heat transfer coefficients Calculation method;

EN-ISO 13370 (2007)- Thermal performance of buildings - Heat transfer via the ground - Calculation methods;

EN-ISO 10456 (2007)- Building materials and products- Tabulated design values and procedures for determining declared and design thermal values;

EN-ISO 9251 - Thermal insulation- Heat transfer conditions and properties of materials

EN ISO 7345- Thermal insulation - Physical quantities and definitions;

EN-ISO 6946 (2007) - Building components and building elements - Thermal resistance and thermal transmittance - Calculation method.

Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings;

EN 15603 (2008) - Energy performance of buildings - Overall energy use and definition of energy ratings;

prEN 15459:2006 - Energy Efficiency for Buildings — Standard economic evaluation procedure for energy systems in buildings;

UNI 10339:1995 - Air-conditioning systems for thermal comfort in buildings. General, classification and requirements. Offer, order and supply specifications;

EN 15378 (2007) - Heating systems in buildings – Inspection of boilers and heating systems;

EN 15316 (2007) - Heating systems in building – Method of calculation of system energy requirements and system efficiencies;

EN 15193 (2007) - Energy performance of buildings - Energy requirements for lighting;

BS EN 15232:2012 - Energy performance of buildings. Impact of Building Automation, Controls and Building Management.

DIN V 18599-10:2007-02 - Energy efficiency of buildings — Calculation of the energy needs, delivered energy and primary energy for heating, cooling, ventilation, domestic hot water and lighting — Part 10: Boundary conditions of use, climatic data.

1. INTRODUCTION AND EXECUTIVE SUMMARY

Pro-Energy project aiming at enhancing and improving the coordination of SEAP's and other relevant energy Efficiency Plans, in order to reach Energy Saving and the National targets on public buildings' energy efficiency. The project will develop and test a technologically oriented methodology that focuses on increasing cooperation among public authorities through Joint Actions.

Pro-Energy aims at improving the efficiency of policy tools and energy saving plans (national/regional energy plans and SEAPs), by studying and promoting new financial mechanisms (Energy Performance Contracting, green taxation, public-private partnerships, etc.), in order to undertake Energy Saving measures and policies related to public/municipal buildings. Pro-Energy will promote strategies supporting local authorities towards the optimization of the procedure of planning the sustainable energy measures, through a more efficient use of available financing possibilities of these measures.

The project's methodology is based upon a local and international collective approach, which will enable the design of large scale SEAPs through Joint Actions. To achieve this, partners will cooperate with the authorities at local and/or regional level. The coordinator will be responsible for the design of inter-municipal interventions, will handle a request to the Structural Funds and will mobilize the involvement of ESCO's and other private actors. Through an on-line platform, Pro-Energy will strengthen the cooperation for the achievement of the common SEAP's goals.

The on-line platform will be used as a database for the collection of data related to SEAP's energy plans and energy efficiency measures that have been successfully implemented in EU and especially Med countries. The platform will aim to bridge the partners' activities with those undertaken by the Municipalities, facilitating the organization of information on existing SEAP's and other initiatives related to energy objectives.

The purpose of this Energy Audit is as follows: Identify the gaps of energy use in 20 public buildings structures located in Permet, Saranda, Vlora and Gjirokastra region and identify opportunities for making cost-effective improvements, for reducing environment footprint and improve energy efficiency. This Energy Audit is analysing the actual energy consumption and

EE/RES measures to be invested in order to improve environment and increase energy efficiency and role of RES meeting all energy services for “Koto Hoxhi” school (Gjirokaster Municipality). This analysis presents the key findings and recommendations from the application of EE/RES measures for “Koto Hoxhi” school, which was implemented by a team of experts in March-May 2018. The objective of this energy audit is to analyse the current energy performance and effectiveness of “Koto Hoxhi” school service sectors, identify and prioritize energy efficiency opportunities.

Essential for Energy Efficiency and RES investments in “Koto Hoxhi” school is to improve (i) the school’s ability to deliver sufficient services to its clients and hence increase living and learning conditions as well as to (ii) reduce specific energy consumption for those services towards sustainable utilization of resources and sustainable finances. Energy efficiency investments in **improving service and comfort levels** while helping to **comply with standards for a healthy environment and realize reduced budget spending**.

Due to the importance of both urban and tourism development in Gjirokaster, particular attention was paid to identification and development of integrated measures to **deliver combined benefits of school energy savings service delivery and education development**. For example, the retrofit of **school** increases its attractiveness and supply comfort for teachers and children.

In order to implement the energy efficiency measures suggested in this energy audit and feasibility study **assessment** and embark upon a path of energy conservation and improved “Koto Hoxhi” school service delivery, it should focus on the following three key areas: (i) **Adoption of the energy efficiency investment plan by** “Koto Hoxhi” school; (ii) **Development and promotion of sustainable energy efficiency financing mechanisms** that consider multi-year energy savings to repay energy efficiency investment and (iii) **Strengthening energy efficiency delivery capacity in** “Koto Hoxhi” school and implementation of the energy efficiency plan.

The table 1 summarizes **9 energy efficiency investment and RES measures** “Koto Hoxhi” school that were identified. **The total investment costs for the recommended energy efficiency and RES measures amount to 372,862.56 Euro.**

EE/RES Measures with the quickest paybacks, short implementation period and low complexity is the efficient lighting of the school as the most effective reduce budget spending. Highest energy saving potential is identified by investment measures in the energy savings for space heating through thermal insulation of the outside walls, thermal insulation of the roof, efficient windows and introduction of the efficient pellet heating system.

1.1 The purpose and objective of conducting an energy audit

NR.	PERSHKRIMI I /DESCRIPTION OF THE WORK	NJESIA/UNIT	SASIA/QUANTITY	CMIMI/PRICE	VLERA/VALUE
	1.PUNIME TERMOIZOLIM TARACE/TERACE THERMAL INSULATION WORKS				
1	Prishje betoni solete tarrace/Demolition of concrete terrace Shtrese me zall lumime koker 2-3 cmt=5cm/Coarse gravel layer 2-3 cmt = 5cm Shtrese izoluese me dy flete guajn t=4mm + prajmer/Insulating layer with two sheets has t = 4mm + primer Shtrese betoni e lehtesuar per pjerresi t mes =10 cm/Lightweight concrete layer for medium slope = 10 cm Shtrese termoizoluese me polisterol t=5 cm ne tarrace/Thermal insulation layer with polystyrene t = 5 cm on the terrace Shtrese avullizoluese gjeotekstil/Geotextile vapor barrier layer F.V. Ulluke Vertikal bakri seksion drejtkendesh 10x6cm/F.V. Vertical copper grooves rectangular section 10x6cm F.V. Hinke plastike + reduksion plastik/F.V. Plastic funnel + plastic reduction	m2	697	84	58548
	SHUMA 1/AMOUNT 1				58548
	2.PUNIME DYER DRITARE/WINDOW DOOR WORKS				
	Heqje e dritareve ekzistuese dhe transportit te mbeturinave,F.V Dritare te reja dopioxham plastike./Removal of existing windows and waste transport, F.V New double glazed plastic windows	m2	201	161	32361
2	Heqje e dyerve te brendshme ekzistuese dhe transportit te mbeturinave, F.V dyer te reja tamburate dhe alumini/Removal of existing interior doors and transport of waste, F.V new drum and aluminum doors Dere d/alumini pa xham,me mbushje d/alumini Wc/Door d / aluminum without glass, with filling d / aluminum Wc V F dyer te brendeshme tamburate te rimesuara klasat/V F interior doors drummed rhyming classes	m2	93.6	235	21996

	F.V. Derë d/alumini me hapje me dy kanata me krah me piston pneumatik +vetrate hyrja/F.V. Aluminum door with double opening with wing with pneumatic piston + entrance window				
	Heqje e davancaleve ekzistuese,transporti mbeturinave,F.V.e davancaleve te mermerit/Removal of existing mortgages, waste transport, F.V. of marble mortgages	m2	104.87	75	7865.25
	SHUMA 2/AMOUNT 2				**62222.25**
3	**3.PUNIME TERMOIZOLIM I JASHTEM/EXTERIOR THERMAL INSULATION WORKS**				
	Prishja e suvatimeve te pjesshme dhe riparimil tyre,Ndertimi I skelerive, F.V e sistemit kapote sipas projektit ne anen lindore dhe veriore te objektit./Demolition of partial plastering and their repair, Construction of scaffolding, PV of the hood system according to the project on the east and north side of the building. Lyerje me plastike importi nga jashtë me pigment/Painting with imported plastic from abroad with pigment Veshje fasade me polisterol kompakt jeshil t=5cm + rrjete + suva./Facade cladding with compact green polystyrene t = 5cm + nets + plaster.	m2	780	58	45240
	SHUMA 3/AMOUNT 3				**45240**
4	**4.PUNIME TAVANI**				
	Ndertim tavani I varur me pllaka 60*60 ne koridore dhe monolit	m2	357	36	12852
	SHUMA 4/AMOUNT 4				**12852**
5	**5.PUNIME LYERJE/PAINTING WORKS**				
	Riparimi I tavaneve,mureve dhe lyerje me boje plastike/Repair of ceilings, walls and painting with plastic paint	m2	4072	4.4	17917
	SHUMA 5/AMOUNT 5				**17917**
6	**6.PUNIME TE JASHTME/**				
	Prishje e shkalleve te hyrjes dhe verandes dhe shtrimi me pllaka dhe mermer/Demolition of the entrance and veranda stairs and paving with tiles and marble	m2	111	88	9768
	SHUMA 6/AMOUNT 6				**9768**
7	**7.PUNIME TE NDRYSHME/DIFFERENT WORKS**				
	Ndertim zgare hekuri ne dritaret qe shohin fushat e sportit/Iron grill construction on windows overlooking sports fields	ml	81.2	184	14940.8
	Izolimi, rregullimi I kanalit te jashtem,pastrimi dhe drenazhimi dhe sistemime te jashtme	m2	46	85	3910
	SHUMA 7/AMOUNT7				**18850.8**
	8.PUNIME ELEKTRIKE/ELECTRICAL WORKS				

8	C'montimie instalimeve te vjetra elektrike,F.Ve instalimeve te reja elektrike,kuadrot elektrik,ndricimi,internet dhe paisje per matjen e eficences se energjise/Disassembly of old electrical installations, F. With new electrical installations, electrical frames, lighting, internet and equipment for measuring energy efficiency Rrjeti i Prizave te Fuqise / Power Network Sockets Rrjeti i Kabllove te Fuqise / Power Network Cables Panelet dhe Kuadrot Shperndares Elektrike / Electrical Distribution Boards and Panel Rrjeti i Detektimit te Zjarrit / Fire Detection NeTwork F1. Makineri dhe paisje elektrike / Machinery and Equipment	m2	1547	34	52598
	SHUMA 8/AMOUNT 8				**52598**
	9.PUNIME MEKANIKE/MECHANICAL WORKS				
9	Riparim I kaldajes egzistuese,riparim tubash dhe kolektoresh	euro	1	27,869	12700
	Prishje e banjove egzistuese,transport I mbeturinave,F.V. e hidrosanitareve dhe pllakave te banjove,ndertimi I gropes septike/Demolition of existing bathrooms, transport of waste, F.V. of sanitary ware and bathroom tiles, construction of septic tank	cop	17	1750	29750
	SHUMA 9/AMOUNT9				**42450**

Table 1 table of investment of reconstruction School Koto Hoxhi

Efficient energy management possesses a key challenge for all building management or home users. Adding the benefits of energy survey and audit as instrument to improve energy management has the potential to improve overall energy situation.

The objective of Energy Management is to achieve and maintain optimum energy procurement and utilization, throughout the organization and:

- To minimize energy costs / waste without affecting production & quality
- To minimize environmental effects.

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc. In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of Energy Audit is to determine ways to reduce energy consumption. Energy Audit provides a “bench-mark" (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.

Energy Audit can be classified into the following two types: Preliminary or Walkthrough Energy Audit and Detailed Energy Audit.

The type of Energy Audit to be performed depends on:

- ✓ Function and type of buildings
- ✓ Depth to which final audit is needed, and
- ✓ Potential and magnitude of cost reduction desired

Thus Energy Audit can be classified into the following two types.

i) Preliminary or Walk through Audit

Preliminary energy audit is a relatively quick exercise to:

- ✓ Establish energy consumption
- ✓ Estimate the scope for saving
- ✓ Identify the most likely (and the easiest areas for attention
- ✓ Identify immediate (especially no-/low-cost) improvements/ savings
- ✓ Set a 'reference point'
- ✓ Identify areas for more detailed study/measurement
- ✓ Preliminary energy audit uses existing, or easily obtained data

ii) Detailed Audit

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost. In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges.

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost. In this regard, detailed energy audit will focus clarifying into more detail and accuracy the energy consumption patterns and argumentation of energy efficiency measures.

1.2 Brief description of" Koto Hoxhi" School

The walls are stone and uninsured. The actual situation analysis suggests that it is imperative to recommend the total renovation of the inner plinth using the appropriate materials to avoid the problems observed on the ground in the future and to create a better aesthetic appearance for the inner spaces. In sanitary rooms and moisture areas, where moisture problems are monitored, plaster should be removed and replaced. Painting the walls and the ceiling should be renewed.

For all sanitary rooms and other wet areas it is proposed to break down all the installations to the simple concrete and the wall structure of the rooms. This involves removing all surfaces of the wall and floor covering including plaster and floor mortar. The next step is the investigation by a structural engineer about the extent to which the structure of the building has been affected by water and moisture over the years. All damage to the moisture must be repaired, which should have an impact on the structure of the building.

Roof and the floor are also patermostilated and their thermosylation is indispensable. Windows are in a bad condition and need to be replaced with efficient windows. Energy Audit is a systematic process applied to existing buildings to identify energy efficiency measures improvements and to ensure building system functionality. The basic process includes two fundamental procedures that were carrying out by the Audit Team:

a) Investigation and data collection &
b) Analysis of data

Each of these procedures is discussed below.

The Audit process started by collecting and evaluating design drawings and data pertaining to facility equipment and current operation. Building layouts were prepared after situation record and have been reviewed to gain a better understanding of the building design and the installed equipment.

The initial site assessment consisted of spending a day in the building during august, interviewing staff, inspecting equipment, performing an audit, and performing an analysis of the site-gathered data. The investigative process consists of first obtaining as much building documentation to become familiar with the building and its systems. Equipment lists, system schematic drawings and 3 years months of utility billing data are collected.

The Audit Team analyzed the site interview data, written documentation, and monitored data. From this work the findings were formalized, estimates for their associated energy savings and costs to implement were developed through the following activities:

- Description of the existing situation
- Present Energy Consumption
- Identified Energy Efficiency Potential
- Description of the recommended EE Measures
- Environment benefits/improvements

The information contained in this report is based on a range of sources that have been compiled during inspections; these sources include building monthly/annual energy consumption data, electrical meter readings, site observations, and discussions with site personnel and municipality officials in charge of school maintenance. Recommendations and observations are based on visual inspections of building and equipment.

The Koto Hoxhi School was built in the early 1960's and is located in the city center. The facade and front entrance of the building is oriented to the north and its structure of the building consists of 3 floors - all connected by the main stairs and a large hallway with single floor and teacher's hall. The total built area is about 2285 square meters. The school consists of 20 classes, 10 workshops / training laboratories. Administrative salon for a large and long salon with 5 offices.

The walls of the building are all uninsured and in very poor condition everywhere. The roof of the building is covered with tiles, without insulation and very poorly maintained and leaked in many places. The roof of the first floor is covered with 1 cm thick and without insulation or cover. The ground floor has a layer of gravel (20cm) and concrete (10cm) with a layer of wooden roof panels (1.5cm) or thin carpet (0.5cm from its opening the building is used as a public school and is currently fully operational from 7am to 7 pm on weekdays.

1.3 Brief description of Gjirokaster Municipality and use of the building

The design of the energy efficiency scenario prepared under the Strategy of Energy (approved in August 8, 2018) for the services sector is based on the following quantitative and qualitative measures that are primarily derived from the 2nd and 3rd NEEAP. Several different types of measures are foreseen, such as the increase of electricity price, implementation of energy building codes in public and private building stock, application of fiscal incentives for energy, renewable resources, and other efficient resources, awareness campaigns, etc. The following quantitative and qualitative measures are considered to be the most important according to Strategy for the following years:

- Adding termal insulation and the use of efficient windows in existing public and prívate buildings that will contribute to the reduction of electricity, LPG and fuel Wood for space heating and cooling.
- Construction of new public and prívate buildings based on the approved Energy Building Code, which will be established based on the New Draft EPB Law.
- Penetration of efficient biomass heating system (including pellets and briquettes) that will contribute to the reduction of electricity and fuel Wood consumed for cooking and space heating.
- Penetration of solar wáter heating systems for meeting domestic hot wáter demand, which will reduce electricity consumption.
- Higher penetration of efficient bulbs that will reduce theel ectricity in lighting.
- A gradual introduction of small-scale combine dhe at and power plants and central heatings chemes for large and small buildings (hospitals, boarding-schools, hotels, etc.), particularly through substitution of existing conventional systems.
- Implementation of energy audits in public and prívate buildings in the public buildings and big commercial and hotel centres.

- An increase in the efficiency of electric appliances and equipment (pumps, refrigerators etc.) used in public and prívate buildings.
- Public Campaignon Energy Savings and EE improvement for the service buildings.

1.4. Brief description of Gjirokaster Municipality and use of the building

Gjirokastra is a city in southern Albania, lying in a valley between Mali i Gjere and the Drino River, located 300 m above sea level. The old town is a World Cultural Heritage protected by UNESCO and described by it as "a rare case preserved by Ottoman perennials built by large farmers". From the city's castle you can see the whole city center. The Municipality of Gjirokastra was formed in the year 2015 by the union of the municipal units of Antigone, Cepo, Gjirokaster, Lazarat, Lunxheri, Odrie and Picar. The population of the city is 25,301 (2011) and the total area is 469.25 km 2.

The current Energy Efficiency Law number # 124 date 12.11.2015; requests Albanian municipalities to a) prepare municipal energy efficiency plans (article 7) and b) establish a municipal energy management department (article 25). The present document of the draft municipal energy efficiency plan for Gjirokastra can contribute to satisfy those obligations.

In addition, the municipal energy efficiency plan for Gjirokastra can create momentum to commit to achieving EU energy and climate related targets at local levels by participation in the EU Covenant of Mayors initiative (CoM). The present document can also be used as basis for the elaboration of a Sustainable Energy Action Plan (SEAP). The participation in the Gjirokastra can increase the opportunities for Gjirokastra municipality to exchange experience, gain related know-how, build capacities and acquire financial support from EU pre-accession programs for the realization of investments.

Gjirokastra, a UNESCO World Heritage site, is known as the "Museum City of Albania". Gjirokastra is a small municipality surrounded by many ecotourism products, including a hot spring and waterfalls, and with a good potential for trail development. A more than 2,000 year old castle overlooks the city with numerous, high architectural and historical neighborhoods.

The Greater Gjirokastra Municipality comprises 38 villages and has a total population of 55,500 inhabitants, of which approximately 35,000 inhabitants live in the City of Gjirokastra.

Economically, the city relies on the sectors agriculture, food production and processing, trade and tourism. The overall GDP of Gjirokastra municipality was approximately 282 million USD in 2015[1].

The municipal budget amounted to 8 million USD in 2015 with approximately 0.73 million USD spent on energy for municipal services such as public transport, public buildings, street lighting, waste and water supply.

Basic data were collected from the utilities and departments of the Gjirokastra Municipality by questionnaires and interviews to compile energy Key Performance Indicators (KPIs) for each sector

Gjirokastra's buildings can be divided into two types according to the funds used by the budget: belonging to the Central Government and those belonging to the Municipality. Due to a decentralized structure, only a small part of the buildings can be classified as buildings which are generally owned by the Government. Specifically, they include buildings in the heritage areas, such as the castle walls and the castle, which operate under the responsibility of the Ministry of Culture. Other public buildings belonging to the agencies and Ministries of the Central Government are hospitals, public safety, and the buildings of justice and tax administration. The Municipality of Gjirokastra is responsible for the operation and maintenance of buildings located within its borders, including local administrative buildings, schools, kindergartens, museums and libraries located in different villages belonging to the Municipality, etc. Energy Consumption of Municipal Buildings is measured every month and it is reported to the City Budget Department. The annual supply of fuels and fuels such as gasoline / oil is decided by the Municipality based on historical data and the available budget. However, the real need is not usually met due to the huge losses.

Schools and kindergartens are operated by the Department of Social and Educational Development. In total, the Municipality operates 58 municipal buildings with a total area of 18,950 m² including those public buildings located in the villages, of which 28 are educational buildings (17 schools, total area of 10,200 m², 11 gardens, 2,750 m² are heated). 30 remaining Municipal Buildings have an area of 6,000 m² including 3 dormitories, the Municipality, 2 children's homes,

[1] Estimate based on national level per capita incomes.

the Cultural Palace and the administrative buildings. Other Public Buildings belonging to the Central Government have a heated surface of 3,000 m².

The Municipal Social Welfare Agency is responsible for the operation of kindergartens, schools, dormitories and polyclinics. The municipality has a limited budget for heating the buildings: only a limited amount of wood or oil is purchased from the Municipality and then shipped to private buildings. There are limits on energy consumption that are communicated to the facility's executives, but no consumption is monitored.

The municipality has full control over more than 58 buildings, provides maintenance of the building, renovation, water, and supply of fuels and energy. The municipality does not have any authority over the operation and supply of energy to the buildings of the central government in Gjirokastra. The annual energy consumption of these non-municipal public buildings is about 0.43 GWh and is considered in the energy balance.

The total amount of energy consumed in 2015 by the Municipal Buildings was 3.05 GWh, which includes energy consumption for space heating, lighting and electrical appliances as well as some small electric boilers for water heating. The energy consumed for heating is approximately 150 kWh / m2 per year, and the energy consumed for lighting is about 11 kWh / m². The heating season lasts from 1 November to 15 April. The main part of electricity is used in the residential and commercial sector including schools for heating electricity and many other electrical appliances. Electricity contributes by 49%, followed by diesel by 26% and firewood by 11%.

The buildings sector plays an important role with regard to tapping the country's GHG mitigation potential and will be important for the Albanian Government to demonstrate progress in implementing its nationally determined contributions (NDC) and Energy Community targets. Financing this project is thus a critical opportunity to kick-start a sector-wide transformation towards a carbon-neutral buildings sector. The suggested project builds upon and supports the objective outlined in the Third National Communication of the Republic of Albania on Climate Change to the UNFCCC and the National Energy Efficiency Action Plan (NEEAP) to develop and operationalize a sustainable financing mechanism to scale up energy efficiency investments in the buildings sector.

The project would be embedded in the National Energy Strategy 2030, Albania's Climate Strategy as well as the ongoing energy efficiency and climate policy efforts by the Albanian Government.

The Albanian Government is currently in the process of passing a new draft law on Climate Change to the plenary session of Albanian Parliament. This draft law will serve as a basis for setting a more detailed legal framework for climate action to operationalize the recently adopted Strategy on Climate Change. It sets the framework for climate action based on the defined NDC targets (11.5 % reduction of CO2eq by 2030 compared to baseline emission scenarios) and highlights the need for addressing energy efficiency in the buildings sector due to the sector's high carbon-intensity and natural resource consumption.

A key objective for the public buildings sector is to achieve compliance with Article 5 of the EU Energy Efficiency Directive to rehabilitate 1% of the central and municipal building stock as well as to achieve significant emissions reductions to comply with Albania's NDC pledges. The project would contribute to this 1% target as well as to Albania's other Energy Community obligations in the sector to (i) contributing towards the country's 6.8 % energy savings target by 2020; (ii) supporting the establishment of an energy efficiency fund; (iii) providing experience to support implementation of energy performance in buildings law. In the context of the wider rollout for the whole buildings sector in the country the project would also play a critical role in buildings the necessary technical and human resource capacities. Under the assumption that the REEF could retrofit up to 60 public building annually, the project would significantly contribute to achieve the 1% target.

In addition, the investments would contribute to human capacity development by targeting the improvement of comfort conditions in public buildings, to improving energy security, freeing up public budgets for other priority investments, and serving as a catalyst for developing the EE market in other sectors. As such, the financing mechanism represents a unique setup to scale up the country's mitigation ambition in the sector and beyond. The project proposal builds on the discussions with the Government of Albania and on findings detailed in two reports that investigated the institutional and regulatory framework for EE in the country, and quantified the EE potential in the public buildings sector.

The basic idea of the suggested financing mechanism is that energy cost savings resulting from EE investments can resolve to support additional EE investments and limit additional capital injections or increasing public debt. An integral part of this REEF would be to monitor, verify and capture the generated energy cost savings from each retrofitted facility in a dedicated escrow account to allow the funds to revolve and support additional EE investments in public buildings (see figure 1).

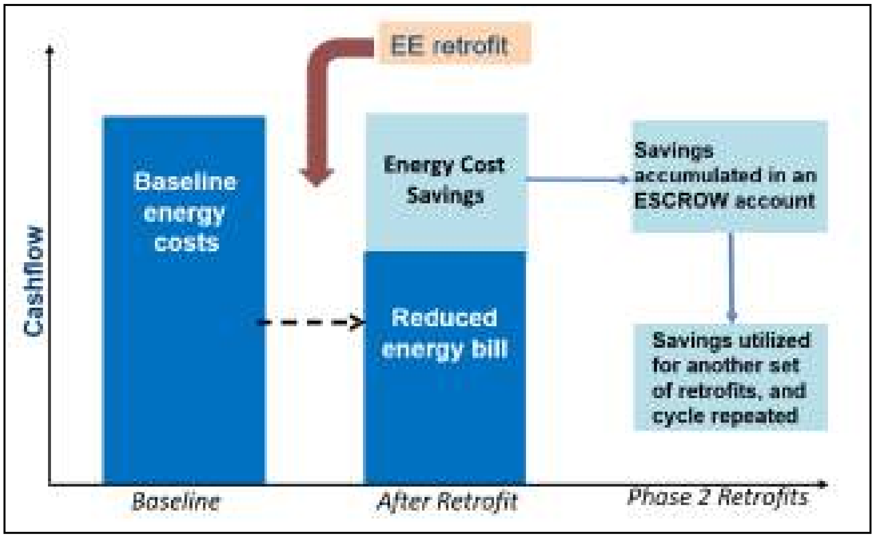


Fig. 1: Illustration of a revolving financing mechanism

The mechanism anticipates that financing for initial capitalization of the REEF is provided by the MoFE using a combination of government budget allocations (for example, for planned retrofit of hospitals, schools, or social facilities) and funds from donors and IFIs. This funding would cover the necessary upfront EE investment costs during the project implementation period. The resulting energy cost savings are then accumulated in an EE escrow account and used to repay the REEF until the original investment is recovered. The repayments can then be used to finance additional projects, thereby allowing the capital to revolve and create a sustainable financing mechanism. In order to allow sufficient time for institutional and market capacity start-up the implementation will be performed by consecutively increasing the number of building retrofits. The suggested structure of the REEF mechanism is summarized in figure 2.

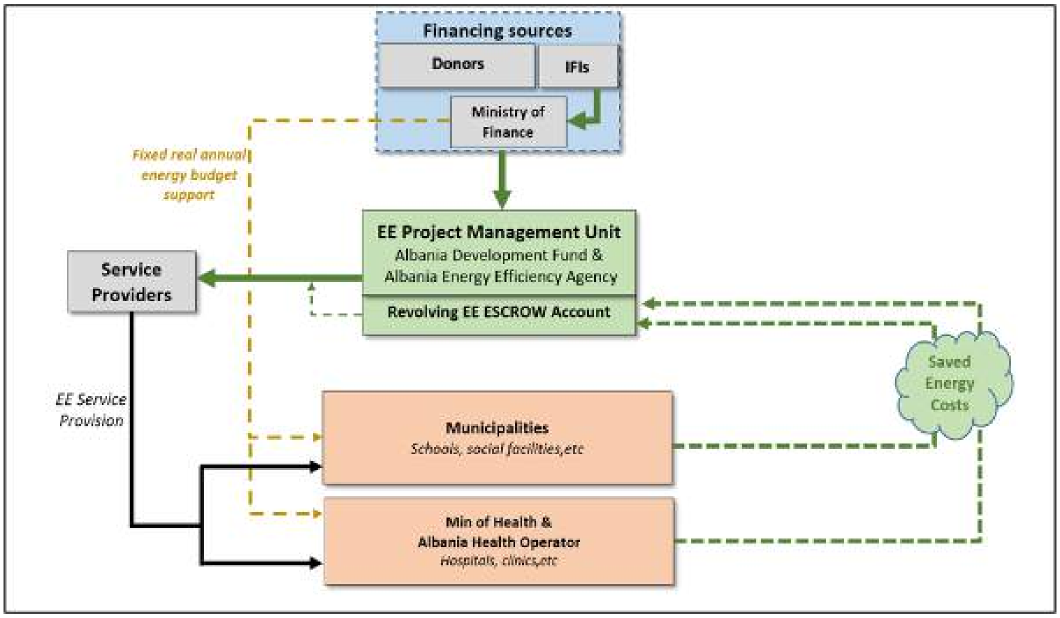


Figure 2: Proposed REEF organizational structure

Current investment practices into the public buildings stock depend on the owner and operator of the respective public building. Both central government building operators (e.g. ministries and their state agencies) and municipalities are responsible for regular investments in the maintenance of public buildings.

Current retrofit efforts in public buildings tend to focus on increasing comfort, safety, and the appearance of the building. Even though energy saving technologies are known and locally available, building operators lack knowledge and experience to systemically target and implement standardized EE investments to reduce energy consumption and CO2 emissions. By institutionalizing the REEF mechanism as a one stop shop for public buildings renovation, investments in this sector could be centrally managed and implemented more efficiently, thereby reducing transaction costs and significantly increasing technical capacities for retrofit planning and implementation along with improved supply-side capacities. The envisaged first stage of REEF with rehabilitation of approximately 210 buildings will serve as a pilot to subsequently extend the scope of the REEF mechanism to all other public sector buildings upon successful implementation in health and municipal education buildings.

1.4 Brief description of the energy system

During energy audits the following energy installations are checked:

Heating installations

- Central heating system
  - Radiators
  - Boiler room
  - Other central heating components (valves, pipes, pumps etc.)
- Hot water system

Electric installations

- Lighting system
- Electric distribution and protection system
- Electric boilers
- Electric heaters
- Sanitary water boilers
- Electric recirculation pumps
- IT equipment’s
- Other electrical equipment’s

1.5 Brief description of the comforts of staying in the building

Comfort conditions at school are poor, since space heating is secure in minimum, no space cooling, no hot water and lighting is close to average standard figures. Based on university guidelines "Energy Management" from Dr. Besim Islami, as a standard, we used those temperatures:

Classroom inside temperature should be +20 ^{o}C.

Teachers' room inside temperature should be +20 ^{o}C.

Halls for brake time inside temperature should be +18 ^{o}C.

In mean time, according to Energy Building Code the comfort level temperature for classrooms should follow the EU standard of 20 ^{o}C. Therefore, heating degree day calculations are significant in reflecting the demand for energy. School buildings should be designed to an outside degree template of 3 ^{o}C for Gjirokaster Municipality

Comfort conditions for lighting: Comparison of existing lighting conditions with the comfort requirements, with conclude that they do not met adequately. Number of lamps placed, is not in proportion to the intensity of the lighting they should provide. This happens because in some premises no efficient lamps are used and where they exist, are too old and dysfunctional. In the following table is given, the existing luminance and Lighting requirements according to European Norms "Lighting of work places", of such spaces

Table 2: Data on existing illuminates

Type of premises	Actual illumination (lx)	Required: EU standards illumination (lx)
Classrooms	220	300
School board	220	500
Main halls – corridors	120	100- 200
Stairs	100	150
Toilets	130	200
Auxiliary facilities	110	150-200

Data on existing illuminates are obtained from measurements with lux-meter, and we conclude that they are not fulfilling the needs for lighting required by EU norms.

2. ANALYSIS OF THE CURRENT STATE OF THE BUILDING;

ENERGY CHARACTERISTICS OF THE BUILDING AND THERMO - TECHNICAL SYSTEMS

2.1 Methodology of Energy Audit

In order to ensure the realization of the main objective, which is the improvement of the general use of energy in the building, as well as the use of renewable energy, in this energy audit will be accomplished the following tasks

Task 1- Examining the current operational characteristics of the building

Through a number of on-site visits and involvement of stakeholders in the project, the characteristics of building operation, technical specifications of power systems, operational maintenance procedures, preliminary investigation areas, operational limitations due to unusual situations, extensions or modifications that envisage future training needs and other issues related to the operation of the building.

Task 2 - Review of existing documentation and management practices

All available documentation was analysed by energy auditors. This documentation should include the architectural and construction aspects of the building, the operational and maintenance procedures of the building, the history of modification for the most important interventions, electricity bills, water and fuels for the previous years. It should be noted that the available plans should be controlled under realistic conditions, rather than being checked in relation to the way they were thought during their compilation.

The review should include: Energy intensity of the building; Source of fuel; Maintenance Contracts if exists any; Building energy management policies (if there are maintenance reports, organizational structure, maintenance budgets, utility bills (energy, water, fuels, etc.); Characteristics of the building automation system, especially those related to consumer monitoring of electricity.

Task 3 - Detailed construction inspection and energy audit

After thorough review of engineering and construction documentation, as well as operational and management documentation, high energy consumption processes in the building were reviewed. Inspection focused on these key issues:

1. Operation of systems in buildings (including heating / cooling system);

2. Coverage of the building (including wall insulation, energy performance of windows, doors, ceilings, etc.);

3. Ventilation system (if it exists, if not the consequences of its absence should not be described);

4. Lighting system (including lighting intensity, efficiency of use and control);

5. General characteristics of the electrical system;

6. Heating / Cooling System: general characteristics (fuel type, number of operating units, performance coefficient, etc.)

The general purpose of the energy audit is to identify: Current energy needs for heating / cooling; Current consumption of heating / cooling energy; Status of the heating / cooling system; Technical Requirements Related to Additional Power Resources.

Task 4 – Preparation of report for Energy Audit.

The report analysed and presented the availability of priority interventions or measures for energy efficiency in the building as well as the possibilities and the availability for the use of alternative energy sources. For all EE measures identified, the installation costs, energy savings, NPV, IRR, LDC and return on investment were calculated. The report includes a description of the systems and their operation, a system analysis that consumes more energy, a description of the recommended measures and impacts in terms of energy cost reduction, implementation costs, benefits and return period of the investment. The report includes a summary of all the activities, efforts and costs required to achieve the expected energy efficiency improvements in the building.

2.2 Analysis of thermal properties of the overlay of the building

The Koto Hoxhi School is located in the city of Gjirokastra in the neighbourhood of 18 September. The building is 3 floors with stone walls of 50 cm, stone bases and basement. The covering structure of the building is with a terrace, giving a span of 1 m in all its perimeter. In total there are 902 pupils in this school. Heating in the school is realized through boiler with diesel fuel and electric power when fuel supply is lacking. Lighting in the school is realized through incandescent lamps, which in a dormant part are missing.

Thermal characteristics of building envelope are presented in much more details at the session 4.1.

Figures 2 : Overview of the school

2.3 Analysis of energy characteristics in the heated space of the building.

The general condition of the Koto Hoxhi school building is described below:

- The walls are not thermal insulation and often the plaster is cracked in some places.
- Windows: Some windows have been installed in this building. Windows installation and energy performance are in poor condition;
- Humidity damages occur within the building due to the following reasons:

- Capillary from foundation to ground floor;

- Condensation water in the interior spaces;

- We have the creation of moisture in the part of the windows due to the lack of isolation and the creation of thermal bridges;

• The building's roofs are made up of tiled roofs. Roof has no thermal insulation. The energy performance of the cat is under bad conditions;

• Toilets have natural ventilation and because of lack of isolation we have moisture generation;

• The waste water discharge system is old and new installations are needed;

• The sanitary water system is not in good condition, so new installations should be made;

• The electrical system and lighting are in poor condition. The intensity of the lighting did not meet the norms. The need to perform new electrical installations and installation of new lighting systems to achieve the intensity of light according to the norms;

• The heating / cooling system is also in poor condition with electrical heater.

• The heating / cooling system is also based on two mono-split air conditioners and in some areas this type of heating and cooling is lacking. Because of the lack of heating / cooling system, the municipal staff uses electrical appliances for space heating. So our conclusion is that the heating / cooling system should be new to create the state of comfort for the staff;

• There is no warm water system in the school

Many of these building performance deficiencies are recommended in the structural reconstruction of the building. While some of these shortages will be governed by energy efficiency measures to be taken (such as walls, windows, terraces or lighting as part of the electrical system, heating system - air conditioning and sanitary hot water system).

Table 3 gives the thermal characteristics of the overlay of the building.

Table 3 Thermal specifications of the building envelope.

Main elements of the building envelope	DIMENSION (m^2)	THERMAL TRASMITTANCE U ($W/m^2 \cdot K$)
ROOF	970.47	3.241
GROUND FLOOR	940.68	2.028
PERIMETER WALLS NORTHERN EXPOSURE	394.21	2.14
PERIMETER WALLS EXPOSURE EST	376.85	2.14
PERIMETER WALLS SOUTHERN EXPOSURE	392.27	2.14
PERIMETER WALLS EXPOSURE WEST	376.85	2.14
WINDOWS NORTHERN EXPOSURE	50.4	4.8
WINDOWS EXPOSURE EST	88.8	4.8
WINDOWS SOUTHERN EXPOSURE	50.4	4.8
WINDOWS EXPOSURE WEST	79.2	4.8

2.4 Analysis of characteristics of the cooling system in the building space

As noted above, the school is mainly heated with electric radiators and the heating / cooling system is also based on two mono-split air conditioners. Of course, the heating and cooling provided in these systems cannot guarantee the comfort conditions.

2.5 Analysis of the energy characteristics of ventilation and air-conditioning system

There is no ventilation and air conditioning system in the school, except for two mono-split air conditioners.

2.6 Analysis of the energy characteristics of ventilation and air-conditioning system

There is no ventilation and air conditioning system in the school, except for two mono-split air conditioners.

2.7 Analysis of the energy properties of theelectric energy consumption system - electrical, lighting, appliances and other loads

In the school there is a lighting system with most incandescent lamps and in many weekly classes only some lamps that cannot guarantee the lighting required under the required comfort conditions.

2.8 Analysis of the energy characteristics of specific sub systems (kitchen, laundry, etc.)

There are not any kitchen or any laundry in this school, so, it might clearly stated that hot water is not supplied in this school.

2.9 Analysis of cold water consumption

Cold water supply is only 2-3 times a day in the school and to make it possible to have water, especially for the toilets, some deposits are placed, which do not guarantee the requirements for normal hygiene.

2.10 Analysis of the regulation and management system

The development of the energy efficiency program for Gjirokaster Municipality is based on the analysis of municipal energy data for the baseline year 2015 and foresees an implementation horizon of 15 years from 2016 to 2030. The time horizon was chosen to comply with strategic planning documents: (a) Strategy and action Plan for the Tourism in Gjirokaster the Municipal Development Plan of Gjirokaster, (b) the Community Development Plan of Gjirokaster and (ii) the Draft Albanian National Energy Strategy Sector Development 2014-2030.

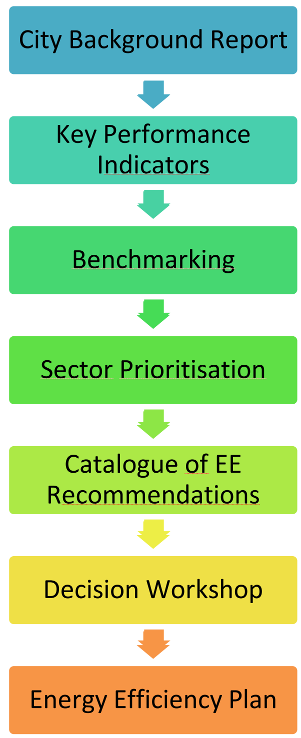
The current Energy Efficiency Law number # 124 dated 12.11.2015; requests Albanian municipalities to a) prepare municipal energy efficiency plans (article 7) and b) establish a municipal energy management department (article 25). The present document of the draft municipal energy efficiency plan for Gjirokaster can contribute to satisfy those obligations.

Table 4: Gjirokaster key statistics of 2019

№	Indicator	Value in 2019	Unit
1	Population	55,500	Inhabitants
3	Municipal / City area	294/8	km^2

№	Indicator	Value in 2019	Unit
2	Population Density	190	inh/km^2
4	Primary Energy Consumption	149.3	GWh
5	Employment rate	n/a	%
6	Human Development Index (HDI)	0.733	
7	Total annual Municipality budget	8,026,100 923	USD million ALL
8	Spending for Energy (for municipal sectors: public transport, municipal buildings, street lighting, waste, water and waste water services)	726,218 Equal to 9%	USD of municipal budget
9	Municipality expenditures for energy in public buildings	350,000 Equal to 4.5%	USD of municipal budget
10	GDP (2019)	Approximately 282	million USD

2.11 Analysis of the energy properties of the system to produce electricenergy from renewable energy sources (if they exist on the site)



The process of energy efficiency diagnostics carried out from the consultant commenced with the data collection and compilation in September 2019 and was supported by the Municipality of Gjirokaster as well as related utilities and municipal services departments.

Based on the collected data the Key Performance Indicators (KPI) for the Municipality of Gjirokaster were calculated. The availability and quality of received data and information is satisfying.

The main determinants for the identification of prioritized sectors are a) schools energy spending, b) potential energy savings related to the relative energy intensity and c) the level of control by the energy consumption over sectoral budgets, regulation and enforcement power for energy efficiency and RES measures.

Based on the collected data and interviews a long list of potential sectoral energy efficiency recommendations was compiled according to the school's needs.

The Energy Efficiency Investment Plan (a) reflects the decisions with set priorities, interventions and targets; (b) analysis the energy efficiency potentials and benefits of a refined list of energy efficiency investment measures and (c) outlines an implementation strategy for the plan.

3. ANALYSIS OF CONSUMPTION AND COST FOR ENERGY AND WATER

This session describes the consumption of electricity to meet different needs in recent years, so it is possible to see the trend of total energy consumption. In order to describe it, the consultant team has visited the Koto Hoxhi School and has opened financial books registers to read about energy consumption in various energy services, as will be described below.

Figure 3 shows the breakdown of final energy consumption by sectors. The main part of electricity is used in the residential and commercial sector including schools for heating electricity and many other electrical appliances (figure 4). Electricity contributes by 49%, followed by oil by 26% and firewood by 11%.

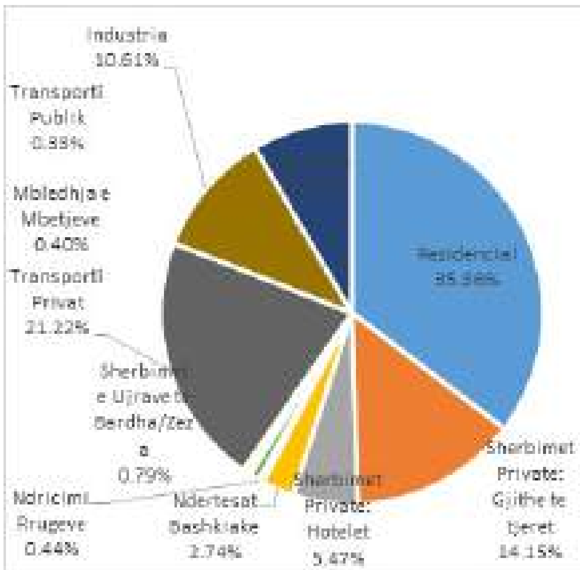


Figure 3: Share of energy consumption by sectors

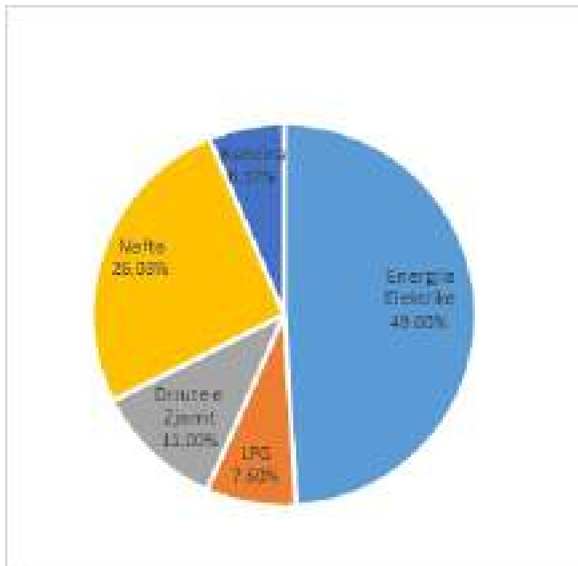


Figure 4: Final energy consumptions in municipal sectors in 2019 by fuels

3.1 Analysis of electricity consumption

During the whole 2017 period, the Koto Hoxhi School has had a slight increase in electricity consumption compared to 2016 based on the data of the education directorate. This is a good indicator especially for electricity consumption, as it will be described in the other schools analysed. The total electricity consumption in 2017 was approximately 194,522 kWh / year.

3.2 Analysis of fuel consumption

In this school there is not any fuel consumption for time being.

3.3 Analysis of indicators of energy consumption and costs for energy and water

Water consumption in this school is not measured and payment is done with flat rate.

4. CALCULATION OF THERMAL NEEDS OF THE BUILDING

4.1 Calculation of heating need

Since it was designed there was no central heating (figure 6 & 7). For winter period "Koto Hoxhi" school use AC unit with COP value equal to 3. Now let's analyse the energy requirements for heating the school rooms. The consultant team has received some data during the site visit, and the relevant drawings are presented in Figures 7-9.

Figure 7: Layout of the Ground Floor]

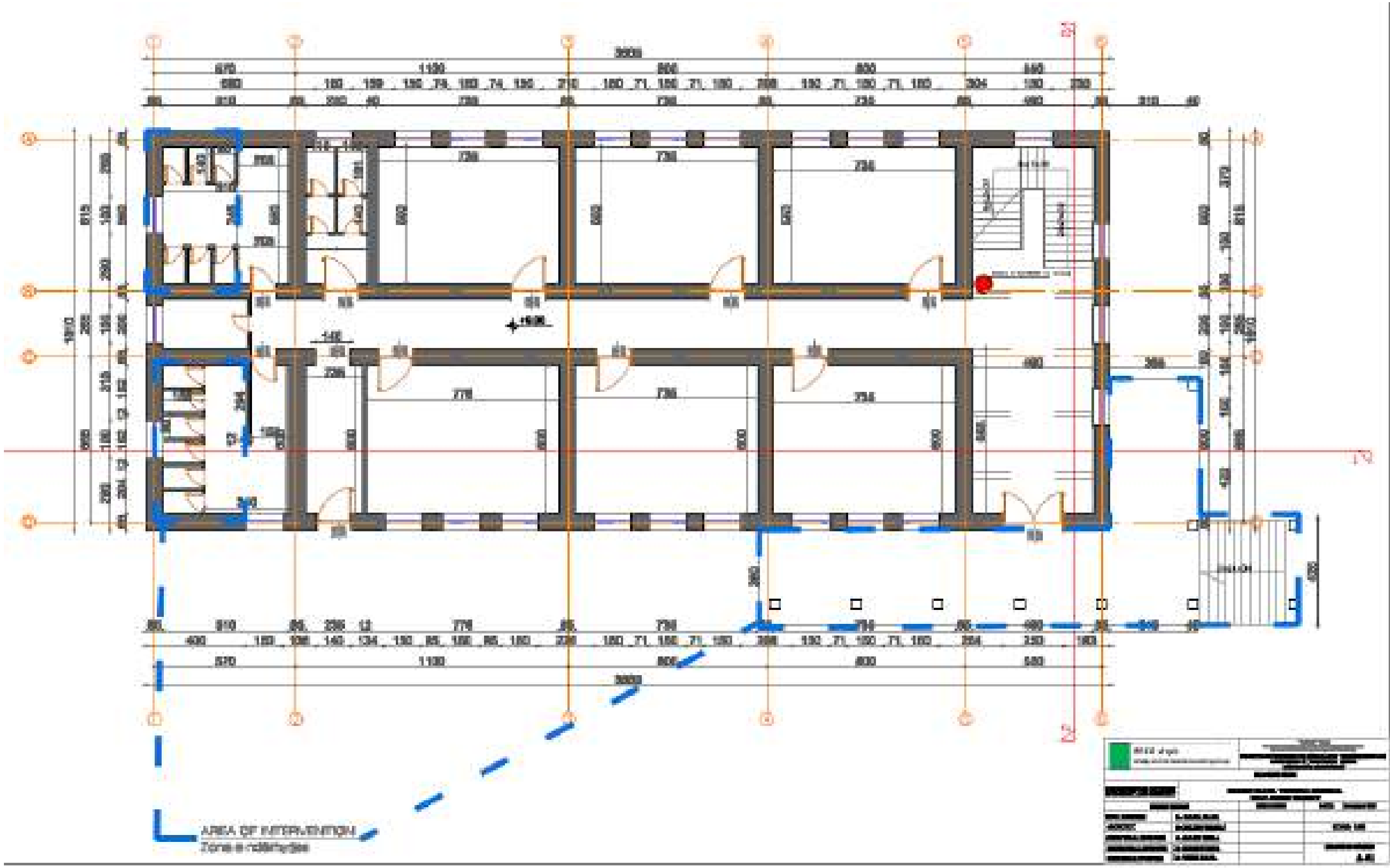


Figure 8: Layout of the First Floor

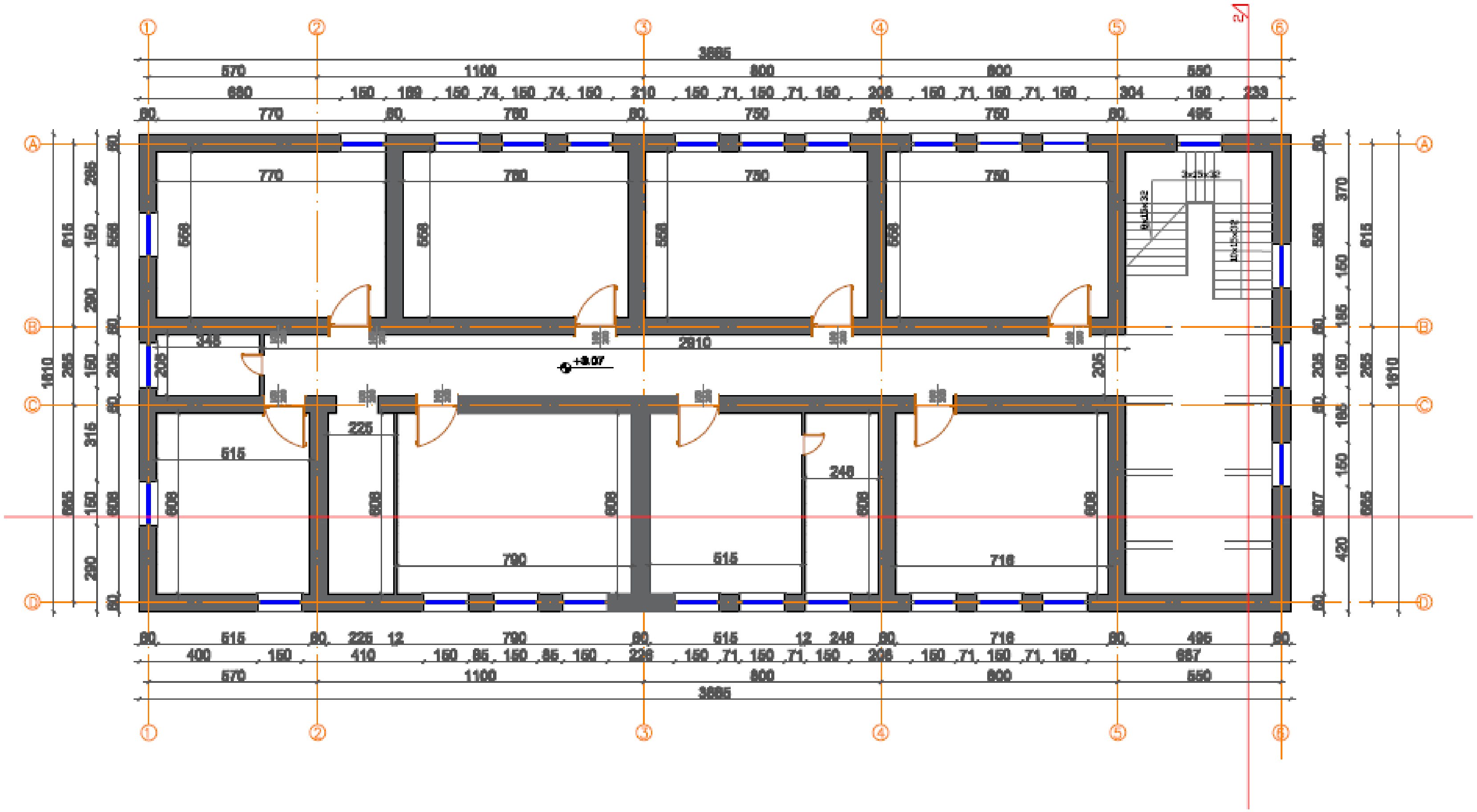
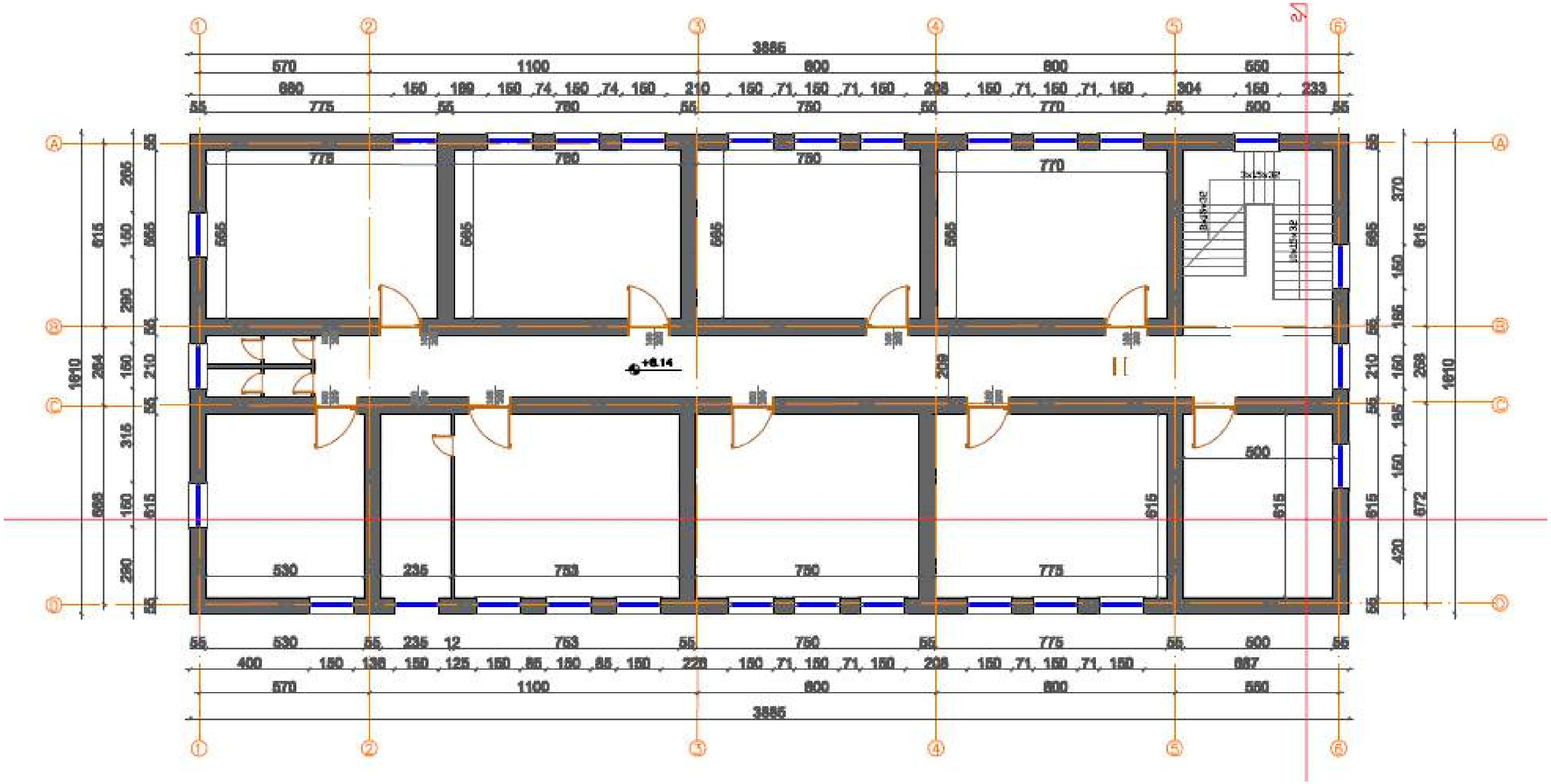


Figure 9: Layout of the Second Floor



From the Albanian Energetic Building Code, for Private Schools, which is prepared by the Albanian National Agency of Energy, are taken the number of degree-days for Gjirokaster – where school Koto Hoxhi is located. Calculation of the additional thermal losses depends from space heating system's functioning, average heat transfer coefficient from the building, and the building orientation. From the studies carried out by other Albanian researchers are determined such additional thermal losses for different types and activities in a building. Coefficient r =1 – 0.6, represents the coefficient which takes in consideration the space heating interruptions during the day and/or the weekends.

Based on well-known international methods, the calculation of energy losses to fulfil the energy demands for heating and cooling is carried out based on those losses which happen in the envelope of the building (outside walls, windows, outside doors, roof and floor). Based on these losses, it is possible to calculate the power of the heating and cooling systems. Meanwhile, it is understood that the rooms contains minibars which consume a lot of energy, or air conditioning units which work even when the door/window is opened as well as when the outside temperature changes. This is an important part, in order to than offer investing interventions, which may not be just constructions.

The consultant team has observed in detail the construction structures of exterior walls, roofs, floors, windows and has calculated the respective thermodynamic parameters, especially in relation to the heat transfer coefficient.

Tables 5 to 9 provide the calculation of the total heat transfer coefficients for the external walls, roofs, floors, windows and exterior doors for the current situation in the base case.

Wall	Base Case		
1540.2 m²	d	λ	R
Layer	[mm]	[W/mK]	[m²K/W]
Plaster	20	0.80	0.03
Block/Bricks	500	1.22	0.41
Plaster	20	0.80	0.03
U Value [W/m²K]			**2.175**

Table 5 – Calculation of the heat transfer coefficient from the outside wall

Figure 10-11 : Outside walls of the building

Roof	Base Case		
970.0 m²	d	λ	R
Layer	[mm]	[W/mK]	[m²K/W]
Plaster	25	0.80	0.03
Block/Bricks	200	2.16	0.09
Play wood	50	0.30	0.17
U Value [W/m²K]			**3.475**

Table 6 - Calculation of the heat transfer coefficient for the first type of roof

Floor	Base Case		
940.68 m²	d	λ	R
Layer	[mm]	[W/mK]	[m²K/W]
Ceramic	10	0.91	0.01
Screed	200	1.15	0.17

EPS	0	0.04	0.00
Concrete slab	250	2.10	0.12
U Value [W/m²K]			**3.301**

Table 7 – Calculation of the heat transfer coefficient from the basement

Figure 12-13: Floor of the building

Type	Description	Area [m²]	Existing "U" value [Wm²/K]	Proposed "U" value [Wm²/K]
Windows 1 – PVC frame	Double Glazing	268.80	4.8	1.1
Total		**268.80**	**4.80**	**1.10**

Table 8 – Calculation of the heat transfer coefficient from the windows

Figure 14-15 : Pictures of the window walls

Type	Description	Area [m²]	Existing "U" value	Proposed "U" value
			[Wm²/K]	[Wm²/K]
Doors1 - Metal frame	Metal frame	10.56	5.6	1.5
Total		**10.56**	**5.60**	**1.50**

Table 9 – Calculation of the heat transfer coefficient from the outside doors

Figure 15-16: Pictures of the wall of outside doors

Based on the above mentioned calculation and HDD and CDD for Gjirokaster Municipality is becoming possible to be calculated energy demand for heating and cooling. Calculation results are presented at table 10.

All envilope elements	Heat transfer coeficient (W/m²°C)	Length (m)	Height / Width (m)	Area (m²)	Area to be substracted (m²)	Calculated area (m²)	Internal Temperature during heating season (°C)	Outside air temperature (°C) Winter	Transmission heat losses (W)	Change of air in one hour	Infiltration heat losses (W)	Transmission and Infiltration heat losses (W)	Internal Temperature during cooling season (°C)	Outside air temperature (°C) Summer	Transmission cooling losses (W)	Infiltration cooling losses (W)	Transmission and Infiltration cooling losses (W)	Heating Degree Days	Cooling Degree Days
Wall	2.175	283.0	6.400	1,811	269	1,542	20	-2	73,793	1.60	281,703	355,497	23	30	23,480	89,633	113,113		
Windows	4.80			269		269	20	-2	28,385			28,385	23	30	9,032		9,032		
Outside doors	5.60			10.6		10.6	20	-2	1,301			1,301	23	30	414		414	1,479	152
Floor	3.30	37.3	26.00	970		970	20	-2	70,472			70,472	23	30	22,423		22,423		
Roof	3.46	37.3	26.00	970		970	20	-2	73,810			73,810	23	30	23,485		23,485		
Volume of the flat / house	23,705 m³		Window ratio	0.15						Capacity (kW)		529					168	kWh/m2	
Floor Area	2,444 m2									Heating Energy Demand (kWh)							512,561	210	
										Cooling Energy Demand (kWh)							42,142	17	
																	554,703	226.9809	

Table 10 - Calculation of energy demand for space heating and cooling by fulfilling comfort conditions

Summary of the results are presented at the following :

- **Total heat requirement capacity – 529 kW**
- **Total space heating energy demand – 42,142 kWh/year**
- **Total specific space heating energy demand – 17 kWh/m²*year**

4.2 Energy Demand for Covering Space Cooling Needs

Energy demand for cooling purposes was calculated based on the Gv – Volumetric heat losses coefficient - (which in itself was calculated when have been calculated energy demand for space heating) and cooling degree-days. Cooling decree days are taken approximately because up to now don't exist any figure. So it is a duty of Institute of Hydrometeorology to calculate this figures especially actually when the penetration of cooling devices is very high.

Based on the calculation model of the energy demand is become possible to be calculated space cooling energy demand.

- **Total cooling requirement capacity – 168 kW**
- **Total space cooling energy demand – 210 kWh/m^2*year**
- **Total specific space cooling energy demand – 512,561 kWh/year**

4.3 Energy Demand for Covering Hot Water Needs

Let analyse more in details the energy consumption for preparing hot water up to nowThe Energy Demand Forecast to Prepare Wet Water should be calculated assuming that the students will only use it for personal hygiene. Based on the average cold water temperature for each month and the number of students, the needs for hot water for personal hygiene are calculated. Based on the model of calculation for energy demand it has been reached the conclusion that hot water energy demand for the school is 3,900 kWh/year taking into consideration a 85% efficiency of electrical boilers and one solar how water system already installed and without taking any measure for energy efficiency or using solar water heaters in their full area requested.

4.4 Energy Demand for Covering Cooking Needs

Energy demand used for cooking is zero since there will be not a kitchen in this school.

4.5 Electricity Demand for Covering Lighting Needs

The natural lighting gives an important contribution for lighting an internal area and can provide sufficient lighting for a defined period during the day, by avoiding the artificial lighting. The aspects of natural lighting depend, firstly, on the form and the orientation of the buildings and its windows. The main influencing factors that should be taken into consideration for evaluating the efficiency of energy used for lighting are: natural lighting, types of lamps, barriers, commanding and controlling, illuminator type, and maintenance. In the building of

"Koto Hoxhi" school, the calculations related to the electricity consumption for lighting are based on taking into account the number of lamps, the average lamp power, and the average time of their operation, during the summer and winter periods. Total yearly electricity consumption for baseline with comfort conditions is equal to 32,075 kWh. Later we will analyse especially the distance between lamps and the measures that should be taken related to efficiency. These measures should be feasible for saving electricity used for lighting. These measures make possible energy saving which will be used for lightening

4.6 Electricity Demand for Covering Electrical Appliances Needs

The group of electric appliances includes: computers, photocopy and water pomp. Based on the model of calculation energy demand for each service in general and electrical appliances in particular was reach in the conclusion that electrical appliances energy demand is 5,055 kWh/year without taking any measure for energy efficiency.

4.7 Energy Demand for All Needs

Figure 17 summarizes the energy demand to guarantee each service. As shown in the figure 18, the space heating is expected to play the main role will be for space heating with 84.48%, the second one for cooling with 6.95%, followed by electric appliances 2.64%, cooking 0%, hot water 0.64% and lighting 5.29%

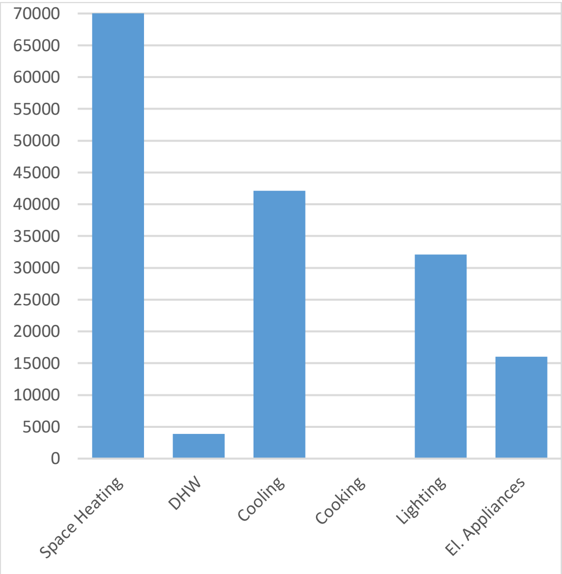


Figure 17: All energy service demand in school [kWh/year]

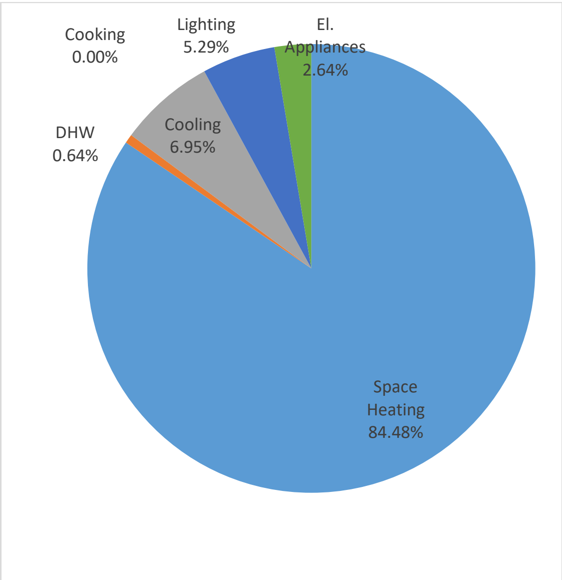


Figure 18: All energy service demand in school [%]

Figure 19 & 20 summarizes the energy demand for each energy commodity in School. As shown in the figure, the main role is played by electricity with 100% and this shows clearly why the cost of energy services in the school are very high. Let compare now the annual energy sources consumption for all energy services for the year 2017 with the energy demands calculated above in each section.

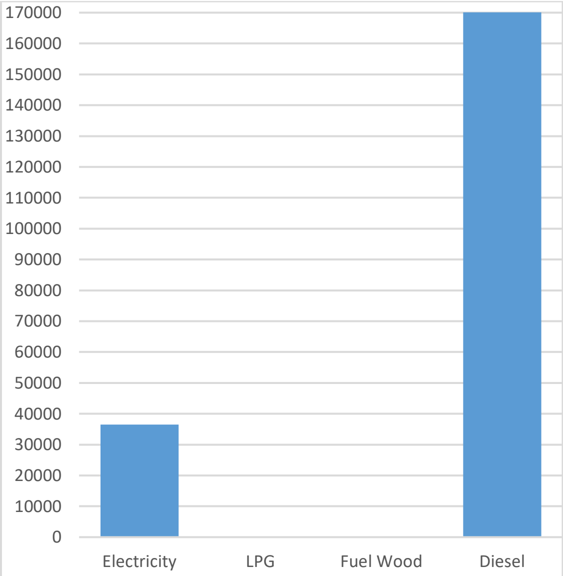


Figure 19: All energy commodities demand [kWh/year]

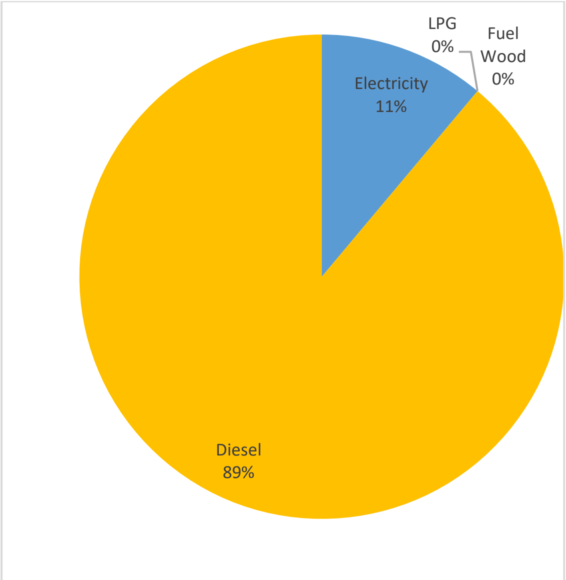


Figure 20: All energy commodities demand [%]

Based on figure 21 and in the above analysis, the energy demand for providing all services is 606,716 kWh and all energy commodities consumption has been 328,673 kWh/year. The actual consumption of energy sources for all energy services during the year 2017 (electricity) given in kWh is shown in figures 21 & 22.

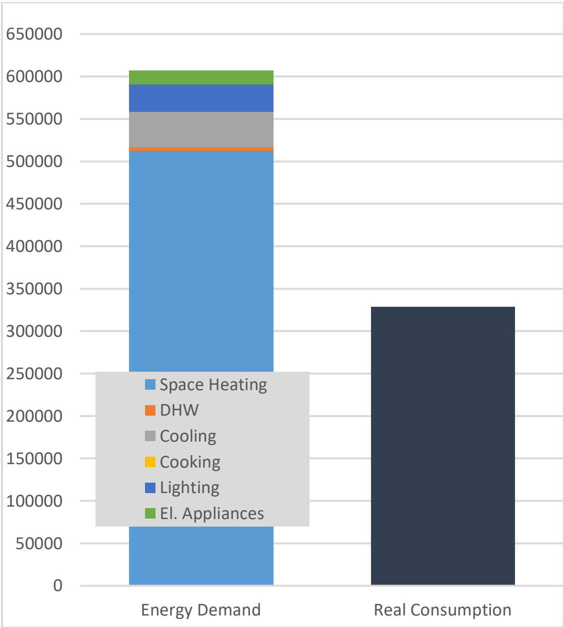


Figure 21: Energy Demand and real consumption for year 2016\17 [kWh/year]

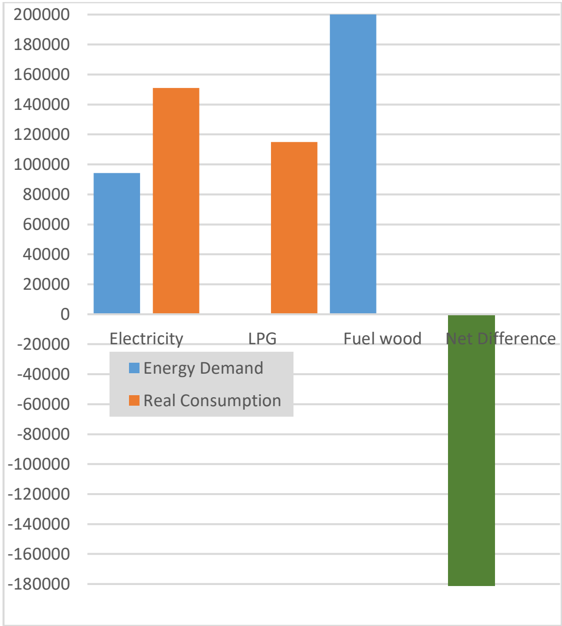


Figure 22: All energy commodities demand [%]

From this analysis we come in a very important conclusion related to use of energy consumption in School Koto Hoxhi: energy supply is much lower for each energy commodities than energy demand and this shows that is a room to introduce much better energy supply to reach comfort and in the same time to introduce efficient energy system to manage future energy consumption.

5. ANALYSIS AND SELECTION OF POSSIBLE MEASURES TO IMPROVE ENERGY CHARACTERISTICS OF BUILDINGS

The techniques used in the management of energy have much in common with those required for management of any resource in a school. The overall objective of the Energy Manager is to save money (table 11). Although it is an over-simplification to imagine that, this is just a question of establishing areas of inefficiency and taking appropriate corrective actions, it does form a convenient starting point in the description of the activity of the Energy Manager. Based on the above-mentioned algorithm described in the following table 11. The manager of energy should work to implement the main objective for saving money in the school.

Table 11: Algorithm for describing an energy audit

	Primary question	Present facts	Alternatives	Selected alternatives
Purpose	What is done?	Is it necessary? Why?	What else could be done?	What should be done?
Means	How is done?	Why like this?	How else could it be done?	How should it be done?
Place	Where is done?	Why there?	Where else could it be done?	Where should it be done?
Time	When is this done?	Why then?	When else could it be done?	When should it be done?
Source	Where does the input source come from?	Why this source?	What other source could be used?	What source should be used?
Sink	Where does the rejected resource go?	Why there?	Where could it be redirected?	Where should it be redirected?

By analysing and taking decision on each step, Energy Manager fulfils the main objective that we mentioned on the beginning: what should I do to save money? As fist view, these activities are summarized in figure 81. So the diagram summarizes the techniques, which can save money. Each type of activity will be considered in turn.

- **Same usage. Reduce costs by tariff negotiation.** The fuel and energy costs of a school are related to tariffs, which are published by suppliers. There is often a choice of tariff structure, for example with electricity. The tariff structure will not of itself necessary alter the total consumption of fuel but may suggest a different pattern of usage to reduce costs.

- **Less usage: Good housekeeping, by running existing energy plant in a more effective way.** The phrase "good housekeeping" is often heard when energy management is under discussion. It generally refers to the situation where all personnel within a school are constantly aware of the cost of energy and adopt simple measures to save energy. An example as personnel switching off equipment when it is not being used; lights are portable heaters are examples of this. It could be also a constant awareness of leaks of hot water and oil. This aspect of the Energy Manager's job is more to do with the education of the personnel, and the success of "good housekeeping" is more as much a matter of good personnel management as the application of engineering principles.

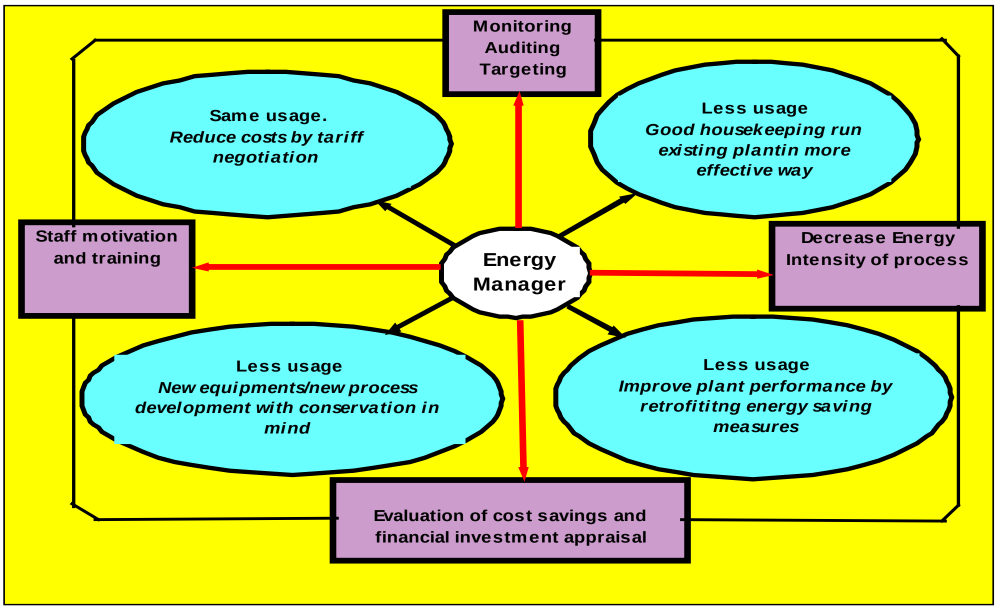


Figure 23: The main tasks of energy manager

- **Less usage: Improve plant performance by introducing energy-saving measures.** This is a suitable time to introduce three more commonly used phrases: Energy Monitoring, Energy Auditing and Energy Targeting. Basically, when an Energy Manager collects data about the overall energy consumption of a site from succession bills, or about a particular piece of plant by measuring input and output energy flows than we can say that energy consumption is being monitored. When the data are analysed to shown the pattern and efficiency of energy usage this can be said to be an energy audit. Finally, if the audit reveals that either good housekeeping and/or the utilization of extra energy-saving devices will improve the utilization than targets can be established for future levels of consumption (figure 18).

5.1 Description and analysis of the savings of proposed measures to increase energy efficiency in the building

Consultant have prepared a list of EE/RES measures for improvement of the EE in Koto Hoxhi (Gjirokaster) school and they are as follows:

1. Thermal insulation of external walls
2. Thermal insulation of the roof
3. Thermal insulation of the floor
4. Installing Efficient Windows
5. Installing external efficient doors
6. Installing an efficient heating system
7. Installing the SHWS
8. Installing the Photovoltaic System
9. Installing of EE Bulbs.

5.2 Thermal insulation of outside walls

In South East Europe (including Albania) energy consumption for heating is 1.5-2 greater than same building in Western Europe.Increasing the thermal insulation level and reducing the losses from natural and mechanical ventilation, can reduce greatly the energy consumption in the buildings. If a building should be renovated due to its degradation (replacement of old windows, roof improvement etc.), it is reasonable to combine these steps with energy efficiency measures because the energy consumption reduction can lower sensibly the payback period. Apart from reduction of energy consumption, the thermal improvement can increase also the lifespan of the building and at the same time reduce the emissions into the atmosphere from fuel burning. This will contribute in reducing local environmental pollution and greenhouses gases.

The economical thickness is a thickness that gives the highest energy consumption for the lowest investment costs. This figure depends on the thermal characteristic of the material (energy consumption), material cost, installation cost, and prices of energy sources that will be used for providing space heating. The total cost for installing insulation is a fixed cost per m^2 and the material cost depend on the insulation thickness. Therefore, the first cm of insulation is relatively more expensive than the other cm.

The energy losses depend on the structure of the building, insulation material thickness and the climatic conditions. The energy losses have not a linear correlation with the above three parameters. The difference in the extra savings will be lower for extra cm of insulation. Thus, for the first cm-s, as it was underlined above, there are higher savings than the other cm-s. The economical insulation thickness is that the sum of the costs of energy losses and costs of investments for insulation, to be lower. With the current world prices of energy market, the economical thickness of the insulation for Europe is 8-12 cm the previous experience has shown that the electricity prices are subject to the rapid and very non-stabilized changes.

The optimum insulation layer is calculated based on the program of technical-economic analysis of thermal insulation, by taking into consideration the fuel cost, maintenance of district heating plant, initial investment of the thermal insulation material, labour power for placing the insulating material etc.

By using the external insulation, we can eliminate the existing thermal bridges, the damages of concrete walls can be repaired, the losses can be reduced drastically and the lifespan of the building is extended. In general, the problems related to the condensation should be avoided, there is not any more the risk of dew point in the walls and the construction remains dry during all the time. Before installing the external layer of insulation, the transporting load abilities should be tested and the cracks and existing damages should be repaired.

The outside walls are not thermo insulated and the arent in good shape becouse thaey have had no maintaince since their building. Based on the above analyses is prepared the block scheme for analysing the technical and economic effect of the thermal insulation of external walls and roofs of the building. The analyses are made by calculating energy losses (as thermal power and as thermal energy necessary for space heating in both cases, with or without thermal insulation), the total cost (investments of the thermal insulation plant, service, labours, depreciation, and fuel),), Net Present Value of both cases (with and without thermal insulation) and other specific indicators. Roof (terrace) insulation is a well-proven energy efficiency measure, which reduces heat loss in allbuilding. In table 12 jare given parameters of outside walls includinf thermoinsulated layer of 10 cm.

Wall type 1	Renovated		
1540.2 m²	d	λ	R
Shtresa	[mm]	[W/mK]	[m²K/W]
Suva	20	0.80	0.03
Blok	500	1.22	0.41
Suva	20	0.80	0.03
Materiali termoizolues EPS	60	0.04	1.50
Suva	0	0.80	0.00
U Value [W/m²K]			**0.510**

Table 12 – Outside walls parameters along with the thermal insulating layer of 10 cm

These tables are better to be associated with those of the base scenario for comparison. Table 13 gives the basic parameters of technical calculation of energy saving as a result of the thermal insulation of the exterior walls of the building. The unit price per thermal insulation of the outside walls for 1 m2 of thermal insulation is 31.25 Euro / m2 and the total investment for 1,540.2 m2 of external walls is equal to 23,406 Euro.

External wall insulation			XPS	0.08	m														
All envilope elements	Heat transfer coeficient (W/m²°C)	Length (m)	Height / Width (m)	Area (m²)	Area to be substracted (m²)	Calculated area (m²)	Internal Temperature during heating season (°C)	Outside air temperature (°C) Winter	Transmission heat losses (W)	Change of air in one hour	Infiltration heat losses (W)	Transmission and infiltration heat losses (W)	Internal Temperature during cooling season (°C)	Outside air temperature (°C) Summer	Transmission cooling losses (W)	Infiltration cooling losses (W)	Transmission and infiltration cooling losses (W)	Heating Degree Days	Cooling Degree Days
Wall	0.510	283.0	6.400	1,811	269	1,542	20	-2	17,310	1.45	255,294	272,603	23	35	9,442	139,251	148,693		
Windows	4.80			269		269	20	-2	28,406			28,406	23	35	15,494		15,494		
Outside doors	5.60			10.6		10.6	20	-2	1,306			1,306	23	35	2,923		2,923	1,479	152
Floor	3.30	37.3	26.00	970		970	20	-2	70,438			70,438	23	35	38,421		38,421		
Roof	3.46	37.3	26.00	970		970	20	-2	73,775			73,775	23	35	40,241		40,241		
Volume of the flat / house	23,705 m³		Window ratio	0.15						Capacity (kW)		447					246	kWh/m2	
investment	71,318									Heating Energy Demand (kWh)							432,272	177	
savings €/year	9,050									Cooling Energy Demand (kWh)							35,863	15	
payback	7.88									Heating & Cooling Energy Demand (kWh) difference							86,568	15.61%	

Table 13 – Calculation of energy demand for heating and cooling for the base case by completing the comfort conditions for the case of placing thermal insulation in the outside walls

Calculation of energy efficiency for the application of thermal insulation of external walls (exterior) shows the following results: energy savings are 11,158 kWh / year equal with a saving in percentage versus the basic case with 15.61%.

5.3 Thermal Insulation of the Roof

As noted above, the roofs of the building are uninsured and in poor condition and in some places roof leaks. Even for the application of thermal insulation of the roof, a calculation scheme has been prepared to analyze the technical and economic effect on thermal insulation. Table 14 shows the parameters together with the thermal insulating layer of 10 cm.

Roof type 1	Renovated		
970.5 m²	d	λ	R
Layer	[mm]	[W/mK]	[m²K/W]
Plaster	25	0.80	0.03
Concrete slab	200	2.16	0.09
Rock wool	100	0.04	2.50
Planks	50	0.30	0.17
U Value [W/m²K]			**0.359**

Table 14 – Outside walls parameters along with peak thermal insulating layer of 16 and 10 cm along with its waterproofing

Table 15 gives the basic parameters of the technical calculation of energy saving as a result of the thermal insulation of the building roof. The unit price of 1 m2 of thermal insulation is 57.25 Euro / m2 and the total investment for 970.5 m2 roof is equal to 9,833 Euro.

Roof insulation		glass wool		0.10	m														
All envilope elements	Heat transfer coeficient (W/m²°C)	Length (m)	Height / Width (m)	Area (m²)	Area to be substracted (m²)	Calculated area (m²)	Internal Temperature during heating season (°C)	Outside air temperature (°C) Winter	Transmission heat losses (W)	Change of air in one hour	Infiltration heat losses (W)	Transmission and Infiltration heat losses (W)	Internal Temperature during cooling season (°C)	Outside air temperature (°C) Summer	Transmission cooling losses (W)	Infiltration cooling losses (W)	Transmission and Infiltration cooling losses (W)	Heating Degree Days	Cooling Degree Days
Wall	2.175	283.0	6.400	1,811	269	1,542	20	-2	73,774	1.55	272,900	346,674	23	35	40,240	148,855	189,095		
Windows	4.80			269		269	20	-2	28,406			28,406	23	35	15,494		15,494		
Outside doors	5.60			10.6		10.6	20	-2	14,616			14,616	23	30	2,923		2,923	1,479	152
Floor	3.30	37.3	26.00	970		970	20	-2	70,438			70,438	23	35	38,421		38,421		
Roof	0.36	37.3	26.00	970		970	20	-2	7,651			7,651	23	35	4,173		4,173		
Volume of the flat / house	23,705 m³		Window ratio	0.15						Capacity (kW)		468					250	kWh/m2	
investment	42,195									Heating Energy Demand (kWh)							452,850	185	
savings €/year	6,833									Cooling Energy Demand (kWh)							36,496	15	
payback	6.175									Heating & Cooling Energy Demand (kWh) difference							65,357	11.78%	

Table 15 – Calculation of energydemand for heating and cooling for the base case completing the comfort conditions for the case of placing thermal insulation in the roof/ terrace

Calculation of energy efficiency for the application of thermal insulation of the roof shows the following results: energy savings are 8726 kWh / year equal this with a saving in percentage versus the basic case with 11.78%.

5.4 Thermal insulation of the floor

As noted above, the floor of the building is uninsulated and in poor condition and in many places it is damaged. Also for the application of the thermal insulation of the floor is prepared calculator to analyse the technical and economic effect on the thermal insulation. Table 16 gives floor parameters along with the thermal insulating layer.

Floor type	Renovated		
940.68 m²	d	λ	R
Layer	[mm]	[W/mK]	[m²K/W]
Ceramic	10	0.91	0.01
Screed	200	1.15	0.17
EPS	50	0.04	1.25
Concrete slab	Concrete slab	2.10	0.12
U Value [W/m²K]			**0.644**

Table 16 – Parameters of roof of outside walls within thermal insulated layer of the roof of 16 cm and 10 cm and with its hydro insulation.

Table 17 gives the basic parameters of technical calculations of energy saving as a result of the installation of thermal insulation of the floor. The unit price per 1 m2 of thermal insulation is 50 Euro / m2 and the total investment for 940.48 m2 floor is equal to 11,543 Euro.

Floor insulation																			
All envilope elements	Heat transfer coeficient (W/m²°C)	Length (m)	Height / Width (m)	Area (m²)	Area to be substracted (m²)	Calculated area (m²)	Internal Temperature during heating season (°C)	Outside air temperature (°C) Winter	Transmission heat losses (W)	Change of air in one hour	Infiltration heat losses (W)	Transmission and infiltration heat losses (W)	Internal Temperature during cooling season (°C)	Outside air temperature (°C) Summer	Transmission cooling losses (W)	Infiltration cooling losses (W)	Transmission and infiltration cooling losses (W)	Heating Degree Days	Cooling Degree Days
Wall	2.175	283.0	6.400	1,811	269	1,542	20	-2	73,774	1.45	255,294	329,068	23	35	40,240	139,251	179,491		
Windows	4.80			269		269	20	-2	28,406			28,406	23	35	15,494		15,494		
Outside doors	5.60			10.6		10.6	20	-2	1,306			14,616	23	30	2,923		2,923	1,479	152
Floor	0.51	37.3	26.00	970		970	20	-2	10,889			10,889	23	35	5,939		5,939		
Roof	3.46	37.3	26.00	970		970	20	-2	73,775			73,775	23	35	40,241		40,241		
Volume of the flat / house	23,705.15	10.0	15.90	159		159				Capacity (kW)		457					244	kWh/m2	
investment	65,475									Heating Energy Demand (kWh)							442,171	456	
savings €/year	9,593									Cooling Energy Demand (kWh)							20,777	21	
payback	6.83									Heating & Cooling Energy Demand (kWh) difference							91,755	16.54%	

Table 17 – Calculation of energy demand for heating and cooling for the base case completing the comfort conditions for the case of placing floor thermal insulation

Calculation of energy efficiency for the application of thermal insulation of the floor shows the following results: energy savings are 12,251 kWh / year, this value equals a saving expressed in percentage versus the basic case of 16.54%.

5.5 Introduction of Efficient Windows

As noted above a small part of the windows have been replaced by the last 10-15 years by the education department, while another part still continues with the first windows installed since the construction of this building. Based on the above analysis, a schematic diagram was prepared to analyse the technical and economic effect of window replacement with new efficient windows. Table 18 shows the settings for new efficient windows to be installed in this building.

Type	Description	Area [m²]	Existing "U" value	Proposed "U" value

			[Wm²/K]	[Wm²/K]
Windows 1 - PVC frame	Bilayer	268.80	4.8	1.1
Total		**268.80**	**4.80**	**1.10**

Table 18 – Parameters of new efficient windows that will be installed in this building

Secure sealing of the casements is achieved by using special sealing materials (EPDM rubber) and good sealing between the frames and the walls is provided by polyurethane (PU) foam. Absolute sealing must be avoided, so as to secure the necessary minimal level of natural window ventilation. The minimal necessary natural ventilation is reached with special openings with shutters (automatic and manual) located in the PVC and Al profiles. Thermopane windows can contain, on the inner side of the glass pane, a layer of special emulsion, which does not allow heat to flow from the room to the outside environment. The space between glass panes, besides being filled with air, can also be filled with argon (Ar).

An efficient refurbishment measure with wooden windows is to build-in special sealing tapes in grooves of window frames and window panes (Al, EPDM and silicone tapes). In practice, wooden and metal single-paned windows are most commonly met. Wooden windows decay due to bad maintenance, they distort and lose geometry, and therefore the losses caused by the breach of air become significant. Sealing tapes are not regularly changed on metal windows which makes the losses increase. Refurbishment implies all the measures being taken targeting to bring the windows to their initial state, which may significantly reduce losses caused by air breach

Table 19 gives the basic parameters of technical energy saving calculations as a result of the installation of new efficient windows in this building. The unit price per 1 m2 of efficient windows is 172.5 Euro / m2 and the total investment for 203 m2 of external walls is equal to 13,608 Euro.

Windows (double-glazed 4-16-4)																			
All envilope elements	Heat transfer coeficient (W/m²°C)	Length (m)	Height / Width (m)	Area (m²)	Area to be substracted (m²)	Calculated area (m²)	Internal Temperature during heating season (°C)	Outside air temperature (°C) Winter	Transmission heat losses (W)	Change of air in one hour	Infiltration heat losses (W)	Transmission and Infiltration heat losses (W)	Internal Temperature during cooling season (°C)	Outside air temperature (°C) Summer	Transmission cooling losses (W)	Infiltration cooling losses (W)	Transmission and Infiltration cooling losses (W)	Heating Degree Days	Cooling Degree Days
Wall	2.175	283.0	6.400	1,811	269	1,542	20	-2	73,774	1.40	246,490	320,265	23	35	40,240	134,449	174,690		
Windows	1.10			269		269	20	-2	6,510			6,510	23	35	3,551		3,551		
Outside doors	5.60			10.6		10.6	20	-2	1,306			1,306	23	35	712		712	1,479	152
Floor	3.30	37.3	26.00	970		970	20	-2	70,438			70,438	23	35	38,421		38,421		
Roof	3.46	37.3	26.00	970		970	20	-2	73,775			73,775	23	35	40,241		40,241		
Volume of the flat / house	23,705 m³		Window ratio	0.15						Capacity (kW)		472					258	kWh/m2	
investment	41,964									Heating Energy Demand (kWh)							457,214	187	
savings €/year	6,262									Cooling Energy Demand (kWh)							37,591	15	
payback	6.70									Heating & Cooling Energy Demand (kWh) difference							59,898	10.80%	

Table 19 – Calculation of energetic needs for heating and cooling for the base case completing the comfort conditions for the new efficient windoes that will be installed in this building

Calculation of energy efficiency for placing efficient windows shows these results: the energy savings are 7997 kWh/ year this equal to a saving expressed in percentage against the base case with 10.80 %.

5.6 Installing efficient outside doors

Replacing outside doors requires replacement of actual doors with efficient products using profiles with thermal barriers. This measure can increase the temperature in the internal spaces with 2-4 °C, reducing in the same time the energy consumes for heating. As it is highlighted above, the building outside doors are metallic and in very bad condition because they are not maintained since their placement. Based on the above analyses, is prepared the calculating scheme to analyse the technical and economic effect in the placement of outside doors in the building. In table 20 are given the outside walls parameters along with the placement of efficient outside doors.

Type	Description	Area [m²]	Existing "U" value [Wm²/K]	Proposed "U" value [Wm²/K]
Doors1 - Metal frame	Metal Frame	10.56	5.6	1.5

Total		**10.56**	**5.60**	**1.50**

Table 20 – Parameters of outside walls together with outside doors

Table 21 gives the basic parameters of the technical calculation of energy saving as a result of the change of efficient exterior doors of the building. The unit price per 1 m2 of thermal insulation is 607.5 Euro / m2 and the total investment for 15.36 m2 of external walls is 3,780 Euros.

Efficient Outside Doors																			
All envilope elements	Heat transfer coeficient (W/m²°C)	Length (m)	Height / Width (m)	Area (m²)	Area to be substracted (m²)	Calculated area (m²)	Internal Temperature during heating season (°C)	Outside air temperature (°C) Winter	Transmission heat losses (W)	Change of air in one hour	Infiltration heat losses (W)	Transmission and Infiltration heat losses (W)	Internal Temperature during cooling season (°C)	Outside air temperature (°C) Summer	Transmission cooling losses (W)	Infiltration cooling losses (W)	Transmission and Infiltration cooling losses (W)	Heating Degree Days	Cooling Degree Days
Wall	2.175	283.0	6.400	1,811	269	1,542	20	-2	73,774	1.50	264,097	337,871	23	35	40,240	144,053	184,293		
Windows	4.80			269		269	20	-2	28,406			28,406	23	35	15,494		15,494		
Outside doors	1.50			10.6		10.6	20	-2	350			350	23	35	191		191	1,479	152
Floor	3.30	37.3	26.00	970		970	20	-2	70,438			70,438	23	35	38,421		38,421		
Roof	3.46	37.3	26.00	970		970	20	-2	73,775			73,775	23	35	40,241		40,241		
Volume of the flat / house	23,705 m³		Window ratio	0.15						Capacity (kW)		511					279	kWh/m2	
investment	8,745									Heating Energy Demand (kWh)							494,530	202	
savings €/year	2,040									Cooling Energy Demand (kWh)							40,659	17	
payback	4.29									Heating & Cooling Energy Demand (kWh) difference							19,513	3.52%	

Table 21 – Calculation of energetic needs for heating and cooling for the outside doors

Calculation of energy efficiency for changing efficient outside doors shows these results: energy sacings are 2303 kWh/ year this equal to a saving expressed in percentage against the base case with 3.52 %.

5.7 Installation of an efficient heating system

Biomass for burning as a fuel includes wood, wood manufacturing by-products (like pellets, briquettes). Although burning biomass releases carbon dioxide (CO_2) to the atmosphere, this is principally offset by the CO_2 absorbed in the original growth of the biomass, or captured in the growth of new biomass which replaces the materials used when it is sustainably sourced. Using biomass for heating therefore results in very low net ‘lifecycle’ carbon emissions relative to conventional sources of heating, such as gas, heating oil or diesel. The selection of the fuel to be used can be complex as it depends on many factors. While cost is a key driver for fuel selection, the space available for fuel storage, access for fuel deliveries and the method of delivery are all key considerations. Pellets are a local and environmentally-friendly fuel, which is not subject to the crises and fluctuations of the market.

Further more, pellets production provides jobs for local residents especially at rural areas of municipality and other north municipalities of Albania. That is why pellets is the perfect fuel, not just from an economic perspective, but also from an environmental point of view. Scrap wood such as branches, twigs and sawmill cuttings are turned into pellets with a cleaver. The quality class is determined by the wood used.

The high-temperature combustion chamber is 4-shelled, guaranteeing clean combustion. The jacket cooling, together with the water-cooled stoker duct minimize radiant heat losses and guarantee high efficiency. Thanks to the moving conveyor grate, boiler operation is trouble- and maintenance-free, even when using low grade fuels which tend to form cinder. Separation of the primary air zone guarantees full, efficient burnout. This keeps emission levels very low (CO less than 10 mg/MJ). The ashes that fall under the grate are automatically transported to the ash container by a rake. To calculate investments required, energy auditor has used the average figures of 10 similar projects carried out from the consultant in last three years with installed capacity 150 kW up to 250 kW.

The unit price is based on 650 projects already implemented for central heating systems for apartments in the KoSEP / EBRD project and is 40-50 Euro / m2. Table 22 provides the basic parameters of the technical calculation of energy saving as a result of the establishment of efficient pellet boiler

Efficient Heating System	kW	235.89
Baseline consumption		
Avg. mix energy	kWh/yr.	354,147
Total mix energy	MWh	354.15
Project consumption		
Avg. mix energy	kWh/lp	302,320
Total mix energy	MWh	302.32
Energy savings		
Total energy savings	MWh	51.83
Total cost savings		

Price of mix energy	Euro/kWh	0.105
Cost of mix energy	1000 Euro	37.02
Price of mix energy	Euro/ton	200
Net Calorific Value of Pellets	MJ/kg	19
Unit Cost of mix energy	Euro/kWh	0.0379
Cost of mix energy	1000 Euro	11.46
Cost of saving energy	1000 Euro	25.57
Staff and O&M cost savings	1000 Euro	0
Total	1000 Euro	37.02
Investment costs 000 Euro	1000 Euro	195.506

Table 22 – Calculation of energetic needs and saving through an efficient central system with pellets for the base case completing the comfort conditions.

5.8 Installation of Solar Hot Water System (SHWS) for preparing hot water

According to the calculations on the solar radiation carried out by ex-Institute of Hydrometeorology, under the conditions of the geographic belt where the station is located the total yearly solar radiation will vary from a minimum of 1,185 kWh/m^2 in North East Albania (Kukes) to a maximum of 1,690 kWh/m^2 in the South West (Saranda) and should be mentioned that Gjirokaster Municipality is among average solar radiation regions of Albania. So, the yearly average solar radiation in Albania is 1,450 kWh/m^2. Most areas of the Albania benefit more than 2,200 sunshine hours per year while the average for the whole country is about 2,400 sunshine hours per year and the western part receives more than 2,500 sunshine hours per year. Table 23 shows the average daily solar radiation (kJ/m2) for Gjirokaster Municipality for each month of the year.

Table 23 : The values of solar radiation for Gjirokaster Municipality

District	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Gjirokaster	10,037	11,848	14,270	15,472	17,584	19,664	21,177	20,267	19,268	14,512	12,438	11,830

In another study performed by the author, the optimal inclining angles of solar panel have been calculated in order to get a maximum of solar energy collected. Table 24 shows these values for some districts of Albania including Gjirokaster.

Table 24. Optimal seasonal (winter or summer) and annual angles for installing solar panel

District	***Gjirokaster***
Optimal annual angle	**36.23**
Optimal seasonal angle (summer)	**27.4**
Optimal seasonal angle (winter)	**55.52**

For the financial evaluation of this feasibility study on the use of SWH system to provide Hot Water (DHW), is created a program in EXCEL. The financial evaluation for this study has been carried out for Koto Hoxhi School.

Analysis shows that by increasing the installed collector area (increasing the initial investment), the running cost of the integrated water heating system (SWH system & backup system) are reduced

Table 25 present the base characteristics of technical calculations for energy savings by introducing solar hot water system.

Introduction of two units of SHWS - 10 m2	Nr	5.20
Baseline consumption		
Avg. electricity consumption	kWh/yr.	3,900
Total electricity consumption	MWh	3.90
Project consumption		
Avg. electricity consumption	kWh/lp	3,900
Total electricity consumption	MWh	3.90
Energy savings		
Total electricity savings	MWh	0.00
Total cost savings		
Price of electricity	Euro/kWh	0.105
Cost saving electricity	1000 Euro	0.408
Staff and O&M cost savings	1000 Euro	0
Total	1000 Euro	0.408

Investment costs 000 Euro	1000 Euro	3.000

Table 25 - present the base characteristics of technical calculations for energy savings by introducing solar hot water system

Optimization of the solar collector area is carried out based on the optimum value of the NPV financial indicator versus solar collector area. NPV indicator is calculated based on all assumption mentioned above regarding the first investment (which consider total investment of solar water heating system including installation cost), running cost (labour cost, O&M cost, back-up energy cost) and profits which are coming from substituting electricity boilers). **Based in this analyse the optimal area of SWH System for** Koto Hoxhi School 5.2 m^2**. Area has been taken lower than optimal one since during the summer there are holydays and demand will be covered normally with such area due to high solar radiation during these months**

Energy quantity that the panel produces is 3,900 kWh.

5.9 Instalation of a PV system

A network-connected photovoltaic system (usually this is the public electricity network) and makes it possible for the electricity produced to be supplied directly to the grid. Networked systems vary by size from home with an installed power of 2-10kWp) to SPVPP stations (with an installed power above 10 MWp). This is a form of decentralized generation of electricity. In the case of photovoltaic systems installed in buildings, energy demand is met by these systems and only excess supplies the network. Network nutrition requires the transformation of this energy from continuous current (DC) to alternating current (AC) by means of a special inverter.

The experience of these plants already realized in some places and some facilities in Albania creates the possibility for the autoproducing scheme to be used also for the case of Koto Hoxhi School - object of this study and to fulfil part of the electro-energy needs.

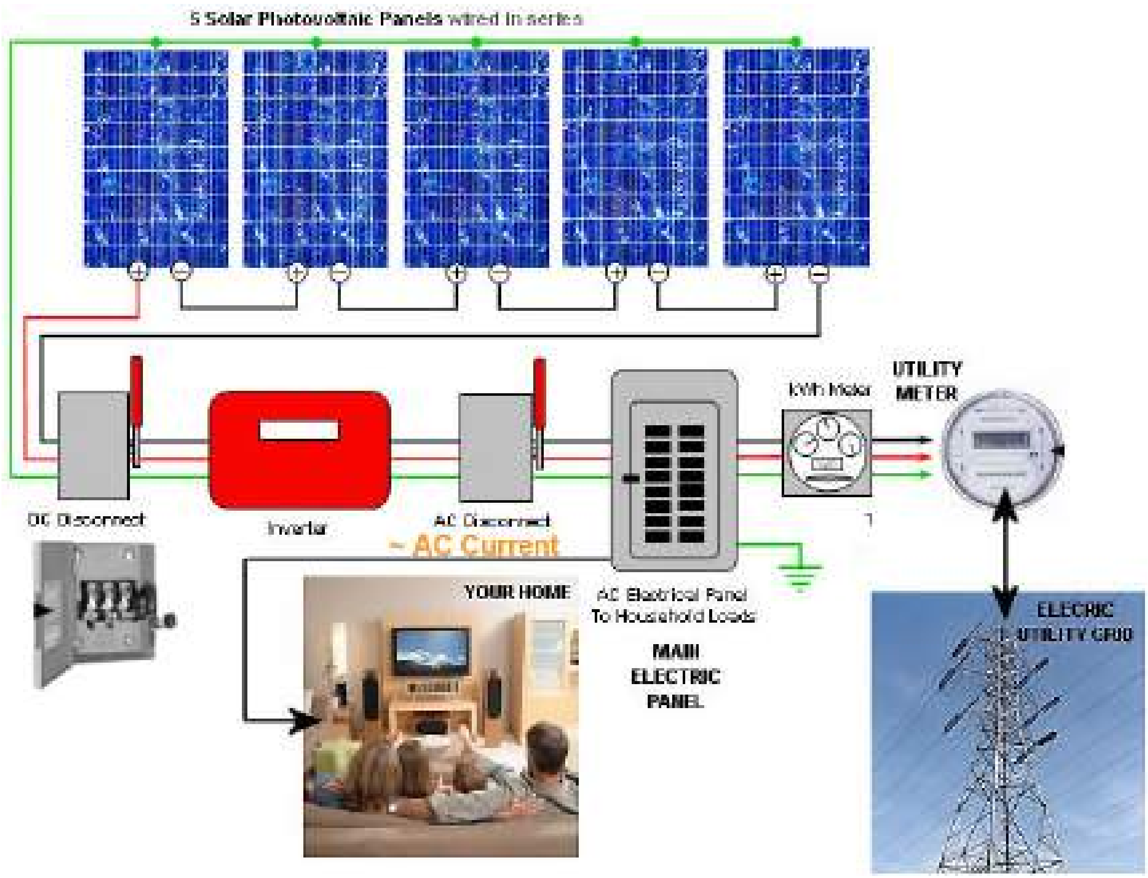


Figure 24: PV system installed for a school (or home) along with the main schema

In the figure is provided an installed PV system for a school (or home family) along with the main schema and PV modules installed in the school class along with the main schema.

Table 26 gives the basic parameters of the technical calculation of energy saving as a result of the installation of photovoltaic modules for the school.

Introduction of 7.5 kW PV System	Nr	5
Baseline consumption		
Avg. electricity consumption	kWh/yr.	7,750
Total electricity consumption	MWh	7.75
Project consumption		
Avg. electricity consumption	kWh/lp	7,750

Total electricity consumption	MWh	7.75
Energy savings		
Total electricity savings	MWh	0.00
Total cost savings		
Price of electricity	Euro/kWh	0.105
Cost saving electricity	1000 Euro	0.81
Staff and O&M cost savings	1000 Euro	0
Total	1000 Euro	0.81
Investment costs 000 Euro	1000 Euro	7.500

Table 26 - Calculation of energy demand and saving through Photovoltaic System for the EE scenario and meeting the comfort conditions

Based in this analyse the optimal capacity of PV System for Koto Hoxhi School 5 kW. Energy amount that the solar system will produce will be 7,750 kWh.

5.10 Installation of EE lamps

Adequate lighting control can bring to savings of energy that is used for lighting of schools, in average, 20 to 80%. Basically, these savings are achieved by using natural day lighting, when possible, as well as by controlling artificial lighting according to minimal necessary needs, depending on the occupancy of buildings. It is of a great importance that the system for lighting control is simple to use and can be used by anybody very easily.

Manual switchers are important and necessary in the premises where a lot of people are residing, and especially where changeable levels of lighting are desirable, either because there are not always people present in some parts of the premises or because there is more natural lighting at some parts of premises. Systems for automatic lighting control can be sorted in three groups:

- Time-controlled systems, that switches off the lighting in accordance with predefined schedules but, with an option that people present in the room can switch on/off lighting as they please, independently from the system.
- Systems that work depending on whether there is someone present in the room or not, that use infrared, acoustic, ultrasonic or microwave sensors that detect movement or noise in the room. They switch the lighting on/off upon detection that there is/is not someone/anyone present in the room.

Systems that work depending on the level of daylight, that measure daylight level by means of photoelectric sensors and, depending on the level of natural lighting, add artificial light.





Local positioning of photoelectric sensors at every individual luminary is more desirable and, if possible, sensors are to be put at the side towards the daylight source, in that way giving a precisely determined quantity of additional lighting to every luminary and in every part of the space, all that with maximal usage of natural lighting. The use of artificial lighting is very important; the regular monitoring of energy use and giving different measures regarding lighting savings are essential. .

Let analyze if it is profitable the investment related to the replacement of the existing 60 W incandescent lamps with 5 E LED lamps. So, it is clear there is the electricity saving are very high. The incandescent lamps have a lifespan of 1,000 hours, meanwhile LEDs bulbs have a lifetime equal to 50,000 hours. The hours of artificial lighting per year are taken the same as in the above case (the case for which are prepared the lighting load charts), and the respective costs for each lamp is 0.5 Euro/bulbs for incandescent lamps and 12 Euro/bulbs for LED bulbs. Calculated result are shown in table 27

Number of Bulbs	Actual lightening	EE lightening
Average Capacity of Bulb	153	153
Yearly Electricity Consumption	60	8
Total Investment	32075.27	4276.703
Simple Pay Back Period		2291.091

Number of Bulbs		1.267963

Table 27 – Substitutions of incandescent bulbs with LED for internal and outside lighting

6. FINANCIAL ANALYSIS OF OPTIMAL SCENARIO INVESTEMENT

The operating costs, energy savings, estimated on a yearly basis, are included into the part of the fixed costs, independent of the load of the plant. This includes the costs for the staff, costs for primary and auxiliary materials, the maintenance expenses and the cost for various services, loans and payments made to third parties. The cash flow is the difference between profits accruing in a given year from the selling of electricity, and the operating cost and the gross profit tax. Various methods have been and are being employed so as to come up with a financial decision, including that on net present value (NPV), the internal rate of return (IRR), the wealth maximizing rate (WMR), and the payback period (PBP). The financial formulas most wide used include NPV and IRR, and their respective calculations are given in formula 1 and 2.

$$NPV = \sum_{t=0}^{30} \frac{B_t}{(1+r_t)^t} - \sum_{t=0}^{30} \frac{C_t}{(1+r_t)^t} \qquad (1)$$

$$NPV = \sum_{t=0}^{30} \frac{B_t}{(1+IRR)^t} - \sum_{t=0}^{30} \frac{C_t}{(1+IRR)^t} = 0 \qquad (2)$$

Where:

t → the period of the cash flow: varying from 0 (year of installation) to n (the last year equal to lifetime

rt → the nominal discount rate (for the purpose of such financial analysis; 6-9% (it must also be noted that a sensitivity analysis has also been made) based on the reference values recommended by the Bank. In the sensitivity analysis, where variation of NPV is compared to rt, reference is made to the interval (6-9%);

Bt → profits accrued under the Project, which are obtained by multiplying the energy savings by the price of energy source for each year;

Ct → initial investment (only C_O) and the operating cost of the Project, which is obtained by multiplying the energy savings by the price of energy source for each year.

$$LDC = \frac{\sum_{i=0}^{30} \frac{C_i}{(1+r_i)^i}}{\sum_{i=0}^{30} \frac{E_i}{(1+r_i)^i}} \quad \text{[Leke/kWh]} \qquad (3)$$

At the above mentioned formula there are the following elements:

Ci- sum of investment cost and yearly operation costs.

Ei-saved/generated (in the case of RES measures) energy;

Another approach towards making the financial decisions accommodates the concept around the payback period for the investments. The payback period has been determined as the least indispensable time required by the EE Measures, so as to ensure that, during such period, profits exceed costs. Let us mark by ‘Xt’ a cash flow in the year‘t’; Xt is negative if it represents the cost, and is positive if it represents a profit. Let us mark the payback period for the investments by ‘PBP.’ Hence, the simplest formula for calculating PBP is obtained from the following:

$$\sum_{t=0}^{PBP} X_t \geq 0 \quad \text{whereXt = Bt – Ct} \qquad (4)$$

Without discounting the cash flows, PBP has a significant gap since it ignores the time value of money and therefore it should not be used any longer. As the discounting is included, then the equation for calculating the payback period will be:

$$\sum_{t=0}^{PBP} \frac{X_t}{(1+r_t)^t} \geq 0 \qquad (5)$$

In this case, the discounted cash flows accumulate until their sum becomes positive. For the purpose of making a comprehensive financial ratio analysis of the EE measures, all the financial formulas described earlier on, including NPV, IRR, LDC, and PBP, will be employed.

6.1 Financial analysis of thermal insulation of exterior walls

Based on the technical calculations presented in Chapter 5 above it has been possible to realize simple financial calculations for assessing the establishment of thermal insulation and the results for the baseline case are given in Table 28 together with some other indicators including the level of reduction of greenhouse gases.

Financial indicators	Unit	Value
Average Cost Saving	1000 Euro	11.56
Net Present Value (interest rate = 5%)	1000 Euro	54.53
Simple Pay Back Period (years)	Years	6.17
Discount Pay Back Period (years)	Years	9.159
Levelled Discount Unit Saving Energy Cost	Euro/kWh	0.07240
Internal Rate of Return (%)	%	15.17%
Reduction of the GHG [tons/year]		24.24

Table 28 - Financial indicators along with some other indicators including the level of greenhouse gas reduction

The analysis shows that the investment for the realization of the external thermal insulation of the building walls is very positive with a Payback period of 6.17 years and IRR = 15.17%. These values together with other calculated indicators are presented in Figures 20-25. Detailed energy and financial calculations for the feasibility of applying Thermal Exterior Thermal Insulation for basic sensitivity scenarios are presented in Annexes 6-9.

6.2 Financial analysis of thermal insulation of the roof

Based on the technical calculations presented in Chapter 5 above it has been possible to realize simple financial calculations for assessing the establishment of thermal insulation and the results for the baseline case are given in Table 29 together with some other indicators including the level of reduction of greenhouse gases.

Financial indicators	Unit	Value
Average Cost Saving	1000 Euro	8.726

Net Present Value (interest rate = 5%)	1000 Euro	52.82
Simple Pay Back Period (years)	Years	4.835
Discount Pay Back Period (years)	Years	7.178
Levelled Discount Unit Saving Energy Cost	Euro/kWh	0.05673
Internal Rate of Return (%)	%	21.16%
Reduction of the GHG [tons/year]		18.3

Table 29 - Financial indicators along with some other indicators including the level of greenhouse gas reduction in the case of l the roof thermal insulation

The analysis shows that the investment for the realization of the external thermal insulation of the building walls is very positive with a payback period of 4.84 years and IRR = 21.16%. These values together with other calculated indicators are presented in Figures 20-25. Detailed energy and financial calculations for the feasibility of applying the Thermal Exterior Thermal Insulation for the basic sensitivity scenarios are presented in Annexes 10-13.

6.3 Financial analysis of thermal insulation of the floor

Based on the technical calculations it has been possible to realize simple financial calculations for assessing the establishment of thermal insulation and the results for the baseline case are given in Table 30 together with some other indicators including the level of reduction of greenhouse gases.

Financial indicators	Unit	Value
Average Cost Saving	1000 Euro	12.25
Net Present Value (interest rate = 5%)	1000 Euro	67.91
Simple Pay Back Period (years)	Years	5.344
Discount Pay Back Period (years)	Years	7.933
Levelled Discount Unit Saving Energy Cost	Euro/kWh	0.06271
Internal Rate of Return (%)	%	18.5%
Reduction of the GHG [tons/year]		25.69

Table 30 - Financial indicators along with some other indicators including the level of greenhouse gas reduction in the case of l the floor thermal insulation

The analysis shows that the investment for the realization of the thermal insulation of the floor is very positive with a payback period of 5.34 years and IRR = 18.5%. These values together with other calculated indicators are shown in Figures 20-25. Detailed energy and financial calculations for the feasibility of floor Thermal Insulation and for basic sensitivity scenarios are presented in Annexes 14-17

6.4 Financial Analysis of Installing Efficient Windows

Based on the technical logs introduced in chapter 5 it has been possible to realize the simple financial calculations for the evaluation of the application of efficient windows and the results are given in Table 31 together with some other indicators including the level of reduction of gases with greenhouse effect.

Financial indicators	Unit	Value
Average Cost Saving	1000 Euro	7.997
Net Present Value (interest rate = 5%)	1000 Euro	45.11
Simple Pay Back Period (years)	Years	5.247
Discount Pay Back Period (years)	Years	7.789
Levelled Discount Unit Saving Energy Cost	Euro/kWh	0.06157
Internal Rate of Return (%)	%	18.99%
Reduction of the GHG [tons/year]		16.77

Table 31 - Financial indicators along with some other indicators including the level of greenhouse gas reduction and the application of efficient windows

The analysis shows that the investment for the realization of the efficient windows of the building is very positive with a payback period of 5.24 years and IRR = 18.99%. These values together with other calculated indicators are shown in Figures 16-21. Detailed energy and financial calculations for the feasibility of setting up efficient windows together for basic sensitivity scenarios are presented in Annexes 18-21.

6.5 Financial analysis of installation of efficient external doors

Based on the technical calculations presented in chapter 5, it is possible to realize simple financial calculations for the evaluation of the change of external doors and the results are given in table 32 together with some other indicators including the level of the reduction of gases with greenhouse effect.

Financial indicators	Unit	Value
Average Cost Saving	1000 Euro	2.6054
Net Present Value (interest rate = 5%)	1000 Euro	19.623
Simple Pay Back Period (years)	Years	3.3565
Discount Pay Back Period (years)	Years	4.9824
Levelled Discount Unit Saving Energy Cost	Euro/kWh	0.03938
Internal Rate of Return (%)	%	33.71%
Reduction of the GHG [tons/year]		62.25

Table 32 - Financial indicators along with some other indicators including the level of greenhouse effect reduction for the evaluation of the change of exterior doors

The analysis shows that the investment for the realization of external thermal insulation of the building walls is positive with a payback period of 3.36 years and IRR = 33.71%. These values together with other calculated indicators are shown in Figures 20-25. Detailed energy and financial calculations for the feasibility of establishing efficient external doors for basic sensitivity scenarios are set out in Annexes 22 -25.

6.6 Financial analysis of the installation of a central heating system

Based on the technical drawings in chapter 5, it was possible to realize simple financial calculations for the assessment of the installation of the central efficient heating system and the results are given in Table 33 together with some other indicators, including the level of reduction of greenhouse gases

Financial indicators	Unit	Value
Average Cost Saving	1000 Euro	47.28

Net Present Value (interest rate = 5%)	1000 Euro	319.3
Simple Pay Back Period (years)	Years	4.135
Discount Pay Back Period (years)	Years	6.137
Levelled Discount Unit Saving Energy Cost	Euro/kWh	0.0345
Internal Rate of Return (%)	%	25.9%
Reduction of the GHG [tons/year]		99.16

Table 33 - Financial indicators along with some other indicators including the level of greenhouse effect reduction for the central efficient heating system

The analysis shows that the investment for the realization of the central efficient heating system is very positive, having a payback period of 4.13 years and IRR = 25.9%. These values together with other calculated indicators are shown in Figures 20-25. Detailed energy and financial calculations for the feasibility of central heating installation of eficientl central systems for basic sensitivity scenarios are presented in Annexes 26-29.

6.7 Financial Analysis of the Installation of the Solar Water Heaters System (SHWS)

Based on the technical calculations presented in chapter 5, it is possible to realize simple financial calculations for the assessment of the Solar Water Heaters System and the results are given in Table 34 along with some other indicators including also the level of reduction of greenhouse gases.

Financial indicators	Unit	Value
Average Cost Saving	1000 Euro	0.521
Net Present Value (interest rate = 5%)	1000 Euro	2.67
Simple Pay Back Period (years)	Years	5.761
Discount Pay Back Period (years)	Years	8.552
Levelled Discount Unit Saving Energy Cost	Euro/kWh	0.06760
Internal Rate of Return (%)	%	17%
Reduction of the GHG [tons/year]		1.092

Table 34 - Financial indicators along with some other indicators including the level of greenhouse gas reduction level of the Solar Water Heaters System

The analysis shows that the investment for the Solar Water Heaters System is very positive with a payback period of 5.76 years and IRR = 17%. These values together with other calculated indicators are shown in Figures 20-25. Detailed energy and financial calculations for the feasibility of the Solar Water Heaters System for basic sensitivity scenarios are presented in Annexes 30-33.

6.8 Financial Analysis of the Installation of the Photovoltaic System

Based on the technical calculations presented in chapter 5, it is possible to realize simple financial calculations for photovoltaic system evaluation and the results are given in Table 35 together with some other indicators including also the level of greenhouse gas reduction.

Financial indicators	Unit	Value
Average Cost Saving	1000 Euro	1.035
Net Present Value (interest rate = 5%)	1000 Euro	3.767
Simple Pay Back Period (years)	Years	7.248
Discount Pay Back Period (years)	Years	10.76
Levelled Discount Unit Saving Energy Cost	Euro/kWh	0.08504
Internal Rate of Return (%)	%	12%
Reduction of the GHG [tons/year]		2.17

Table 35 - Financial indicators along with several other indicators including the level of greenhouse gas emission reduction of the Photovoltaic System

The analysis shows that the investment for the realization of the Photovoltaic System is positive with a payback period of 7.24 years and IRR = 12%. These values together with other calculated indicators are shown in Figures 20-25. Detailed energy and financial calculations for the feasibility of the Photovoltaic System. for basic sensitivity scenarios are presented in Annexes 34-37.

6.9 Installation of EE lamps

Based on the technical logs presented in Chapter 5 it has been possible to carry out simple financial calculations for the assessment of the placement of efficient lamps and the results are given in Table 36 together with some other indicators, including the level of GHG reduction greenhouse effect.

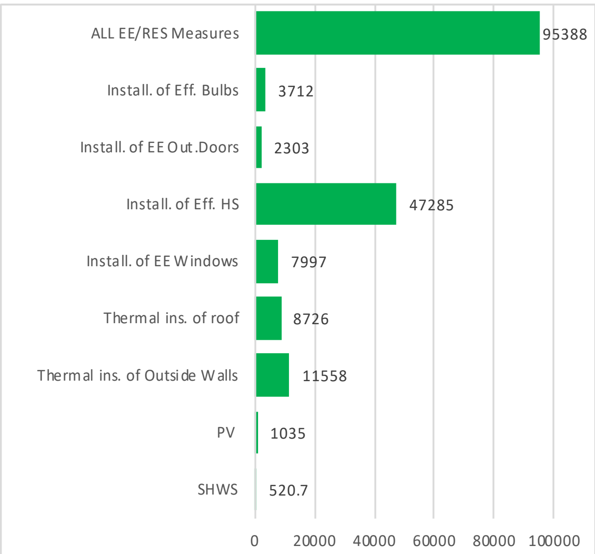
Financial indicators	Unit	Value
Average Cost Saving	1000 Euro	3.712
Net Present Value (interest rate = 5%)	1000 Euro	35.21
Simple Pay Back Period (years)	Years	0.617
Discount Pay Back Period (years)	Years	0.916
Levelled Discount Unit Saving Energy Cost	Euro/kWh	0.00724
Internal Rate of Return (%)	%	134%
Reduction of the GHG [tons/year]		7.784

Table 36 - Financial indicators along with several other indicators including the level of greenhouse effect reduction for efficient lamps

The analysis shows that the investment for the realization of the Efficent lights is very positive with a payback period of 0.62 years and IRR = 134%. These values together with other calculated indicators are shown in Figures 20-25. Detailed energy and financial calculations for the feasibility of the EE lightening. for basic sensitivity scenarios are presented in Annexes 2-5.

6.10 Financial Reporting for all EE & RES measures

This section summarizes all the results of the implementation of all EE / RES measures, which were analysed in detail above and the corresponding summary results are shown in Figures 26-31.



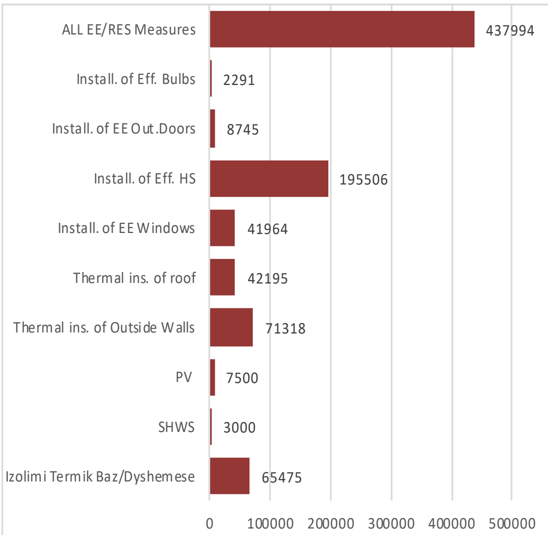


Figure 26 – Yearly energy savings from the introduction of all EE/RES measures [Euro/year]

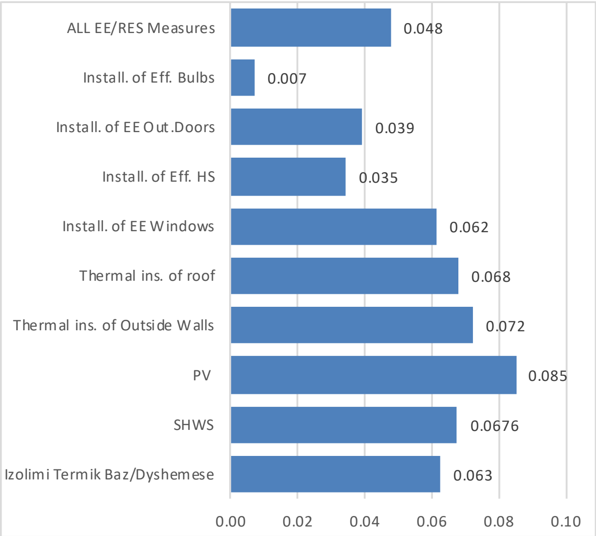


Figure 28 – LDC energy savings from the introduction of all EE/RES measures [Euro/kWh]

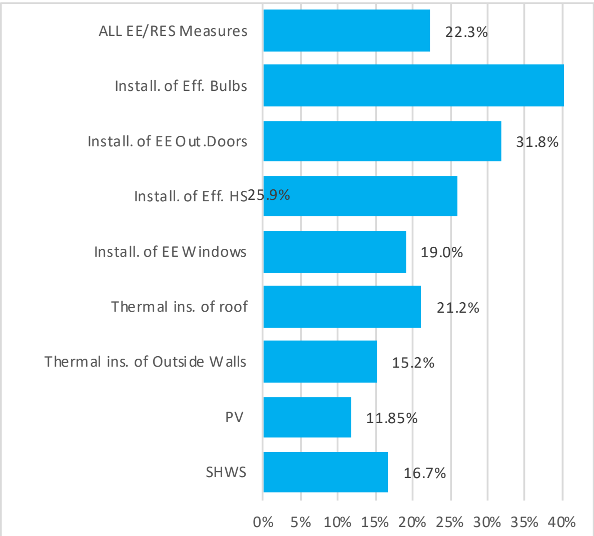


Figure 30- IRR from the introduction of all EE/RES measures [%]

Figure 27 – Total investment requirements from the introduction of all EE/RES measures [Euro]

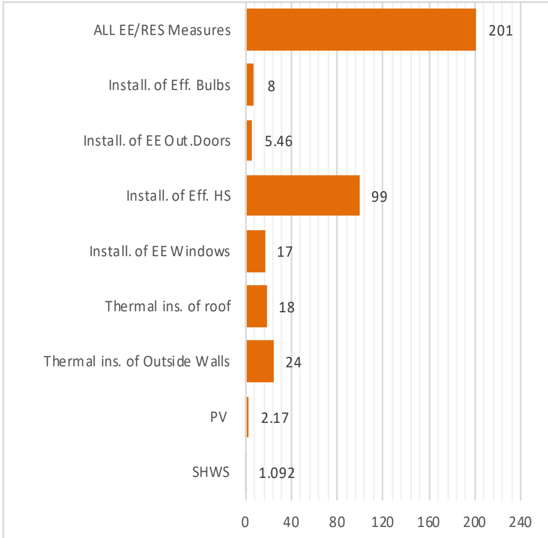


Figure 29 – GHG reduction from the introduction of all EE/RES measures [ton Co2 eqv/year]

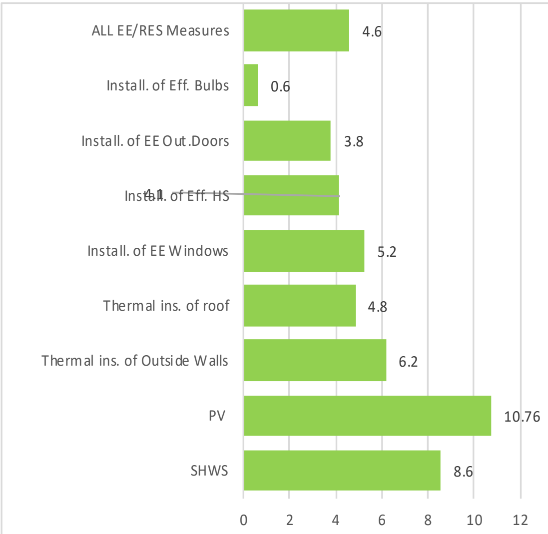


Figure 31 - PBP from the introduction of all EE/RES measures [years]

The final conclusion of the analysis shows that the application of all EE & RES measures is beneficial for this building. While the net present value is positive, IRR = 22.3% and the investment maturity is 4.6 years.

7 COMPARATIVE ANALYSIS OF RELEVANT INDICATORS OF ELECTRIC CONSUMPTION AND THERMAL NEEDS OF THE BUILDING (2017 and 2022)

7.1 Indicators of energy consumption and thermal needs for the current state

The selected buildings in this project have been audited by applying the relevant steps of the following methodology:

- Interviewing children and teachers;
- Site visit - inspection of the envelope of the building;
- Analysis of equipment and energy systems;
- Collection of data on electricity expenditures and data on expenditures for energy resources;
- Analyzes of collected data
- Building a basic energy consumption scenario for heating and lighting - essential energy services that have a common impact on the two above services
- Calculation of energy losses for each case and calculation of energy savings,
- Calculation of the required amount of energy and financial analysis for proposed energy efficiency measures;
- Identification of energy efficiency measures with financial cost and payback period of the investment.

As mentioned above, the first step was the collection of energy consumption data throughout the 2017. Koto Hoxhi School has had a small increase in electricity consumption compared to 2016 based on the data of educational directorate. The total electricity consumption in 2017 was approximately 106,420 kWh / year and the specific consumption is 138 kWh / m2 year.

7.2 Indicators of energy consumption and thermal needs after the implementation of EE measures according to the optimal scenario

Consultants have prepared a list of EE / RES investments to increase energy efficiency and the measures identified in the Koto Hoxhi School (Gjirokaster) are as follows:

1. Thermal insulation of external walls
2. Thermal insulation of the roof
3. Thermal insulation of the floor

4. Installing Efficient Windows
5. Installing external efficient doors
6. Installing an efficient heating system
7. Installing the SHWS
8. Installing the Photovoltaic System
9. Installing of EE Bulbs.

Figure 1 shows current energy consumption and also the energy consumption after applying energy efficiency measures.

The analysis of Figure 1 shows that current consumption is lower than base scenario consumption based on meeting the comfort conditions but without the application of EE measures. This clearly shows an inefficiency in terms of consumption

7.3 Comparative analysis of indicators of energy consumption and thermal needs of the current situation and after the implementation of the optimal scenario

The financial analysis of the proposed interventions was made on the basis of the methods described in the details above: Simple Payback Period (PBP), Internal Rate of Return Simple Return Method (IRR)) and Net Present Value (NPV):

The report also includes the rate of carbon dioxide reduction with the application of recommended measures based on international methods of calculation. This analysis presents the main findings of the Energy Audit and recommendations from the application of EE measures that are:

- (i) Improving the learning environment of students and teachers;
- (i) Increasing energy efficiency as a result of reducing school expenditure by reducing specific energy consumption for those energy services through the use of sustainable resource sources;
- (ii) increase the life expectancy and value of the school;
- (iii) Improve the environmental conditions at the level of the building, at the level of municipalities and at the level of Albania.

Figures 32 and 33 show specific consumption after each EE measures and specific energy-saving levels expressed in kWh / year and kWh / m2 per year.

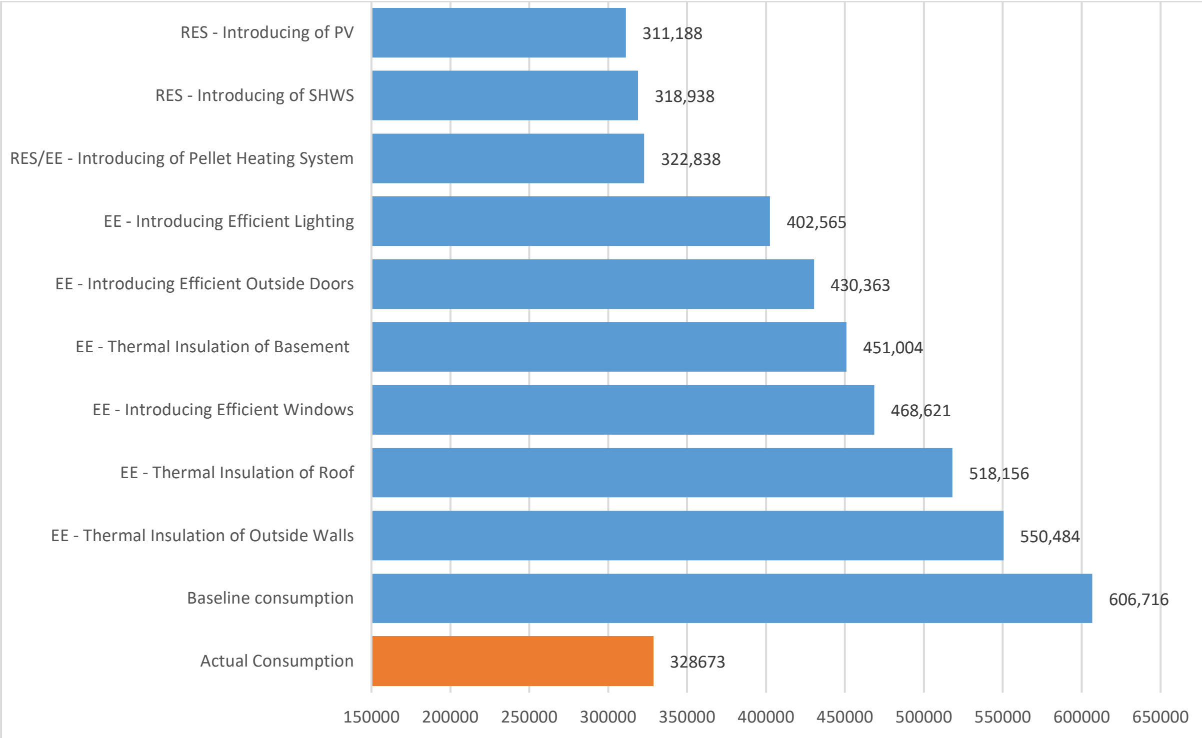


Figure 32–Total yearly consumption and consumption after each EE/RES measure, kWh/year

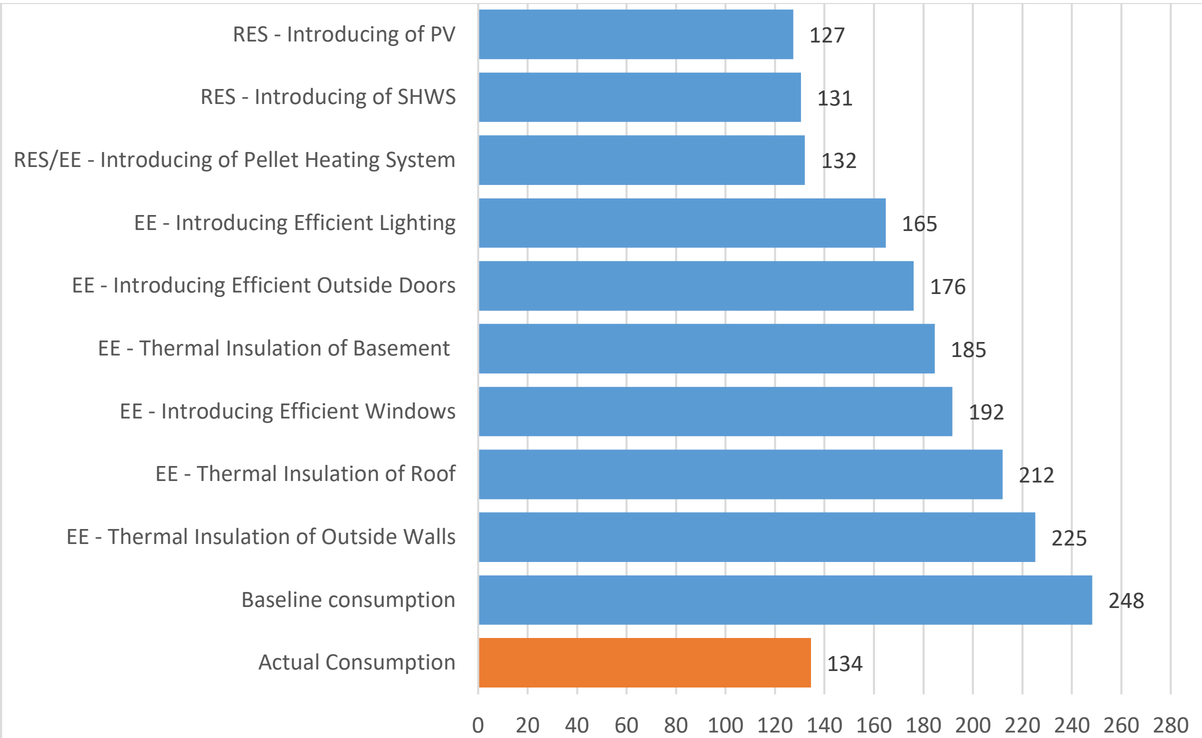


Figure 33- Total yearly specific consumption and consumption after each EE/RES measure, kWh/year, and kWh/m2 year

The final conclusion of the analysis (to be provided in detail throughout this energy audit report) indicates that the application of the 9-EE measures will bring about a reduction of actual consumption from the Final Conclusion of the Analysis (to be given in detailed way throughout this energy audit report) indicates that the application of 9-EE measures will bring about a reduction of actual consumption from 138 kWh / m2 per year (without reaching comfort and achieving comfort the consumption level is based on the baseline scenario - worth 205 kWh / m2 year) at approximately 86 kWh / m2 per year.

EE / BRE measures with faster investment repayment, with a short implementation period and low complexity, is the efficient lighting in the Koto Hoxhi School, which also serves as the most effective measure to reduce budget expenditures. The highest energy saving potential is identified by investment measures for space heating through thermal insulation of exterior walls, thermal roof insulation, efficient windows and efficient heating system installation by pellets. Table 37 gives the technical-financial-environmental indicators of all EE measures for the building.

Main parameters	insulation of floor	SHWS	PV	insulation of walls	Insulation of roof	EE Windows	EE central heating system	EE outside doors	EE Lighting	ALL EE/RES measures
Levelled discount cost (LDC) [Euro/kWh]	0.063	0.0676	0.085	0.072	0.068	0.062	0.035	0.039	0.007	0.048
Average yearly savings [kWh/year]	12251	520.7	1035	11558	8726	7997	47285	2303	3712	95388
GWP [ton CO2 eqv./year]	25.69	1.092	2.17	24	18	17	99	5.46	8	201
IRR	18.5%	16.7%	11.85%	15.2%	21.2%	19.0%	25.9%	31.8%	133.7%	22.3%
PBP	7.9	8.6	10.76	6.2	4.8	5.2	4.1	3.8	0.6	4.6

Table 37 - Technical-financial-environmental indicators of all EE measures for the school

Main technical-financial-environmental indicators for all EE/RES measures shows clearly that introduction of all EE/RES measures is very positive one and municipality should implement all of them.

8. CLASSIFICATION OF BUILDING IN THE ENERGY CLASS ACCORDING TO THE RULE BOOK ON THE ENERGY CERTIFICATION OF BUILDINGS

Requirements given in several Articles of the EPBD:

- Article 4 Setting of minimum energy performance requirements
- Article 5 Calculation of cost-optimal levels of minimum energy performance requirements
- Article 6 New buildings
- Article 7 Existing buildings
- Article 8 Technical building systems
- Article 9 Nearly zero-energy buildings

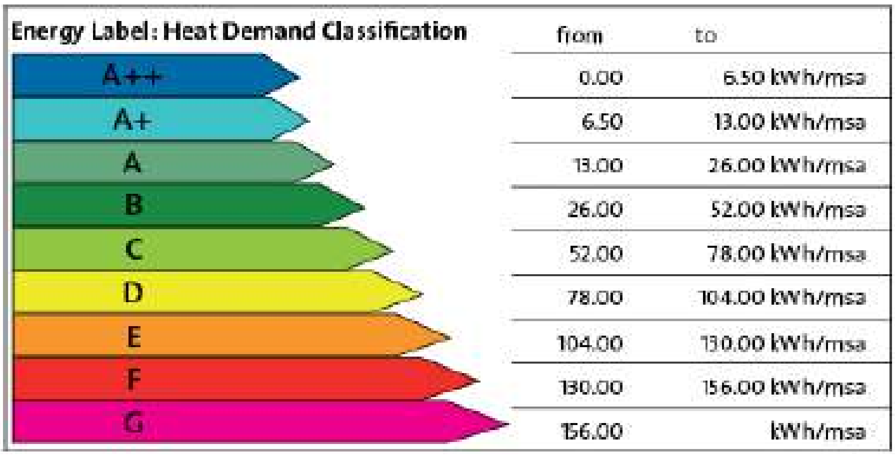
For the preparation of the Energy Certificate based on the European Directive on Energy Performance of Buildings and the Albanian Electricity Performance in Buildings, the following steps are required to complete the following steps to the designation of the building certificate under Albanian conditions:

- Decision to start developing new minimum energy performance requirements, and necessary resources and funds for its development allocated or secured.
- Selection and description of approach to be used for setting of minimum energy performance parameters
- Definition of national input values for the purpose of cost- optimal calculations
- Energy and costcalculations
- Derivation of cost-optimal level of energy performance
- Updating/development of the regulation describing the minimum energy performance requirements

- Requirement to lay down necessary measures to establish a system for certification of the energy performance of buildings as required by the EPBD included into appropriate national law, and necessary resources and funds for its development allocated or secured
- Development of Regulation on Energy Performance Certification of buildings, incl. national values for each class (A, B, C, etc.)
- Description of organisational model for the energy certification system (development of EPC, issue, control, information, training and accreditation of experts, reporting, evaluation, etc.)
- Development of Guidelines for energy performance certification of buildings

  Development of Certification Tool (Issue, statistics, information dissemination, reporting)

Based on the European Construction Performance Directive, it is possible to have seven classes defined by A to G for specific energy consumption in buildings. This classification based on the directive is given in Figure 34.



Energy Label: Heat Demand Classification	from	to
A++	0.00	6.50 kWh/msa
A+	6.50	13.00 kWh/msa
A	13.00	26.00 kWh/msa
B	26.00	52.00 kWh/msa
C	52.00	78.00 kWh/msa
D	78.00	104.00 kWh/msa
E	104.00	130.00 kWh/msa
F	130.00	156.00 kWh/msa
G	156.00	kWh/msa

Figure 33: Energy Building Certificate based on the European Construction Performance Directive (kWh / m2 year)

Since the Albanian Energy Building Certificate is under preparation by the Ministry of Infrastructure and Energy, the current classification will be realized based on the European Certificate.

The energy calculations of the specific energy consumption for the base case and for the introduction of the energy efficiency measures, while at the same time fulfilling the conditions of comfort, shown in all sessions of this Energy Audit, are shown in Figure 35.

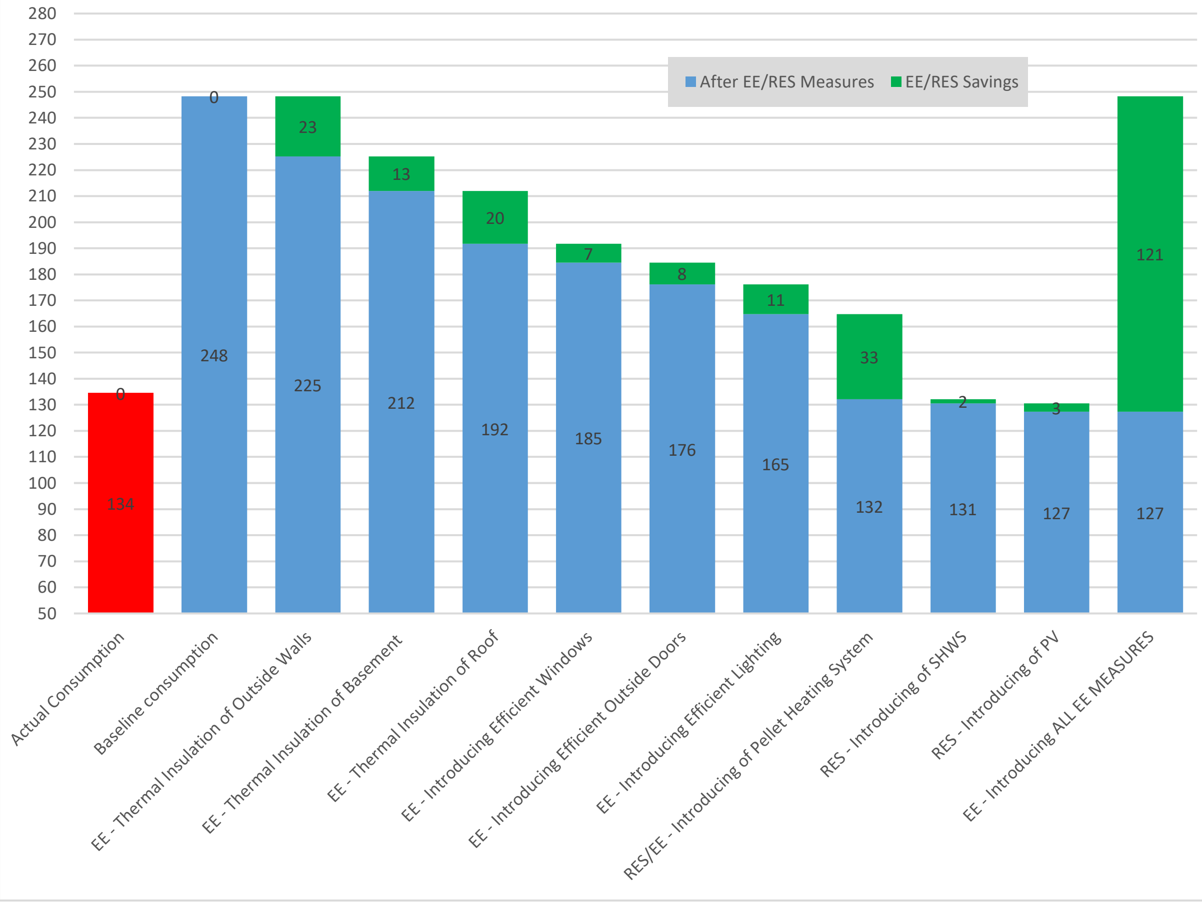


Figure 35: Specific energy consumption for the base case and for the introduction of energy efficiency measures, simultaneously fulfilling the conditions of comfort

The specific energy consumption for the base case is 248 kWh / m2 year - which indicates that the Koto Hoxhi School on the basis of the European Certificate can be classified as a G building as it is consumed higher than 156 kWh / m2 per year.

<u>**The specific energy consumption for the introduction of all energy efficiency measures is 127 kWh / m2 year - which indicates that the Koto Hoxhi School based on the European Certificate can be classified as E building as it is higher than 104 kWh / m2 year.**</u>

9. FINAL CONCLUSIONS AND RECOMMENDATIONS OF ENERGY AUDIT REPORT

This feasibility study has made it possible to carry out the energy auditing, technical and financial evaluation of all the possible financial benefits of EE / RES that can be realized in the Koto Hoxhi School.

9.1 Low and no cost recommendations for increasing energy efficiency

Include practically no or low-cost investment and without any disruption to school Koto Hoxhi operation, normally, involving general housekeeping measures.

Type of measures proposed:

- Reduction of the water temperature;
- Usage of tents for refreshing environments during the summer
- Periodical maintenance of the boiler and heating pipeline
- Cleaning the chimney
- Turning off lights, when not in use, or the instalment of sensors
- Periodic maintenance-cleaning of fluorescent lamps (covers and bulbs)
- Many electronics (chargers, computers, etc.) use power even when not using them. Unplug them when not in use.
- Ensure that staff computers are switched off at the end of every working day.
- Encourage staff to turn off computer monitors when they are not using them.

Effective Control of Heating System

- Use local thermostats to control the operation of the air-handling units.
- Do not control the heating temperature by opening windows!
- A thermostat must be located in a spot that has a temperature representative
- Of the area, it is controlling. Ensure that it is not placed next to a source of heat
- Such as a photocopier, or near an outside door that's in frequent use.
- Ensure that the heating timer allows hourly/daily control, so that the building is not heated on unoccupied days.
- Consider fitting optimum-start control to the heating system: this ensures that the heating comes on to pre-heat the building no sooner or later than necessary to meet the required temperature by the required time.

9.2 Medium cost recommendations for increasing energy efficiency

Include low cost investment with some minor disruption to building operation.

Type of measure proposed

- Replacing Incandescent Lamps with LED lamps
- Automatic Lighting Controls
  - Automatic lighting controls are worth considering ensuring that lights are only on when needed.
  - Occupancy sensing controls / presence detectors: these can be ideal for intermittently used areas such as corridors, and toilets in school.

9.3 High cost recommendations for increasing energy efficiency

Involves relatively high capital cost investment

- External thermal insulation throughout the outside walls
- External thermal insulation in the roof
- Also cleaning outside radiators surfaces.
- Changing valves rubber sealing.
- Pipe insulation is a low-cost measure. Just turning off lights when leaving a room or corridor and when you leave at the end of the day can reduce lighting costs by 15%- it's the easiest way to save energy;
- Take regular maintenance and cleaning of lamps, luminaries and windows to maximize their day-lighting potential;
- Localized lighting is more efficient than general lighting;
- Install automatic lighting control and occupancy sensors.
- Most people prefer to work in natural light. Organize your workplace to make better use of natural daylight.
- Use task lighting where is available in order to minimize lighting costs if low level background lighting is provided for the rest of the work area.

Table 38 summarizes 10 energy efficiency investments and RES measures identified in the Koto Hoxhi School (Gjirokaster). The total investment cost for the recommended energy efficiency and RES measures amount to **372,862.56** Euros**.**

Table 38: Summarizes 10 energy efficiency investment and RES measures

	KOTO HOXHI SCHOOL GJIROKASTER				
Nr.	**Description of works**	**Unit**	**Quantity**	**Price**	**Value**
	CIVIL WORKS				
1	**TERACE THERMAL INSULATION WORKS**				
	Demolition of existing layers, waste transport, cement chandelier layer, placement of Scm polystyrene, geotextile layer, waterproofing 2 quarters first quality, protective chandelier according to standards, placement of gutters and hinges, vertical discharge columns with flanged or terrace with brick and concrete wall + sheet metal.	m2	835	84 €	69,931 €
2	**WINDOW DOOR WORKS**				
	Removal of existing windows and transport of waste, F.V New plastic double glazed windows.	m2	230.00	161 €	37,088 €
	Removal of existing mortgages, transport of waste, F.V. of marble davancals	m2	73.80	75 €	5,535 €

	Removal of existing interior doors and transport of waste, F.V new drum and aluminum doors	m2	50.00	235 €	11,760 €
3	**EXTERIOR THERMAL INSULATION WORKS**				
	Demolition of partial plastering and their repair, Construction of scaffolding, F.V of the hood system according to the project detail on the east and north side of the building	m2	176.00	58 €	10,240 €
4	**CEILING WORKS**				
	Suspended ceiling construction with 60 * 60 tiles in the corridor and monolith	m2	357	36 €	12,941 €
5	**PAINTING WORKS**				
	Repair of ceilings, walls and painting with plastic paint	m2	5,160	4.40 €	22,680 €
6	**EXTERNAL WORKS**				
	Demolition of stairs and the entrance yard of the school, transport of waste, F.V. with tiles and marble	m2	120	88 €	10,500 €
7	**DIFFERENT WORKS**				
	Isolation, external canal adjustment, cleaning and drainage and external systems	ml	72	184 €	13,250 €
	Supply-installation of decorative railings	ml	21	85 €	1,785 €
ELECTRICAL WORKS					
8	**PUNIME ELEKTRIKE**				
	Installation of old electrical installations, PV of new electrical installations, electrical frames, lighting, internet and	m2	1,825	34 €	62,640 €

	equipment for measuring energy efficiency				
MECHANICAL WORKS					
9	**HEATING WORKS**				
	Repair of existing boiler, repair of pipes and collectors	Euro	1	27868.8	27,868.8 €
10	**HYDRO-SANITARY WORKS**				
	Demolition of existing bathrooms, transport of waste, F.V. of sanitary ware and bathroom tiles	cope	14	1,750 €	24,500 €
TOTAL VALUE WITHOUT VAT					**310,718.80 €**
VAT					**62,143.76 €**
TOTAL VALUE INCLUDING VAT					**372,862.56 €**

The EE / BRE measure with the fastest investment rate, with a short period of implementation and low complexity, is the school's lighting effect, which also serves as an effective measure to reduce spending on the budget. The highest energy saving potential is identified by investment measures for space heating by thermal insulation of exterior walls, thermal insulation of roofs, efficient windows and introduction of efficient heating system by pellets.

1. Annex 1: Questionnaire of Energy Survey

Compiled by:	**Expert of EECG**		**Municipality**	**Gjirokaster**		**Kindergarten/other building**	**X**		**9-Year School**		
Date:	**8 April 2018**		**Village**			**Primary School**			**College**		

A.	General
1	What kind of activity are you carry out in your building? ❒ Kindergarten/other building. Xcollege ❒ Primary School ❒9 year School
2	What kind of building. ❒ One floor building – urban. ❒ One floor building-rural. ❒ Multi floor building- urban .❒ Multi floor building-rural.
3	How many persons is the capacity of your building. ❒---------- *capacity number of the building* ❒---------- *days of the week in which the building is occupied*
4	When was your building built? ❒ before 1944 ❒1945-1960 ❒1961-1990 ❒1991-1999 X 2000-2010 ❒2011-2017
C.	Energy Commodity Use for Water and Space Heating
5	What kind of energy source you use for securing space heating? ❒fuel wood X electricity ❒LPG ❒briquettes ❒pellets ❒Central Heating System ❒District Heating System ❒coal ❒mix (wood/coal)
6	How do You secure fuel wood supply for your building? ❒ buying them from wood supplier ❒ buying them from non-licensed persons ❒self-collection in nearby forest ❒self-collection in faraway forest
7	What kind of fuel wood equipment consumption do you have to secure space heating? ☐Wood stoves produced in Kosovo ☐Wood stoves imported

	☐Wood boilers with high efficiency ☐Wood fire place
8	How much energy or fuel do you use: A. steer fuel wood [m^3/year] ❐up to 15 m^3 ❐ 15.1-20 m^3 ❐20.1-50 m^3 B. diesel [litters/year] ❐up to 600 ❐601-800 ❐801-1200 ❐1201-2000 C. LPG [kg/year] ❐up to 500 ❐501-700 ❐701-1000 ❐1001-1500 D.1 Electricity [kWh/year] ❐up to 6000 ❐6001-8400 ❐8401-10000 ❐10001-15000 X 40000-50000 D.2 Electricity [Euro/year] ❐up to 500 ❐501-700 ❐701-1000 ❐1001-2000 D.3 Electricity [kWh/month] for the year 2018 (optional – if the data are easy to be found)

Jan	Feb	Marc	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3570	3490	3250	3500	3350	3200	4390	4750	3330	3325	2950	3505

D.4 Electricity [Euro/month] for the year 2019 (optional – if the data are easy to be found)

Jan	Feb	Marc	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
420	407	385	410	395	380	537	585	403	402	355	411

D. Energy Use for Hot Water and Another Consumer Behaviour	
9	What kind of energy source do you use for securing hot water: ❐fuel wood stoves ❐electric stoves ❐electric boiler❐LPG stoves X Solar Water Collectors ❐Central Heating System
10	Calculate volume of hot water hat e person will use per day? [liter/day] ❐ up to 60 ❐ 60-120 X 120-180 ❐180-240
E.	Energy Use for Electric equipment & Air Conditioning & Lighting
11	What kind of energy source will be used for cooking? ❐wood X electricity ❐LPG ❐coal
12	Averaged number of energy hour used for cooking?

	❒ less than 2 ❒ 2-3 ❒6-8 X 3-4 ❒4-6 ❒8-12											
13	What are the electric equipment that you have at your building? X television ☐radio X computer X washing machine ☐dish washer X drier X refrigerator X freezer X microwave Please indicate how many electric equipment for each type that you have at your school? 20…. television …. Radio …2. Computer …2. Washing machine …. dish washer 5 drier …10. Refrigerator …1. Freezer …2. Microwave …1. ironing …1 photocopy machines 1 ESPRESSO											
14	What king of bulbs do you use at your *building*? ❒incandescent ❒ fluorescent ❒ compact florescent Please indicate how many bulbs do you use at your school? ….incandescent ….fluorescent …. compact fluorescent …. LED ….mix (incad./fluorescent) 200…. mix (LED/fluorescent)											
15	What kind of vehicle do you use? ❒ motorcycles X car ❒ van ❒ bus											
	Do you use this vehicle for:❒ yourself ❒yourself and your family											
	What kind of fuel does it use? ❒ Diesel ❒ Gasoline ❒ LPG											
	Vehicle's Year of Production?											
	What is the brand of your vehicle?											
	How much fuel do you consume as average for 100 km?											
	How many km have you done during the whole year 2016? How many km have you done in each month during the year 2016? (optional – if the data are easy to be found)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dic
	THANK YOU VERY MUCH INDEED FOR INTERESTS THAT YOU SHOW!											

2. Annex 2: Energy and financial calculation for introducing Efficient Lighting – base case

Substitution of Incadeshent Bulbs with LED Bulbs: Base Case																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Consumption base: Lighting points	nr	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075
Total electricity consumption	MWh	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08
Project consumption																	
Avg. electricity consumption	kWh/lp	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277
Total electricity consumption	MWh	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Energy savings																	
Total electricity savings	MWh	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving electricity	1000 Euro	2.906	2.993	3.083	3.176	3.271	3.369	3.47	3.574	3.682	3.792	3.906	4.023	4.144	4.268	4.396	4.528
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	2.906	2.993	3.083	3.176	3.271	3.369	3.47	3.574	3.682	3.792	3.906	4.023	4.144	4.268	4.396	4.528
Investment costs 000 Euro	1000 Euro	2.291															
Not Discounted Cash Flow	1000 Euro	-2.291	2.993	3.083	3.176	3.271	3.369	3.47	3.574	3.682	3.792	3.906	4.023	4.144	4.268	4.396	4.528
Cumulated Not Discounted Cash Flow	1000 Euro	-2.291	0.702	3.786	6.961	10.23	13.6	17.07	20.65	24.33	28.12	32.02	36.05	40.19	44.46	48.86	53.38
Discounted Cash Flow	1000 Euro	-2.291	2.851	2.797	2.743	2.691	2.64	2.589	2.54	2.492	2.444	2.398	2.352	2.307	2.263	2.22	2.178
Cumulated Discounted Cash Flow	1000 Euro	-2.291	0.56	3.356	6.1	8.791	11.43	14.02	16.56	19.05	21.5	23.89	26.25	28.55	30.82	33.04	35.21
Discounted Cash Flow	MWh	27.8	26.47	25.21	24.01	22.87	21.78	20.74	19.76	18.82	17.92	17.07	16.25	15.48	14.74	14.04	13.37
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**3.712**															
Net Present Value (interest rate = 5%)	1000 Euro	**35.21**															
Simple Pay Back Period (years)	years	**0.617**															
Discount Pay Back Period (years)	years	**0.916**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.00724															
Internal Rate of Return (%)	%	**134%**															

3. Annex 3: Energy and financial calculation for introducing Efficient Lighting – Sensitivity 1 case

Substitution of Incadeshent Bulbs with LED Bulbs: Sensitivity case 1 (10% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Consumption base: Lighting points	nr	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075
Total electricity consumption	MWh	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08
Project consumption																	
Avg. electricity consumption	kWh/lp	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277
Total electricity consumption	MWh	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Energy savings																	
Total electricity savings	MWh	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving electricity	1000 Euro	2.906	2.993	3.083	3.176	3.271	3.369	3.47	3.574	3.682	3.792	3.906	4.023	4.144	4.268	4.396	4.528
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	2.906	2.993	3.083	3.176	3.271	3.369	3.47	3.574	3.682	3.792	3.906	4.023	4.144	4.268	4.396	4.528
Investment costs 000 Euro	1000 Euro	2.520															
Not Discounted Cash Flow	1000 Euro	-2.520	2.993	3.083	3.176	3.271	3.369	3.47	3.574	3.682	3.792	3.906	4.023	4.144	4.268	4.396	4.528
Cumulated Not Discounted Cash Flow	1000 Euro	-2.52	0.473	3.556	6.732	10	13.37	16.84	20.42	24.1	27.89	31.8	35.82	39.96	44.23	48.63	53.15
Discounted Cash Flow	1000 Euro	-2.52	2.851	2.797	2.743	2.691	2.64	2.589	2.54	2.492	2.444	2.398	2.352	2.307	2.263	2.22	2.178
Cumulated Discounted Cash Flow	1000 Euro	-2.52	0.331	3.127	5.871	8.562	11.2	13.79	16.33	18.82	21.27	23.66	26.02	28.32	30.59	32.81	34.99
Discounted Cash Flow	MWh	27.8	26.47	25.21	24.01	22.87	21.78	20.74	19.76	18.82	17.92	17.07	16.25	15.48	14.74	14.04	13.37
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**3.712**															
Net Present Value (interest rate = 5%)	1000 Euro	**34.99**															
Simple Pay Back Period (years)	years	**0.679**															
Discount Pay Back Period (years)	years	**1.008**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.00797															
Internal Rate of Return (%)	%	**122%**															

4. Annex 4: Energy and financial calculation for introducing Efficient Lighting – Sensitivity 2 case

Substitution of Incadeshent Bulbs with LED Bulbs: Sensitivity case 2 (20% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Consumption base: Lighting points	nr	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075
Total electricity consumption	MWh	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08
Project consumption																	
Avg. electricity consumption	kWh/lp	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277
Total electricity consumption	MWh	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Energy savings																	
Total electricity savings	MWh	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving electricity	1000 Euro	2.906	2.993	3.083	3.176	3.271	3.369	3.47	3.574	3.682	3.792	3.906	4.023	4.144	4.268	4.396	4.528
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	2.906	2.993	3.083	3.176	3.271	3.369	3.47	3.574	3.682	3.792	3.906	4.023	4.144	4.268	4.396	4.528
Investment costs 000 Euro	1000 Euro	2.749															
Not Discounted Cash Flow	1000 Euro	-2.749	2.993	3.083	3.176	3.271	3.369	3.47	3.574	3.682	3.792	3.906	4.023	4.144	4.268	4.396	4.528
Cumulated Not Discounted Cash Flow	1000 Euro	-2.749	0.244	3.327	6.503	9.774	13.14	16.61	20.19	23.87	27.66	31.57	35.59	39.73	44	48.4	52.92
Discounted Cash Flow	1000 Euro	-2.749	2.851	2.797	2.743	2.691	2.64	2.589	2.54	2.492	2.444	2.398	2.352	2.307	2.263	2.22	2.178
Cumulated Discounted Cash Flow	1000 Euro	-2.749	0.102	2.898	5.641	8.332	10.97	13.56	16.1	18.59	21.04	23.44	25.79	28.1	30.36	32.58	34.76
Discounted Cash Flow	MWh	27.8	26.47	25.21	24.01	22.87	21.78	20.74	19.76	18.82	17.92	17.07	16.25	15.48	14.74	14.04	13.37
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**3.712**															
Net Present Value (interest rate = 5%)	1000 Euro	**34.76**															
Simple Pay Back Period (years)	years	**0.741**															
Discount Pay Back Period (years)	years	**1.1**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.00869															
Internal Rate of Return (%)	%	**112%**															

5. Annex 5: Energy and financial calculation for introducing Efficient Lighting – Sensitivity 3 case

Substitution of Incadeshent Bulbs with LED Bulbs: Sensitivity case 3 (lower increase growth rate for the tariffs)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Consumption base: Lighting points	nr	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075	32,075
Total electricity consumption	MWh	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08
Project consumption																	
Avg. electricity consumption	kWh/lp	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277	4,277
Total electricity consumption	MWh	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Energy savings																	
Total electricity savings	MWh	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80	27.80
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.106	0.108	0.109	0.111	0.113	0.114	0.116	0.118	0.12	0.121	0.123	0.125	0.127	0.129	0.131
Cost saving electricity	1000 Euro	2.906	2.95	2.994	3.039	3.085	3.131	3.178	3.225	3.274	3.323	3.373	3.423	3.475	3.527	3.58	3.633
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	2.906	2.95	2.994	3.039	3.085	3.131	3.178	3.225	3.274	3.323	3.373	3.423	3.475	3.527	3.58	3.633
Investment costs 000 Euro	1000 Euro	2.291															
Not Discounted Cash Flow	1000 Euro	-2.291	2.95	2.994	3.039	3.085	3.131	3.178	3.225	3.274	3.323	3.373	3.423	3.475	3.527	3.58	3.633
Cumulated Not Discounted Cash Flow	1000 Euro	-2.291	0.659	3.653	6.692	9.776	12.91	16.08	19.31	22.58	25.91	29.28	32.7	36.18	39.7	43.28	46.92
Discounted Cash Flow	1000 Euro	-2.291	2.809	2.716	2.625	2.538	2.453	2.371	2.292	2.216	2.142	2.071	2.002	1.935	1.87	1.808	1.748
Cumulated Discounted Cash Flow	1000 Euro	-2.291	0.518	3.234	5.859	8.397	10.85	13.22	15.51	17.73	19.87	21.94	23.94	25.88	27.75	29.56	31.3
Discounted Cash Flow	MWh	27.8	26.47	25.21	24.01	22.87	21.78	20.74	19.76	18.82	17.92	17.07	16.25	15.48	14.74	14.04	13.37
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**3.281**															
Net Present Value (interest rate = 5%)	1000 Euro	**31.3**															
Simple Pay Back Period (years)	years	**0.698**															
Discount Pay Back Period (years)	years	**1.023**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.00724															
Internal Rate of Return (%)	%	**130%**															

6. Annex 6: Energy and financial calculation for introducing Thermal Insulation of the Outside Walls – base case

Thermal insulation of outside walls: higher density polystere for outside walls: Base Case																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation of outside walls	m2	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135
Total energy consumption	MWh	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13
Energy savings																	
Total energy savings	MWh	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	9.05	9.322	9.601	9.889	10.19	10.49	10.81	11.13	11.46	11.81	12.16	12.53	12.9	13.29	13.69	14.1
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	9.05	9.322	9.601	9.889	10.19	10.49	10.81	11.13	11.46	11.81	12.16	12.53	12.9	13.29	13.69	14.1
Investment costs 000 Euro	1000 Euro	71.318															
Not Discounted Cash Flow	1000 Euro	-62.27	9.322	9.601	9.889	10.19	10.49	10.81	11.13	11.46	11.81	12.16	12.53	12.9	13.29	13.69	14.1
Cumulated Not Discounted Cash Flow	1000 Euro	-62.27	-52.95	-43.34	-33.45	-23.27	-12.78	-1.97	9.161	20.63	32.43	44.6	57.12	70.03	83.32	97.01	111.1
Discounted Cash Flow	1000 Euro	-62.27	8.878	8.709	8.543	8.38	8.221	8.064	7.91	7.76	7.612	7.467	7.325	7.185	7.048	6.914	6.782
Cumulated Discounted Cash Flow	1000 Euro	-62.27	-53.39	-44.68	-36.14	-27.76	-19.54	-11.47	-3.563	4.197	11.81	19.28	26.6	33.79	40.83	47.75	54.53
Discounted Energy Flow	MWh	86.57	82.45	78.52	74.78	71.22	67.83	64.6	61.52	58.59	55.8	53.15	50.61	48.2	45.91	43.72	41.64
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**11.56**															
Net Present Value (interest rate = 5%)	1000 Euro	**54.53**															
Simple Pay Back Period (years)	years	**6.17**															
Discount Pay Back Period (years)	years	**9.159**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.07240															
Internal Rate of Return (%)	%	**15.17%**															

7. Annex 7: Energy and financial calculation for introducing Thermal Insulation of the Outside Walls – Sensitivity 1 case

Thermal insulation of outside walls: higher density polysterene for outside walls: Sensitivity case 1 (10% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation of outside walls	m2	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135
Total energy consumption	MWh	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13
Energy savings																	
Total energy savings	MWh	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	9.05	9.322	9.601	9.889	10.19	10.49	10.81	11.13	11.46	11.81	12.16	12.53	12.9	13.29	13.69	14.1
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	9.05	9.322	9.601	9.889	10.19	10.49	10.81	11.13	11.46	11.81	12.16	12.53	12.9	13.29	13.69	14.1
Investment costs 000 Euro	1000 Euro	78.449															
Not Discounted Cash Flow	1000 Euro	-69.399	9.322	9.601	9.889	10.19	10.49	10.81	11.13	11.46	11.81	12.16	12.53	12.9	13.29	13.69	14.1
Cumulated Not Discounted Cash Flow	1000 Euro	-69.4	-60.08	-50.48	-40.59	-30.4	-19.91	-9.102	2.029	13.49	25.3	37.46	49.99	62.9	76.19	89.88	104
Discounted Cash Flow	1000 Euro	-69.4	8.878	8.709	8.543	8.38	8.221	8.064	7.91	7.76	7.612	7.467	7.325	7.185	7.048	6.914	6.782
Cumulated Discounted Cash Flow	1000 Euro	-69.4	-60.52	-51.81	-43.27	-34.89	-26.67	-18.6	-10.69	-2.935	4.677	12.14	19.47	26.65	33.7	40.62	47.4
Discounted Energy Flow	MWh	86.57	82.45	78.52	74.78	71.22	67.83	64.6	61.52	58.59	55.8	53.15	50.61	48.2	45.91	43.72	41.64
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**11.56**															
Net Present Value (interest rate = 5%)	1000 Euro	**47.4**															
Simple Pay Back Period (years)	years	**6.787**															
Discount Pay Back Period (years)	years	**10.08**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.07963															
Internal Rate of Return (%)	%	**13.15%**															

8. Annex 8: Energy and financial calculation for introducing Thermal Insulation of the OutsideWalls – Sensitivity 2 case

Thermal insulation of outside walls: higher density polystyrene for outside walls: Sensitivity case 2 (20% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation of outside walls	m2	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135	468,135
Total energy consumption	MWh	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13
Energy savings																	
Total energy savings	MWh	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	9.05	9.322	9.601	9.889	10.19	10.49	10.81	11.13	11.46	11.81	12.16	12.53	12.9	13.29	13.69	14.1
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	9.05	9.322	9.601	9.889	10.19	10.49	10.81	11.13	11.46	11.81	12.16	12.53	12.9	13.29	13.69	14.1
Investment costs 000 Euro	1000 Euro	85.6															
Not Discounted Cash Flow	1000 Euro	-77	9.322	9.601	9.889	10.19	10.49	10.81	11.13	11.46	11.81	12.16	12.53	12.9	13.29	13.69	14.1
Cumulated Not Discounted Cash Flow	1000 Euro	-76.53	-67.21	-57.61	-47.72	-37.53	-27.04	-16.23	-5.103	6.362	18.17	30.33	42.86	55.76	69.05	82.74	96.84
Discounted Cash Flow	1000 Euro	-76.53	8.878	8.709	8.543	8.38	8.221	8.064	7.91	7.76	7.612	7.467	7.325	7.185	7.048	6.914	6.782
Cumulated Discounted Cash Flow	1000 Euro	-76.53	-67.65	-58.94	-50.4	-42.02	-33.8	-25.74	-17.83	-10.07	-2.454	5.012	12.34	19.52	26.57	33.48	40.27
Discounted Energy Flow	MWh	86.57	82.45	78.52	74.78	71.22	67.83	64.6	61.52	58.59	55.8	53.15	50.61	48.2	45.91	43.72	41.64
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**11.56**															
Net Present Value (interest rate = 5%)	1000 Euro	**40.27**															
Simple Pay Back Period (years)	years	**7.404**															
Discount Pay Back Period (years)	years	**10.99**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.08687															
Internal Rate of Return (%)	%	**11.45%**															

9. Annex 9: Energy and financial calculation for introducing Thermal Insulation of the OutsideWalls – Sensitivity 3 case

Thermal insulation of outside walls: higher density polystyrene for outside walls: Sensitivity case 3 (lower increase growth rate for the tariffs)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation of outside walls	m2	1,542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542	1542
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7
Project consumption																	
Avg. energy consumption	kWh/lp	468135	468135	468135	468135	468135	468135	468135	468135	468135	468135	468135	468135	468135	468135	468135	468135
Total energy consumption	MWh	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13	468.13
Energy savings																	
Total energy savings	MWh	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57	86.57
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.106	0.108	0.109	0.111	0.113	0.114	0.116	0.118	0.12	0.121	0.123	0.125	0.127	0.129	0.131
Cost saving mix energy	1000 Euro	9.05	9.186	9.324	9.464	9.606	9.75	9.896	10.04	10.2	10.35	10.5	10.66	10.82	10.98	11.15	11.31
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	9.05	9.186	9.324	9.464	9.606	9.75	9.896	10.04	10.2	10.35	10.5	10.66	10.82	10.98	11.15	11.31
Investment costs 000 Euro	1000 Euro	71.318															
Not Discounted Cash Flow	1000 Euro	-62	9.186	9.324	9.464	9.606	9.75	9.896	10.04	10.2	10.35	10.5	10.66	10.82	10.98	11.15	11.31
Cumulated Not Discounted Cash Flow	1000 Euro	-62.27	-53.08	-43.76	-34.29	-24.69	-14.94	-5.042	5.002	15.2	25.55	36.05	46.71	57.53	68.51	79.66	90.98
Discounted Cash Flow	1000 Euro	-62.27	8.749	8.457	8.175	7.903	7.639	7.385	7.138	6.9	6.67	6.448	6.233	6.025	5.825	5.63	5.443
Cumulated Discounted Cash Flow	1000 Euro	-62.27	-53.52	-45.06	-36.89	-28.98	-21.34	-13.96	-6.822	0.078	6.749	13.2	19.43	25.46	31.28	36.91	42.35
Discounted Energy Flow	MWh	86.57	82.45	78.52	74.78	71.22	67.83	64.6	61.52	58.59	55.8	53.15	50.61	48.2	45.91	43.72	41.64
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**10.22**															
Net Present Value (interest rate = 5%)	1000 Euro	**42.35**															
Simple Pay Back Period (years)	years	**6.981**															
Discount Pay Back Period (years)	years	**10.23**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.07240															
Internal Rate of Return (%)	%	**13.49%**															

10. Annex 10: Energy and financial calculation for introducing Thermal Insulation of the Roof – base case

Thermal insulation: glass wool for roof/tarrace: Base Case																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation: glass wool for roof/tarrace	m2	970	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346
Total energy consumption	MWh	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35
Energy savings																	
Total energy savings	MWh	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	6.833	7.038	7.249	7.466	7.69	7.921	8.159	8.403	8.656	8.915	9.183	9.458	9.742	10.03	10.34	10.65
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	6.833	7.038	7.249	7.466	7.69	7.921	8.159	8.403	8.656	8.915	9.183	9.458	9.742	10.03	10.34	10.65
Investment costs 000 Euro	1000 Euro	42.195															
Not Discounted Cash Flow	1000 Euro	-35.36	7.038	7.249	7.466	7.69	7.921	8.159	8.403	8.656	8.915	9.183	9.458	9.742	10.03	10.34	10.65
Cumulated Not Discounted Cash Flow	1000 Euro	-35.36	-28.32	-21.08	-13.61	-5.919	2.002	10.16	18.56	27.22	36.13	45.32	54.78	64.52	74.55	84.89	95.53
Discounted Cash Flow	1000 Euro	-35.36	6.703	6.575	6.45	6.327	6.206	6.088	5.972	5.858	5.747	5.637	5.53	5.425	5.321	5.22	5.121
Cumulated Discounted Cash Flow	1000 Euro	-35.36	-28.66	-22.08	-15.63	-9.308	-3.102	2.986	8.958	14.82	20.56	26.2	31.73	37.16	42.48	47.7	52.82
Discounted Energy Flow	MWh	65.36	62.24	59.28	56.46	53.77	51.21	48.77	46.45	44.24	42.13	40.12	38.21	36.39	34.66	33.01	31.44
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**8.726**															
Net Present Value (interest rate = 5%)	1000 Euro	**52.82**															
Simple Pay Back Period (years)	years	**4.835**															
Discount Pay Back Period (years)	years	**7.178**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.05673															
Internal Rate of Return (%)	%	**21.16%**															

Annex 11: Energy and financial calculation for introducing Thermal Insulation of the Roof – Sensitivity 1 case

Thermal insulation: glass wool for roof/tarrace : Sensitivity case 1 (10% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation of outside walls	m2	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346
Total energy consumption	MWh	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35
Energy savings																	
Total energy savings	MWh	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	6.833	7.038	7.249	7.466	7.69	7.921	8.159	8.403	8.656	8.915	9.183	9.458	9.742	10.03	10.34	10.65
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	6.833	7.038	7.249	7.466	7.69	7.921	8.159	8.403	8.656	8.915	9.183	9.458	9.742	10.03	10.34	10.65
Investment costs 000 Euro	1000 Euro	46.415															
Not Discounted Cash Flow	1000 Euro	-39.582	7.038	7.249	7.466	7.69	7.921	8.159	8.403	8.656	8.915	9.183	9.458	9.742	10.03	10.34	10.65
Cumulated Not Discounted Cash Flow	1000 Euro	-39.58	-32.54	-25.3	-17.83	-10.14	-2.217	5.941	14.34	23	31.92	41.1	50.56	60.3	70.33	80.67	91.31
Discounted Cash Flow	1000 Euro	-39.58	6.703	6.575	6.45	6.327	6.206	6.088	5.972	5.858	5.747	5.637	5.53	5.425	5.321	5.22	5.121
Cumulated Discounted Cash Flow	1000 Euro	-39.58	-32.88	-26.3	-19.85	-13.53	-7.321	-1.233	4.739	10.6	16.34	21.98	27.51	32.94	38.26	43.48	48.6
Discounted Energy Flow	MWh	65.36	62.24	59.28	56.46	53.77	51.21	48.77	46.45	44.24	42.13	40.12	38.21	36.39	34.66	33.01	31.44
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**8.726**															
Net Present Value (interest rate = 5%)	1000 Euro	**48.6**															
Simple Pay Back Period (years)	years	**5.319**															
Discount Pay Back Period (years)	years	**7.895**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06241															
Internal Rate of Return (%)	%	**18.65%**															

11. Annex 12: Energy and financialcal culation for introducing Thermal Insulation of the Roof – Sensitivity 2 case

Thermal insulation: glass wool for roof/tarrace: Sensitivity case 2 (20% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation: glass wool for roof/tarrace	m2	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346
Total energy consumption	MWh	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35
Energy savings																	
Total energy savings	MWh	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	6.833	7.038	7.249	7.466	7.69	7.921	8.159	8.403	8.656	8.915	9.183	9.458	9.742	10.03	10.34	10.65
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	6.833	7.038	7.249	7.466	7.69	7.921	8.159	8.403	8.656	8.915	9.183	9.458	9.742	10.03	10.34	10.65
Investment costs 000 Euro	1000 Euro	51															
Not Discounted Cash Flow	1000 Euro	-44	7.038	7.249	7.466	7.69	7.921	8.159	8.403	8.656	8.915	9.183	9.458	9.742	10.03	10.34	10.65
Cumulated Not Discounted Cash Flow	1000 Euro	-43.8	-36.76	-29.51	-22.05	-14.36	-6.437	1.722	10.13	18.78	27.7	36.88	46.34	56.08	66.11	76.45	87.09
Discounted Cash Flow	1000 Euro	-43.8	6.703	6.575	6.45	6.327	6.206	6.088	5.972	5.858	5.747	5.637	5.53	5.425	5.321	5.22	5.121
Cumulated Discounted Cash Flow	1000 Euro	-43.8	-37.1	-30.52	-24.07	-17.75	-11.54	-5.453	0.519	6.378	12.12	17.76	23.29	28.72	34.04	39.26	44.38
Discounted Energy Flow	MWh	65.36	62.24	59.28	56.46	53.77	51.21	48.77	46.45	44.24	42.13	40.12	38.21	36.39	34.66	33.01	31.44
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**8.726**															
Net Present Value (interest rate = 5%)	1000 Euro	**44.38**															
Simple Pay Back Period (years)	years	**5.802**															
Discount Pay Back Period (years)	years	**8.613**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06808															
Internal Rate of Return (%)	%	**16.55%**															

12. Annex 13: Energy and financial calculation for introducing Thermal Insulation of the Roof – Sensitivity 3 case

Thermal insulation: glass wool for roof/tarrace: Sensitivity case 3 (lower increase growth rate for the tariffs)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation: glass wool for roof/tarrace	m2	970	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5	970.5
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346	489,346
Total energy consumption	MWh	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35	489.35
Energy savings																	
Total energy savings	MWh	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36	65.36
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.106	0.108	0.109	0.111	0.113	0.114	0.116	0.118	0.12	0.121	0.123	0.125	0.127	0.129	0.131
Cost saving mix energy	1000 Euro	6.833	6.935	7.039	7.145	7.252	7.361	7.471	7.583	7.697	7.813	7.93	8.049	8.169	8.292	8.416	8.543
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	6.833	6.935	7.039	7.145	7.252	7.361	7.471	7.583	7.697	7.813	7.93	8.049	8.169	8.292	8.416	8.543
Investment costs 000 Euro	1000 Euro	42.195															
Not Discounted Cash Flow	1000 Euro	-35	6.935	7.039	7.145	7.252	7.361	7.471	7.583	7.697	7.813	7.93	8.049	8.169	8.292	8.416	8.543
Cumulated Not Discounted Cash Flow	1000 Euro	-35.36	-28.43	-21.39	-14.24	-6.991	0.37	7.841	15.42	23.12	30.93	38.86	46.91	55.08	63.37	71.79	80.33
Discounted Cash Flow	1000 Euro	-35.36	6.605	6.385	6.172	5.966	5.767	5.575	5.389	5.21	5.036	4.868	4.706	4.549	4.397	4.251	4.109
Cumulated Discounted Cash Flow	1000 Euro	-35.36	-28.76	-22.37	-16.2	-10.23	-4.467	1.108	6.498	11.71	16.74	21.61	26.32	30.87	35.26	39.51	43.62
Discounted Energy Flow	MWh	65.36	62.24	59.28	56.46	53.77	51.21	48.77	46.45	44.24	42.13	40.12	38.21	36.39	34.66	33.01	31.44
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**7.713**															
Net Present Value (interest rate = 5%)	1000 Euro	**43.62**															
Simple Pay Back Period (years)	years	**5.471**															
Discount Pay Back Period (years)	years	**8.013**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.05673															
Internal Rate of Return (%)	%	**19.40%**															

13. Annex 14: Energy and financial calculation for introducing Thermal Insulation of the Basement – base case

Thermal insulation of bassement: Base Case																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation of bassement	m2	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947
Total energy consumption	MWh	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95
Energy savings																	
Total energy savings	MWh	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	9.593	9.88	10.18	10.48	10.8	11.12	11.45	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.94
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	9.593	9.88	10.18	10.48	10.8	11.12	11.45	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.94
Investment costs 000 Euro	1000 Euro	65.475															
Not Discounted Cash Flow	1000 Euro	-55.88	9.88	10.18	10.48	10.8	11.12	11.45	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.94
Cumulated Not Discounted Cash Flow	1000 Euro	-55.88	-46	-35.83	-25.34	-14.55	-3.426	8.028	19.83	31.98	44.49	57.39	70.66	84.34	98.43	112.9	127.9
Discounted Cash Flow	1000 Euro	-55.88	9.41	9.231	9.055	8.882	8.713	8.547	8.384	8.225	8.068	7.914	7.764	7.616	7.471	7.328	7.189
Cumulated Discounted Cash Flow	1000 Euro	-55.88	-46.47	-37.24	-28.19	-19.3	-10.59	-2.044	6.34	14.56	22.63	30.55	38.31	45.93	53.4	60.73	67.91
Discounted Energy Flow	MWh	91.76	87.39	83.22	79.26	75.49	71.89	68.47	65.21	62.1	59.15	56.33	53.65	51.09	48.66	46.34	44.14
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**12.25**															
Net Present Value (interest rate = 5%)	1000 Euro	**67.91**															
Simple Pay Back Period (years)	years	**5.344**															
Discount Pay Back Period (years)	years	**7.933**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06271															
Internal Rate of Return (%)	%	**18.5%**															

Annex 15: Energy and financial calculation for introducing Thermal Insulation of the Basement – Sensitivity 1 case

Thermal insulation of bassement: Sensitivity case 1 (10% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation of bassement	m2	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947
Total energy consumption	MWh	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95
Energy savings																	
Total energy savings	MWh	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	9.593	9.88	10.18	10.48	10.8	11.12	11.45	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.94
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	9.593	9.88	10.18	10.48	10.8	11.12	11.45	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.94
Investment costs 000 Euro	1000 Euro	72.023															
Not Discounted Cash Flow	1000 Euro	-62.430	9.88	10.18	10.48	10.8	11.12	11.45	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.94
Cumulated Not Discounted Cash Flow	1000 Euro	-62.43	-52.55	-42.37	-31.89	-21.09	-9.974	1.48	13.28	25.43	37.95	50.84	64.12	77.79	91.88	106.4	121.3
Discounted Cash Flow	1000 Euro	-62.43	9.41	9.231	9.055	8.882	8.713	8.547	8.384	8.225	8.068	7.914	7.764	7.616	7.471	7.328	7.189
Cumulated Discounted Cash Flow	1000 Euro	-62.43	-53.02	-43.79	-34.73	-25.85	-17.14	-8.592	-0.207	8.017	16.09	24	31.76	39.38	46.85	54.18	61.37
Discounted Energy Flow	MWh	91.76	87.39	83.22	79.26	75.49	71.89	68.47	65.21	62.1	59.15	56.33	53.65	51.09	48.66	46.34	44.14
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**12.25**															
Net Present Value (interest rate = 5%)	1000 Euro	**61.37**															
Simple Pay Back Period (years)	years	**5.879**															
Discount Pay Back Period (years)	years	**8.727**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06898															
Internal Rate of Return (%)	%	**16.2%**															

14. Annex 16: Energy and financial calculation for introducing Thermal Insulation of the Basement – Sensitivity 2 case

Thermal insulation of bassement: Sensitivity case 2 (20% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation of bassement	m2	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947	462,947
Total energy consumption	MWh	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95
Energy savings																	
Total energy savings	MWh	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	9.593	9.88	10.18	10.48	10.8	11.12	11.45	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.94
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	9.593	9.88	10.18	10.48	10.8	11.12	11.45	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.94
Investment costs 000 Euro	1000 Euro	78.6															
Not Discounted Cash Flow	1000 Euro	-69	9.88	10.18	10.48	10.8	11.12	11.45	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.94
Cumulated Not Discounted Cash Flow	1000 Euro	-68.98	-59.1	-48.92	-38.44	-27.64	-16.52	-5.067	6.731	18.88	31.4	44.29	57.57	71.25	85.33	99.84	114.8
Discounted Cash Flow	1000 Euro	-68.98	9.41	9.231	9.055	8.882	8.713	8.547	8.384	8.225	8.068	7.914	7.764	7.616	7.471	7.328	7.189
Cumulated Discounted Cash Flow	1000 Euro	-68.98	-59.57	-50.34	-41.28	-32.4	-23.69	-15.14	-6.755	1.47	9.538	17.45	25.22	32.83	40.3	47.63	54.82
Discounted Energy Flow	MWh	91.76	87.39	83.22	79.26	75.49	71.89	68.47	65.21	62.1	59.15	56.33	53.65	51.09	48.66	46.34	44.14
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**12.25**															
Net Present Value (interest rate = 5%)	1000 Euro	**54.82**															
Simple Pay Back Period (years)	years	**6.413**															
Discount Pay Back Period (years)	years	**9.52**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.07525															
Internal Rate of Return (%)	%	**14.3%**															

15. Annex 17: Energy and financial calculation for introducing Thermal Insulation of the Basement – Sensitivity 3 case

Thermal insulation of bassement: Sensitivity case 3 (lower increase growth rate for the tariffs)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Thermal insulation of bassement	m2	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7	554.7
Project consumption																	
Avg. energy consumption	kWh/lp	462947	462947	462947	462947	462947	462947	462947	462947	462947	462947	462947	462947	462947	462947	462947	462947
Total energy consumption	MWh	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95	462.95
Energy savings																	
Total energy savings	MWh	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76	91.76
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.106	0.108	0.109	0.111	0.113	0.114	0.116	0.118	0.12	0.121	0.123	0.125	0.127	0.129	0.131
Cost saving mix energy	1000 Euro	9.593	9.736	9.883	10.03	10.18	10.33	10.49	10.65	10.81	10.97	11.13	11.3	11.47	11.64	11.82	11.99
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	9.593	9.736	9.883	10.03	10.18	10.33	10.49	10.65	10.81	10.97	11.13	11.3	11.47	11.64	11.82	11.99
Investment costs 000 Euro	1000 Euro	65.475															
Not Discounted Cash Flow	1000 Euro	-56	9.736	9.883	10.03	10.18	10.33	10.49	10.65	10.81	10.97	11.13	11.3	11.47	11.64	11.82	11.99
Cumulated Not Discounted Cash Flow	1000 Euro	-55.88	-46.15	-36.26	-26.23	-16.05	-5.717	4.772	15.42	26.22	37.19	48.32	59.62	71.09	82.73	94.55	106.5
Discounted Cash Flow	1000 Euro	-55.88	9.273	8.964	8.665	8.376	8.097	7.827	7.566	7.314	7.07	6.834	6.607	6.386	6.174	5.968	5.769
Cumulated Discounted Cash Flow	1000 Euro	-55.88	-46.61	-37.65	-28.98	-20.6	-12.51	-4.681	2.885	10.2	17.27	24.1	30.71	37.1	43.27	49.24	55.01
Discounted Energy Flow	MWh	91.76	87.39	83.22	79.26	75.49	71.89	68.47	65.21	62.1	59.15	56.33	53.65	51.09	48.66	46.34	44.14
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**10.83**															
Net Present Value (interest rate = 5%)	1000 Euro	**55.01**															
Simple Pay Back Period (years)	years	**6.047**															
Discount Pay Back Period (years)	years	**8.857**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06271															
Internal Rate of Return (%)	%	**16.8%**															

16. Annex 18: Energy and financial calculation for introducing Efficient Windows – base case

Efficient windows : Base Case																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Efficient windows	m2	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805
Total energy consumption	MWh	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81
Energy savings																	
Total energy savings	MWh	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90
Total cost savings																	
Price of mix energy	Euro/kWh	0.1045	0.1077	0.1109	0.1142	0.1177	0.1212	0.1248	0.1286	0.1324	0.1364	0.1405	0.1447	0.1491	0.1535	0.1581	0.1629
Cost saving mix energy	1000 Euro	6.262	6.45	6.643	6.843	7.048	7.259	7.477	7.702	7.933	8.171	8.416	8.668	8.928	9.196	9.472	9.756
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	6.262	6.45	6.643	6.843	7.048	7.259	7.477	7.702	7.933	8.171	8.416	8.668	8.928	9.196	9.472	9.756
Investment costs 000 Euro	1000 Euro	41.964															
Not Discounted Cash Flow	1000 Euro	-35.70	6.45	6.643	6.843	7.048	7.259	7.477	7.702	7.933	8.171	8.416	8.668	8.928	9.196	9.472	9.756
Cumulated Not Discounted Cash Flow	1000 Euro	-35.7	-29.25	-22.61	-15.77	-8.718	-1.459	6.019	13.72	21.65	29.82	38.24	46.91	55.83	65.03	74.5	84.26
Discounted Cash Flow	1000 Euro	-35.7	6.143	6.026	5.911	5.798	5.688	5.58	5.473	5.369	5.267	5.166	5.068	4.972	4.877	4.784	4.693
Cumulated Discounted Cash Flow	1000 Euro	-35.7	-29.56	-23.53	-17.62	-11.82	-6.136	-0.557	4.917	10.29	15.55	20.72	25.79	30.76	35.64	40.42	45.11
Discounted Energy Flow	MWh	59.9	57.05	54.33	51.74	49.28	46.93	44.7	42.57	40.54	38.61	36.77	35.02	33.35	31.76	30.25	28.81
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**7.997**															
Net Present Value (interest rate = 5%)	1000 Euro	**45.11**															
Simple Pay Back Period (years)	years	**5.247**															
Discount Pay Back Period (years)	years	**7.789**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06157															
Internal Rate of Return (%)	%	**18.99%**															

17. Annex 19: Energy and financial calculation for introducing Efficient Windows – Sensitivity 1 case

Efficient windows : Sensitivity case 1 (10% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Efficient windows	m2	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
Project consumption																	
Avg. energy consumption	kWh/lp	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805
Total energy consumption	MWh	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81
Energy savings																	
Total energy savings	MWh	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90
Total cost savings																	
Price of mix energy	Euro/kWh	0.1045	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	6.262	6.45	6.643	6.843	7.048	7.259	7.477	7.702	7.933	8.171	8.416	8.668	8.928	9.196	9.472	9.756
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	6.262	6.45	6.643	6.843	7.048	7.259	7.477	7.702	7.933	8.171	8.416	8.668	8.928	9.196	9.472	9.756
Investment costs 000 Euro	1000 Euro	46.160															
Not Discounted Cash Flow	1000 Euro	-39.898	6.45	6.643	6.843	7.048	7.259	7.477	7.702	7.933	8.171	8.416	8.668	8.928	9.196	9.472	9.756
Cumulated Not Discounted Cash Flow	1000 Euro	-39.9	-33.45	-26.81	-19.96	-12.91	-5.655	1.822	9.524	17.46	25.63	34.04	42.71	51.64	60.83	70.31	80.06
Discounted Cash Flow	1000 Euro	-39.9	6.143	6.026	5.911	5.798	5.688	5.58	5.473	5.369	5.267	5.166	5.068	4.972	4.877	4.784	4.693
Cumulated Discounted Cash Flow	1000 Euro	-39.9	-33.76	-27.73	-21.82	-16.02	-10.33	-4.753	0.72	6.089	11.36	16.52	21.59	26.56	31.44	36.22	40.92
Discounted Energy Flow	MWh	59.9	57.05	54.33	51.74	49.28	46.93	44.7	42.57	40.54	38.61	36.77	35.02	33.35	31.76	30.25	28.81
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**7.997**															
Net Present Value (interest rate = 5%)	1000 Euro	**40.92**															
Simple Pay Back Period (years)	years	**5.772**															
Discount Pay Back Period (years)	years	**8.568**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06772															
Internal Rate of Return (%)	%	**16.67%**															

18. Annex 20: Energy and financial calculation for introducing Efficient Windows – Sensitivity 2 case

Efficient windows : Sensitivity case 2 (20% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Efficient windows	m2	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
Project consumption																	
Avg. energy consumption	kWh/lp	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805
Total energy consumption	MWh	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81
Energy savings																	
Total energy savings	MWh	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	6.262	6.45	6.643	6.843	7.048	7.259	7.477	7.702	7.933	8.171	8.416	8.668	8.928	9.196	9.472	9.756
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	6.262	6.45	6.643	6.843	7.048	7.259	7.477	7.702	7.933	8.171	8.416	8.668	8.928	9.196	9.472	9.756
Investment costs 000 Euro	1000 Euro	50.357															
Not Discounted Cash Flow	1000 Euro	-44	6.45	6.643	6.843	7.048	7.259	7.477	7.702	7.933	8.171	8.416	8.668	8.928	9.196	9.472	9.756
Cumulated Not Discounted Cash Flow	1000 Euro	-44.09	-37.64	-31	-24.16	-17.11	-9.851	-2.374	5.327	13.26	21.43	29.85	38.51	47.44	56.64	66.11	75.87
Discounted Cash Flow	1000 Euro	-44.09	6.143	6.026	5.911	5.798	5.688	5.58	5.473	5.369	5.267	5.166	5.068	4.972	4.877	4.784	4.693
Cumulated Discounted Cash Flow	1000 Euro	-44.09	-37.95	-31.93	-26.02	-20.22	-14.53	-8.949	-3.476	1.893	7.16	12.33	17.39	22.37	27.24	32.03	36.72
Discounted Energy Flow	MWh	59.9	57.05	54.33	51.74	49.28	46.93	44.7	42.57	40.54	38.61	36.77	35.02	33.35	31.76	30.25	28.81
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**7.997**															
Net Present Value (interest rate = 5%)	1000 Euro	**36.72**															
Simple Pay Back Period (years)	years	**6.297**															
Discount Pay Back Period (years)	years	**9.347**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.07388															
Internal Rate of Return (%)	%	**14.72%**															

19. Annex 21: Energy and financial calculation for introducing Efficient Windows – Sensitivity 3 case

Efficient windows: Sensitivity case 3 (lower increase growth rate for the tariffs)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Efficient windows	m2	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
Project consumption																	
Avg. energy consumption	kWh/lp	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805	494,805
Total energy consumption	MWh	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81	494.81
Energy savings																	
Total energy savings	MWh	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90	59.90
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.106	0.108	0.109	0.111	0.113	0.114	0.116	0.118	0.12	0.121	0.123	0.125	0.127	0.129	0.131
Cost saving mix energy	1000 Euro	6.262	6.356	6.451	6.548	6.646	6.746	6.847	6.95	7.054	7.16	7.267	7.376	7.487	7.599	7.713	7.829
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	6.262	6.356	6.451	6.548	6.646	6.746	6.847	6.95	7.054	7.16	7.267	7.376	7.487	7.599	7.713	7.829
Investment costs 000 Euro	1000 Euro	41.964															
Not Discounted Cash Flow	1000 Euro	-36	6.356	6.451	6.548	6.646	6.746	6.847	6.95	7.054	7.16	7.267	7.376	7.487	7.599	7.713	7.829
Cumulated Not Discounted Cash Flow	1000 Euro	-35.7	-29.35	-22.89	-16.35	-9.7	-2.954	3.893	10.84	17.9	25.06	32.32	39.7	47.19	54.79	62.5	70.33
Discounted Cash Flow	1000 Euro	-35.7	6.053	5.852	5.656	5.468	5.286	5.109	4.939	4.775	4.615	4.462	4.313	4.169	4.03	3.896	3.766
Cumulated Discounted Cash Flow	1000 Euro	-35.7	-29.65	-23.8	-18.14	-12.67	-7.387	-2.278	2.661	7.436	12.05	16.51	20.83	24.99	29.02	32.92	36.69
Discounted Energy Flow	MWh	59.9	57.05	54.33	51.74	49.28	46.93	44.7	42.57	40.54	38.61	36.77	35.02	33.35	31.76	30.25	28.81
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**7.069**															
Net Present Value (interest rate = 5%)	1000 Euro	**36.69**															
Simple Pay Back Period (years)	years	**5.937**															
Discount Pay Back Period (years)	years	**8.696**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06157															
Internal Rate of Return (%)	%	**17.26%**															

20. Annex 22: Energy and financial calculation for introducing Outside Doors – base case

Efficient Outside Doors: Base Case																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Outside Doors	m2	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70	554.70
Project consumption																	
Avg. energy consumption	kWh/lp	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189
Total energy consumption	MWh	535.19	535.19	535.19	535.19	535.19	535.19	535.19	535.19	535.19	535.19	535.19	535.19	535.19	535.19	535.19	535.19
Energy savings																	
Total energy savings	MWh	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51
Total cost savings																	
Price of mix energy	Euro/kWh	0.1045	0.1077	0.1109	0.1142	0.1177	0.1212	0.1248	0.1286	0.1324	0.1364	0.1405	0.1447	0.1491	0.1535	0.1581	0.1629
Cost saving mix energy	1000 Euro	2.04	2.101	2.164	2.229	2.296	2.365	2.436	2.509	2.584	2.662	2.742	2.824	2.909	2.996	3.086	3.178
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	2.04	2.101	2.164	2.229	2.296	2.365	2.436	2.509	2.584	2.662	2.742	2.824	2.909	2.996	3.086	3.178
Investment costs 000 Euro	1000 Euro	8.745															
Not Discounted Cash Flow	1000 Euro	-6.70	2.101	2.164	2.229	2.296	2.365	2.436	2.509	2.584	2.662	2.742	2.824	2.909	2.996	3.086	3.178
Cumulated Not Discounted Cash Flow	1000 Euro	-6.705	-4.604	-2.439	-0.21	2.086	4.451	6.887	9.396	11.98	14.64	17.38	20.21	23.12	26.11	29.2	32.38
Discounted Cash Flow	1000 Euro	-6.705	2.001	1.963	1.926	1.889	1.853	1.818	1.783	1.749	1.716	1.683	1.651	1.62	1.589	1.559	1.529
Cumulated Discounted Cash Flow	1000 Euro	-6.705	-4.704	-2.741	-0.815	1.074	2.927	4.745	6.528	8.277	9.993	11.68	13.33	14.95	16.54	18.09	19.62
Discounted Energy Flow	MWh	19.51	18.58	17.7	16.86	16.05	15.29	14.56	13.87	13.21	12.58	11.98	11.41	10.87	10.35	9.856	9.386
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**2.605**															
Net Present Value (interest rate = 5%)	1000 Euro	**19.62**															
Simple Pay Back Period (years)	years	**3.357**															
Discount Pay Back Period (years)	years	**4.982**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.03938															
Internal Rate of Return (%)	%	**33.71%**															

21. Annex 23: Energy and financial calculation for introducing Outside Doors – Sensitivity 1 case

Efficient Outside Doors : Sensitivity case 1 (10% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Outside Doors	m2	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
Project consumption																	
Avg. energy consumption	kWh/lp	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189
Total energy consumption	MWh	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535
Energy savings																	
Total energy savings	MWh	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51
Total cost savings																	
Price of mix energy	Euro/kWh	0.1045	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	2.04	2.101	2.164	2.229	2.296	2.365	2.436	2.509	2.584	2.662	2.742	2.824	2.909	2.996	3.086	3.178
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	2.04	2.101	2.164	2.229	2.296	2.365	2.436	2.509	2.584	2.662	2.742	2.824	2.909	2.996	3.086	3.178
Investment costs 000 Euro	1000 Euro	9.620															
Not Discounted Cash Flow	1000 Euro	-7.579	2.101	2.164	2.229	2.296	2.365	2.436	2.509	2.584	2.662	2.742	2.824	2.909	2.996	3.086	3.178
Cumulated Not Discounted Cash Flow	1000 Euro	-7.579	-5.478	-3.314	-1.085	1.211	3.576	6.012	8.521	11.11	13.77	16.51	19.33	22.24	25.24	28.32	31.5
Discounted Cash Flow	1000 Euro	-7.579	2.001	1.963	1.926	1.889	1.853	1.818	1.783	1.749	1.716	1.683	1.651	1.62	1.589	1.559	1.529
Cumulated Discounted Cash Flow	1000 Euro	-7.579	-5.578	-3.615	-1.69	0.199	2.052	3.87	5.653	7.402	9.118	10.8	12.45	14.07	15.66	17.22	18.75
Discounted Energy Flow	MWh	19.51	18.58	17.7	16.86	16.05	15.29	14.56	13.87	13.21	12.58	11.98	11.41	10.87	10.35	9.856	9.386
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**2.605**															
Net Present Value (interest rate = 5%)	1000 Euro	**18.75**															
Simple Pay Back Period (years)	years	**3.692**															
Discount Pay Back Period (years)	years	**5.481**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.04332															
Internal Rate of Return (%)	%	####															

22. Annex 24: Energy and financial calculation for introducing Outside Doors – Sensitivity 2 case

Efficient windows : Sensitivity case 2 (20% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Outside Doors	m2	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
Project consumption																	
Avg. energy consumption	kWh/lp	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189
Total energy consumption	MWh	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535
Energy savings																	
Total energy savings	MWh	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving mix energy	1000 Euro	2.04	2.101	2.164	2.229	2.296	2.365	2.436	2.509	2.584	2.662	2.742	2.824	2.909	2.996	3.086	3.178
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	2.04	2.101	2.164	2.229	2.296	2.365	2.436	2.509	2.584	2.662	2.742	2.824	2.909	2.996	3.086	3.178
Investment costs 000 Euro	1000 Euro	10.494															
Not Discounted Cash Flow	1000 Euro	-8	2.101	2.164	2.229	2.296	2.365	2.436	2.509	2.584	2.662	2.742	2.824	2.909	2.996	3.086	3.178
Cumulated Not Discounted Cash Flow	1000 Euro	-8.454	-6.353	-4.188	-1.959	0.337	2.702	5.138	7.647	10.23	12.89	15.63	18.46	21.37	24.36	27.45	30.63
Discounted Cash Flow	1000 Euro	-8.454	2.001	1.963	1.926	1.889	1.853	1.818	1.783	1.749	1.716	1.683	1.651	1.62	1.589	1.559	1.529
Cumulated Discounted Cash Flow	1000 Euro	-8.454	-6.453	-4.49	-2.564	-0.675	1.178	2.996	4.779	6.528	8.244	9.927	11.58	13.2	14.79	16.34	17.87
Discounted Energy Flow	MWh	19.51	18.58	17.7	16.86	16.05	15.29	14.56	13.87	13.21	12.58	11.98	11.41	10.87	10.35	9.856	9.386
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**2.605**															
Net Present Value (interest rate = 5%)	1000 Euro	**17.87**															
Simple Pay Back Period (years)	years	**4.028**															
Discount Pay Back Period (years)	years	**5.979**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.04726															
Internal Rate of Return (%)	%	####															

23. Annex 25: Energy and financial calculation for introducing Outside Doors – Sensitivity 3 case

Efficient windows: Sensitivity case 3 (lower increase growth rate for the tariffs)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Outside Doors	m2	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Baseline consumption																	
Avg. energy consumption	kWh/yr.	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703	554703
Total energy consumption	MWh	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
Project consumption																	
Avg. energy consumption	kWh/lp	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189	535,189
Total energy consumption	MWh	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535
Energy savings																	
Total energy savings	MWh	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51	19.51
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.106	0.108	0.109	0.111	0.113	0.114	0.116	0.118	0.12	0.121	0.123	0.125	0.127	0.129	0.131
Cost saving mix energy	1000 Euro	2.04	2.071	2.102	2.133	2.165	2.198	2.231	2.264	2.298	2.333	2.368	2.403	2.439	2.476	2.513	2.551
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	2.04	2.071	2.102	2.133	2.165	2.198	2.231	2.264	2.298	2.333	2.368	2.403	2.439	2.476	2.513	2.551
Investment costs 000 Euro	1000 Euro	8.745															
Not Discounted Cash Flow	1000 Euro	-7	2.071	2.102	2.133	2.165	2.198	2.231	2.264	2.298	2.333	2.368	2.403	2.439	2.476	2.513	2.551
Cumulated Not Discounted Cash Flow	1000 Euro	-6.705	-4.634	-2.533	-0.399	1.766	3.963	6.194	8.458	10.76	13.09	15.46	17.86	20.3	22.77	25.29	27.84
Discounted Cash Flow	1000 Euro	-6.705	1.972	1.906	1.843	1.781	1.722	1.665	1.609	1.555	1.504	1.453	1.405	1.358	1.313	1.269	1.227
Cumulated Discounted Cash Flow	1000 Euro	-6.705	-4.733	-2.827	-0.984	0.797	2.519	4.184	5.793	7.348	8.852	10.31	11.71	13.07	14.38	15.65	16.88
Discounted Energy Flow	MWh	19.51	18.58	17.7	16.86	16.05	15.29	14.56	13.87	13.21	12.58	11.98	11.41	10.87	10.35	9.856	9.386
Main Financial Indicators																	
Average Cost Saving	1000 Euro	**2.303**															
Net Present Value (interest rate = 5%)	1000 Euro	**16.88**															
Simple Pay Back Period (years)	years	**3.797**															
Discount Pay Back Period (years)	years	**5.562**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.03938															
Internal Rate of Return (%)	%	**31.77%**															

24. Annex 26: Energy and financial calculation for introducing Efficient Pellet Heating System – base case

Efficient Heating System: Base Case																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Efficient Heating System	kW	235.89	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9
Baseline consumption																	
Avg. mix energy	kWh/yr.	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147
Total mix energy	MWh	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15
Project consumption																	
Avg. mix energy	kWh/lp	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320
Total mix energy	MWh	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32
Energy savings																	
Total energy savings	MWh	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost of mix energy	1000 Euro	37.02	38.14	39.28	40.46	41.67	42.92	44.21	45.54	46.9	48.31	49.76	51.25	52.79	54.37	56	57.68
Price of mix energy	Euro/ton	200	206	212.2	218.5	225.1	231.9	238.8	246	253.4	261	268.8	276.8	285.2	293.7	302.5	311.6
Net Calorific Value of Pellets	MJ/kg	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Unit Cost of mix energy	Euro/kWh	0.0379	0.0390	0.0402	0.0414	0.0427	0.0439	0.0452	0.0466	0.0480	0.0494	0.0509	0.0525	0.0540	0.0556	0.0573	0.0590
Cost of mix energy	1000 Euro	11.46	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.95	15.4	15.86	16.33	16.82	17.33	17.85
Cost of saving energy	1000 Euro	25.57	26.34	27.13	27.94	28.78	29.64	30.53	31.45	32.39	33.36	34.36	35.39	36.45	37.55	38.67	39.83
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	37.02	38.14	39.28	40.46	41.67	42.92	44.21	45.54	46.9	48.31	49.76	51.25	52.79	54.37	56	57.68
Investment costs 000 Euro	1000 Euro	195.506															
Not Discounted Cash Flow	1000 Euro	-158.48	38.14	39.28	40.46	41.67	42.92	44.21	45.54	46.9	48.31	49.76	51.25	52.79	54.37	56	57.68
Cumulated Not Discounted Cash Flow	1000 Euro	-158.5	-120.3	-81.07	-40.61	1.061	43.98	88.19	133.7	180.6	228.9	278.7	329.9	382.7	437.1	493.1	550.8
Discounted Cash Flow	1000 Euro	-158.5	36.32	35.63	34.95	34.28	33.63	32.99	32.36	31.74	31.14	30.55	29.97	29.39	28.83	28.29	27.75
Cumulated Discounted Cash Flow	1000 Euro	-158.5	-122.2	-86.54	-51.59	-17.3	16.33	49.32	81.68	113.4	144.6	175.1	205.1	234.5	263.3	291.6	319.3
Discounted Energy Flow	MWh	51.83	49.36	47.01	44.77	42.64	40.61	38.67	36.83	35.08	33.41	31.82	30.3	28.86	27.48	26.18	24.93
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**47.28**															
Net Present Value (interest rate = 5%)	1000 Euro	**319.3**															
Simple Pay Back Period (years)	years	**4.135**															
Discount Pay Back Period (years)	years	**6.137**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.0345															
Internal Rate of Return (%)	%	**25.9%**															

25. Annex 27: Energy and financial calculation for introducing Efficient Pellet Heating System – Sensitivity 1 case

Efficient Heating System: Sensitivity case 1 (10% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Efficient Heating System	kW	235.89	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9
Baseline consumption																	
Avg. mix energy	kWh/yr.	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147
Total mix energy	MWh	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15
Project consumption																	
Avg. mix energy	kWh/lp	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320
Total mix energy	MWh	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32
Energy savings																	
Total energy savings	MWh	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost of mix energy	1000 Euro	37.02	38.14	39.28	40.46	41.67	42.92	44.21	45.54	46.9	48.31	49.76	51.25	52.79	54.37	56	57.68
Price of mix energy	Euro/ton	200	206	212.2	218.5	225.1	231.9	238.8	246	253.4	261	268.8	276.8	285.2	293.7	302.5	311.6
Net Calorific Value of Pellets	MJ/kg	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Unit Cost of mix energy	Euro/kWh	0.0379	0.0390	0.0402	0.0414	0.0427	0.0439	0.0452	0.0466	0.0480	0.0494	0.0509	0.0525	0.0540	0.0556	0.0573	0.0590
Cost of mix energy	1000 Euro	11.46	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.95	15.4	15.86	16.33	16.82	17.33	17.85
Cost of saving energy	1000 Euro	25.57	26.34	27.13	27.94	28.78	29.64	30.53	31.45	32.39	33.36	34.36	35.39	36.45	37.55	38.67	39.83
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	37.02	38.14	39.28	40.46	41.67	42.92	44.21	45.54	46.9	48.31	49.76	51.25	52.79	54.37	56	57.68
Investment costs 000 Euro	1000 Euro	215.1															
Not Discounted Cash Flow	1000 Euro	-178.03	38.14	39.28	40.46	41.67	42.92	44.21	45.54	46.9	48.31	49.76	51.25	52.79	54.37	56	57.68
Cumulated Not Discounted Cash Flow	1000 Euro	-178	-139.9	-100.6	-60.16	-18.49	24.43	68.64	114.2	161.1	209.4	259.1	310.4	363.2	417.6	473.6	531.2
Discounted Cash Flow	1000 Euro	-178	36.32	35.63	34.95	34.28	33.63	32.99	32.36	31.74	31.14	30.55	29.97	29.39	28.83	28.29	27.75
Cumulated Discounted Cash Flow	1000 Euro	-178	-141.7	-106.1	-71.14	-36.85	-3.224	29.77	62.13	93.87	125	155.6	185.5	214.9	243.8	272	299.8
Discounted Energy Flow	MWh	51.83	49.36	47.01	44.77	42.64	40.61	38.67	36.83	35.08	33.41	31.82	30.3	28.86	27.48	26.18	24.93
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**47.28**															
Net Present Value (interest rate = 5%)	1000 Euro	**299.8**															
Simple Pay Back Period (years)	years	**4.548**															
Discount Pay Back Period (years)	years	**6.751**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.36465															
Internal Rate of Return (%)	%	**22.9%**															

26. Annex 28: Energy and financial calculation for introducing Efficient Pellet Heating System – Sensitivity 2 case

Efficient Heating System: Sensitivity case 2 (20% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Efficient Heating System	kW	235.89	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9
Baseline consumption																	
Avg. mix energy	kWh/yr.	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147
Total mix energy	MWh	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15
Project consumption																	
Avg. mix energy	kWh/lp	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320
Total mix energy	MWh	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32
Energy savings																	
Total energy savings	MWh	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost of mix energy	1000 Euro	37.02	38.14	39.28	40.46	41.67	42.92	44.21	45.54	46.9	48.31	49.76	51.25	52.79	54.37	56	57.68
Price of mix energy	Euro/ton	200	206	212.2	218.5	225.1	231.9	238.8	246	253.4	261	268.8	276.8	285.2	293.7	302.5	311.6
Net Calorific Value of Pellets	MJ/kg	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Unit Cost of mix energy	Euro/kWh	0.0379	0.0390	0.0402	0.0414	0.0427	0.0439	0.0452	0.0466	0.0480	0.0494	0.0509	0.0525	0.0540	0.0556	0.0573	0.0590
Cost of mix energy	1000 Euro	11.46	11.8	12.15	12.52	12.89	13.28	13.68	14.09	14.51	14.95	15.4	15.86	16.33	16.82	17.33	17.85
Cost of saving energy	1000 Euro	25.57	26.34	27.13	27.94	28.78	29.64	30.53	31.45	32.39	33.36	34.36	35.39	36.45	37.55	38.67	39.83
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	37.02	38.14	39.28	40.46	41.67	42.92	44.21	45.54	46.9	48.31	49.76	51.25	52.79	54.37	56	57.68
Investment costs 000 Euro	1000 Euro	234.6															
Not Discounted Cash Flow	1000 Euro	-197.58	38.14	39.28	40.46	41.67	42.92	44.21	45.54	46.9	48.31	49.76	51.25	52.79	54.37	56	57.68
Cumulated Not Discounted Cash Flow	1000 Euro	-197.6	-159.4	-120.2	-79.71	-38.04	4.881	49.09	94.63	141.5	189.8	239.6	290.8	343.6	398	454	511.7
Discounted Cash Flow	1000 Euro	-197.6	36.32	35.63	34.95	34.28	33.63	32.99	32.36	31.74	31.14	30.55	29.97	29.39	28.83	28.29	27.75
Cumulated Discounted Cash Flow	1000 Euro	-197.6	-161.3	-125.6	-90.69	-56.4	-22.77	10.21	42.58	74.32	105.5	136	166	195.4	224.2	252.5	280.2
Discounted Energy Flow	MWh	51.83	49.36	47.01	44.77	42.64	40.61	38.67	36.83	35.08	33.41	31.82	30.3	28.86	27.48	26.18	24.93
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**47.28**															
Net Present Value (interest rate = 5%)	1000 Euro	**280.2**															
Simple Pay Back Period (years)	years	**4.962**															
Discount Pay Back Period (years)	years	**12.4**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.39780															
Internal Rate of Return (%)	%	**20%**															

27. Annex 29: Energy and financial calculation for introducing Efficient Pellet Heating System – Sensitivity 3 case

Efficient Heating System: Sensitivity case 3 (lower increase growth rate for the tariffs)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Efficient Heating System	kW	235.89	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9	235.9
Baseline consumption																	
Avg. mix energy	kWh/yr.	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147	354,147
Total mix energy	MWh	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15	354.15
Project consumption																	
Avg. mix energy	kWh/lp	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320	302,320
Total mix energy	MWh	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32	302.32
Energy savings																	
Total energy savings	MWh	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83	51.83
Total cost savings																	
Price of mix energy	Euro/kWh	0.105	0.106	0.108	0.109	0.111	0.113	0.114	0.116	0.118	0.12	0.121	0.123	0.125	0.127	0.129	0.131
Cost of mix energy	1000 Euro	37.02	37.58	38.14	38.72	39.3	39.89	40.48	41.09	41.71	42.33	42.97	43.61	44.27	44.93	45.61	46.29
Price of mix energy	Euro/ton	200	203	206	209.1	212.3	215.5	218.7	222	225.3	228.7	232.1	235.6	239.1	242.7	246.4	250
Net Calorific Value of Pellets	MJ/kg	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Unit Cost of mix energy	Euro/kWh	0.0379	0.0385	0.0390	0.0396	0.0402	0.0408	0.0414	0.0421	0.0427	0.0433	0.0440	0.0446	0.0453	0.0460	0.0467	0.0474
Cost of mix energy	1000 Euro	11.46	11.63	11.8	11.98	12.16	12.34	12.53	12.71	12.91	13.1	13.3	13.49	13.7	13.9	14.11	14.32
Cost of saving energy	1000 Euro	25.57	25.95	26.34	26.74	27.14	27.54	27.96	28.38	28.8	29.23	29.67	30.12	30.57	31.03	31.49	31.97
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	37.02	37.58	38.14	38.72	39.3	39.89	40.48	41.09	41.71	42.33	42.97	43.61	44.27	44.93	45.61	46.29
Investment costs 000 Euro	1000 Euro	195.51															
Not Discounted Cash Flow	1000 Euro	-158.48	37.58	38.14	38.72	39.3	39.89	40.48	41.09	41.71	42.33	42.97	43.61	44.27	44.93	45.61	46.29
Cumulated Not Discounted Cash Flow	1000 Euro	-158.5	-120.9	-82.76	-44.04	-4.747	35.14	75.62	116.7	158.4	200.8	243.7	287.3	331.6	376.5	422.1	468.4
Discounted Cash Flow	1000 Euro	-158.5	35.79	34.6	33.44	32.33	31.25	30.21	29.2	28.23	27.29	26.38	25.5	24.65	23.83	23.03	22.27
Cumulated Discounted Cash Flow	1000 Euro	-158.5	-122.7	-88.09	-54.65	-22.32	8.93	39.14	68.34	96.57	123.9	150.2	175.7	200.4	224.2	247.3	269.5
Discounted Energy Flow	MWh	51.83	49.36	47.01	44.77	42.64	40.61	38.67	36.83	35.08	33.41	31.82	30.3	28.86	27.48	26.18	24.93
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**41.79**															
Net Present Value (interest rate = 5%)	1000 Euro	**269.5**															
Simple Pay Back Period (years)	years	**4.678**															
Discount Pay Back Period (years)	years	**6.852**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.33150															
Internal Rate of Return (%)	%	**24.0%**															

28. Annex 30: Energy and financial calculation for introducing Solar Hot Water System – base case

Introduction of two units of SHWS - 5.2 m2: Base Case																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Introduction of two units of SHWS - 5.2 m2	nr	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
Total electricity consumption	MWh	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Project consumption																	
Avg. electricity consumption	kWh/lp	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
Total electricity consumption	MWh	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Energy savings																	
Total electricity savings	MWh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving electricity	1000 Euro	0.408	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	0.408	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Investment costs 000 Euro	1000 Euro	3.000															
Not Discounted Cash Flow	1000 Euro	-2.592	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Cumulated Not Discounted Cash Flow	1000 Euro	-2.592	-2.172	-1.74	-1.294	-0.835	-0.363	0.124	0.626	1.142	1.674	2.222	2.786	3.368	3.967	4.583	5.219
Discounted Cash Flow	1000 Euro	-2.592	0.4	0.392	0.385	0.378	0.37	0.363	0.356	0.35	0.343	0.336	0.33	0.324	0.318	0.311	0.306
Cumulated Discounted Cash Flow	1000 Euro	-2.592	-2.192	-1.8	-1.415	-1.038	-0.667	-0.304	0.052	0.402	0.745	1.081	1.411	1.735	2.053	2.364	2.67
Discounted Cash Flow	MWh	3900	3714	3537	3369	3209	3056	2910	2772	2640	2514	2394	2280	2172	2068	1970	1876
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**0.521**															
Net Present Value (interest rate = 5%)	1000 Euro	**2.67**															
Simple Pay Back Period (years)	years	**5.761**															
Discount Pay Back Period (years)	years	**8.552**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06760															
Internal Rate of Return (%)	%	**17%**															

29. Annex 31: Energy and financial calculation for introducing Solar Hot Water System – Sensitivity 1 case

Introduction of two units of SHWS - 5.2 m2: Sensitivity case 1 (10% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Introduction of two units of SHWS - 5.2 m2	nr	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
Total electricity consumption	MWh	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Project consumption																	
Avg. electricity consumption	kWh/lp	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
Total electricity consumption	MWh	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Energy savings																	
Total electricity savings	MWh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving electricity	1000 Euro	0.408	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	0.408	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Investment costs 000 Euro	1000 Euro	3.300															
Not Discounted Cash Flow	1000 Euro	-2.892	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Cumulated Not Discounted Cash Flow	1000 Euro	-2.892	-2.472	-2.04	-1.594	-1.135	-0.663	-0.176	0.326	0.842	1.374	1.922	2.486	3.068	3.667	4.283	4.919
Discounted Cash Flow	1000 Euro	-2.892	0.4	0.392	0.385	0.378	0.37	0.363	0.356	0.35	0.343	0.336	0.33	0.324	0.318	0.311	0.306
Cumulated Discounted Cash Flow	1000 Euro	-2.892	-2.492	-2.1	-1.715	-1.338	-0.967	-0.604	-0.248	0.102	0.445	0.781	1.111	1.435	1.753	2.064	2.37
Discounted Cash Flow	MWh	3900	3714	3537	3369	3209	3056	2910	2772	2640	2514	2394	2280	2172	2068	1970	1876
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**0.521**															
Net Present Value (interest rate = 5%)	1000 Euro	**2.37**															
Simple Pay Back Period (years)	years	**6.337**															
Discount Pay Back Period (years)	years	**9.407**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.07436															
Internal Rate of Return (%)	%	**15%**															

30. Annex 32: Energy and financial calculation for introducing Solar Hot Water System – Sensitivity 2 case

Introduction of two units of SHWS - 5.2 m2: Sensitivity case 2 (20% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Introduction of two units of SHWS - 5.2 m2	nr	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
Total electricity consumption	MWh	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Project consumption																	
Avg. electricity consumption	kWh/lp	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
Total electricity consumption	MWh	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Energy savings																	
Total electricity savings	MWh	0.41	0.42	0.43	0.45	0.46	0.47	0.49	0.50	0.52	0.53	0.55	0.56	0.58	0.60	0.62	0.64
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving electricity	1000 Euro	0.408	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	0.408	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Investment costs 000 Euro	1000 Euro	3.600															
Not Discounted Cash Flow	1000 Euro	-3.192	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Cumulated Not Discounted Cash Flow	1000 Euro	-3.192	-2.772	-2.34	-1.894	-1.435	-0.963	-0.476	0.026	0.542	1.074	1.622	2.186	2.768	3.367	3.983	4.619
Discounted Cash Flow	1000 Euro	-3.192	0.4	0.392	0.385	0.378	0.37	0.363	0.356	0.35	0.343	0.336	0.33	0.324	0.318	0.311	0.306
Cumulated Discounted Cash Flow	1000 Euro	-3.192	-2.792	-2.4	-2.015	-1.638	-1.267	-0.904	-0.548	-0.198	0.145	0.481	0.811	1.135	1.453	1.764	2.07
Discounted Cash Flow	MWh	3900	3714	3537	3369	3209	3056	2910	2772	2640	2514	2394	2280	2172	2068	1970	1876
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**0.521**															
Net Present Value (interest rate = 5%)	1000 Euro	**2.07**															
Simple Pay Back Period (years)	years	**6.914**															
Discount Pay Back Period (years)	years	**10.26**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.08112															
Internal Rate of Return (%)	%	**13%**															

31. Annex 33: Energy and financial calculation for introducing Solar Hot Water System – Sensitivity 3 case

Introduction of two units of SHWS - 5.2 m2: Sensitivity case 3 (lower increase growth rate for the tariffs)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Introduction of tw o units of SHWS - 5.2 m2	nr	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
Total electricity consumption	MWh	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Project consumption																	
Avg. electricity consumption	kWh/lp	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
Total electricity consumption	MWh	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Energy savings																	
Total electricity savings	MWh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.106	0.108	0.109	0.111	0.113	0.114	0.116	0.118	0.12	0.121	0.123	0.125	0.127	0.129	0.131
Cost saving electricity	1000 Euro	0.408	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	0.408	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Investment costs 000 Euro	1000 Euro	3.000															
Not Discounted Cash Flow	1000 Euro	-2.592	0.42	0.433	0.446	0.459	0.473	0.487	0.501	0.516	0.532	0.548	0.564	0.581	0.599	0.617	0.635
Cumulated Not Discounted Cash Flow	1000 Euro	-2.592	-2.172	-1.74	-1.294	-0.835	-0.363	0.124	0.626	1.142	1.674	2.222	2.786	3.368	3.967	4.583	5.219
Discounted Cash Flow	1000 Euro	-2.592	0.4	0.392	0.385	0.378	0.37	0.363	0.356	0.35	0.343	0.336	0.33	0.324	0.318	0.311	0.306
Cumulated Discounted Cash Flow	1000 Euro	-2.592	-2.192	-1.8	-1.415	-1.038	-0.667	-0.304	0.052	0.402	0.745	1.081	1.411	1.735	2.053	2.364	2.67
Discounted Cash Flow	MWh	3900	3714	3537	3369	3209	3056	2910	2772	2640	2514	2394	2280	2172	2068	1970	1876
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**0.521**															
Net Present Value (interest rate = 5%)	1000 Euro	**2.67**															
Simple Pay Back Period (years)	years	**5.761**															
Discount Pay Back Period (years)	years	**8.552**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.06760															
Internal Rate of Return (%)	%	**17%**															

32. Annex 34: Energy and financial calculation fo rintroducing Solar Photovoltaic System – base case

Introduction of 5 kW PV System: Base Case																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Introduction of 5 kW PV System	nr	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750
Total electricity consumption	MWh	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Project consumption																	
Avg. electricity consumption	kWh/lp	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750
Total electricity consumption	MWh	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Energy savings																	
Total electricity savings	MWh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving electricity	1000 Euro	0.81	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	0.81	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Investment costs 000 Euro	1000 Euro	7.500															
Not Discounted Cash Flow	1000 Euro	-6.690	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Cumulated Not Discounted Cash Flow	1000 Euro	-6.69	-5.855	-4.996	-4.11	-3.198	-2.259	-1.292	-0.295	0.731	1.788	2.877	3.999	5.154	6.344	7.569	8.832
Discounted Cash Flow	1000 Euro	-6.69	0.795	0.78	0.765	0.75	0.736	0.722	0.708	0.695	0.681	0.668	0.656	0.643	0.631	0.619	0.607
Cumulated Discounted Cash Flow	1000 Euro	-6.69	-5.895	-5.115	-4.351	-3.6	-2.864	-2.142	-1.434	-0.74	-0.058	0.61	1.266	1.909	2.54	3.159	3.767
Discounted Cash Flow	MWh	7750	7381	7029	6695	6376	6072	5783	5508	5246	4996	4758	4531	4315	4110	3914	3728
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**1.035**															
Net Present Value (interest rate = 5%)	1000 Euro	**3.767**															
Simple Pay Back Period (years)	years	**7.248**															
Discount Pay Back Period (years)	years	**10.76**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.08504															
Internal Rate of Return (%)	%	**12%**															

33. Annex 35: Energy and financial calculation for introducing Solar Photovoltaic System – Sensitivity 1 case

Introduction of 5 kW PV System: Sensitivity case 1 (10% higher investments)

Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Introduction of 5 kW PV System	nr	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750
Total electricity consumption	MWh	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Project consumption																	
Avg. electricity consumption	kWh/lp	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750
Total electricity consumption	MWh	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Energy savings																	
Total electricity savings	MWh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving electricity	1000 Euro	0.81	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	0.81	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Investment costs 000 Euro	1000 Euro	8.250															
Not Discounted Cash Flow	1000 Euro	-7.440	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Cumulated Not Discounted Cash Flow	1000 Euro	-7.44	-6.605	-5.746	-4.86	-3.948	-3.009	-2.042	-1.045	-0.019	1.038	2.127	3.249	4.404	5.594	6.819	8.082
Discounted Cash Flow	1000 Euro	-7.44	0.795	0.78	0.765	0.75	0.736	0.722	0.708	0.695	0.681	0.668	0.656	0.643	0.631	0.619	0.607
Cumulated Discounted Cash Flow	1000 Euro	-7.44	-6.645	-5.865	-5.101	-4.35	-3.614	-2.892	-2.184	-1.49	-0.808	-0.14	0.516	1.159	1.79	2.409	3.017
Discounted Cash Flow	MWh	7750	7381	7029	6695	6376	6072	5783	5508	5246	4996	4758	4531	4315	4110	3914	3728
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**1.035**															
Net Present Value (interest rate = 5%)	1000 Euro	**3.017**															
Simple Pay Back Period (years)	years	**7.973**															
Discount Pay Back Period (years)	years	**11.83**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.09355															
Internal Rate of Return (%)	%	**10%**															

34. Annex 36: Energy and financial calculation for introducing Solar Photovoltaic System – Sensitivity 2 case

Introduction of 5 kW PV System: Sensitivity case 2 (20% higher investments)																	
Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Introduction of 5 kW PV System	nr	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750
Total electricity consumption	MWh	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Project consumption																	
Avg. electricity consumption	kWh/lp	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750
Total electricity consumption	MWh	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Energy savings																	
Total electricity savings	MWh	0.81	0.83	0.86	0.89	0.91	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.16	1.19	1.23	1.26
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.108	0.111	0.114	0.118	0.121	0.125	0.129	0.132	0.136	0.141	0.145	0.149	0.154	0.158	0.163
Cost saving electricity	1000 Euro	0.81	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	0.81	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Investment costs 000 Euro	1000 Euro	9.000															
Not Discounted Cash Flow	1000 Euro	-8.190	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Cumulated Not Discounted Cash Flow	1000 Euro	-8.19	-7.355	-6.496	-5.61	-4.698	-3.759	-2.792	-1.795	-0.769	0.288	1.377	2.499	3.654	4.844	6.069	7.332
Discounted Cash Flow	1000 Euro	-8.19	0.795	0.78	0.765	0.75	0.736	0.722	0.708	0.695	0.681	0.668	0.656	0.643	0.631	0.619	0.607
Cumulated Discounted Cash Flow	1000 Euro	-8.19	-7.395	-6.615	-5.851	-5.1	-4.364	-3.642	-2.934	-2.24	-1.558	-0.89	-0.234	0.409	1.04	1.659	2.267
Discounted Cash Flow	MWh	7750	7381	7029	6695	6376	6072	5783	5508	5246	4996	4758	4531	4315	4110	3914	3728
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**1.035**															
Net Present Value (interest rate = 5%)	1000 Euro	**2.267**															
Simple Pay Back Period (years)	years	**8.698**															
Discount Pay Back Period (years)	years	**12.91**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.10205															
Internal Rate of Return (%)	%	**9%**															

35. Annex 37: Energy and financial calculation for introducing Solar Photovoltaic System – Sensitivity 3 case

Introduction of 5 kW PV System: Sensitivity case 3 (lower increase growth rate for the tariffs)

Project operation		no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year of operation		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Description	Unit	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Introduction of 5 kW PV System	nr	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Baseline consumption																	
Avg. electricity consumption	kWh/yr.	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750
Total electricity consumption	MWh	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Project consumption																	
Avg. electricity consumption	kWh/lp	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750	7,750
Total electricity consumption	MWh	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Energy savings																	
Total electricity savings	MWh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost savings																	
Price of electricity	Euro/kWh	0.105	0.106	0.108	0.109	0.111	0.113	0.114	0.116	0.118	0.12	0.121	0.123	0.125	0.127	0.129	0.131
Cost saving electricity	1000 Euro	0.81	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Staff and O&M cost savings	1000 Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1000 Euro	0.81	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Investment costs 000 Euro	1000 Euro	7.500															
Not Discounted Cash Flow	1000 Euro	-6.690	0.835	0.86	0.885	0.912	0.939	0.967	0.996	1.026	1.057	1.089	1.122	1.155	1.19	1.226	1.262
Cumulated Not Discounted Cash Flow	1000 Euro	-6.69	-5.855	-4.996	-4.11	-3.198	-2.259	-1.292	-0.295	0.731	1.788	2.877	3.999	5.154	6.344	7.569	8.832
Discounted Cash Flow	1000 Euro	-6.69	0.795	0.78	0.765	0.75	0.736	0.722	0.708	0.695	0.681	0.668	0.656	0.643	0.631	0.619	0.607
Cumulated Discounted Cash Flow	1000 Euro	-6.69	-5.895	-5.115	-4.351	-3.6	-2.864	-2.142	-1.434	-0.74	-0.058	0.61	1.266	1.909	2.54	3.159	3.767
Discounted Cash Flow	MWh	7750	7381	7029	6695	6376	6072	5783	5508	5246	4996	4758	4531	4315	4110	3914	3728
Main Financial Indicators																	
Average City Cost Saving	1000 Euro	**1.035**															
Net Present Value (interest rate = 5%)	1000 Euro	**3.767**															
Simple Pay Back Period (years)	years	**7.248**															
Discount Pay Back Period (years)	years	**10.76**															
Levelised Discount Unit Seving Energy Cost	Euro/kWh	0.08504															
Internal Rate of Return (%)	%	**12%**															

ANNEX: 38

Monitoring report of pilot projects and demonstrative actions in school "Koto Hoxhi" Gjirokaster

Rationale

The realization of the pilot projects and demonstrative actions will obviously produce some benefits for the territories hosting them. The main goal of the Pro-Energy project is however that of promoting energy sustainability on a much wider scale in the Balkan Med area, so we need to capitalize at best from these pilot initiatives.







Partner	**National Agency of Natural Resources (PB6)**
Municipality	**Gjirokastra**
Intervention title	Implementation energy efficiency measures and Renewable Energy in Public Buildings in Koto Hoxhi School in Gjirokastra

A Structured description of the implemented action

A.1 General description

The project is carries out in frame of collaboration of Balkan MED Programme with Albania through the Program, titled "**Sustainable Energy Supply for Communes.**" The overall objective of the Program is to promote economic growth and productivity enhancement in the Albanian economy, through the promotion of suitable and viable Energy Efficient investments.

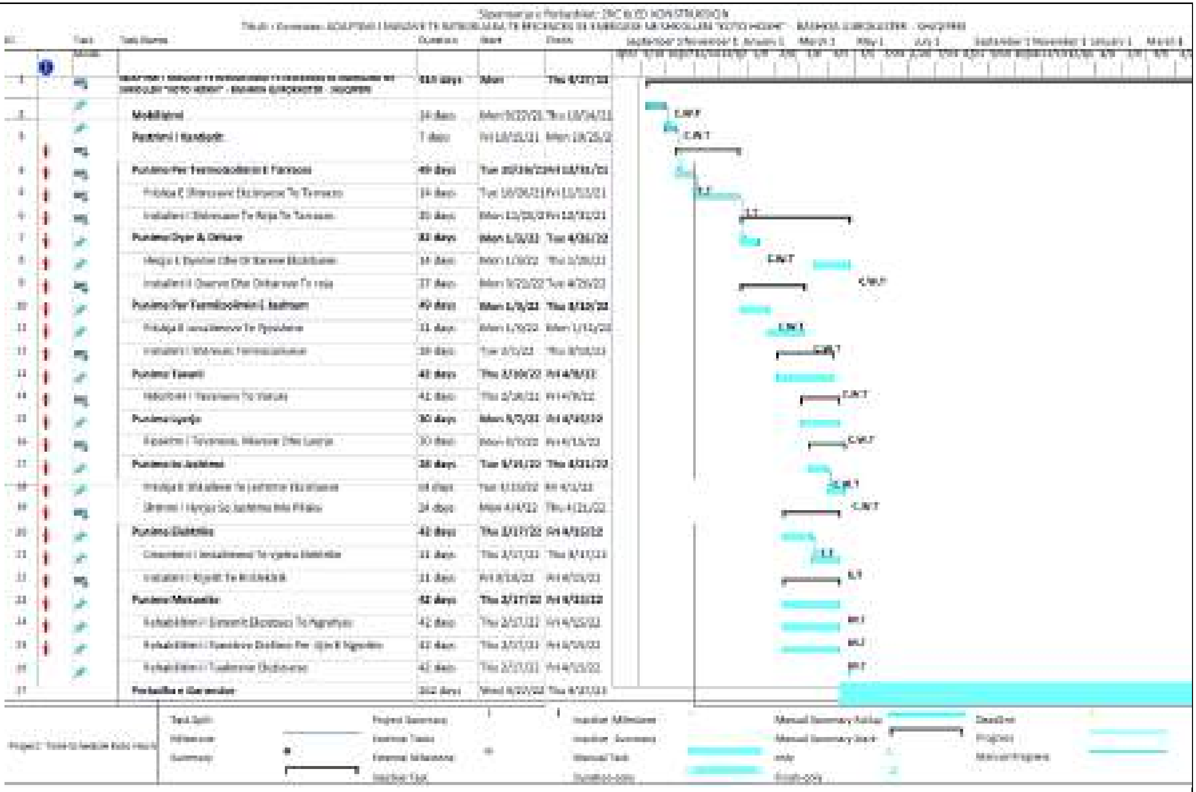
The program includes "The promotion of Energy Efficiency in Public Buildings, Albania. The main scope of this part of the Program is to promote energy efficiency measures in Albanian Public buildings, by selecting cost-effective projects with high visibility, ensuring high benefit to the end-users, energy savings and environmental benefits, contributing to the growth and productivity of the Albanian economy.
The subjects of the supplies, works and services is divided into two phases:
Phase nº. 1: Energy Efficiency Measures at the building envelope
Turnkey supply and installation of fully functional systems:

- Installation of external thermal insulation and roof insulation at the building and also floor thermal insulation (together with the thermal insulation of the floor).
- Supply and installation of new PVC double-glass windows and doors
- Providing supporting energy efficiency measures (which have no direct impact in energy efficiency, but they are necessary to guaranty lifespan of energy efficiency), like: reconstruction of the toilet and internal walls, repairing internal doors, placement of inside doors and painting of all walls.

phase nº 2: Heating, solar, and lighting systems
Turn key supply, installation and commissioning of fully functional systems as follows:

- Supply, installation, commissioning, testing and regular maintenance of a new complete wwod/pellets stoves and solar hot water system with a hot water tank for the supply of sanitary hot water
- Supply, installation, commissioning and testing of flat-plate glazed solar collector system at the rooftop of the building, with a hot water tank connected to the sanitary hot water supply system (heated by the boiler).
- *Supply, installation, operation of a new energy efficient lighting system to all spaces of the building and also replacement of electrical system of the building and smart sensor systems the recording of energy consumption & the measurement of the impact of behavioral change measures*.

A.2 implementation times



Electrical Energy Consumption Meter

Device (emri i Paisjes)	EUI (kodi i paisjes)	Location (Vendidhja e paisjes)	Comments on the location (Komentet Cfare te dhenash mat
Energy measuring unite	19R007170420	Power distribution central unit	Total energy parameters
Energy measuring unite	19R007170421	Power distribution unit floor 00	Energy parameters on floor 00
Energy measuring unite	19R007161215	Power distribution unit floor +1	Energy parameters on floor +1
Energy measuring unite	19R007210525	Power distribution unit floor +2	Energy parameters on floor +2

B Technical and economic impact

B.1 Impact on the energy balance Energy Efficiency

Energy situation in Albania almost directly is impacting as well as energy supply situation in Gjirokastra region. It is important also to point out that energy situation in each unit including as well as distect of Gjirokastra has two sides: consumption (in the past), demand in the future and supply side. Since, Albanian energy system is unic one especially related with power system, its pros and cons influence power supply also for all residential, service, SMEs enterprises of Gjirokastra region. Establishing a sustainable energy balance of supply for Gjirokastra will depend totally from its renewable energy resources potential and as well as EE potential in residential, service, SMEs enterprises. It is important to be mentioned that most of the measures that will be recommend for having a sustainable energy development for Gjirokastra region are similar with those presented in Albanian RES Action Plan and Albanian EE Action Plan (approved from Albanian Government on Sept 9, 2020). Under Albanian EE

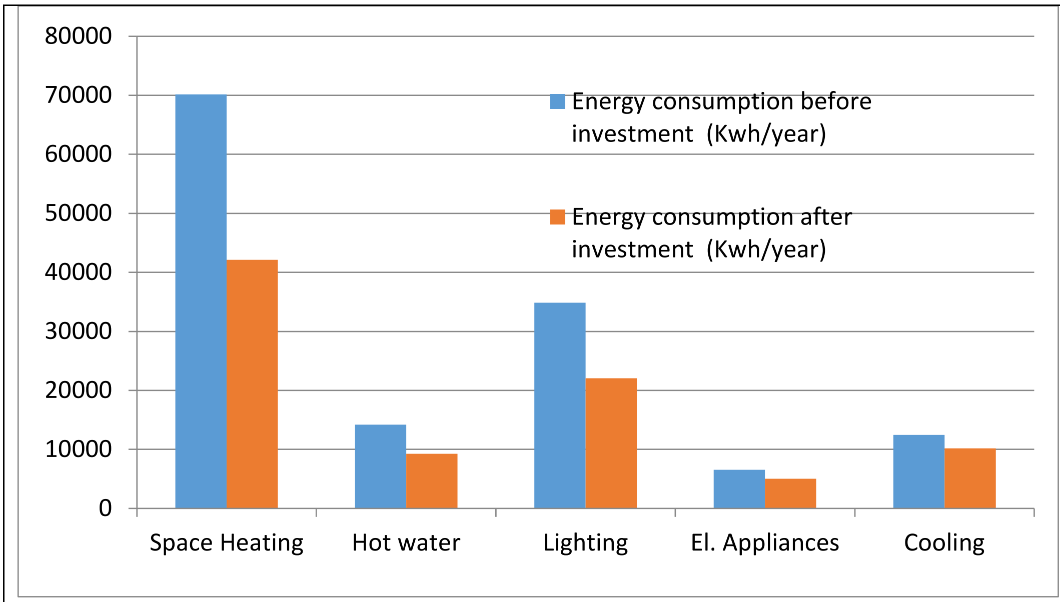
Action Plan it is requested that each Municipality and each Commune to prepare its energy sustainable plan and this is first good attempt to fulfill such important task.

4 The common challenge of PRO-ENERGY is to improve energy efficiency of public buildings (municipal/provincial/regional buildings, schools, universities, health centers, hospitals, museums, sports facilities etc.). This is a common problem faced by the territories participating in the project characterized by old facilities, outdated/degraded building façades, materials & equipment (insulation, electrical appliances, cooling/heating systems etc.), low energy consciousness & awareness, lack of skilled civil servants, etc. leading to high-energy consumption & CO2 emissions.

B. Energy Impact

Promotion of efficient and economic use of energy and with a minimal effect on the environment, in a way that the energy sector to be a supporting sector for the sustainable development of all the other economic and social sectors of Albania .

Nr.	Energy services	Energy consumption before investment (Kwh/year)	Energy consumption after investment (Kwh/year)	Energy Savings, kWh/year)	Energy Savings, %
1	Space Heating	86,420	42,142	44,278	51%
2	Hot water	14209	9250	4,959	35%
3	Lighting	34870	22075	12,795	37%
4	El. Appliances	6563	5055	1,508	23%
5	Cooling	12450	10200	2,250	18%
6	Energy for m2	205	104	101	49%
7	Total Energy	**154512**	**88722**	**65790**	43%



B.2 Impact on the CO_2 emissions

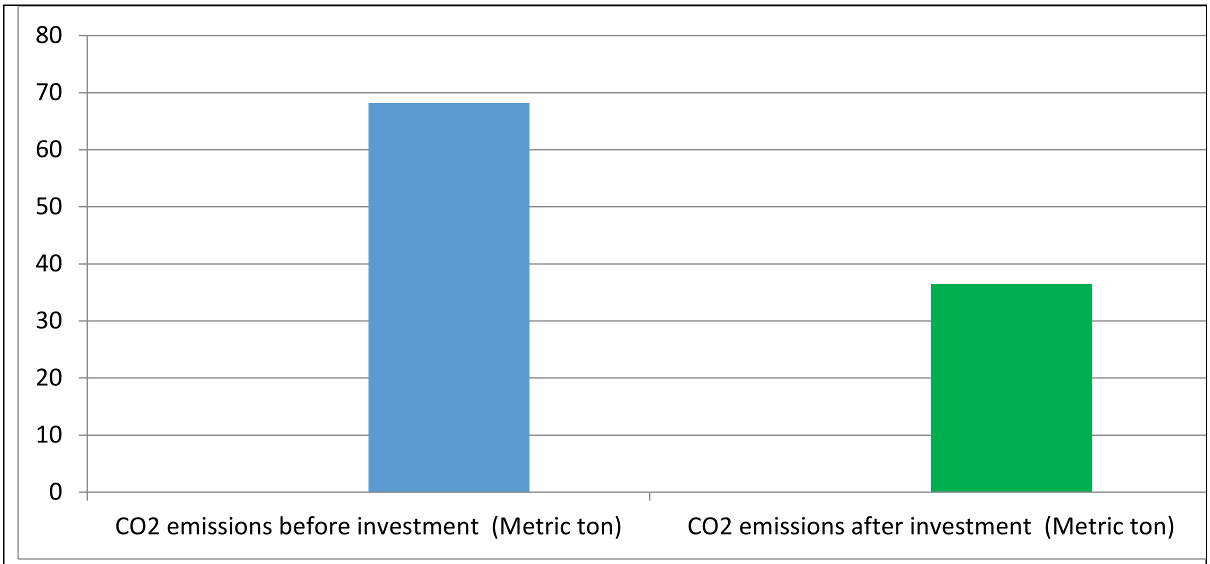
The environmental benefits of the foreseen energy efficiency measures to be introduced into public buildings are numerous and include:

- reduction in air pollution
- reduction of GHG emissions
- Use of environmentally friendly materials as replacements for the existing ones (such as window frames, roof materials, floors, doors, light bulbs, etc).

In terms of the impact of the proposed measures on other emissions, public building mainly use different energy commodities for their heating systems and by decreasing energy consumption, air pollution, including CO2, will be reduced 31.75 metric ton.

Table. CO_2 EMISSIONS (ton)

Nr.	Energy services	**CO_2 emissions** before investment (Metric ton)	**CO_2 emissions** after investment (Metric ton)	**CO_2 emissions reduction [t CO_2]**	**CO_2 emissions reduction [% CO_2]**
1	Space Heating	48.39	24.00	24.39	50%
2	Hot water	9.80	2.94	6.86	70%
3	Lighting	5.50	2.20	3.30	60%
4	El. Appliances	4.53	4.53	0.00	0%
5	Cooling	3.49	2.79	0.70	20%
6	**Total Energy**	68.21	36.46	31.75	47%



B.3 Impact on the quality of services

The Energy Efficiency Potential of the Public Buildings Stock of the Region of Gjirokastra consists of changes realistically achievable between actual energy consumption and the energy consumption after the implementation of energy efficiency and sustainable measures. The measures has improved energy efficiency are implemented in school Koto Hoxhi, the total energy consumption can be reduced by **138239** kWh/year to **88722** kWh/year, which is a 36% decrease compared to the present situation.

Measures to improve the Energy Efficiency in the public buildings in Gjirokastra Region
Thermal Insulation: Thermal insulation of Koto Hoxhi, in Gjirokastra Region has improved the thermal standards of the buildings in according to the standard for energy conservation. The improvement of the existing buildings stock from the thermal insulation point of view and construction of public buildings based on the new Albania energetic code (that is being prepared AKBN will make possible the saving of energy commodities that are used for the space heating and space cooling.

Interior Renovation of the Heating Systems: For the rehabilitation of public buildings in Gjirokastra Region, are made more efficient heating systems by type and size of insulated buildings.

Energy Efficient Lighting: Koto Hoxhi, in Gjirokastra Region are replacement of all lamps with energy efficient / economic lamps. This measure is expected to bring in future the energy savings of approximately 60 % of the energy consumed for interior lighting.

Non-technical measures (promotion and awareness raising activities). The team of Koto Hoxhi, has organized public awareness campaigns to promote energy efficiency given the specifics of each target group and using concrete facts about motivation.

The benefits of pilots project has been, especially increasing comfort in health sector and perhaps more significant in the long term, such as the reduction of depletion rate of non-renewable energy sources (fuel-wood) and the reduction of atmospheric pollution (greenhouse effect, acid rains, smog, etc.).

C. Social impact

C.1 Social acceptance and impact on the citizen

A social-economic analysis in Gjirokastra region has verified the degree of utility of the intervention for the community. The economic analysis carried out has taken into account any external costs and benefits and indirect costs involved with the intervention. The economic external costs are those related, as example, to other further necessary intervention, the costs of health, costs for time spending. The economic benefits are those accruing to the community as a whole by the implementation and management of the intervention. In this section it is important to refer to Alterenergy activities related to the capacity building and awareness raising carried out in the target communities. It is very important to point out that taken into account above mentioned external elements (included them in economic analysis) was possible to calculated all economic indicators and results shows a positive/feasible analysis.

C.2 Engagement of and impact on the stakeholders

This step aims the initial selection of the groups that will be the target for the local energy efficiency implementation. The purpose of this step is to determine for which groups it is useful to collect additional and detailed information, and which group should be excluded from the programme of
Increasing energy efficiency in the Gjirokastra Region and particularly In Koto Hoxhi, stock .

Instruments that local governments are used various legislative measures. Also communication with the target group, together with other intermediaries can be useful instruments. These intermediaries (mediators) has been for the Koto Hoxhi, of Gjirokastra Region:

- Head of the Department for Asset Management,
- Head of the Department for Public Services,
- Head of the Department for Health and Social Protection,
- Head of the Department for Urban Planning and Environment Protection,
- Head of the Department for Economy and Finance,
- Environmental association NGO (non-governmental Organization)
- Construction Association NGO (non-governmental Organization)
- Agriculture association NGO (non-governmental Organization)

The impact of stakeholder are In focusing on the final energy consumers, many possible target-groups appear in public building stock of Region. Looking at the policy fields that Koto Hoxhi, has to deal with, energy efficiency and Renewable energy as well as the promotion of pilot projects in Koto Hoxhi, stock in Gjirokastra Region

C.3 Wider social and economic impacts

In terms of **Wider social and economic impacts of Alterenergy project and pilot projects**, one benefit that has generated a great deal of interest is job creation. Jobs are created as a result of efficiency programs in three categories:
Direct.
Direct jobs are in firms that are actually receiving the efficiency program and doing the energy efficiency work that a program is targeting (e.g., construction, engineering, architecture).
Indirect.
Indirect jobs are jobs in firms supplying goods and services to energy efficiency firms (e.g., manufacturing, accounting).
Induced.
Induced jobs are those created by the demand generated by wage and business income from energy efficiency investments and by energy bill savings.

D. Impact on the local administration

D.1 Difficulties and obstacles encountered in the realization of the intervention

- Social and behavioural barriers: lack of knowledge/information of citizen and investors about the existing incentive system, professional (engineers, architects, intstallers, etc.) conservatism on new renewable energy and energy efficiency solutions, media presentation of information about environmental issue; citizen acceptance of the status quo and disjunction between verbal support and willingness to take action about environmental issue, a lack of widely available and understood cost-comparison data about existing solutions on sustainable topic.
- Institutional barriers: complex regulations in theme of renewable energy and unstable market both at national and local level, complex and slow ‘red tape’ processes needed to gain authorization for renewable sources systems or energy efficiency investiments, lack of willingness of local administrators about European and national initiative to support energy sustainability, lack of experts or personell committed on energy topic in local administrations.
- Economic barriers: limited cost effective impact of some solutions (especially in tertiary industry), lack of economic and financial resources to carry out investments, return of investment in energy sustainable solutions have often long time horizons, conflicting interests about investment in building energy efficiency between owners and teneant, local monopolies that increase cost of micro-renewable installations and/or energy efficiency interventions.

D.2 Lessons learnt

The lessons learnt during the implementation of the pilot projects or demonstrative action, individuating the “good practices”. There is a wide range of surveying approaches to determine these benefits. These include willingness to pay and willingness to accept contingent valuation (CV) studies, comparative or relative valuations, and other revealed preference and stated preference approaches. Surveys are used specifically for determining relatively subjective program participant benefits when quantification is difficult and/or expensive. However, pilot projects can be used for almost all benefit types where participants and non-participants can be asked to provide data (e.g., energy population, how many people they hired for determining job impacts, whether they believe their indoor air quality is better, if there are distribution projects that were delayed). Good proctise

has been in technology 'know how', spread across some involved territories, in specific operational areas and with regards to some application areas of energy efficieny and Renewable energy.
D.3 Impact on internal competences
Impact on internal competences for Gjirokastra Region has been at: • Supporting local level management of energy resources and propose ways of improving energy availability. • Through the evaluation of energetic situation in Local Territories, carry out analysis for the implementation of energy efficiency measures in the Public Buildings Stock. • Supporting pilot implementation of energy efficiency measures in selected Public Buildings. • Providing guidance, and advice and capacity building in the energy planning and energy efficiency within the local government level.
D.3 Impact on energy and territorial planning
Energy efficiency is not just about new technologies; it is about new behaviors and better decisions. Local authorities through the experience of Alerenergy project have established energy efficiency programs to support the development of, implementation of, and compliance with Albania Action Plan of Energy Efficiency. These programs include efforts such as emerging technology programs, compliance-enhancement programs, and stretch (or reach) goal programs, as well as training on different stakeholders for building code officials, builders, contractors, and designers. Local Authorities have all possibilities according the experience of Alterenergy project to implement of the intervention impacted on local territorial/urban and energy planning as well as air pollution reduction and GHG mitigation goals
E. Replicability
E.1 Potential for evolution and replication at local level
Potential for evolution and replication at local level could be replicated one or two years or even longer due to condition of public buildings in Albania. The point at which programs are being designed is ideally when the impact, market, and process evaluation planning process should begin. This is primarily so that the program budget, schedule, and resources can properly take into account evaluation requirements and opportunities. It is also a way to reinforce the concept that evaluation is an integral part of the portfolio process, supporting the portfolio's success through an assessment of the program's impacts as well as the program's theory for how savings are to be achieved.
E.2 Potential for replication in different urban contexts in the Adriatic area
The implemented action could be replicated in the wider Balkan Med area which is in Coherence between the project and Albania Energy Strategy for the development of the sector for energy efficiency and the creation of energy from renewable sources.