Cost Efficient Options and Financing Mechanisms for nearly Zero Energy Renovation of existing Buildings Stock

DELIVERABLE 2.3

REPORT SUMMARIZING OBSTACLES, RISKS AND DIFFICULTIES FOR THE RENOVATION SCHEMES

Municipality of Coimbra, Portugal

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ABBREVIATIONS AND ACRONYMS

Acronym	Definition
COP	Coefficient of performance
EPBD	European Performance Buildings Directive
HVAC	Heating Ventilation Air Conditioning
ICT	Information and Communication Technology
nZEB	Nearly Zero Energy Building
PUR	Polyurethane
PV	Photovoltaic
RES	Renewable Energy Sources

CERTUS PROJECT IN BRIEF

Southern European countries undergo a severe economic crisis. This hinders the compliance to the latest Energy Efficiency Directive, demanding strict energy efficiency measures for the public sector. Investments required to renovate public buildings and achieve nearly zero energy consumption have long payback times. So the interest of financing entities and ESCOs is small, especially when banks have limited resources. Many of the municipal buildings in Southern Europe require deep renovations to become nZEB and this should not be regarded as a threat but rather as an opportunity for the energy service and the financing sector.

The objective of the proposed action is to help stakeholders gain confidence in such investments and initiate the growth of this energy service sector.

Municipalities, energy service companies and financing entities in Italy, Greece, Spain and Portugal are involved in this project. The plan is to produce representative deep renovation projects that will act as models for replication. Twelve buildings in four municipalities in each country have been selected. The partners will adapt existing energy service models and procedures and will work out financing schemes suitable for the 12 projects. Consequently, the partners will create materials, such as guides and maxi brochures, suitable to support an intensive communication plan.

The plan includes four workshops with B2B sessions targeted to municipalities, ESCOs and financing entities. These actions shall be complemented by four training activities targeting municipal employees and the participation in international events targeting all 3 stakeholders. We expect that our action will have a significant impact by triggering investments in renovations to achieve nZEB and the uptake of the ESCO market in Southern European member states.

EXECUTIVE SUMMARY

This deliverable is part of the work carried out in Work Package 2 "Technical and Economic Validation of the nZEB Renovation Schemes" and summaries the obstacles, risks and difficulties for the renovation schemes for each building addressed in the four Municipalities.

This document presents the obstacles, risks and difficulties for the renovation schemes in the Municipality of Coimbra. The three buildings are presented, according to the following structure:

- Brief introduction to the building: main typological characteristics, location, use and energetic profile, etc.;
- Short presentation of the selected renovation scheme, including presentation of adopted measures;
- Technical difficulties envisaged for the implementation of the proposed solutions;
- Economic and/or financial risks to be considered;
- Legislative obstacles considered in the selection of the renovation schemes.

At the end, a summary of the actions is presented, as well as the main conclusions for the Municipality of Coimbra.

The main technical barriers are the use of electricity in other buildings managed by other entities without any metering to ensure the disaggregation of consumption between the buildings, in the School and the Library. Other important technical barrier is the incompatibility between use and renovation works in the Library and Town Hall. There is also the technical risk in the quality of products due to the need of public procurement processes.

The main economic barrier is the high overall investment, which is aggravated by the lack of public budget and the low availability of financial schemes. The main legislative obstacle is the protection level of the Town Hall, since it is part of the property "University of Coimbra — Alta and Sofia" inscribed on the World Heritage List of UNESCO.

1. OBSTACLES, RISKS AND DIFFICULTIES FOR THE RENOVATION SCHEMES IN COIMBRA

1.1. ELEMENTARY SCHOOL OF SOLUM

1.1.1. INTRODUCTION

The Elementary School of Solum (Escola Básica do 1º Ciclo da Solum) was built in the 1950s. Until the 1970s this was an annex school to the teacher training colleges dedicated to pedagogical training. In the 1990s it was converted into an Elementary School. The construction of refectory and a partial renovation of the building was done 10 years ago. Figure 1 presents the front façade of the building. The building is located in the East side of the city, near to the Stadium and a commercial area.

FIGURE 1: ELEMENTARY SCHOOL OF SOLUM

The building is divided in 3 main areas: 2 blocks of classrooms and the refectory. It has total area of about 1655 m^2 (756 m^2 in each block and 142 m^2 in the refectory) and a volume of 6269,21 m^3 (2828,19 m^3 in each block and 612,84 m^3 in the refectory). The roof is of ceramic tile and has a surface of 898 m^2. Figure 2 presents the plan view of the building.

FIGURE 2: PLAN VIEW OF THE ELEMENTARY SCHOOL OF SOLUM

The building is used as an elementary school (with about 300 students) and has the following schedule of diary activities (Monday to Friday):

- Classes – 9h00 to 12h30 and 14h00 to 16h00
- Lunch – 12h30 to 14h00
- Extra-curricular activities – 16h30 to 17h30
- Family support – 7h30 to 9h00 and 17h30 to 19h00

The periods of classes during 2013/2014 were:

- 1st period – September, 16th to December, 17th
- 2nd period – January, 6th to April, 4th
- 3rd period – April, 22nd to June, 13th

Outside these periods the use of the building is very low.

In 2013 the building had an electricity consumption of about 30 MWh and an associated cost of about 6,7 k€. Figure 3 presents the disaggregation of electricity consumption between uses.

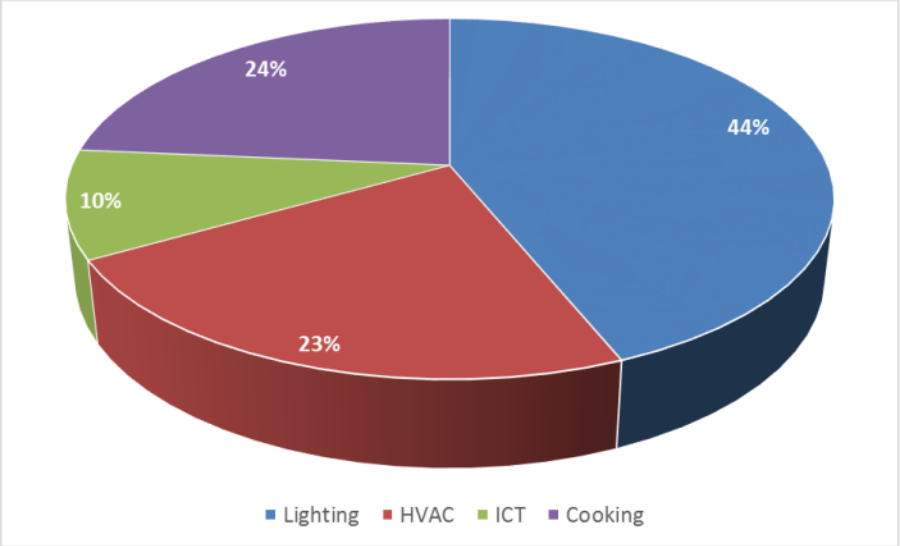

FIGURE 3: DISAGGREGATION OF ELECTRICITY CONSUMPTION BETWEEN USES, EXCLUDING THE PREFABRICATED BUILDING

The building also has consumption of natural gas during the winter (used in the heating of the refectory building). The consumption in 2013 was 16775 kWh (1548 m^3) with an associated cost of 1778 €.

The building has a PV system of 4230 W with all the generated energy being sold to the grid, which ensures an average yearly generation of 6100 kWh (20% of the electricity consumption in 2013).

1.1.2. Renovation Plan

In the renovation plan the following main options were considered:

- Increase of the PV generation system;
  - Scenario 1: duplicate the row of 18 panels and use the same structure in area 7 (total of 72 panels);
  - Scenario 2: increase the row for 27 panels, duplicate the row and repeat the structure in the area 7 (total of 108 panels);
- Retrofit of the lighting system;
  - Scenario 1 - Replacement of all T8 lamps with electromagnetic ballast by T5 lamps with electronic ballast;
  - Scenario 2 - Replacement of all lamps by LEDs;
- Retrofit of the HVAC system;
  - Replacement of the gas boiler used in the central heating of the refectory by a heat pump;

- Replacement of ICT and cooking appliances.

The selected scenario is constituted by:

- Increase the PV system to 72 PV panels;
- Replacement of all T8 lamps with electromagnetic ballast by T5 lamps with electronic ballast;
- Replacement of the gas boiler by a heat pump.

1.1.3. TECHNICAL DIFFICULTIES

General

There are 7 prefabricated buildings in the exterior area of the school (Figure 4). Such buildings are not a permanent construction and do not belong to the Municipality, being managed by the Family Support project. However, they receive electricity from the school (Figure 5) without any individual metering. Therefore, its consumption is included in the total consumption of the building, but such energy consumption cannot be considered as a consumption of the studied building. The consumption of the prefabricated buildings was assessed (considered to be 27% of the total energy consumption) and subtracted from the total considered for the building. This situation can also be a barrier in the future, creating difficulties to a properly monitoring of savings.

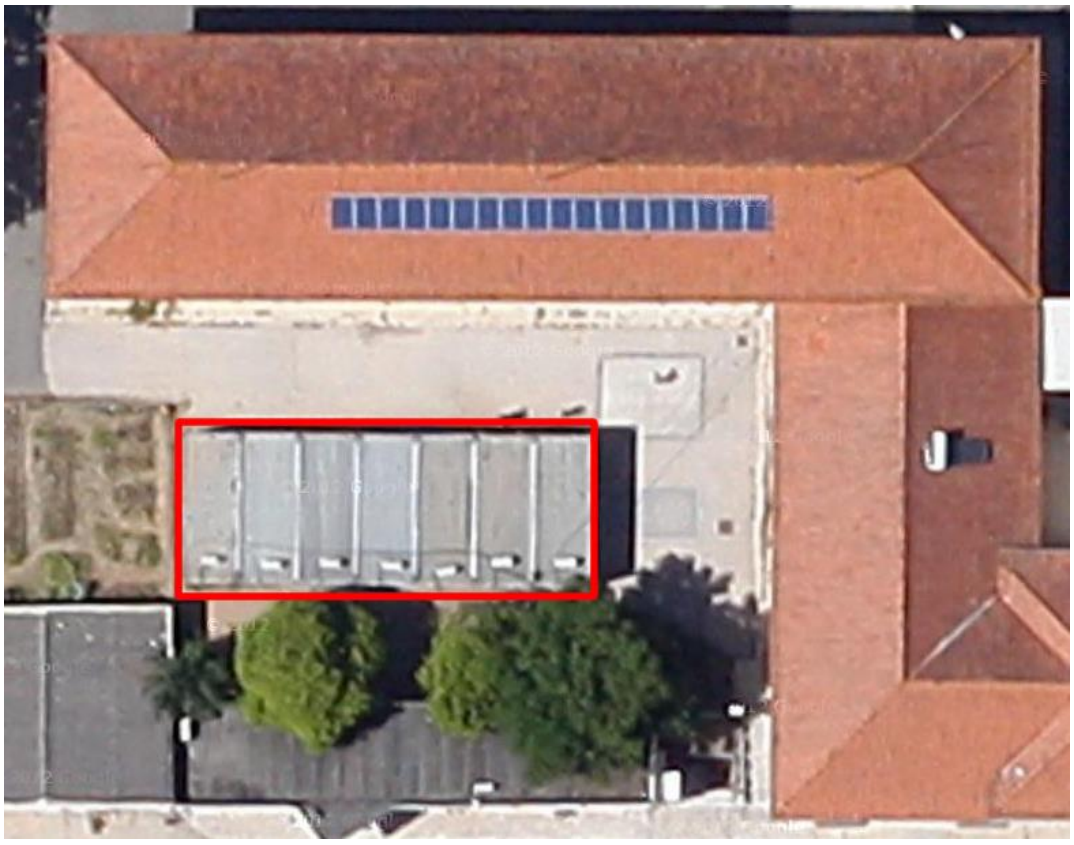

FIGURE 4: PREFABRICATED BUILDING FROM THE FAMILY SUPPORT PROJECT

FIGURE 5: PREFABRICATED BUILDING FROM THE FAMILY SUPPORT PROJECT (CABLE FROM THE MAIN BUILDING)

One general technical risk is the quality of the products. In a public procurement process the brand and model of the technology cannot be previously chosen and therefore there are always uncertainty regarding the quality of some products proposed by the installers (lifetime, quality of light in the lighting products, etc.).

PV

There are no major technical limitations to the installation of PV systems, since the roof presents a good orientation and tilt and there is enough available area. However, since the building already has a PV system, the best solution is to keep such system and to increase the number of PV panels using the available area. Therefore, it was considered the use of the same type of PV panels and inverters. The installed PV system was also considered as a limitation to define the number of PV panels in each scenario, since it was decided to just increase and/or replicate the actual structure to minimize the visual impact (avoiding an irregular distribution of PV panels in the roof).

Envelope

Since most of the buildings do not have any regular source of heating or cooling, the improvement of the envelope would not bring relevant energy savings.

Lighting

There are no major technical limitations to the retrofit of the lighting system.

HVAC

The building only has central heating in the refectory. The other areas of the building do not have central heating, being the heating in the classrooms ensured by one oil-filled radiator during the coldest days. However, the option to replace such oil-filled radiators by heat pumps is not effective due to the following reasons:

- The oil-filled radiators have a small power and do not ensure all the needed power for the heating requirements of each room. Then, the replacement would increase the available

thermal power. Due to the higher control capabilities of a heat pump the use would also increase.

- The heat pump can also be used for cooling and since actually the building does not have any cooling source (since it is not needed), it would create new energy consumption.

This renovation is an option to increase the comfort in the building. However, it cannot be considered as an option to increase the energy efficiency since the total energy consumption would increase and therefore it is not included in the renovation plan.

Appliances

ICT and other appliances (mainly PCs, monitors and printers) do not represent individually a large share of energy consumption and therefore the achieved savings with such appliances would not have a major impact on the total energy consumption. The replacement of such appliances by new devices is not cost-effective just from the energy savings point of view and therefore this is not considered in the renovation plan. However, in the regular replacement of ICT appliances it is recommended to install just ICT appliances with lower energy consumption.

From the energy savings point of view, the most cost-effective solution is the installation of devices to reduce the standby consumption of ICT appliances, the so called standby killers. However, the potential savings achieved with such devices do not depend on the technology, but on the users' behaviour and therefore a reliable assessment of savings is not possible. Therefore, such measure is not included in the renovation plan, due to the difficulty of assessment, but its implementation is recommended.

The cooking appliances also do not have a major impact on the total energy consumption and the quantity of equipment is low. Therefore, its renovation was not included in the plan. However, in the regular replacement of such appliances it is recommended to install just appliances with lower energy consumption (with label A+ or better).

1.1.4. ECONOMIC/FINANCIAL RISKS

The main economic barrier to the implementation of the renovation plan is the high overall investment, which is aggravated by the lack of public budget and the low availability of financial schemes (mainly due to the economic crises and the transition period between the Community Support Frameworks).

The main economic risk is the reliability of the value considered to the total investment needed to the implementation, due to the following reasons:

- The prices of the technologies present variations over time, and in some technologies such as photovoltaic the oscillations of prices can be high.
- The percentage of price reduction obtained in the public procurement process is uncertain.

1.1.5. LEGISLATIVE OBSTACLES

There are no major legislative obstacles to the renovation of this building.

1.2. MUNICIPAL HOUSE OF CULTURE

1.2.1. INTRODUCTION

The Municipal House of Culture was built in 1991-1993 and opened on October, 26th 1993. Figure 6 presents the front façade of the building. The building is located near to the city centre and near to the University.

FIGURE 6: MUNICIPAL HOUSE OF CULTURE

Figure 7 presents the plan view of the building.

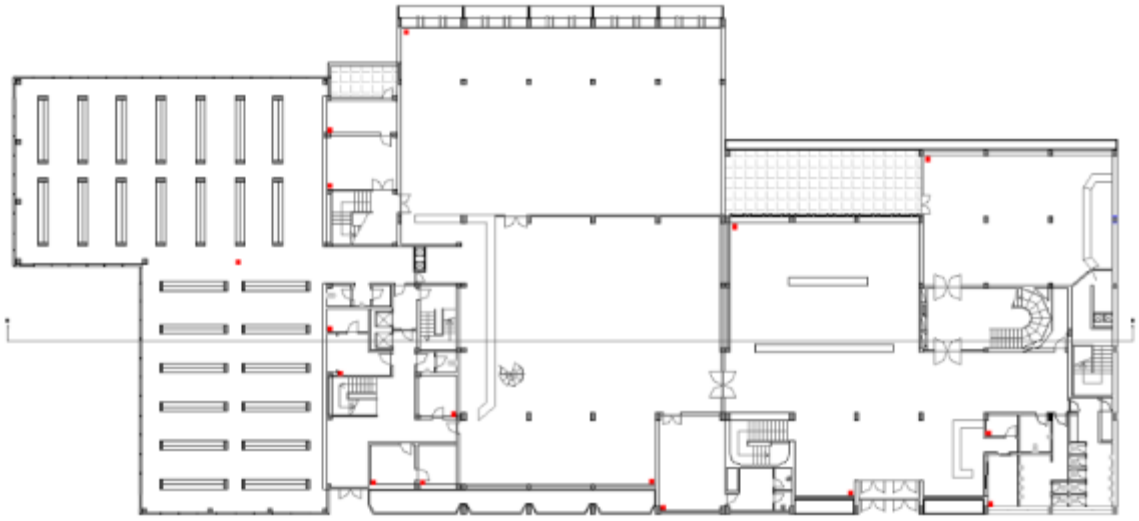

FIGURE 7: PLAN VIEW OF THE MUNICIPAL HOUSE OF CULTURE

The building has 8 floors with a total area of about 13225 m^2 with a total used surface of about 9862 m^2 and a volume of 39944 m^3. The roof is flat without tiles and has a surface of 2565 m^2.

The building is used as Municipal House of Culture and has several cultural equipment, such as library, auditorium and art gallery, as well as several offices. The building has 80 employees and is visited by 17 500 users/year and works with the following schedule.

- July 15th to September 15th:

- Monday to Friday: 9h00 – 18h30
- September 16th to July 14th:
  - Monday to Friday: 9h00 – 19h30
  - Saturday: 11h00 – 13h00 and 14h00 and 19h00

The users have aces to the rooms of public use only after 10h00.

In 2013 the building had an electricity consumption of about 521 MWh and an associated cost of about 84 k€. Figure 8 presents the disaggregation of electricity consumption between uses.

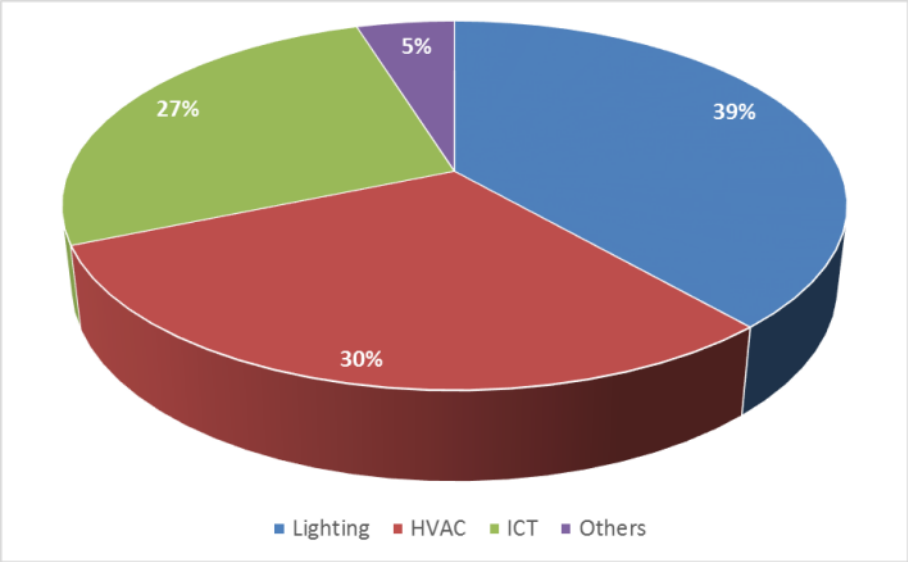

FIGURE 8: DISAGGREGATION OF ELECTRICITY CONSUMPTION BETWEEN USES, EXCLUDING THE REFECTORY

1.2.2. RENOVATION PLAN

In the renovation plan the following main options were considered:

- Installation of the PV generation;
- Retrofit of the lighting system;
- Retrofit of the HVAC system;
  - Scenario 1 - Replacement of all T8 lamps with electromagnetic ballast by T5 lamps with electronic ballast and replacement of the incandescent lamps by CFLs;
  - Scenario 2 - Replacement of all lamps by LEDs;
- Replacement of ICT and other appliances.

The selected scenario is constituted by:

- Installation of 770 PV panels;
- Replacement of all lamps by LEDs;
- Replacement of the THC and mono-split systems by systems with higher COP/EER.

1.2.3. TECHNICAL DIFFICULTIES

General

Part of floor -2 is a refectory from the University of Coimbra. However, this refectory receives electricity from the Municipal House of Culture without any individual metering. Therefore, its

consumption is included in the total consumption of the building, but such energy consumption cannot be considered as a consumption of the studied building. The consumption of the refectory was assessed (considered to be 17% of the total energy consumption) and subtracted from the total considered for the building. This situation can also be a barrier in the future, creating difficulties to a properly monitoring of savings.

Additionally, it was detected that 4 of the 9 systems of temperature and humidity control (THC) are not working and since this is not the normal mode of operation the electricity consumption for the baseline was corrected to take into account the consumption of the 9 systems.

The building have an intensive utilization, receiving a large number of visitors, and is the working place for a large number of Municipal employees and such activities cannot be interrupted since it is not easy to temporarily move the services to another building. Therefore, renovation options requiring major construction works, incompatible with the normal activities of the building, should be avoided.

One general technical risk is the quality of the products. In a public procurement process the brand and model of the technology cannot be previously chosen and therefore there are always uncertainty regarding the quality of some products proposed by the installers (lifetime, quality of light in the lighting products, etc.).

PV

Some areas of the roof have shading due to a small extra floor (floor 4) and in other area the installation of PV panels would cause shading on the skylights.

The building is not perfectly oriented to south, presenting an azimuth of 20º. Despite the reduction of the production, the PV panels should be installed keeping the orientation of the building (azimuth of 20º) in order to minimize the visual impact.

Envelope

As previously explained, renovation options requiring major construction works, incompatible with the normal activities of the building, should be avoided.

Lighting

Some rooms have a false roof in wood with small square holes, being the luminaries installed above the false roof. The installation of the lamps above the false roof causes a high loss of luminosity, which is aggravated by the difficulty of maintenance of such luminaries. These situations lead to a low visibility in some areas. Therefore, other renovation option would be to move the luminaires to below the false roof.

This retrofit option would increase the comfort level, ensuring a better distribution of light and would facilitate the maintenance. However, such option would not bring a major reduction of energy consumption since the power of lamps cannot be substantially decreased just due to this change. It would be possible to decrease the total power of the lighting system by decreasing the number of lamps. However, such option would require larger changes on the lighting circuits, impossible to

achieve without major construction works which would have a large impact on the activities. This would also have much higher costs, reducing the cost-effectiveness of the renovation.

HVAC

The replacement of the several mono-split systems by multi-split systems was not considered, since despite the potential lower purchase cost of multi-split systems the costs of installation would be higher and mainly the impact of the installation process on the building operation would be much higher.

Appliances

ICT appliances (mainly PCs, monitors and printers) represent an important share of the consumption. The replacement of such appliances by new devices is not cost-effective just from the energy savings point of view and therefore this is not considered in the renovation plan. However, in the regular replacement of ICT appliances it is recommended to install just ICT appliances with lower energy consumption.

From the energy savings point of view, the most cost-effective solution is the installation of devices to reduce the standby consumption of ICT appliances, the so called standby killers. However, the potential savings achieved with such devices do not depend on the technology, but on the users' behaviour and therefore a reliable assessment of savings is not possible. Therefore, such measure is not included in the renovation plan, due to the difficulty of assessment, its implementation is recommended.

The building also has 2 lifts 2 small goods lifts. However, the use of such lifts is low since they serve areas without public and therefore the replacement of such lifts by systems with higher efficiency is not cost-effective.

1.2.4. ECONOMIC/FINANCIAL RISKS

The main economic barrier to the implementation of the renovation plan is the high overall investment, which is aggravated by the lack of public budget and the low availability of financial schemes (mainly due to the economic crises and the transition period between the Community Support Frameworks).

The main economic risk is the reliability of the value considered to the total investment needed to the implementation, due to the following reasons:

- The prices of the technologies present variations over time, and in some technologies such as photovoltaic the oscillations of prices can be high.
- The percentage of price reduction obtained in the public procurement process is uncertain.

1.2.5. LEGISLATIVE OBSTACLES

There are no major legislative obstacles for the renovation of this building.

1.3. TOWN HALL

1.3.1. INTRODUCTION

The Coimbra Town Hall was built after the demolition of part of the old Monastery of Santa Cruz. The demolitions works and construction was carried out mainly between 1876 and 1879, but some construction works were developed gradually until the beginning of century XX. Figure 9 presents the front façade of the building. The building is located in the downtown.

FIGURE 9: COIMBRA TOWN HALL

The building has 3 floors and 2 intermediate floors with a total area of about 5880m^2 with a total used surface of about 3711m^2 and a volume of 40575m^3. The roof is made of ceramic tile and has a surface of 1974m^2. Figure 10 presents the plan view of the building.

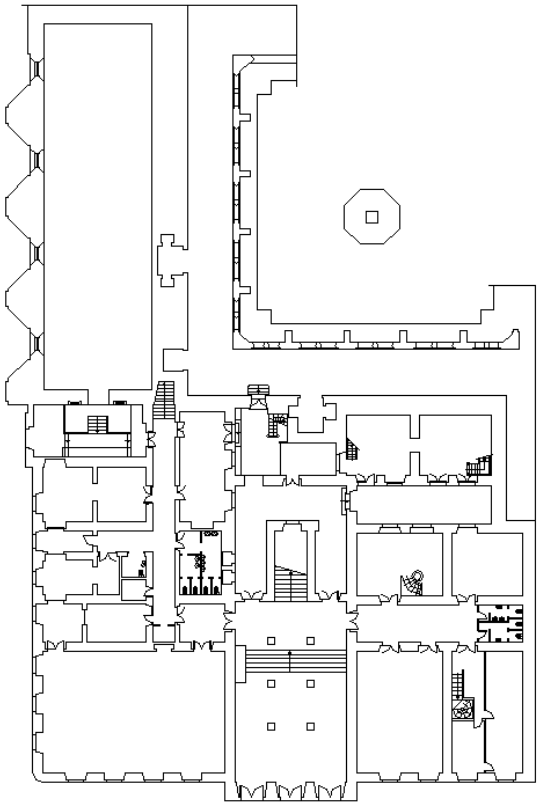

FIGURE 10: PLAN VIEW OF THE TOWN HALL

The building is used as the town hall of the Municipality of Coimbra. Therefore, the building is mainly constituted by offices and storage areas. The building usually has occupation between 7h30 and 19h30 (Monday to Friday). However, the public only have access between 9h00 and 17h00. The building has 220 employees and is visited by a large number of public.

In 2013 the building had an electricity consumption of about 305 MWh and an associated cost of about 60 k€. Figure 11 presents the disaggregation of electricity consumption between uses.

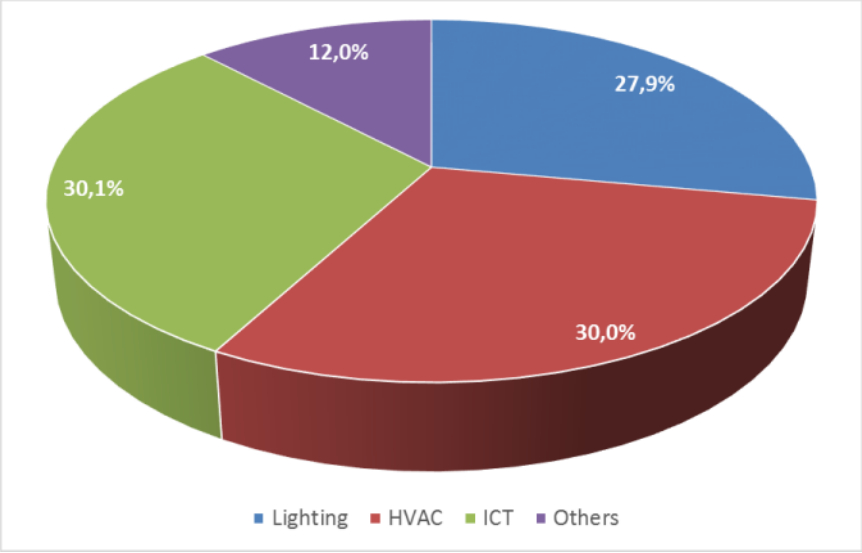

FIGURE 11: DISAGGREGATION OF ELECTRICITY CONSUMPTION BETWEEN USES

1.3.2. RENOVATION PLAN

In the renovation plan the following main options were considered:

- Installation of the PV generation;
- Retrofit of the lighting system;
  - Scenario 1 - Replacement of all T8 lamps with electromagnetic ballast by T5 lamps with electronic; and replacement of the incandescent lamps by CFLs
  - Scenario 2 - Replacement of all lamps by LEDs.
- Retrofit of the HVAC system;
- Replacement of ICT and other appliances.

The selected scenario is constituted by:

- Installation of 126.1kWp of PV tiles;
- Replacement of all lamps by LEDs;
- Replacement of the THC and mono-split systems by systems with higher COP/EER.

1.3.3. TECHNICAL DIFFICULTIES

General

The general technical difficulties are imposed by the protection rules. Since the building is part of the property "University of Coimbra — Alta and Sofia" inscribed on the World Heritage List of UNESCO several strong restrictions are applied in the renovation of such building due to the protection rules. Therefore, it is not possible to implement any change in the building envelope able to cause any visual impact.

The building have an intensive utilization, receiving a large number of visitors and is the working place for a large number of Municipal employees and such activities cannot be interrupted since it is not easy to temporarily move the services to another building. Therefore, renovation options requiring major construction works, incompatible with the normal activities of the building, should be avoided.

One general technical risk is the quality of the products. In a public procurement process the brand and model of the technology cannot be previously chosen and therefore there are always uncertainty regarding the quality of some products proposed by the installers (lifetime, quality of light in the lighting products, etc.).

PV

The orientation of the building is not the optimum, since it presents an azimuth of -10º, and mainly due to the orientation to west of the larger faced. However, this do not represent a major constrain, since the impact on the possible generation level is not too large.

The main restrictions are due to the protection rules. Since it is not possible to implement any change in the building envelope able to cause any visual impact, the use of traditional PV panels was not considered due to its high visual impact. Therefore, it was considered the use of solar tiles to replace the actual roof. This is aligned with the actual regulation that allows the use of PV panels if integrated into the roof. However, the actual regulation also limits it to a maximum area of 3 m^2 by building and by keeping this restriction it is not possible to achieve a nZEB level.

Envelope

Due to the protection rules it is not possible to replace the windows by double glazed windows using standard solutions; because the original frame must be kept (the usual solution is to implement other window in the interior). Since this cannot be ensured with standard solutions available in the market, this solution is not cost-effective just from the energy efficiency perspective.

Lighting

The building uses a large number of different formats of lamps and luminaires and for some formats (e.g. 2G11 or F30) the availability in the market and quality of solutions is lower.

HVAC

The replacement of the several mono-split systems by multi-split systems was not considered, since despite the potential lower purchase cost of multi-split systems the costs of installation would be higher and mainly the impact of the installation process on the building operation would be much higher.

Appliances

ICT appliances (mainly PCs, monitors and printers) represent an important share of the consumption. Replacing the PC and monitors by laptops would save, in average, 60% of the energy (a laptop has an average power of 50 W whereas a PC with CRT monitor has an average power of 150W and a PC with TFT monitor has an average power of 100W).

However, the replacement of such appliances by new devices is not cost-effective just from the energy savings point of view due to the high cost of the equipment and therefore this is not considered in the renovation plan. However, in the regular replacement of ICT appliances it is recommended to install just ICT appliances with lower energy consumption.

From the energy savings point of view, the most cost-effective solution is the installation of devices to reduce the standby consumption of ICT appliances, the so called standby killers. However, the potential savings achieved with such devices do not depend on the technology, but on the users' behaviour and therefore a reliable assessment of savings is not possible. Therefore, such measure is not included in the renovation plan, due to the difficulty of assessment, its implementation is recommended.

The main ICT systems receive power from 3 groups of UPS with a total power of 39kVA. Such UPS have a weighted efficiency of 92% and nowadays there are available in the market products with higher efficiency (weighted efficiency of 95% or higher). The replacement of a UPS before the end of its lifetime is not cost-effective. However, in the processes of renovation due to the end of lifetime or due to needed upgrades on the ICT system, such UPS should be replaced by high efficient UPS systems.

1.3.4. ECONOMIC/FINANCIAL RISKS

The main economic barrier to the implementation of the renovation plan is the high overall investment, which is aggravated by the lack of public budget and the low availability of financial

schemes (mainly due to the economic crises and the transition period between the Community Support Frameworks). Other economic barrier is the large payback period of the solar tiles.

The main economic risk is the reliability of the value considered to the total investment needed to the implementation, due to the following reasons:

- The prices of the technologies present variations over time, and in some technologies such as photovoltaic the oscillations of prices can be high.
- The percentage of price reduction obtained in the public procurement process is uncertain.

This risk is higher in the installation of solar tiles, since the availability of such solutions in the national market is low and therefore the reliability of the investment estimation is lower.

1.3.5. LEGISLATIVE OBSTACLES

Coimbra - part of the historic city center, older University buildings and other urban structures - is since June 22th 2013 inscribed on the World Heritage List of UNESCO. The Property inscribed is called University of Coimbra — Alta and Sofia (http://worldheritage.uc.pt/). It is composed of a set of buildings whose history has been associated to the academic institution, either through participation in the process of knowledge production and dissemination, or through contribution to the creation of unique cultural and identitarian traditions. The Coimbra Town Hall is included in this area and therefore strong restrictions are applied in the renovation of such building due to the protection rules. Therefore, it is not possible to implement any change in the building envelope able to cause any visual impact.

1.4. SUMMARY

Two buildings present global main technical difficulties due to the use of electricity in other buildings managed by other entities without any metering to ensure the disaggregation of consumption between the buildings. Such situation created difficulties in the design of the renovation plans and can be an important barrier to a properly monitoring of the achieved savings.

The Library and the Town Hall also present other major technical barrier, the incompatibility between use and renovation works, since these buildings have an intensive utilization. Therefore, renovation options requiring major construction works, incompatible with the normal activities of the building, had to be avoided.

The most important general technical risk is the quality of the products. In a public procurement process the brand and model of the technology cannot be previously chosen and therefore there are always uncertainty regarding the quality of some products proposed by the installers (lifetime, quality of light in the lighting products, etc.).

Regarding the economic barriers, the main barrier is the high overall investment, which is aggravated by the lack of public budget and the low availability of financial schemes. In some situations (e.g. the PV installation in the Town Hall) the large payback period is also a strong economic barrier.

The main economic risk is uncertainty on the assessment of the total investment needed to the implementation due the regular variations of costs and uncertainty about the percentage of price reduction achieved in the public procurement process. In the case of the installation of solar tiles in the Town Hall the risk is higher due to the low availability of solutions in the national market.

The main legislative obstacle is the protection level of the Town Hall, since it is part of the property “University of Coimbra — Alta and Sofia” inscribed on the World Heritage List of UNESCO. Therefore, several strong restrictions are applied in the renovation of such building with high impact on the options of renovation in the envelope and on installation of renewable generation. The other two buildings do not have major legislative obstacles.

ENEA – Italian National Agency for New Technologies, Energy and Sustainable Economic Development (IT)

Municipality of Messina (IT)

Municipality of Errenteria (ES)

Municipality of Coimbra (PT)

Municipality of Alimos (EL)

ISR – University of Coimbra (PT)

SINLOC - Sistema Inizative Locali Spa (IT)

ETVA VI.PE. S.A. (EL)

TECNALIA Research & Innovation Foundation (ES)

EUDITI Energy and Environmental Design LTD (EL)

Innova B.I.C. Business Innovation Centre S.r.l. (IT)

Danish Building Research Institute, Aalborg University Copenhagen (DK) - SBi/AAU

ASSISTAL (IT)

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