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ENERGY EFFICIENCY SURVEY OF THE GANADO ADVOCATES OFFICES

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ABSTRACT: The Green Energy Committee within GANADO Advocates has been working on a number of initiatives to enhance the energy efficiency of its office building in Valletta. Following major renovation to the law firm's offices, it was deemed appropriate to carry out an energy audit to identify steps that can be taken to save on energy and enable the law firm to become 'greener'. The audit was made possible thanks to the collaboration between the law firm and the Institute for Sustainable Energy of the University of Malta. A specific training activity under the auspices of the project entitled: "Renewable Energy Scenarios in Islands (R.E.S.I.), co-financed by the Operative Programme Italy-Malta 2007-2013, and led by the Province of Ragusa, Italy, has enabled the exchange of scientists, engineers and architects between Italy and the Institute in Malta.
The energy audit was carried out in November 2012 and focused on the building envelope, energy consumption and lighting, as well as the potential of installing renewable energy systems. The study provided solutions to a number of issues that were identified during the survey, some of which have already been implemented.

Keywords: Energy audit, energy conservation, lighting, heating and cooling, photovoltaic system.

1 ANALYSIS OF POWER EQUIPMENT AND LIGHTING

European and Maltese legislation [3-9] all identify buildings as the primary sector where energy savings and energy efficiency can be implemented quickly and effectively. Office buildings in particular, are mainly characterised by heavy demand for lighting, heating and cooling, as well as computer and electronic systems consumption. They are responsible for the peak loads that power stations may encounter during the summer days, due to air-conditioning.

This study case is no exception but it was important to understand the operations of the office, in order to prioritise the energy consumption sectors and hence the energy efficiency measures.

Working within tight budgets is often encountered in such circumstances and it becomes essential, not only to pin-point the best value for money energy efficiency measure, but also have sufficient information and data that will convince decision makers to take the initiative and invest towards a greener environment.

For this purpose, data was collected on all electrical equipment, based on their nameplate specifications and their hours of operation.

It is to be noted that the law firm's offices are comprised of two back-to-back buildings with two main entrances at 171 Old Bakery Street and 59 Strait Street. All rooms were visited and the following data was gathered:

- n° 91 PC laptops;
- n° 34 air conditioners;
- n° 6 multifunction printers;
- n° 3 paper shredders;
- n° 2 water dispensers hot/cold;
- n° 75 neon lights;
- n° 22 printers inkjet;
- n° 4 televisions;
- n° 2 microwaves;
- n° 1 fridge freezer;
- n° 2 coffee machines;
- n° 2 toasters;
- n° 1 dishwasher.

These equipment were found on different floors of the two building blocks (excluding lighting), as follows:

1. Entrance at 171 Old Bakery Street:

   a. Fourth Floor (Administration and Human Resources):

- n. 2 air conditioners - rated at 8 kW;
- n. 2 laptops - rated at 90 W;
- n. 1 inkjet printer - rated at 30 W;
- n. 1 television - rated power at 100 W.

   b. Third Floor (IT and Kitchen):

- n. 1 water dispenser hot/cold, rated at 499 W;
- n. 3 air conditioners, rated at 3.4 kW, each;
- n. 9 laptops, with rated power of 90 W;
- n. 4 inkjet printers, rated at 30 W each;
- n. 1 television, with rated power of 100 W;
- n. 2 microwaves, with rated power of 800 W;
- n. 1 refrigerator, with rated power of 300 W;
- n. 2 coffee makers, rated at 1,000 W;
- n. 2 toasters, having a rated power of 1,000 W;
- n. 1 dishwasher, rated at 3 kW.

   c. Second Floor (Shipping, Corporate and Litigation offices):

- n. 3 multifunction printers, with rated power of 1,850 W ;
- n. 1 shredder, with nameplate capacity equal to 670 W;
- n. 8 air conditioners, with rated power of 6.3 kW each;
- n. 5 air conditioners, with rated power equal to 5 kW;
- n. 37 laptops, with rated power of 90 W;
- n. 26 neon lights, having a rated power of 21 W;
- n. 12 printers inkjet, having rated power of 30 W ;
- n. 1 television, with rated power of 100 W.

   d. Ground Floor (Reception):

- n. 2 air conditioners, with rated power of 3.4 kW;
- n. 2 laptops, with rated power of 90 W.

2. Entrance at 59 Strait Street:

   a. Third Floor (Investment Services and Funds, Insurance and Pensions, Firm Secretariat and Governance):

- n. 1 multifunction printer, rated at 1,850 W;
- n. 1 shredder, rated at 670 W;
- n. 1 water dispenser hot/cold, at 499 W;
- n. 1 cooling, with rated power of 8 kW;
- n. 5 air conditioners, at 5 kW each;
- n. 1 cooling, with rated power of 4 kW;
- n. 1 cooling, with rated power of 6.3 kW;
- n. 24 laptops, with rated power of 90 W;
- n. 41 neon lights, having a rated power of 21 W;
- n. 1 inkjet printer, rated at 30 W.

   b. Second Floor (Library, International Banking, Shipping finance):

- n. 1 multifunction printer, rated at 1,850 W;
- n. 4 air conditioners, with rated power of 8 kW;
- n. 11 laptops, with rated power of 90 W;
- n. 4 lights neon with rated power of 21 W;
- n. 1 inkjet printer at 30 W;
- n. 1 television, with rated power of 100 W.

   c. First Floor (Accounts):

- n. 1 multifunction printer, rated at 1,850 W;
- n. 1 paper shredder, at 670 W;
- n. 2 air conditioners, rated at 3.4 kW each;
- n. 6 laptops, with rated power of 90 W;
- n. 4 lights neon with rated power of 21 W;
- n. 3 inkjet printers, having rated power of 30 W.

Hence, the total power capacity of the whole building amounts to 379.939 kW.

A similar exercise was carried out to determine the typical operation of the different appliances, based on actual use and estimates. The results were taken as follows:

- 8 h for PC laptop;
- 4 h for air conditioner;
- 2 h for multifunction printer;
- 2 h for paper shredder;
- 6 h for water dispenser hot/cold;
- 6 h for neon light;
- 1 h for printer inkjet;
- 1 h for television;
- 1 h for microwave;
- 3 h for fridge/freezer;
- 1 h for coffee machine;
- 1 h for toaster;
- 1 h for dishwasher.

Some of the appliances may vary their time of use for different seasons and this has been taken into account, to produce the consumption for each floor, as shown in Table 1.

The distribution of total annual electricity consumption for all appliances of the whole building is shown in Figure 1.

In an office setup, it is sometimes difficult to come up with practical solutions to reduce energy consumption of appliances. However, a number of improvements may be made as follows:

1. All water dispensers shall have a timer-control to switch them off during night time. This measure has now been implemented.
2. Consider using centralised printers/photocopiers, rather than individual ones. However, feedback from the advocates showed that given the sensitivity of their work, it is preferred that every office has its own printer.
3. Future purchase of computers should ideally consider their power rating and aim at purchasing low energy systems. This recommendation has been taken up by the office.

Recommendations for reduction of heating and cooling load are being dealt with separately in Section 2, below.

Table 1: Energy consumption and total power rating for each floor

Floor	Description	Energy (kWh/year)	Power (kW)
	171, Old Bakery Street		
Fourth	Administration HR	11678.48	16.31
Third	IT Kitchen	12334.42	20.63
Second	Shipping Corporate Litigation	64390.30	85.98
First	Accounts	7282.00	9.95
Ground		5167.36	6.98
	59 Strait Street		
Second	Library Banking international Ship finance	25768.34	35.07
First	Accounts	7282.00	9.95
Roof	Central A/C	108,275.20	153.80
Total		**244,100.74**	**379.94**

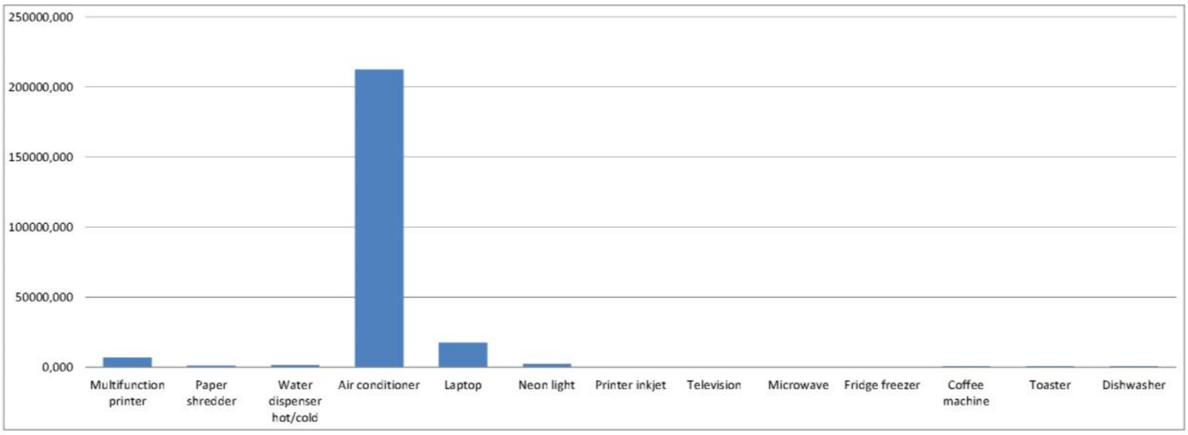

Figure 1: Total electricity consumption by type of equipment (kWh/year)

Lighting

Although the whole building has high efficiency fluorescent lights, being controlled by intelligent sensors and controls, it was evident that the purpose for energy saving was not fully achieved.

A number of corridors were witnessed to have the lights switched on during the day at full bright sunshine, as shown in Figure 2.

It was considered necessary to revise the settings and propose new positions for some sensors, in order to avoid this wastage of light energy. Furthermore, it would be interesting to consider the use of LEDs, especially for the desktop personal lights (Figure 3), which are normally controlled independently by each user.

Another lighting issue was found in the library, whereby the lux level was too low to enable comfortable reading. It was proposed that LED lighting systems may be used there, especially to reduce heat generation and safeguard the books.

Figure 2: Example of a corridor artificially illuminated in the presence of external sunlight

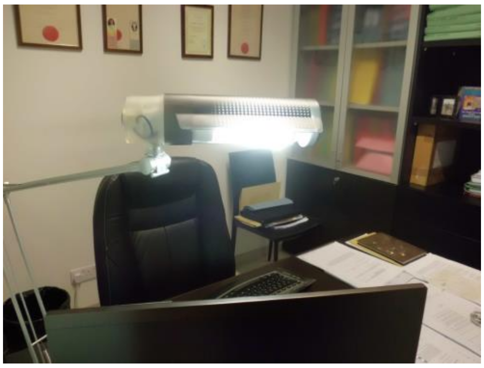

Figure 3: Workspace lighting currently being used

Table 2 shows a summary of the proposed measures for lighting.

Table 2: Artificial lighting problems and solutions

Problem	Solution	Achievable improvement
Failure on/off switch of fluorescent lights in some places even in the presence of natural light or in absence of people	Check and adjust the brightness and human detection system sensors Use of dimming controls according to outdoor natural lighting levels and/or presence of personnel. Use manual controls for specified personal desks.	Best visual comfort in environments Energy savings due to the use of optimal external light source.
Some rooms have poor lighting: e.g. library	Install LED systems	Best visual comfort

2 ANALYSIS OF THE BUILDING ENVELOPE

2.1 Heating and cooling

Over 85% of the total energy consumption is consumed by air-conditioning systems. It was also noted that certain areas within the building have non-uniform temperatures, since the ducting of air-conditioned air seemed to be out of range when compared to the floor area. On the other hand, the top floor seemed to be most affected by over-heating in summer.

Solutions exist in the market, whereby insulation of roofs and exposed single walls will help to reduce the energy consumption of cooling as well as heating.

The insulation could be achieved through the installation of polyurethane foam panels that have very low thermal conductivity, as well as using light coloured rendering on their surface. Ideally, such insulation material is to be fixed on the outer side of the building, so that the thermal mass of the wall is included in the internal space, to help dampen any variations in external temperatures.

2.2 Thermal insulation of fenestration

The use of double glazing with thermal break frames for large windows is recommended, especially for the northern side of the building. Glazing on the east and west side should also be shaded. Given that the sun's elevation is low in the morning and afternoon, it impinges directly on the eastern and western windows and cause internal overheating. The best shading element for these windows shall be vertical rather than horizontal panes. Once again, it is imperative that these shading elements are placed on the external side of the building.

Given the mild climate of Malta, it is sufficient to have double-glazed windows with an air gap. In other words, it is not necessary to opt for high performance windows, because apart from the fact that they are not needed, they have a negative impact on reducing natural light.

2.3 Thermal insulation for roofs and external walls

The existing roof has a traditional water proof a single layer of un-ventilated water-proof membrane, with dark green rendering.

In order to add insulation to the existing roof, it is possible to create what is known as a "hot roof". A hot roof is a roof where insulation material is placed between two layers of waterproofing. It is made with a double waterproofing: one placed below and the other above the insulating material. The first has the function of being a vapour barrier, while the second serves to protect the insulation from the weather elements.

The stratigraphy consists of:

- gradient layer (has the function of channeling water to natural or prepared discharges of terrace);
- impregnant layer;
- vapor Barrier layer (inhibits the passage of water vapor allowing you to control the phenomenon of condensation inside the building system).

The majority of roofs at the law firm's office building are already well protected and all they need to improve their energy efficiency is a further insulation layer and a final top waterproof membrane. It would be important to decide whether the roof is required to be accessible or not. In the case of the former, the insulation and water-proofing materials should be carefully chosen to withstand the weight of persons walking on top of them, without being deformed or damaged.

One interesting product to consider is the insulating panel with ventilated layer. This is made of sintered new generation high-insulation polystyrene. This panel uses a natural element to improve the quality of life, thanks to the media in which it is assembled. A phenolic plywood board, in fact, allows a considerable passage of air just under the roof covering, which eliminates mould and condensation. in a natural way, and eliminate stagnant summer heat. Figure 4 shows a photograph of such a product.

The advantages are:

- excellent thermal conductivity (0.031 W / mK);
- compressive strength (EN 826);
- reaction to fire class E (EN ISO 11925-2);
- water resistance (EN 12087);
- non-toxic material;
- speed of installation;
- interlocking battens and no-capillarity;
- continuity of ventilation;
- separation/sliding layer (to prevent the onset of chemical/physical interactions that would be created by the contact of different elements between them, as shown in Figure 5);
- protective layer (performs control function against changes resulting from mechanical, physical, chemical, as shown in Figure 6).

Figure 4: Ventilated panel sintered polystyrene for roofs

Figure 5: Separation/sliding layer

Figure 6: Example of protection layer

When applied to external walls on the outside, such a system can also eliminate the negative effects of thermal bridges and reduce the risk of surface condensation, which occurs because of temperature changes between the indoor air and the masonry itself.

Since the insulation is placed on the outer side of the wall or roof, this means that the envelope shall remain warm in winter and cool in summer, thus ensuring thermal comfort, since the building envelope is now considered as part of the internal environment and therefore, its high thermal inertia dampens temperature variations and prolongs the comfort period.

Interventions on walls are being recommended for the external walls on the north-west and south-east sides of the building.

2.4 Indoor air quality

Being a relatively old building in Valletta, the indoor design is relatively complex and non-homegenous, with the result that certain areas suffer from lack of fresh air, despite the presence of many windows.

Also, certain areas are over-crowded with individual desks, while other areas have low occupancy rates. It may be interesting to re-consider the occupancy levels and try to distribute it more evenly.

It is imperative to improve air circulation and make use of the internal yard, which is currently closed off by glass and any available shafts. In certain areas, forced ventilation is the only solution.

The internal yard can also play a more pleasant role in the office environment by growing more greenery in it and perhaps use water fountains to enhance evaporative cooling in summer. Such measures were used in Malta, since olden times. These recommendations have now been implemented.

In summer, it is also possible to use by-pass air ducts, and pass them through the existing rain water wells before introducing the fresh air into the rooms. This will help to cool the air, thanks to the relatively stable and cooler temperature of wells in summer.

3 RENEWABLE ENERGY CONTRIBUTIONS

The law firm of "*GANADO Advocates*" has indicated its commitment and willingness to increase its sensitivity to the environment as well as to increase their energy savings, given that the estimated consumption currently amounts to approximately 245 MWh/year.

The only immediate option available is the possibility of installing photovoltaic (PV) modules on the flat roof of the building. Despite the existence of partial shading due to the presence of surrounding buildings, it is still possible to install standard crystalline silicon PV modules coupled with micro-inverters or individual dc power optimisers.

A simulation was carried out using one type of typical PV modules and a renowned power optimiser. A number of considerations were taken into account, such as the optimum compromise between PV module inclination, number of modules and aesthetic impact.

Two separate PV systems may be installed with capacities of 8 kWp and 18 kWp. The PV modules may be inclined at 5° to the horizontal with an azimuth of S48°E.

Figure 7 shows the layout of the 8 kWp on the first roof, together with the estimated monthly electrical output, while Figure 8 shows the larger system of 18 kW setup and its estimated monthly output.

The overall expected PV electrical generation amounts to 39.3 MWh/annum, which would cover up to 16% of the current electrical energy consumption of the offices.

Subject to building permit, it is also possible to consider installing the PV modules on an elevated structure, thus making use of the roof underneath, either as a recreational area or smoking area. In case that the structure cannot take up the load of the PV modules, it is possible to install thin film flexible cells, which are much lighter in weight, although the efficiency is lower than the crystalline silicon modules.

Following this study, efforts have been consolidated and both thin film and crystalline silicon PV modules have been considered for the roof. A decision has been taken to implement the latter.

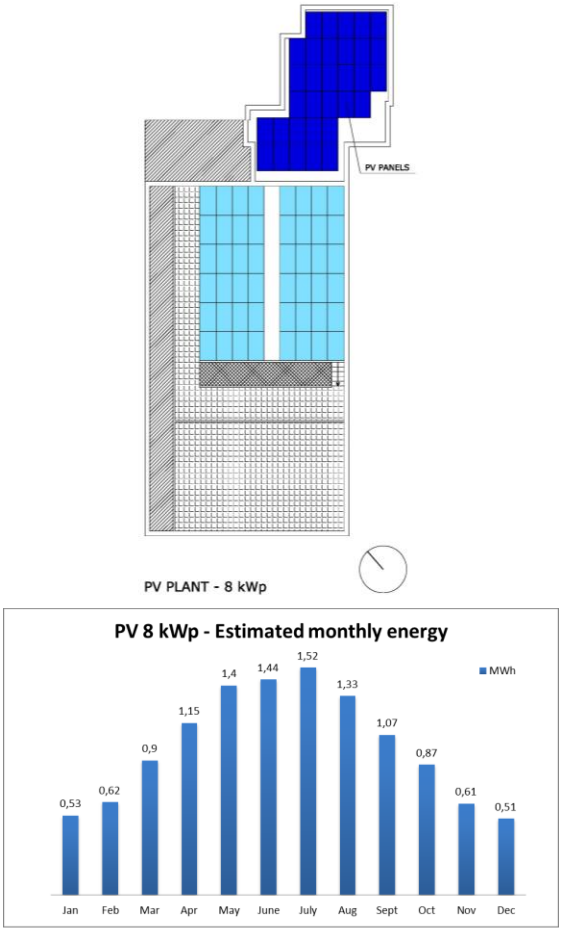

Figure 7: Layout and estimated energy production of the 8 kWp PV system

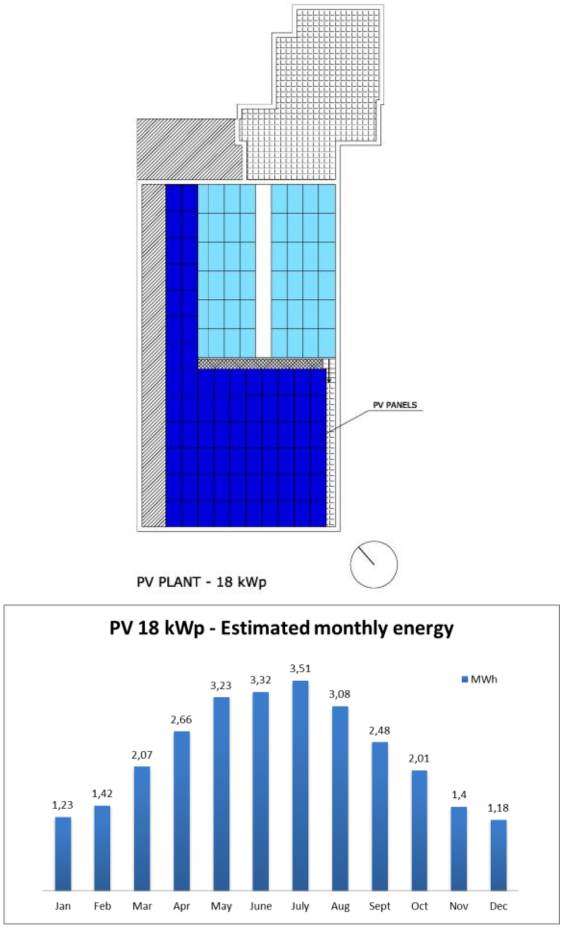

Figure 8: Layout and estimated energy production of the 18 kWp PV system

4 CONCLUSIONS

This work has highlighted a number of possible energy improvements in the building envelope and energy services at the law firm of "*GANADO Advocates*". Such suggestions may enhance their ongoing energy efficiency action plan that aims to improve the energy management of their existing facilities.

The study has identified a number of improvements to lighting controls and improved lighting levels in certain areas. In summer, a forced ventilation system may be passed through the existing water wells before feeding fresh air into the offices. This would help to reduce the cooling load of air-conditioning systems.

Consolidation of printing and photocopying services could further reduce the energy consumption of such machines. The use of timers for water dispensing machines could also reduce energy consumption during the night.

On the other hand, the building envelope can have more insulation on the roof and certain external walls to enhance the thermal performance of the building, while the introduction of photovoltaics may save around 16% of the present electric demand.

5 ACKNOWLEDGEMENTS

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6. REFERENCES

Legislative

[3] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

[4] Directive 2010/31/EC of the European Parliament and of the Council of 19 May 2010 on the energy performance of the building (recast) (*replaces Directive 2002/91/EC*).
[5] 2012/27/UE Directive of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006, / 32/CE.
[6] First National Action Plan for Energy Efficiency (NAPEE), 2008, Malta.
[7] National Plan for Renewable Energy (PNAER), July 2010, Malta.
[8] Legal Notice no. 538 of 2010, "Regulations on the promotion of energy from renewable sources" (*implementing Directive 2009/28/EC*), Malta.
[9] Second National Action Plan for Energy Efficiency (NAPEE), June 2011, Malta.

Sitographic

[1] www.resiproject.eu
[2] www.italiamalta.eu