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Impact of Domestic Solar Water Heating on an Energy Audit of a Residence in Malta

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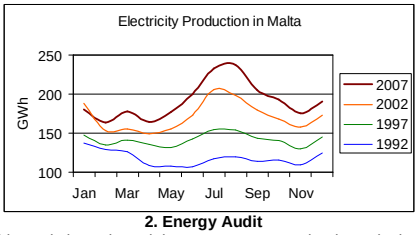
1. Introduction

Electricity production in Malta has been on the increase across all months, with maximum summer demand exceeding that of winter as of the year 2001. The domestic sector has become the major consumer of electricity with a share of 36%. Hence, it is essential to reduce energy consumption and improve end-use energy efficiency in homes; bearing in mind the fact that this sector is also a major contributor to peak loads.



2. Energy Audit

This study investigated the energy consumption in a duplex – top floor apartment leading up to a penthouse, using different energy auditing techniques. The following were identified:

1. Kitchen was fully electric;
2. Open plan design made it more difficult to heat and cool;
3. Many appliances were left in 'Standby' mode;
4. A solar water heater had been installed for 14 years;
5. A large washing machine (136 litres per wash) received hot water from the existing solar water heater;
6. The laundry dryer was mostly used in winter;
7. Free flowing water was used to wash the rooftop patio every week;
8. Severe condensation on the ceiling of one bedroom – that lying directly under the patio – was in evidence;
9. Individual split unit air-conditioners were installed in every room;
10. Oil-filled convection filament heaters were used for space heating;
11. One-hundred light bulbs were installed to illuminate the residence; of which only 13 were energy-saving lights.

3. Energy Audit Results

Water and electricity bills averaged 0.8 m³ and 37 kWh per day respectively. These values were:

1. Higher than the national average;
2. Indicating larger consumption in winter, which was in contrast to the normal trend in Malta (higher loads in summer for space cooling).

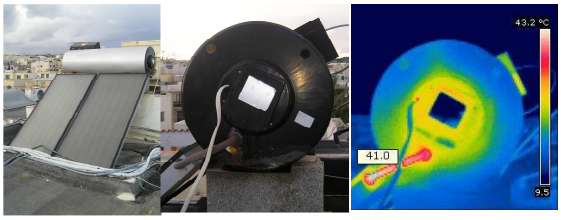
Appliance Category	Electricity Consumption Percentage Share
IT Equipment (Internet, Printers, Laptop, etc.)	3.4%
Kitchen (Cooking, Fridge/Fridge-freezers)	25.6%
Artificial Lighting	20.7%
Laundry (Washing, Drying, Ironing, etc.)	3.5%
Audio / Visual Equipment (TV, DVD, etc.)	7.5%
Solar Water Heating Back-up Element	39.3%

Electricity consumption was found to be highest for the electrical backup heater in the solar water heater storage tank and this explained the peculiar increase in electricity consumption in winter.

Approximately 5 kWh per day were consumed in stand-by mode; with 41% being attributed to Information Technology (IT) equipment (laptops, modems, printer, etc.), and the remaining 59% being consumed by audio-visual entertainment equipment (television sets, DVD players, etc.).

4. Analysis of the Solar Water Heating System

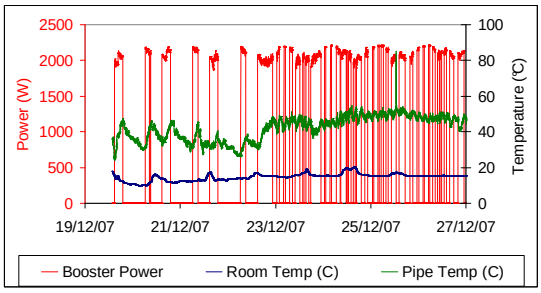
The SWH system was an indirect system, which consisted of two flat-plate solar collectors and a hot water storage tank with an inbuilt electric back-up heater. It was 14 years old.



The main defects were as follows:

1. System orientation was far from optimal (32º degrees East of true South);
2. The hot water delivery pipe to the washing machine had no insulation;
3. Deterioration of solar tank and evidence of some water leakages;
4. A High thermostat setting of the back-up electric heater, leading to higher heat losses, higher electricity consumption and lower absorption of solar energy;
5. The solar system was under-sized. The large washing machine alone consumed 130 litres per wash;
6. No routine maintenance was carried out on the solar system.

The power drawn by the electric backup heater is superimposed on the temperature trace of the hot water delivery pipe to the washing machine and the corresponding ambient temperature of the laundry. It is clear that the pipe remained at an elevated temperature throughout the days and even increased every time the back-up heater switched on.



19 - 22 Dec. – A timer was introduced which reduced electric consumption by 33%
23 - 27 Dec. – Timer was removed for comparison purposes.

5. Recommendations and Conclusions

1. Repair of the freezer & fridge-freezer that had faulty thermostats. (Electricity savings: 12%).
2. Use of air-conditioning units for heating in winter rather than electric filament heaters.
3. Replace washing machine with Class A machine. Change habit of washing patios with free flowing water (Estimated water savings: 40%).
4. Switch off appliances that are rarely used (Estimated electricity savings: 7%).
5. Install more energy saving bulbs.

For the SWH system, the recommendations were the following:

1. Due to the evidence of deterioration of the solar tank and some water leakages, one would recommend the eventual replacement of this SWH with two units. The first would be dedicated to the bathrooms; the second would supply the washing machine and the kitchen, thus reducing the amount of water to be heated by the electric backup heater.
2. Installing a timer on the solar back-up heating element could save up to 12% of the electricity bill and allows the sun to heat up the water during the day.
3. Clothes should ideally be washed later on in the day; by which time the SWH would have absorbed sufficient solar energy.
4. Good insulation on all hot water pipes was also recommended.

TOTAL ELECTRICITY SAVINGS: 31%

The installation of RE systems by itself (even at EU level), is insufficient to ensure energy savings and user satisfaction. A good understanding of the requirements and the lifestyle of consumers planning to install such systems is paramount, to ensure that systems are adequately sized to meet the demands on a case-by-case basis. On the other hand, people using such systems should be aware of the basic operational characteristics, in order to adapt their lifestyles in a way that will give them the full benefits of a renewable resource.