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LIFESTYLE TRENDS FOR HEATING AND COOLING IN MALTESE HOUSEHOLDS

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Abstract

According to the EU Directive 2009/28/EC Malta is obliged to reach a 10% renewable energy share of the total final energy consumption by the year 2020. Due to the challenging targets, Malta seems to be finding it hard to achieve the agreed trajectories. Renewable energy applications in an island state like Malta are hard to achieve due to various constraints, including: lack of space, multiple land-uses and land-use conflicts, few natural resources, low social acceptance, lack of financial resources, lack of expertise, and lack of capacity building. Hence, it would be more feasible to also focus on energy efficiency in buildings which is one of the major consumers of energy on the island. More than 30% of the energy production in Malta is used by buildings, including households. Primarily, this is where the authorities lack information, in the light of heating and cooling of air and water heating in buildings. This paper investigates the status-quo of existing lifestyle trends for space heating and cooling, and water heating, in Maltese households. The scope is to evaluate the potential of shifting to more energy efficient systems that can positively contribute towards the decline of energy consumption in houses, and thus indirectly help to attain the renewable energy targets set for year 2020 and beyond. Energy behaviour and attitudes of Maltese citizens have also been analysed.

Keywords: Energy consumption, households, lifestyle trends, energy efficiency, renewable energy, heating, cooling, Malta.

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1. Introduction

Sustainable energy is a subject of great interest nowadays, especially in the wake of high oil prices and the development of low carbon economies worldwide. Buildings account for around 40% of the total final energy consumed in the European Union (EU). They are also responsible for 36% of the EU's total carbon dioxide emissions (EC, 2013). Reducing the energy consumption in buildings and increasing the use of energy derived from renewable sources and energy efficient technologies in this sector, will eventually reduce the EU's dependency on fossil fuels and energy imports. The reduction in energy consumption will lower carbon dioxide emissions in the EU (Annunziata et al., 2012).

As aforementioned,significant amounts of carbon dioxide are released into the atmosphere, in particular for heating water, and space heating and cooling of residential buildings. The efficient use of energy is essential to slow down the demand growth for energy. Moreover, the growth in clean energy will help decrease the utilization of fossil fuels (Dincer and Rosen, 2007). In Europe, space heating is by far the largest end-use. It is responsible for between 60% to 80% of the total domestic consumption. This share is lower for the Mediterranean countries due to the relatively warm temperatures during the cold season. However, the demand for cooling in summer is increasing rapidly in southern European countries. At present, approximately 1% of the total electricity consumed by households is used for space cooling, where the highest demand lies in the Mediterranean states (Pardo et al., 2013). Hot water is the second largest heating demand and accounts for nearly 14%, of the total energy consumed (Cansino et al., 2011). The average hot water consumption in the EU member states is estimated to be 50 litres per day per person, although this varies from one country to another (Pardo et al., 2013). Lighting and appliances account for 13% of the total household consumption. Cooking has the lowest share of energy usage, with around 4.5% (Cansino et al., 2011).

A large spread in energy consumption per capita in developed countries indicates some scope for reducing consumption by improvements in energy efficiency and changes in lifestyles, since a significant proportion of the total energy produced is being consumed in buildings. The Directive 2010/31/EU on the Energy Performance of Buildings as well as Directive 2009/28/EC on Renewable Energy contribution identify both domestic buildings and commercial premises as the prime sectors where energy efficiency measures can be effectively and easily implemented with immediate and attractive economic benefits. Reducing energy consumption in this area is therefore a priority under the "20-20-20" objectives on energy efficiency. Directive 2012/27/EU on Energy Efficiency brings forward legally binding measures to boost the efforts of member states to use energy more efficiently at all stages of the energy cycle. Measures include the legal obligation to establish energy efficiency obligations schemes or policy measures in all

EU member states. These will enhance energy efficiency improvements in households, transport and industries. Other important measures include an ideal role to be played by the public sector and a right for citizens to know how much energy they consume (EC, 2013).

2. The Case of Malta

The Republic of Malta is an archipelago made up of three islands and four islets located at the centre of the Mediterranean Sea. The Maltese islands have a land surface area of 316 km^2 and a population of 419,000 in 2012. The population density is amongst the highest in the world and practically the highest in Europe, with a density of 1,325 inhabitants per square kilometer (NSO, 2012). Malta became a member of the European Union in 2004, and thus has to abide by EU Directives. The Maltese climate is generally described as a warm temperate maritime climate, typically of the Central Mediterranean Region. Winters are generally mild and wet, while summers are generally hot and dry. Humidity is generally high and prevails all year round. Malta has the highest level of insolation in Europe. Solar radiation incidence on the horizontal plane in Malta varies from approximately 2 kWh/m^2d in winter to 8 kWh/m^2d in summer, where the radiation remains persistently high throughout the year (Fsadni and Sayigh, 2006).

The energy system of Malta is small and isolated, with currently no interconnections to mainland Europe, or to any other country. An interconnector to Sicily is currently being commissioned, and will be completed in two years. Malta relies heavily on fossil fuel imports even though it has indigenous renewable energy sources, such as solar energy, which so far contributes very little to the energy mix. To date, the island state of Malta relies almost 100% on oil imports for the required energy production, making its economy highly susceptible to international oil price fluctuations. Around 75% of the total fuel imports are consumed by power plants for electricity generation (NSO, 2011). The sole state-owned energy provider in Malta is Enemalta Corporation, which runs 2 power plants. The state has so far been unsuccessful in its exploration for oil or natural gas, although it is surrounded by oil export countries such as Libya and Italy (NSO, 2012). More recently the new Government has committed itself to build a new privately-owned 200 MW power plant and convert the existing ones to run on natural gas. This is envisaged to significantly reduce Malta's carbon dioxide emissions.

According to the EU Directive 2009/28/EC Malta is obliged to reach a 10% renewable energy share of the total final energy consumption by year 2020. At present, Malta seems to be finding it hard to achieve the agreed trajectories. Unofficial reports indicate that by the end of 2012, Malta reached around 1.8% renewable energy contribution as opposed to the 2% trajectory target. The official figures will be published on the EU Energy

Transparency website, after July 2013. Renewable energy applications in an island state like Malta are hard to achieve due to various constraints, such as lack of space, expertise, limited financial resources and low social acceptance. Hence, it would be more feasible to focus on energy efficiency in buildings which is one of the major consumers of energy on the island. Unfortunately, energy efficient measures in households have been lagging behind except for some grants on energy efficient lighting systems, double glazing and roof insulation. Many national fiscal incentives have so far focused on solar water heating and photovoltaic systems only. It is estimated that more than 30% of the energy production in Malta is used by buildings, including households. Primarily, this is where the authorities lack information, in the light of heating and cooling of air and water heating in buildings. There exists a potential of shifting to renewable and energy efficient systems, and practices that can positively contribute towards the decline of energy consumption in houses, and thus indirectly help to attain the renewable energy targets set for year 2020 and beyond.

3. Previous Studies

3.1 The Maltese building fabric

Traditionally, globigerina limestone building blocks were used for constructing buildings. These are characterised by high thermal mass. As the continuing building boom started in the 1960s, buildings were being built less massive and the thermal performance worsened (Fsadni and Sayigh, 2006). Globigerina limestone has a high porosity and this contributes to higher indoor humidity in the majority of Maltese houses, resulting in diminished thermal comfort. In recent years, building practices have exposed their handicap in energy efficiency. Modern building design is based more on structural principles rather than on thermal performance. The maritime weather conditions affects the indoor thermal comfort. The thermal mass of the structures is a crucial element in building design in Malta, since it is responsible for reducing the temperature swings outside, from around 12 K down to 2 K inside. The temperature level within a building is determined mostly by the balance of heat gains and losses which depend also on the heat exchange rates (Fsadni & Sayigh, 2008). It is a very common practice that modern structures are built using hollow concrete blocks. One of the reasons for this is that, quarry resources are being depleted. It is clearly seen that with the weather change in November, most of buildings cool down steadily to a rather low temperature. This temperature is retained till late spring. Where no heating is used, inside wall temperatures are normally around 15 ^{o}C (Buhagiar et al., 2007). Good air circulation within the building is fundamental in

removing excess humidity from the buildings. Especially in summer, enhanced night time ventilation has the potential of expelling excessive heat that accumulates during the hot summer days. Since the early 1990s in Malta, rising expectations of thermal comfort and the affordability of air-conditioning systems has changed the pattern of energy use. This has happened throughout the Mediterranean region (Fsadni and Sayigh, 2006).

3.2 Energy Consumption

According to a survey carried out by Said (2010) the households sector is one of the three major consumers of energy, with the domestic consumption accounting for an average of 35% of the total electricity consumption. This excercise was carried out in order to develop detailed data on energy consumption trends for the Maltese households, since to date there is no detailed and reliable information regarding energy consumption in households. The survey concluded that most electricity is consumed by the following appliances:

- Fridges and Freezers (22%);
- Lighting (32%);
- Electric Water Heaters (24%);
- Televisions, Hifi Equipment, and Computers (14%);
- Others (8%).

Lighting, water heating, and refrigeration alone contribute to almost 80% of the total consumption of the average household, albeit these figures are representative of the winter months only. Air-conditioning consumption in the summer months would definitely have a significant contribution to the share of energy consumption in households. This survey indicates that electric water heaters are present and used in almost 90% of households. Most of the people switch their conventional water heaters on and off according to usage. This study showed also that nearly 60% of households have air-conditioning systems, which are normally used for cooling in summer. Interestingly enough, most of household owners expressed a clear preference towards using gas heaters for space heating. Air-conditioning is not a preferred option for space heating, despite the fact that it is more efficient using the air-conditioner for heating during the months of winter, when compared to an electric resistance heater, or gas heater (Said, 2010).

With regards to renewable energy applications, these have been introduced in Malta quite recently, and they are slowly gaining momentum. This particular survey indicated that, solar water heaters are only found in 9% of all households. This is followed by solar photovoltaic systems which are present in 1.3% of the households (Said, 2010). One of

the most particular aspects of Maltese households is that unlike many other European countries, the major part of energy usage at home is electrical energy. In most European countries, most of the energy consumed in households is derived directly from heating oil, natural gas, and biomass. In the case of Malta, the country has to import about 3.5 times primary energy to be able to generate the required electrical power, given that the efficiency of power conversion at present is only around 35% or less.

4. Methodology

4.1 Data Collection

The aim of this research exercise was to gather valuable data regarding the existent situation in Maltese households, vis-à-vis the use of day to day renewable energy and energy efficient measures, with a special focus on space heating and cooling, and water heating in a typical household. For the purpose of this research, the method of telephone surveying was chosen in order to gather valuable data. Mail surveys and email surveys were discarded, mainly due to low response rates. A telephone survey was the preferred choice to maximize response rates as much as possible. It is also an effective method to maintain control over the quality and the correctness of the information gathered.

In the year 2011, the Maltese population was 419,000. The target sample comprised 300 households. A representative sample of 300 citizens across the Maltese Islands (Malta and Gozo) representing 300 households was derived from the electoral registry published in Malta in October 2012. The corresponding telephone numbers of the sample population, were retrieved from the online registry of the GO plc. According to Groves (1990), when members of the target population are selected at random every individual has an equal chance of being surveyed. This in turn, increased the likelihood that the outcome of the survey will be applicable to the whole population. The sampling error for 300 interviews across a total population of 419,000 (NSO, 2011), is plus or minus 5.66% (www.raosoft.com, 2012).

The chosen persons were contacted by phone, between 17.00 and 20.00 during working days, in the month of April 2013. Some of the interviews were also carried out on Saturday mornings, or following an agreed appointment with participants. People were asked to participate in this research by answering the questionnaire over the phone. Each phone call lasted between 5 to 10 minutes, depending on individual cases. There were some refusals, the majority of which obtained in a quick manner, straight after the telephone call was answered. Reasons for refusal were mainly, fear of talking to a

stranger on the phone, disclosure of personal information, lack of participation interest, and time constraints. In order to balance out the number of refusals, an additional number of telephone numbers were retrieved from the online telephone directory.

4.2 Questionnaire Design and Content

For the purpose of this survey, a questionnaire was designed. The questionnaire was divided into three sections: Water Heating, Space Heating, and Space Cooling. The majority of the questions are close-ended ones, simple and straight forward. Close-ended questions are very popular because they provide greater uniformity of response and answers are easily quantified and analysed (Oppanheim, 1992). A major disadvantage with close-ended questions is that respondents may have an answer different from those supplied. As to solve this problem, the 'other' choice was included as necessary.

Respondents were asked in which type of residence they are presently living in, and the number of persons residing. The age of the building was also indicated. Respondants were asked if they have any insulation of the outer walls and roofs. They were also asked if they have any installed double glazing for apertures. Participants were asked questions regarding the use of appliances that are used for space heating and cooling, and also for domestic water heating. Respondents were also asked for how long these appliances are used during the day and/or night. Participants had to indicate the number of months in which they heat or cool their residences.

Respondents were also asked if they are familiar with innovative energy efficient appliances, and renewable energy systems such as heat pumps, solar water heaters, and other energy efficient practices such as using a fan combined with an air-conditioner. Those who have indicated that they cool their houses using air-conditioners were asked to indicate the preferred temperature which they usually set the air-conditioning unit on. Citizens were also asked if they have any renewable energy systems on the roofs of their houses, referring mainly to photovoltaic systems, and solar water heaters, or otherwise, if they are willing to install such systems in the future.

5. Results

5.1 Survey Results

As shown in Fig. 1, the dominant type of residential building in this survey was the terraced dwelling, followed by the maisonette, and apartment respectively. The 'other category comprised of penthouses, townhouses, and houses of character. The sample

distribution according to the age of the building is shown in Fig. 2. As can be observed most of the structures have been build over the past 30 years. In Malta a rapid increase in dwellings was recorded between the 1980s and the mid-1990s. The most common type of dwelling which was built during the 1980s was of the terraced type.

An increasing trend during the past decade was the development of small and medium sized apartment blocks. Many developers have been buying twenty to thirty year old terraced houses, bringing them down, and instead constructing small to medium sized apartments and maisonettes using hollow concrete blocks, instead of globigerina limestone (Buhagiar et al., 2007). Old houses tend to have higher indoor humidity when they lack a damp-proof course. However, old houses have thick walls, high ceilings, and are decently sized. Ventilation holes placed above occupancy level permit the right draft for the exclusion of humidity. Contrary, new buildings do not follow course, and most residents suffer from overheating in summer and cold in winter (Fsadni, 2008).

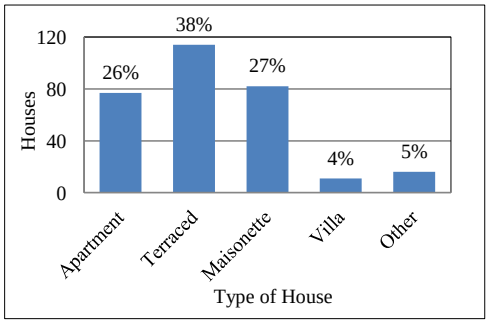

Fig. 1. Types of households

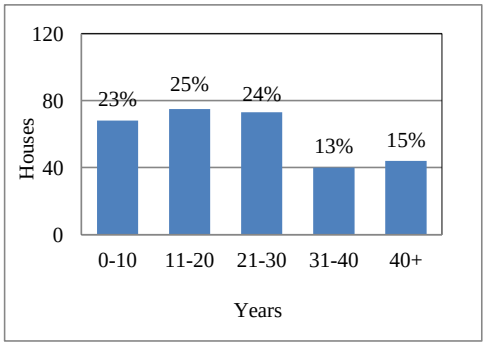

Fig. 2. The age of the households

The number of occupants per household is very important as it is related to energy consumption, attitudes, and energy behaviour of the residents. The composition of households represented in the sample is graphically presented in Fig. 3. The dominant type of household emerged to be the 4-person household, followed by the 3-person and the 2-person respectively. Around 80% of the sample studied had between 2 and 4 occupants.

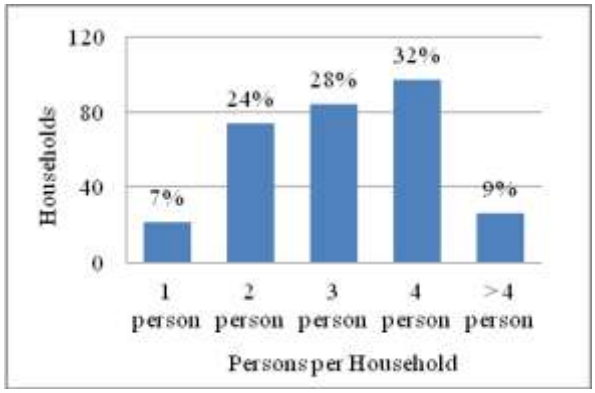

Fig. 3. The size of the households

The majority of houses and apartments lack double glazing, and thermal insulation. Fig. 4 shows how around 80% of the sample population have no insulation of outer walls and roofs. This is quite a disappointing factor, since the absence of insulation will eventually lead to more electricity consumption for space heating and cooling. Insulation is very important in the climatic conditions of Malta, especially during the hot summer months,

where temperatures can easily rise surpass 35°C during summer daytime. Double glazing of apertures is more popular amongst those who participated in the survey, since nearly 35% of respondents indicated that they have double glazing of windows and doors. Nevertheless, this figure is still unsatisfactory, given that the Maltese government had in the past, introduced a subsidy scheme encouraging the change of single to double glazing. It is also to be stressed that double glazing without appropriate shading may indeed lead to higher energy consumption for cooling, as the dwelling could behave as a glasshouse (Yousif et. al, 2013)

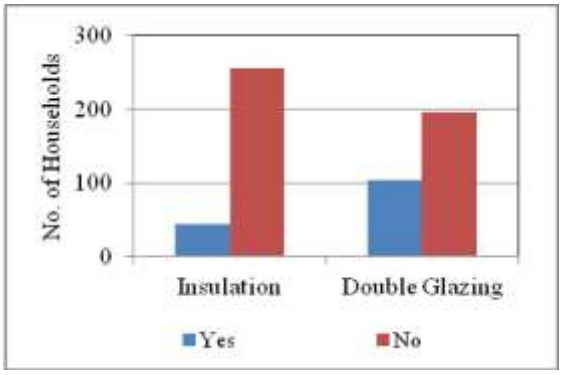

Fig. 4. Installed insulation and double-glazing in households

The Maltese flat roofs are exposed to the high insolation of summer and to high heat loss rates in winter. Bare outer walls oriented due north are exposed to fresh cold winds in winter and cool down further by evaporation at the walls' surfaces once they are soaked by rain. In summer diffuse solar radiation can affect the wall surface temperature. Walls oriented due south are the least exposed to insolation because of the high elevation of the sun during this period. Conversely, in winter the low elevation of the sun leads to significant solar gains that warm up the wall so that little heat loss occurs during sunny days in winter. External east and west facing walls are exposed to significant levels of insolation in summer. These walls are exposed to fresh north east or west to north-west winds that may at times enhance the heat losses, but these remain a source of overheating to the building envelope in summer (Fsadni, 2008). Hence, it is important that adequate insulation is made to these walls.

5.2 Water Heating in Households

The dominant type of water heating system in Maltese households is the conventional electric water heater with storage capacity of around 80 litres, as shown in Fig. 5. The electric water heater features in nearly 80% of all households. Results show that gas water heaters are uncommon, and only present in 8% of dwellings.

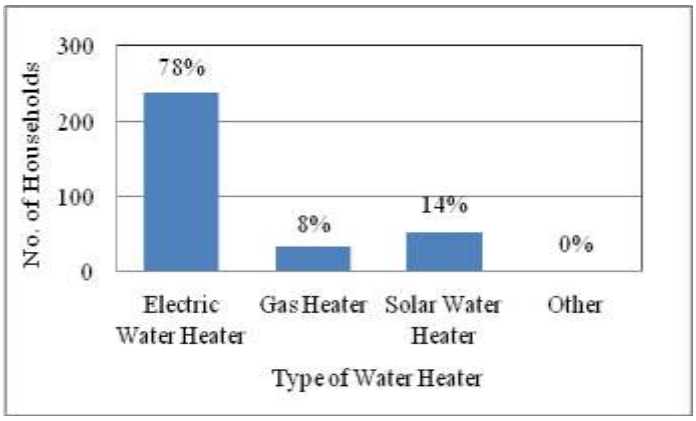

Fig. 5. Methods of domestic water heating in Maltese households

Solar water heaters are only present in 14% of all dwellings (Fig. 5). This of course is very worrying, since the Maltese islands have the highest insolation in Europe. Unlike Malta, Cyprus which is an island state in the Mediterranean, is a world champion in terms of solar thermal applications (Maxoulis and Kalogirou, 2008). In Cyprus, it is estimated that circa 90% of dwellings have an installed solar water heater. This record in thermal applications is mostly attributed to the favourable weather conditions, to a pioneering solar thermal industry, and to a strong coordinated effort by all stakeholders (Florides et al., 2010).

From the information gathered, it transpires that more than 50% of the sample population who use electric water heaters as their main source for heating water, manually switch their system on and off according to usage. However, it is quite disappointing that more than 30% of the sample population, keep their electric heater on all the time. It is very well known that keeping the system always on, consumes electricity to replace heat losses during the day. The main reason for this was that residents preferred to have hot water available all the time, especially during the cold months. Fourteen percent indicated that their system switches on and off by means of a control timer. In summer most of households switch off their electric water heaters, since water becomes comfortably warm during the day.

The government of Malta has introduced grants covering solar water heaters in recent years, in order to encourage the uptake of the solar thermal applications. The rebate on the purchase of solar water heaters was first launched in 2005, and continued each year until 2011. Schemes proved to be quite affective, since it saw the number of purchases increasing year after year. The penetration of solar water heaters for households in Malta at the end of 2010 was estimated at 15,119 (National Energy Plan, 2012). Nearly half of those who have an installed solar water heater, indicated that the back-up heater of the solar tank is controlled by a timer. Thirty percent do not use the back-up heater at all, whilst another 20% leave the back-up heater always on. This means that the system is still using unnecessary electricity for most of the time.

The take up of solar water heaters on domestic buildings is still encountering various barriers. A common problem is that roof space is frequently used for other purposes and activities such as: recreation, drying of clothes, cold water header tanks, satellite dishes, air-conditioners, etc. Shading by other structures or adjacent buildings is another constraint. Certain types of dwellings suffer from problems of roof inaccessibility and roof ownership. Moreover, apartments have limited or no roof space, since the roof is frequently owned by the top most penthouse. On average, 33% of households answered that they would consider installing a domestic solar water heater on their roof. There is still very little awareness on heat pump water heaters, and the energy saving potential that they offer, especially for those who have no roof space or roof ownership. The outcome of this study shows that there is considerable potential for using solar thermal systems and/or heat pumps to replace traditional electric water heaters, which are present in nearly 80% of the sample population. Moreover, the EU Directive 2009/28/EC identifies heat pumps as a possible source of

renewable energy, provided that the energy delivered for heating is significantly higher than the primary energy consumed to drive the motor. In fact, although heat pumps consume electricity, they are considered as renewables, since they provide 3 to 4 times more heat energy per unit of electricity consumed (Morentin Gutiérrez et al., 2010).

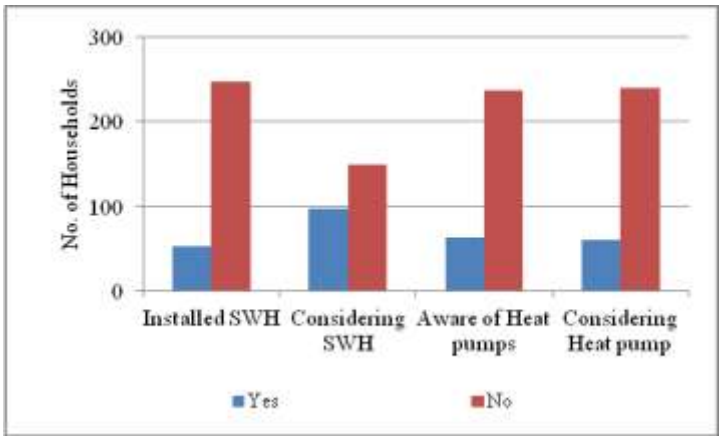

Fig. 6. Solar water heaters and heatpumps in households

5.3 Space Heating

Keeping buildings warm in winter and cool in summer, accounts for up to half the energy requirements of many countries. What a person considers comfortable air temperature depends on humidity, the received radiation flux, the wind speed, clothing and that person's activity, metabolism and lifestyle. Consequently, indoor room temperature may be considered comfortable in the range of about 15^{o}C to 22^{o}C. This implies that the internal built environment should be at such a comfortable temperature (Twidel and Weir, 2006). In Malta, the coldest months are generally, December, January, and February. This study indicates that most of dwellings are heated for 2 to 3 months or more (Fig. 7). Ten percent of those interviewed indicated that they do not heat their house during winter.

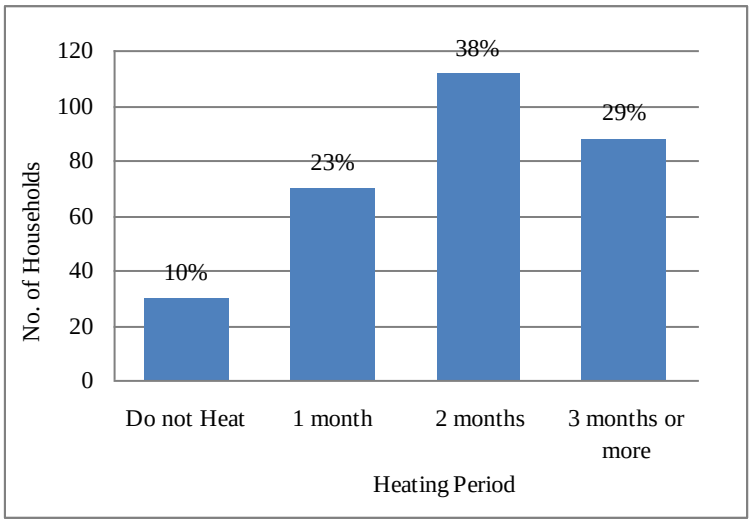

Fig. 7. The heating period in winter

Interestingly enough, most of household owners expressed a clear preference towards using gas heaters for space heating, as indicated in Fig. 8. It is seen clearly that the main source of heating in winter is heating using the liquefied petroleum gas (LPG), which is generally purchased in cylinders of sizes ranging from 12 and 15 kg. During the heating season, most gas heaters are turned on for 1 to 5 hours daily, depending on individual needs, and size of residence. Air-conditioner is the second preferred option for space heating. Most of respondents are not aware that it is more efficient to use the air-conditioner for heating during the months of winter, when compared to an electric resistance heater, or gas heater. Most of the air-conditioning units are split units and they can be used both for heating in winter and cooling in summer, which are both necessary for the Mediterranean type of climate.

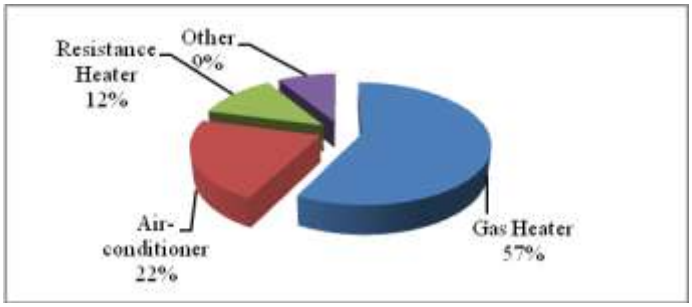

Fig. 8. Methods of space heating in households

Unlike many European countries, central heating systems are not popular on the island. The use of split air-conditioning units is not considered as central heating, since individual units in rooms work separately according to the needs of the user. Resistance heaters are known to use a lot of electricity, but they are still used by 12% of those who heat in winter. The 'other' category comprises stoves and fire places, which are less common amongst respondents.

5.4 Space Cooling

Cooling in summer is becoming more popular. Results obtained show clearly that 65% of respondents cool their houses for 3 months or more (Fig. 9). The preferred option for cooling is mainly the use of forced ventilation (small portable fans), and the air-conditioner. It is worth mentioning that 72% of dwellings own at least one air-conditioning unit. In Malta, it is shown clearly that the demand for cooling using air-conditioners in summer is higher than that for heating in winter. This fact contradicts the

majority of European countries, since the demand for heating is much higher than that for cooling, especially in countries which are found in higher latitudes.

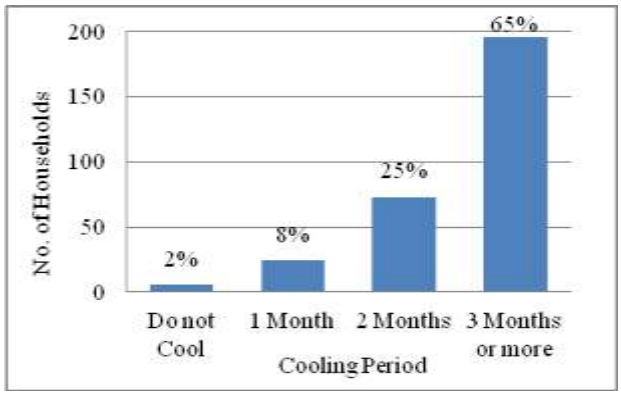

Fig. 9. The cooling period in summer

In Malta, cooling is only obtained through the consumption of electricity, whilst most of the energy consumed for central heating is derived from heating oil, natural gas, and biomass. The most common type of air-conditioner in households is the Class-C type, which is relatively less efficient than the more modern ones (Fig. 10). The Class-A type is the second most common. The most energy efficient system, that is, the air-conditioner with inverter, Class A+ is less common. From the gathered information, the preferred air-conditioning temperature used for cooling in summer ranges between 20°C and 24°C.

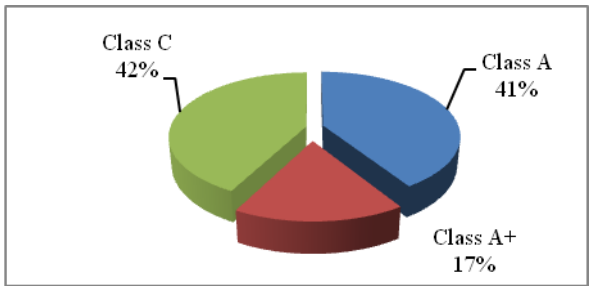

Fig. 10. The types of air-conditioner used for space cooling

The survey has shown that nearly half of respondents use an air-conditioner combined with a fan. Setting the air-conditioner at a higher temperature and combining it with a

conventional fan, will reduce the electricity consumption of the household. Eighty-three percent of respondents has indicated that they usually open up windows for night ventilation during the hot summer months, unless they are using the air-conditioner at night. This practice will eventually cool the building by means of night time natural ventilation.

5.5 Other Renewable Energy Systems

Survey findings indicated that only 6% of respondents have a photovoltaic system installed on their residence. However, it is worth pointing out that 48% of those who do not have a system at present, would consider installing one. Micro-wind turbines and other renewable systems do not feature in this study. A major part of the uptake of photovoltaic systems on residential premises started in 2009, as a result of a grant scheme launched by the former government. Many households benefitted from 50% of the initial capital investment costs, capped at €3,000. The introduction of feed-in tariffs for solar photovoltaic systems in the residential sector in 2010, has contributed significantly to the uptake of these systems. These tariffs are paid only for units produced and exported to the grid (National Energy Plan, 2012). The new grant scheme launched by the present government is intended to boost the installations on residential premises, for the upcoming years. photovoltaic systems encounter the same problems as solar heaters with regards to roof constraints. However, they are much more susceptible to partial shading and every care has to be taken to avoid it.

6. Conclusion

In this paper, the outline, aims and methodology have been presented along with the findings regarding the lifestyle trends in space heating and cooling, and water heating, in Maltese households. The case of Malta is a very particular one, since it is an independent small island state facing multiple difficulties in achieving the renewable energy targets as agreed with the EU. This study has provided information on the most important aspects related to Maltese lifestyles with respect to space heating and cooling, as well as, water heating. From a sample population of 300 households, which were examined, some very interesting conclusions were extracted. Based on these results, an educational campaign may be organised to provide information to the general public, not only on the most efficient appliances for space heating and cooling, and water heating, but also to encourage lifestyle changes that will improve the current use of appliances without reducing the quality of life within residential buildings.

The use of air-conditioning systems for heating should be promoted as the efficiency of operation is 3 to 4 times better than an electric resistance heater. Solar heating and the use of heat pump water heater would need to be promoted and financially supported. Mandatory regulations to include solar heating systems in new buildings at the design stage could also be considered, similar to other countries in Europe. Education for consumers with regards to switching off of water heaters during the night would go a long way towards reducing electrical energy wastage. Insulation of external walls have also been identified as another measure that can be widely implemented to reduce energy consumption for space heating and cooling. The potential savings would be significant. On the other hand, double glazing should be carefully treated as it could make the dwelling act as a greenhouse, if not properly shaded from the sun in summer.

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