Evaluating the Potential and Value of Innovative Renewable Energy Systems; a Strategic Market Perspective

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***Abstract*—** This paper presents the results of a study carried out in Cyprus on measuring the potential and value of innovative, clean, renewable, energy systems and energy saving products from the perspective of the customer. The aim of the project was to investigate whether consumers are ready or willing to invest in renewable energy options. Through a market survey, the drivers are explored behind the investment such as reduction in home energy consumption (bills), and reduction in the negative environmental effects of the current way of electricity production. Further, incentives for renewable energy adoption are evaluated based on consumer's preferences and the level of awareness for renewable energy. Some of the main findings include the following: Consumers want more energy options from their Electricity Suppliers, they are relatively familiar with renewable and energy saving technologies; they tend to postpone the investment in renewables for economic reasons; the energy saving and renewable technology products market is growing very fast; cost drives most purchase decisions. The better understanding of the renewable energy market will help businesses to develop more attractive products and government to provide appropriate incentives for persuading consumers to invest. In this way, renewable energy products will really take off and our world will be saved from the catastrophic effects of environmental pollution.

***Keywords*—** Energy Management, Energy Strategy, Renewable Energy Market, Renewable Energy Systems, Sustainable Development

I. Introduction

ENERGY usage has revolutionized modern societies with unprecedented positive effects in our standard of living, and our quality of life. Obviously there is a relationship between energy use and wealth. This is also supported by a UNDP report [1] which shows the high correlation between per capita income and energy use. On the other hand, there have been catastrophic effects on the environment with the harmful gas emissions of burning fossil fuels. Further, to the negative effects on the environment there is a significant problem of survival for our societies as the current way of consumption of energy is unsustainable [2]. As a result, governments and institutions around the world promote strategies and policies for the more efficient use of energy resources in order to achieve sustainable development. These strategies are good to follow a market driven model such as [3]. Especially, a lot of interest has been drawn on green transport planning with enhancing the public transport mode. Particularly in Cyprus, several studies have been carried out in this direction [4-6]

However, efficiency in fossil fuel energy use is a temporary measure as extracting oil and gas is getting more difficult as time goes by. Therefore, there is a real cost driver on abandoning fossil fuels on top of their harmful effects. This has turned the attention of governments and businesses toward more clean energy alternatives. This led to a new category of clean energy sources, called "renewable". Renewable energy sources are defined as sources which are naturally renewable on a human timescale such as wind, solar, water (hydroelectric and wave), biomass and geothermal heat. Today, renewable energy sources, can replace conventional fuels in many fields such as electricity production, combustion engines and heating. Recently there has been a great interest by researchers around the world to develop innovating renewable energy products. In Cyprus, innovative products such as Heliotrope [7] are under development but already have drawn interest from consumers and investors [8].

The main problem with the current economic model of energy use is that to satisfy their energy needs, most countries would buy conventional fuels from energy producing countries. This involves transportation cost on top of energy price which is usually one the biggest expenses of their annual budget, as well as the largest amount of exportable money. Renewable energy and other new energy technologies could provide each country with a significant amount of energy, so as to reduce both the amounts they spend for conventional fuels consumption and the dependency on other countries to supply them with conventional fuel. Cyprus is currently one of the countries that import all the quantity of conventional fuels that it consumes. Renewable energy could be the best solution to Cyprus's energy problems.

Taking into consideration that Cyprus enjoys clear sunlight for average 300 days yearly as reported in [9]. This can be translated into an average of 2000W/m2 yearly sum of irradiation as reported in [10]. Furthermore, the European Union [11] has set the climate change and energy targets of

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2020 which include the reduction of 1990's greenhouse gas emissions by 20%, the increase in energy efficiency by 20% and the increase of the energy consumption coming from renewable energy sources to 20% of the total energy consumption. For example, Cyprus in 2012 had 7% share of energy from renewable sources of its gross final energy production, and by the year 2020 has to increase it to 13%. Clean/Renewable energy in combination with innovative energy efficient and energy saving products could be the answer to energy dependency [12].

Innovative/Clean/Renewable energy and energy saving products can provide significant positive effects such as reduction of environmental pollution, reduction of energy dependency both for countries and individuals, improvement of energy sustainability and a solution to the climate change problem. Both, countries that own conventional fossil fuel deposits and countries that do not, are trying to establish policies for using these technologies so as to create more alternative ways of energy consumption and ensure sustainability.

The aim of the study presented in this paper is to examine whether consumers are ready to adopt Innovative/Clean/Renewable energy efficient and energy saving recourses options, while the objective is to explore trends in consumer's interest and awareness of Innovative/Clean/Renewable energy options through analysis of survey data.

In the following section, a literature review is carried out regarding the attitudes of consumers on renewable energy. This is followed by section III which describes the methodology adopted for carrying out the survey. Section IV presents an analysis of the most important findings. Finally, conclusions are drawn in section V.

II. Literature Review

For the successful switch to renewable energy researchers, policy decision-makers and companies that deal with Innovative/Clean/Renewable energy systems and energy saving technologies are trying to figure out the behavior and attitudes of costumers. The behavior of consumers regarding renewables is highly uncertain, due to technological, economic and social uncertainties. In the following paragraphs we present a review of a number of studies carried out around the world for understanding consumer behavior when it comes to renewable energy products.

A recent online survey [13] of 1,418 homeowners was carried out the USA, to investigate what they know and think about clean energy products, electric utilities, third party energy service providers and consumer choices. Survey invitations were secured so respondents could only access the survey only one time. The margin error for the survey was +/- 2.7% points and the survey was completed in January 2014. The results have shown that 88% of the US citizens support renewable energy, 62% would be interested in solar power for their homes, 45% believe that solar power is more affordable today than it was three years ago and 73% would welcome an inexpensive and reliable form of energy provided by someone other than their current utility. In addition, 88% of the homeowners believe that renewable energy is important to the country's future and 70% consider or investigate the environmental impact/sustainability of the products when making purchasing decisions and finally 75% of the respondents believe that utilities should not block individual residential customers from installing distributed solar power, energy storage, and other onsite systems.

The most popular energy saving product are light emitting diodes (LED) light bulbs with 31%. This is mainly due LEDs lower prices, in combination with the mid to long term savings. The LED revolution has managed to take hold much more rapidly than many had expected. It is followed by smart thermostats with 11%, double or triple pane windows with 10%, hybrid cars with 9% and high efficiency energy star rated hot water heaters with 9%. The perceived price barriers have kept some homeowners from adopting clean energy saving products. The research has shown that only 45% of the population believes that solar power is more affordable today than it was three years ago, even though for the past several years' prices have dropped by more than half. Homeowners state that low up-front costs, and savings over time would drive increased adoption of solar power and other clean energy saving products.

In another study [14], the determinants of green electricity adoption among residential customers in Germany were investigated. The survey data were generated by means of a telephone survey. Partial Least Square analysis was used to obtain measurements and structural relationship models. The sample contained 267 respondents, from which 53.2% were female, 69.9% were in the age range from 25 to 54 years. Partial least squares (PLS) analysis was used to find the determinants of the willingness to adopt green electricity. The study concluded that the "attitudes towards environmental protection issues" had the strongest impact on the respondents' willingness to adopt green electricity, while "social endorsement of green electricity use" was the second most important determinant. Furthermore "switching difficulty" and "price emphasis" had similar significant effects on the green energy adoption criteria, followed by "switching experience" and "EPC social responsibility". "Price emphasis", "knowledge ability" and "perceived differences between EPC offerings" were not significantly related to the green energy adoption criteria.

According to another survey [15], US adult consumer's support for renewable energy sources is extremely high. The survey was conducted using a structured online questionnaire. The survey analyses consumers' attitudes and awareness for 12 energy and environmental concepts, based on a nationally representative and demographically balanced sample. It involved more than 1,000 US adults, from which 79% of the consumers had a positive view of solar energy, 75% for wind energy, 64% electric cars, 57% biofuels, 47% clean coal, 47%

nuclear power, 42% smart meters, 37% smart grid, 37% carbon offsets, 24% Leadership in Energy and Environmental Design (LEED) certification. The margin of error for the survey results is +/- (3%) with a (95%) confidence interval.

As seen from the above studies there is a great for renewable energy from consumers around the world. On the other hand, these studies were limited in their investigation on what really creates this positive attitude and interest. Therefore, a need arises to examine the reasons behind this and under what circumstances consumers are willing to switch to renewable energy. Further, there is a need to study the attitudes of consumers on specific types of innovative renewable energy systems. The next section presents our methodology, which includes the design of a survey to reveal the real reasons behind the decision to invest in renewable energy products.

III. Methodology

This study is one of the first of its kind in Cyprus, in order to better understand consumers clean-energy and energy-saving actions, perceptions and attitudes. The methodology used was an online survey and involved 100 homeowners across Cyprus. The research was conducted based on probability sampling using the simple random sample technique. The survey's purpose was to gain information and knowledge of the attitudes towards clean-energy and energy-saving products, as well as general attitudes about electricity utilities and energy technologies available. Invitations to the survey were sent to hundreds of people all over Cyprus but they were allowed to take the survey only once.

The data were collected between December 2014 – January 2015. The average margin error for the survey results is +/-2.8 percentage points with a 95% confidence interval. Great care was taken in constructing a survey questionnaire that would yield the most accurate and unbiased results possible. It is worth mentioning that consumers often have difficulty providing survey responses that accurately describe their attitude towards products and concepts with which their familiarity is limited.

The survey consisted of twenty-two 22 closed-ended questions to select from a short list of defined choices, with some of the questions addressing environmental issues, economic, demographic and other topics. Some of the survey questions in regards to the environment referred specifically to the consumer opinion about green, renewable energy sources and energy saving products. The survey, as mentioned previously was web based (on-line survey) and it included a representative sample of Cypriot adults, male and female, from different range of ages and education levels from all over Cyprus.

The analysis of the collected data was carried out though the statistical analysis tool SPSS. The following section presents the most important findings of the study.

IV. Results

Based on the statistical analysis, one of the most important findings is that Cypriot consumers want more alternative energy options. Most consumers are generally not satisfied with the methods of electricity production by Cyprus's sole electricity utility company, which involve only the use of fossil fuels. Specifically, 77% rejects the harmful use of mazut fuel oil.

Further, 96% of consumers say they want more options when it comes to accessing and purchasing electricity for their home. 97% of them would welcome a reliable, low-cost clean energy from a provider other than their current utility company. In addition, 83% agree or strongly agree that the current method of electricity production is causing environmental pollution which affects their quality of life.

Preference for renewable and energy saving products is very strong and wide spread, with a solid majority of Cypriots 98% saying that the protection of the environment is either very important or important for them. Furthermore, 96% believe that renewable energy and energy saving procedures are very important to Cyprus' energy future.

Table I How familiar are you with the following renewable and energy saving technologies?

	Very Familiar	Familiar	Neutral	Unfamiliar	Very Unfamiliar
PV Solar Energy	48%	41%	6%	3%	2%
Wind Energy	34%	51%	12%	2%	1%
Biomass Energy	18%	29%	24%	21%	8%
Solar-thermal Energy	33%	41%	16%	6%	4%
Hydroelectric Power	23%	37%	22%	14%	4%
Nuclear Power	22%	25%	24%	20%	9%
LED Light Bulbs	55%	32%	7%	3%	3%
Voltage Optimization Technologies	24%	19%	16%	32%	9%
Double or Triple Pane Windows	54%	33%	6%	6%	1%
Thermal Insulation	53%	29%	10%	6%	2%
Smart Thermostat & Automation Solutions	34%	29%	19%	14%	4%
Heat Pumps	32%	27%	12%	24%	6%
Other	13%	10%	31%	25%	22%

As seen in Table I, Cypriots are familiar with renewable energy and energy saving technologies. As shown in Fig. 1, procrastination and high initial cost of investment present significant barriers to adoption. Despite Cypriots familiarity with renewable energy and energy saving technologies and their sensitivity towards the environmental impact, more than half of the sample, 53%, have not yet invested in any renewable energy systems (RES) or energy saving technology products yet.

It seems that energy saving and renewable energy products are becoming mainstream. As shown in Fig 2, the most popular past purchase is energy saving lighting bulbs with 25%, following the double or triple windows with 23%,

photovoltaic with 15%, thermal insulation with 14%, and smart thermostats and automation systems with 10%.

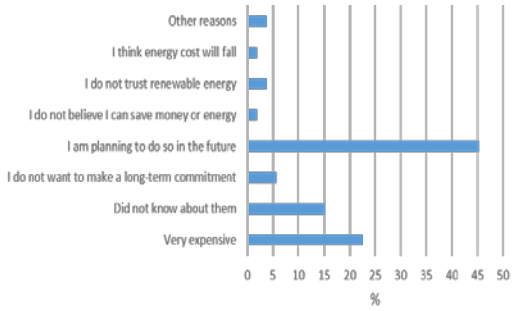

Fig. 1 Indicate the main reason you have not used energy saving or renewable technologies yet

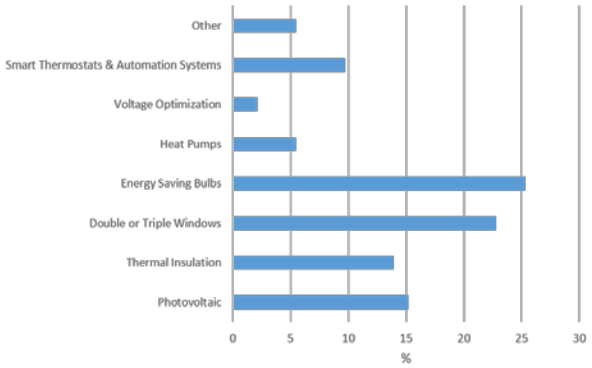

Fig. 2 In which of the following energy saving or renewable technologies have you invested the past few years?

In the case of future investments results, as shown in Fig. 3, are a bit different. The most popular is photovoltaic with 26%, following energy saving lighting bulbs with 17%, thermal insulation with 15%, the double or triple windows with 13%, and finally smart thermostats and automation systems with 10%.

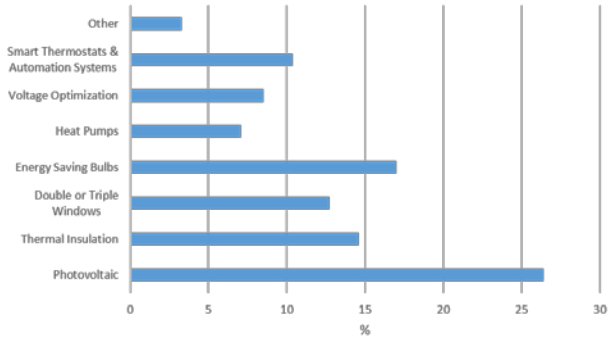

Fig. 3 In which, if any, energy saving technologies are you likely to invest in the upcoming year?

Photovoltaic systems are becoming a trend but perceived price barriers persist, with only 23% of the sample has already installed photovoltaic system at their home. From the 77% of the sample that has not installed a photovoltaic system at their home yet, 84% of them would like to install one and only 16% of them would not install one at all.

Fig. 4 shows the main reasons that encourage consumers to invest in the above energy saving and renewable energy technologies. The 34% invest in order to reduce the cost of their monthly electricity bill. This is followed by 21% which believe that they help to reduce CO2 emissions and environmental pollution. Energy independence from the electricity utility company is also a reason to invest for the 17%, and finally to install it for free and have a pay as you save plan is supported by the 16%.

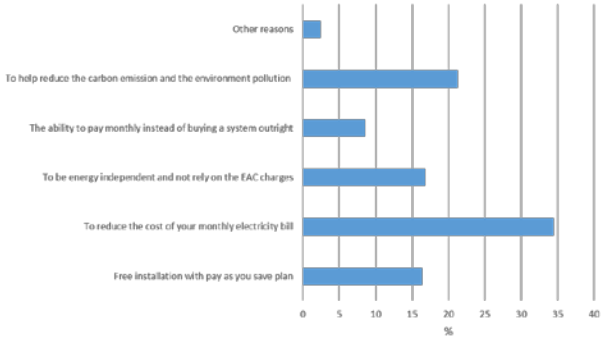

Fig. 4 Indicate the main reasons that have or would encourage you to invest in energy saving or renewable technologies

While Cypriots say they care about the environment, monetary incentives drive most purchase decisions, as revealed in Fig. 5. According to the survey, 36% of Cypriots consider cost as the major factor for their investment, followed by reliability with 28%, the payback period of the investment with 21% and finally the trusted brand with 10%. The factors of cost, reliability and payback period are very important for any renewable or energy saving investment.

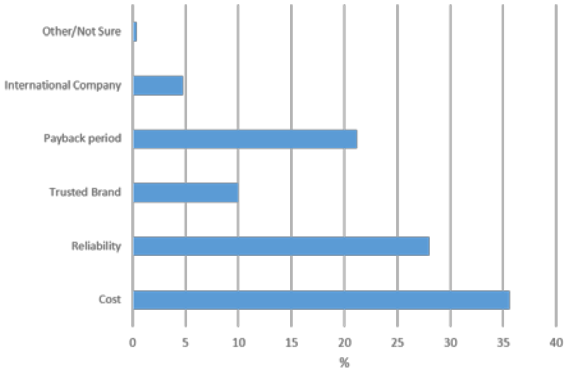

Fig. 5 Which of the following key factors that you would consider when investing on an energy saving or a renewable system

V. Conclusion

The findings of this study show that several barriers exist that hold back consumers from investing in energy efficient and renewable energy technologies. Some of them are financial barriers such as access to finance, payback expectation, investment horizon. Other barriers are institutional and administrative such as regulatory and planning issues. Even though general awareness exists, there is

a need for informing consumers on the benefits of renewable energy systems.

Therefore, governmental agencies and private companies need to embark advertising campaigns to inform consumers about renewable and energy efficient saving products. As price has a big impact on the consumer's mind and perception, the government can help private companies and consumers with subsidy plans to help in adopting these technologies that can benefit all parties involved (private companies, consumers and government). As a result of growth in the renewable energy industry, there will be multiple new job positions, which currently is an issue for both the government and the society due to the financial crisis.

Policymakers can play an important role by providing the right balance between incentives and restrictions. Specifically, tax exemptions or building motives can pull consumers to invest in renewable energy. Clear long-term strategies on behalf of the government and the business world, can really make the market grow rapidly.

Future work in the field can explore and investigate the consumer's interest in various other concepts dealing with renewable and saving energy products, like clean transport, renewable fuels, carbon management and building efficiency.

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