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## **FEASIBILITY STUDY OF THE FIRST ENERGY-EFFICIENT HOUSING PROJECT IN MALTA**

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### **Abstract**

This paper analyses the economic viability of applying energy efficient (EE) and renewable energy (RE) installations to the first energy efficient housing project at *Tal-Ftieh*, Birkirkara, Malta. The methodology included the identification of the existing EE and RE measures within the building envelope and choosing the most prominent or law-binding measures to evaluate their economic viability. Such an exercise gave clear indications to the level of support that certain EE and RE measures would need to make them economically viable and encourage wider use of these possibilities to reduce the carbon footprint of residential buildings. Ranking of the different EE and RE applications under study, were made based on their potential to reduce the carbon footprint, their net present value and their discounted payback period.

### **Overview**

Malta is heavily dependant on fossil fuels for energy provision, with a very low penetration of renewable energy, although the potential may be quite significant. As a European Member State, Malta has to reach 10% renewables by 2020, as set by the European Directive 2009/28/EC on the promotion of the use of energy from renewable sources [1]. Lately, the prices of fuel, gas and electricity have increased steeply, leaving no options except to educate consumers to reduce their energy consumption and most importantly to resort to energy efficient solutions and increase the use of renewable energy sources.

In a bid to lower capital costs, poor building design and practices have accumulated over the years, which caused buildings to be uncomfortable – too cold in winter and too hot in summer. No thought was given to the long-term energy costs of these buildings and therefore no energy saving measures were incorporated at the design stage. This was because the cost of energy was passed on to the buyer and no responsibility by law, was put on the original designer or builder, even if the building was poorly designed in terms of energy performance.

The implementation of the European Directive 2002/91/EC on Energy Performance in Buildings is imminent in Malta [2], and more so since the domestic sector consumes more than thirty percent of the total electricity generated. More recently, Malta transposed this EU Directive into local legislation through Legal Notices L.N. 238 of 2006 (Minimum Requirements on the Energy Performance of Buildings Regulations) and L.N. 261 of 2008 (Energy Performance of Buildings Regulation) [3, 4, 5], but the actual enforcement has still to be effected.

The Housing Authority in Malta has the long-standing mission of providing affordable housing to the community. However it has only recently voluntarily taken the lead to build energy efficient

housing projects since 2003. The first energy-efficient housing project, known as ‘*Tal-Ftieh*’ was built on the outskirts of the second largest town in Malta, *Birkirkara*. The development is a 3-storey building comprising of 10 apartments and a show-room, with underlying semi-basement garages and covering a roof area of 420 m<sup>2</sup>. A number of energy efficient measures were implemented such as tinted double-glazing, louvered windows and doors, insulation to the roof, solar-heating, solar photovoltaics and sun pipes, among others [6]. Figure 1a shows the main building block of *Tal-Ftieh* (Northern and Western elevations, 1b shows the roof plan, 1c shows the Western elevation and 1d shows the Eastern elevation.



Figure 1a: Photograph of the Northern and Western elevations.



Figure 1c: Western elevation.

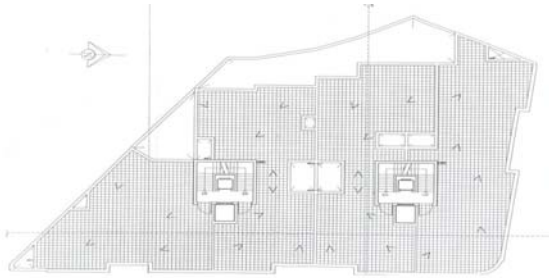


Figure 1b: Roof plan of Tal-Ftieh Building (420 m<sup>2</sup>).



Figure 1d: Eastern elevation

This paper aims to evaluate the economic viability of some of the most prominent energy-efficient measures implemented on site, as one of the tools to be used to educate people on the long-term benefits of such key measures. The underlying idea was always to promote this first energy-conscious approach to social housing as a pilot project for others to follow, not excluding private developments. It is difficult for people to visualise the significance of benefits such as lower carbon dioxide emissions and a greener environment, however, fiscal benefits are easily grasped by everyone as these are the more tangible evidence of energy savings.

Another scope of the paper is to prioritise the different energy-efficient measures as and where applied in the local context, not only from their pure economic value but also in relation to their contribution towards lowering the carbon footprint of energy use in buildings. This study also provides the incremental cost of capital needed in order to comply with the set minimum building requirements with regards to heat transfer. By *incremental cost*, one means the additional cost that one has to pay to acquire the energy efficient or renewable energy system. For example, for a tinted double-glazed door, the incremental cost would be the difference in costs between a clear single-pane glass door and a tinted double-glazed one. As a result, the additional capital cost

required to introduce such new measures and the repercussions on potential buyers who normally borrow from the banks to buy their home, was also evaluated.

## **Methodology**

The preliminary research has focused on gathering information regarding energy efficiency in buildings, in order to understand the basic technicalities of the subject. This has already been completed through extensive use of secondary data, namely discussion papers, books, journals and reports. The primary data has been collected through a number of in-depth interviews carried out with knowledgeable individuals including engineers, architects and researchers. Detailed drawings and information have also been gathered on the particular building project, namely *Tal-Ftieh*, which would be instrumental to evaluate the effectiveness of the energy-saving measures that are in place today.

Around thirty local suppliers of energy efficient and renewable energy products were contacted in order to discuss their experience and knowledge of the availability of energy efficient products. The choice of suppliers was carried out randomly and covered all the required products. These suppliers were helpful in explaining the different technicalities and specifications of products available on the market. They also provided informative information on their products, such as brochures and instruction manuals. All suppliers confirmed that consumers are nowadays more aware of the different energy-efficient products available on the market and their sales have significantly increased following the recent increase in the electricity tariffs of 2010.

Economic analyses and other studies were carried out to evaluate the viability of specific energy-efficient measures, which include roof insulation, use of rain water, tinted double-glazing, louvers for apertures, shading, domestic solar water heating and solar photovoltaic grid-connected systems. In order to determine the capital expenditure entailed by the project, the quotations that were procured from the thirty suppliers were considered and an average cost was calculated for each item.

Operating expenditure was determined by referring to studies carried out by the Institute for Sustainable Energy and by consulting with the suppliers and also with the residents of “*Tal-Ftieh*” buildings. Information regarding electricity tariffs and electricity consumption was obtained from Enemalta Corporation, while the water tariff was obtained from the Water Services Corporation.

One of the most important factors that affect the feasibility of energy saving measures is the availability of funds whether cash or as a loan. Information about the financing of the project, in particular about bank loans, was obtained from specific interviews with Bank Managers.

When evaluating the proposed project, social costs and social benefits were also taken into consideration. It was felt that only by defining and calculating such costs and benefits could a true picture be given of the feasibility or otherwise of the project. Such costs and benefits were extracted from the results of the ExternE (External Cost of Energy) project of the European Commission [7].

Information was also sought from the Environment Protection Department, the Cleaner Technology Centre, and local environmental non-governmental organizations (NGOs), including the Malta Energy Efficiency and Renewable Energies Association (M.E.E.R.E.A.) and Friends of the Earth Malta.

Investment appraisal techniques were applied in order to determine the financial feasibility or otherwise of each measure, and the appropriate conclusions and recommendations were drawn up. Since the variables underlying this study, such as the capital cost of the measures and the cost of energy, may be subject to change, sensitivity analysis was used. Such analysis helps determine those variables to which the results of the study are most sensitive.

## **Financial Evaluation**

### a) Simple Payback Method

The first technique applied was the payback method. Payback measures the number of years it is expected to take for the future net cash flow of a project to match the initial capital outlay. The simple payback method cannot be used on its own to evaluate a project since it ignores the time value of money and this is where discounted cash flow techniques are used to better evaluate a project's viability.

### b) Discounted Cash Flow

Discounted cash flow (DCF) analysis encompasses a family of investment appraisal techniques which take into account the time value of money. By discounting all the payments and receipts to their present values, one can compare them on a common basis. The project has been evaluated by using two of these techniques: net present value (NPV) and the discounted payback period. The lifetime was taken to be 20 years for all systems. In case that a system had a lower lifetime, a new investment was assumed to bring the overall lifetime up to 20 years. This is a typical example for the case of solar heating, where the lifetime of a system was considered to be 10 years.

- **The Discount Factor**

For the purpose of this study, the discount rate of cash flows was 5.2%. It is the money discount rate and is the fixed rate of interest currently payable on a loan repayable in ten years time. It was assumed that individuals will finance the capital expenditure by a ten-year 5.2% loan.

Since this is a project pertaining to individual consumers, the application of the weighted average cost of capital, as a discount factor is not considered adequate. This is due to the fact that it is difficult to determine the portion of debt and equity the individuals would incur to finance the project. Individuals might use their own funds and thus the cost of financing the project would be the opportunity cost of not earning future interest on that sum. However, individuals might finance the project through a loan and in this case the interest rate on that loan is deemed to constitute the cost of financing the project. Another alternative would be for the owners to finance the project partly through their own money and partly through a loan. In the latter case it is difficult to determine the cost of capital, since it depends on the different proportions of 'equity' and debt which are specific to each case and individual. Therefore, in this project it is considered most practical to use the fixed interest rate on a ten-year loan as a discount factor. Since individuals are not entitled to a tax benefit on interest, the pre-tax rate of 5.2% is used.

- **The Inflation Rate**

An inflation rate of 3.08% was considered for this project. This rate was calculated on an average of the actual inflation rates for the previous 5 years in Malta (2005 – 2009).

c) Net Present Value (NPV)

The NPV method calculates a project's net present value by comparing cash outflows with cash inflows at the same point in time.

d) Discounted Payback Method

Since the simple payback method is criticized for ignoring the time value of money, a modification to this method – the 'discounted payback method' can be used. This method calculates how quickly discounted cash flows recoup the initial investment.

## **Results**

The energy efficient and renewable energy financial appraisal was considered for the following measures:

1. Tinted double glazing for existing windows and aluminium doors;
2. Installed louvered windows and doors;
3. Roof insulation in place;
4. Ten domestic solar heating systems is use by the apartments;
5. An installed 1.5 kWp photovoltaic system;
6. Existing shading features on the eastern side;
7. Underground second-class rain water reservoir.

### **1. Tinted Double-Glazing**

Based on today's prices, the areas for the tinted double-glazed windows and doors were determined from the building's plans. Following the standard procedures for calculating the net present values, it was found that tinted double glazing had a relatively short payback period of 2 years, both when computing the simple and the discounting payback method. At the end of the twenty years, there is a positive Net Present Value of €19,637. A positive NPV and a short payback period illustrates that such a measure is worth investing in.

### **2. Louvered Windows and Doors**

The results of the economic analysis have shown that louvered windows and doors have a relatively long payback period, a simple payback period of sixteen years and a discounted payback period of nineteen years. At the end of the twenty years, the NPV amounted to a relatively immaterial sum of €157. This is due to the fact that the total cost of the louvres, which is quite high, is taken as an immediate incremental cost whilst benefits were slowly gained. In this respect, although louvers have been traditionally very popular in Malta, their use in modern buildings has been quite limited. Probably, a good design of fixed shading devices would produce the same effect as louvered windows – that of allowing for natural ventilation without solar gains – but at a fraction of the cost.

### **3. Roof Insulation**

Roof insulation was found to be one of the top high performance measures given its very short payback period, both in terms of simple and discounted payback. It has also a high projected NPV amounting to €33,593. Hence, considering the small incremental capital outlay for such a

measure together with the expected future benefits, it may be considered as an attractive investment, provided that it is carried out during the construction stage of the building. This was the case of *Tal-Ftieh* Building, and hence the cost of labour for laying down the insulation, covering with screed and finishing were considered as part of the project and not included in the financial analysis of the insulation.

#### **4. Solar Water Heating**

The ten solar water heating systems had an exceptional financial performance due to their very short payback period of 4 years under both payback methods and its substantially high NPV of €37,320. It is important to note that these benefits would only be enjoyed in full, assuming that the solar water heaters are used at full capacity (i.e. used by 3 to 4 persons per system).

The actual performance of these solar heating systems was reported in another publication, where the electricity savings would amount up to 1,833 kWh/year [8]. The results were used to predict the actual financial savings based on the current average electricity residential tariff of €0.189 per kWh and without any financial support from Government.

#### **5. Solar Photovoltaic System**

Originally, the 1.5 kWp system was intended to be connected to the common parts and would therefore supplement the electricity demand for the lift and lighting for the common parts. Based on that, the electricity tariff used was that of the domestic rate. This rate encompasses areas that are used by the domestic sector such as small garages and common areas. The rates are different from the residential tariffs. Hence, the simple payback period was found to be seventeen years, a positive NPV of €287.86 and a discounted payback period of twenty years. In reality, the PV system was eventually connected to the showroom, which enjoys preferential electricity rates and hence, the photovoltaic system would be less attractive. It is to be noted that the cost of PV systems is dropping quite fast and the present situation could change significantly in the near future.

#### **6. Shading features**

For this particular building, shading features included closed masonry balconies which were part of the original approved design. When considering the costs of these balconies as incremental to the building, the financial results showed negative NPV and a payback period beyond twenty years for both the simple and the discounted payback method. However, one may argue that the cost of the closed masonry balconies is not incremental since it is part of the building's design. In such a case the cash flows would only consist of the saving due to shading and amounting to €231 per year.

#### **7. Underground second-class rain water reservoir**

According to the Maltese Building Regulations as stipulated by *Document F*, all buildings shall incorporate a cistern or well for the storage of rainwater [5]. In the case of domestic dwellings, including apartment blocks, the cistern or well shall have a volume that is numerically equal to at least sixty per cent of the total roof area. The cost of excavating and building the cistern of the required volume would have amounted to €35,000, which would produce a negative NPV, whilst the payback period goes beyond twenty years, both in case of the simple and the discounted payback method. However, despite these results, this measure still needs to be incorporated due to the established legal obligation. For the case of *Tal-Ftieh* project, there was no cistern built, but this exercise was nevertheless made to highlight the situation.

Besides its strategic importance, water storage helps to avoid flooding of roads whilst also reducing energy demand. In Malta, fifty per cent of the water consumption is generated through reverse osmosis plants which are energy intensive. Therefore, a water reservoir for *Tal-Ftieh*, would have saved a further 808 kWh of energy consumption annually. Appendix A shows the economic results for the best three options [9].

## External Benefits

This study also took into consideration the external benefits in terms of cost savings of the external cost of fossil fuel electricity generation such as global warming, pollution and the protection of public health. In recent years, there has been quite a substantial improvement in the analysis of environmental damage costs of different energy technologies, through different projects specifically designed to evaluate the externalities of energy, both in the USA [10, 11], and in Europe [7, 12]. The ExternE Project is considered as providing a wider perspective and the most up-to-date to incorporate the latest scientific findings. Therefore, the results of this project were used to quantify the avoided external costs of fossil fuel electricity generation for each kWh of solar energy saved by each measure. The typical damage costs for power plants using oil averages €0.045 per kWh among the EU countries [7].

Table 1 shows the benefits that each energy efficiency or renewable energy measure would have on society, converted to monetary values. It is clear that the best return on health and the environment would come primarily from solar water heating, roof insulation, tinted double-glazing and then PV( although PV is consider to be the more prestigious ‘green show-off’ and people tend to invest in it, first)..

Table 1: Present Value of the external benefits over the lifespan of the business

Year	Double Glazing	Louvers	Roof Insulation	Solar Heating	Shading	PV
	315.00	10.00	540.00	825.00	55.00	101.00
1	299.43	9.51	513.31	784.22	52.28	96.01
2	284.63	9.04	487.94	745.46	49.70	91.26
3	270.56	8.59	463.82	708.61	47.24	86.75
4	257.19	8.16	440.89	673.58	44.91	82.46
5	244.47	7.76	419.10	640.29	42.69	78.39
6	232.39	7.38	398.38	608.64	40.58	74.51
7	220.90	7.01	378.69	578.55	38.57	70.83
8	209.98	6.67	359.97	549.96	36.66	67.33
9	199.60	6.34	342.18	522.77	34.85	64.00
10	189.74	6.02	325.26	496.93	33.13	60.84
11	180.36	5.73	309.19	472.37	31.49	57.83
12	171.44	5.44	293.90	449.02	29.93	54.97
13	162.97	5.17	279.38	426.82	28.45	52.25
14	154.91	4.92	265.57	405.73	27.05	49.67
15	147.26	4.67	252.44	385.67	25.71	47.22
16	139.98	4.44	239.96	366.61	24.44	44.88
17	133.06	4.22	228.10	348.49	23.23	42.66
18	126.48	4.02	216.83	331.26	22.08	40.55
19	120.23	3.82	206.11	314.89	20.99	38.55
20	114.29	3.63	195.92	299.32	19.95	36.64
<b>Total (Euro)</b>	<b>3859.87</b>	<b>122.54</b>	<b>6616.92</b>	<b>10109.19</b>	<b>673.95</b>	<b>1237.61</b>

It is also realized that the overall capital investments for installing these three priority energy saving features amounted to €15,648, as shown in Table 2. This implies that each apartment would cost an additional amount of only €1,565 higher than a conventional building. This small increment is considered quite affordable and should not be of concern that these measures could contribute towards raising the cost of property on the local market.

When considering all the energy efficient measures collectively, the overall incremental capital expenditure rises to €77,607. This is considered high but it is to be noted that the major part of €35,000 is taken up by the construction of the cistern, which is required by Law. The remaining measures collectively have a minor effect on the overall cost of the building (€4,260 per apartment). This means that energy efficient and renewable energy measures are feasible and affordable and will not negatively affect the property market in Malta.

Table 2: Capital incremental expenditure budget and estimated annual energy/water savings.

Measure	Capital Cost (€)	Estimated Total Energy Savings (kWh/year)
Solar Water Heating (10 x 150 Litre Systems)	10,480	18,333 (Reference 8)
Roof Insulation for 420 m <sup>2</sup>	3,290	12,000
Tinted Double Glazing (33.84 m <sup>2</sup> )	1,878	7,000
Photovoltaic System (1.5 kWp)	7,500	2,250
Shading Closed Masonry Balcony	11,659	1,224
Louvered Apertures (33.84 m <sup>2</sup> )	7,800	231
Rain Water Cistern (250 m <sup>3</sup> capacity)	35,000	202 m <sup>3</sup> of water

Based on the above results of the financial and social aspects of this project, a table of priorities may be built as shown in Table 3 below. Here, one realizes that the top three energy-saving measures are roof-insulation, tinted double-glazing and solar water heating.

Table 3: Priority List of Measures

Measure	Present Value of External Benefits (€)	Ranking based on External Benefits	Respective NPVs (€)	Ranking based on NPVs	Respective Payback Periods (Years)	Ranking based on Payback Periods
Solar Water Heating	10,109	<b>1</b>	42,920	<b>1</b>	4	<b>3</b>
Roof Insulation	6,617	<b>2</b>	33,593	<b>2</b>	2	<b>1</b>
Tinted Double Glazing	3,860	<b>3</b>	19,637	<b>3</b>	3	<b>2</b>
Photovoltaic System	1,238	4	3,288	4	20	5
Shading	674	5	7,893	6	>20	6
Louvres	122	6	157	5	19	4

## Conclusion

The past few years have witnessed a considerable improvement in the standard of living in Malta. This fact, together with the increasing influx of tourists to Malta, has contributed in part to the increase in the demand for electricity. This was augmented by the fact that air-conditioning systems have become affordable and popular off-the-shelf commodities – albeit to the detriment of a later ‘wake-up’ to their real running costs.

Depending solely on fossil fuels to meet the ever-growing demand for electricity is not a viable long-term option for Malta, both for economic and environmental reasons. For the local energy sector to be truly sustainable, a concerted effort should be made on a national scale to promote energy efficiency, energy conservation and, in particular, renewable energies at the micro-level.

This study has evaluated the implementation of some of the most energy-efficient measures in new or existing buildings. Particular emphasis has been placed on the financial aspect of such options. From the information collected through the field research conducted, it is clear that there is plenty of material on the local market available for energy-saving measures. Some measures such as roof insulation, water storage and tinted double glazing are clearly viable only if made at the design stage because of the nature of their installation. Therefore, such measures should become mandatory in the future update of the local Building Regulations. So far, only wall and roof insulation is mandatory, as well as rain-water cisterns.

The financial evaluation has concluded that measures such as water reservoirs and shaded masonry balconies are not economical due to their negative net present values and long payback periods. The water reservoir is a requirement of law and hence it must be incorporated into new buildings irrespective of its financial aspect. Moreover, such reservoirs have other purposes, such as the strategic use of rain water and the avoidance of immediate flooding of streets.

As the results of the financial evaluation showed, solar water heating is already a very effective measure even without any financial support. It has arrived at a point that policy makers should consider the solar water heating system to become part and parcel of the building regulations and be applied for all new and renovated buildings. However, if it becomes obligatory, the Government would no longer offer grants for what is mandatory by law.

Shading, tinted double-glazing, louvered windows and doors also have an effect on the energy performance of buildings and should be more seriously supported and promoted. At present, there are no schemes or regulations that support these measures. However, when considering their positive financial viability, in particular that of tinted double-glazing, they are very encouraging.

Although the Photovoltaic system ranks fourth in the priority table, it could be an important source of green electricity given that Malta has to reach 10% renewables by 2020. It is not enough to save energy but also to produce renewable energy. An important consideration is that the cost of photovoltaic systems is dropping fast. Till then, Government support would be needed in this area and for quite some time.

The paper showed that the incremental cost of applying the three major measures, namely tinted double glazing, roof insulation and solar water heating, would only add around €1,600 Euros per apartment, which still retained the sold out housing units with a heavily subsidized bracket, thus adhering to underlying social policies. Moreover, similar follow up to this pilot study in the private property market should not contribute to any price hikes in property values in the Maltese market.

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## Appendix A

Table 1: Net Present Value for the best three energy efficient/renewable energy options.

	Year	Net Cash Flow adjusted for inflation @ 3.08% (€)	Discount Factor at 5.2%	Present Value €
<b>Double Glazing</b> All Apertures	0	-1,878.00	1.0000	-1,878.00
	1	1,363.75	0.9506	1,296.34
	2	1,405.75	0.9036	1,270.21
	3	1,449.05	0.8589	1,244.62
	4	1,493.68	0.8165	1,219.54
	5	1,539.69	0.7761	1,194.96
	6	1,587.11	0.7377	1,170.88
	7	1,635.99	0.7013	1,147.28
	8	1,686.38	0.6666	1,124.16
	9	1,738.32	0.6337	1,101.51
	10	1,791.86	0.6023	1,079.31
	11	1,847.05	0.5726	1,057.56
	12	1,903.94	0.5443	1,036.25
	13	1,962.58	0.5174	1,015.37
	14	2,023.03	0.4918	994.90
	15	2,085.34	0.4675	974.85
	16	2,149.56	0.4444	955.21
	17	2,215.77	0.4224	935.96
	18	2,284.02	0.4015	917.10
	19	2,354.36	0.3817	898.62
	20	2,426.88	0.3628	880.51
	<b>NPV</b>			<b>19,637.14</b>
<b>Roof Insulation</b> Full Roof	0	-3,290.00	1.0000	-3,290.00
	1	2,337.85	0.9506	2,222.30
	2	2,409.86	0.9036	2,177.51
	3	2,484.08	0.8589	2,133.63
	4	2,560.59	0.8165	2,090.63
	5	2,639.46	0.7761	2,048.50
	6	2,720.76	0.7377	2,007.22
	7	2,804.55	0.7013	1,966.77
	8	2,890.94	0.6666	1,927.14
	9	2,979.98	0.6337	1,888.30
	10	3,071.76	0.6023	1,850.25
	11	3,166.37	0.5726	1,812.96
	12	3,263.89	0.5443	1,776.43
	13	3,364.42	0.5174	1,740.63
	14	3,468.05	0.4918	1,705.55
	15	3,574.86	0.4675	1,671.18
	16	3,684.97	0.4444	1,637.50
	17	3,798.46	0.4224	1,604.50
	18	3,915.46	0.4015	1,572.17
	19	4,036.05	0.3817	1,540.49
	20	4,160.36	0.3628	1,509.44
	<b>NPV</b>			<b>33,593.09</b>
<b>Solar Heating</b> 10 Systems	0	-10,480.00	1.0000	-10,480.00
	1	3,571.72	0.9506	3,395.17
	2	3,681.73	0.9036	3,326.75
	3	3,795.13	0.8589	3,259.71
	4	3,912.02	0.8165	3,194.02
	5	4,032.51	0.7761	3,129.66
	6	4,156.71	0.7377	3,066.59
	7	4,284.74	0.7013	3,004.79
	8	4,416.71	0.6666	2,944.24
	9	4,552.74	0.6337	2,884.90
	10	-9,501.05	0.6023	-5,722.88
	11	4,837.51	0.5726	2,769.80
	12	4,986.50	0.5443	2,713.98
	13	5,140.09	0.5174	2,659.29
	14	5,298.40	0.4918	2,605.70
	15	5,461.59	0.4675	2,553.19
	16	5,629.81	0.4444	2,501.74
	17	5,803.21	0.4224	2,451.32
	18	5,981.95	0.4015	2,401.92
	19	6,166.19	0.3817	2,353.52
	20	6,356.11	0.3628	2,306.09
	<b>NPV</b>			<b>37,319.52</b>

Table 2: Discounted Payback Period for the top three energy efficient and renewable energy measures

	Year	Net Cash Flow €	Net Cash Flow with 3.08% inflation €	Discount Factor at 5.2%	Present Value €	Cumulative Discounted Cash Flow €
<b>Double Glazing</b> All Apertures	0	-1,878	-1,878.00	1.0000	-1,878.00	-1,878.00
	1	1,323	1,363.75	0.9056	1,296.34	-581.66
	2	1,323	1,405.75	0.9036	1,270.21	688.55
<b>Roof Insulation</b> Full Roof	0	-3,290	-3,290.00	1.0000	-3,290.00	-3,290.00
	1	2,268	2,337.85	0.9056	2,222.30	-1,067.70
	2	2,268	2,409.86	0.9036	2,177.51	1,109.81
<b>Solar Heating</b> 10 Systems	0	-10,480	-10,480.00	1.0000	-10,480.00	-10,480.00
	1	3,465	3,571.72	0.9056	3,395.17	-7,084.83
	2	3,465	3,681.73	0.9036	3,326.75	-3,758.08
	3	3,465	3,795.13	0.8589	3,259.71	-498.36
	4	3,465	3,912.02	0.8165	3,194.02	2,695.66