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Economic Evaluation of Financial Incentive Schemes for Energy Retrofit Projects in Residential Buildings

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Even if the EU has made important progress towards meeting its climate and energy targets for 2020, the effects of financial instability due to the economic crisis are still apparent, especially in the southern European countries, acting as a great obstacle for residents to invest in energy retrofit projects in order to improve their house energy performance. EU Member States striving to limit the risks that such investments entail and to aid with high upfront costs are using financial incentives in the form of funding schemes, grants, tax exemptions/reductions etc. as a way of spurring investments in energy efficient services and technologies. Within this framework, the current study deals with the financial attractiveness of investments in the presence and absence of incentive schemes for energy retrofitting of residential buildings in three European countries (Cyprus, Greece and UK).

The methodology followed uses, as a first step, three case studies of typical residential buildings, one for each country, for the computation of pre-retrofitting and post-retrofitting energy demands. Material and labor costs that apply in each country together with energy costs and economic parameters are taken into account in order to sum up the initial energy upgrade budget for each case. The second step regards the computation of investment criteria such as NPV and IRR and the analysis is performed for a 30-year period to account for the life-cycle of a building using economic parameters such as Discounting and Inflation Rates. Then, the particulars of each Country's funding scheme are incorporated into the economic model to reveal their benefits and evaluate their attractiveness. The final output of the study comprises a comparative analysis of the current funding schemes using Present Worth as an indicator for the evaluation of their application in each country.

Followed the analysis conducted it is concluded that the Cypriot and Greek funding schemes have a strong effect when applied and evaluated in all three countries. On the contrary, the UK's funding scheme is not applicable in terms of financial attractiveness in the case of Greece and Cyprus.

KEYWORDS: Energy retrofits, Residential buildings, Funding schemes, Economic evaluation.

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Introduction

According to the European Commission, EU has made important progress towards meeting its climate and energy targets for 2020. Regarding greenhouse gas emissions, there was a reduction of 18% in the EU between 1990 and 2012, and is well on track to meet the 2020 target. The share of renewables in the EU's energy mix in 2012 reached 14.1%, comparing to 8.5% in 2005 and energy efficiency is predicted to improve by 18% to 19% by 2020 (EU, 2015).

However, an integrated policy framework for the period up to 2030 is needed to ensure regulatory certainty for investors and a coordinated approach among Member States. The new 2030 targets aim to help the EU achieve a more competitive, secure and sustainable energy system and to meet its long-term 2050 greenhouse gas reductions target. The 2030 targets can be summarized to the following (EC, 2014):

- a 40% cut in greenhouse gas emissions compared to 1990 levels
- at least a 27% share of renewable energy consumption
- a 30% improvement in energy efficiency (compared to projections of 2020)

The European Commission proposed a 30% energy savings target for 2030, following a review of the Energy Efficiency Directive (Directive 2012/27/EU, 2012). The proposed target builds on the achievements already reached: new buildings use half the energy they did in the 1980s and industry is about 19% less energy intensive than in 2001. The European Council, however, endorsed an indicative target of 27% to be reviewed in 2020 having in mind a 30% target.

In addition, it has been stated that the cost of meeting the targets does not substantially differ from the price need to be paid to replace ageing energy systems. The main financial effect of decarbonisation will be to alter our energy behavior and turn towards low-carbon technologies. However, Maio et al (2012) and Patlitzianas (2011) highlight that one of the main obstacles for achieving high energy efficiency standards, regards financing such projects when appropriate and competitive financial schemes are absent.

Problem Definition

The successful mobilization and scale up of investments in energy upgrade projects in the building sector has to overcome important obstacles nowadays due to the ongoing economic crisis that EU is facing. Uncertainty and risk created by current economic state of various EU Member States has caused according to BPIE (2010) a freeze or deceleration on critical energy projects and a delay in energy technology development. In addition, as the unemployment rate is increasing, investing in energy efficiency measures in households is considered a "luxury". As indicated by Frederiks et al (2015), investment costs in energy efficiency measures are considerable and immediate, requiring liquidity, while benefits can be seen gradually over time. On the other hand, homeowners are more and more interested in such projects as it is the only way to reduce energy demands and thus energy consumption and annual utility expenses. To tackle this challenge there is a need of widespread adoption and implementation of effective policies and support programmes.

According to Global Buildings Performance Network, effective policy packages for energy upgrade projects should include a collection of policy instruments that, combined, can upscale, finance, and promote deep renovations in Member States. What is crucial indicated by Shnapp (2015) is that respective policy packages of instruments should be formed according to the specific political, economic and social situation of the MS.

Last, according to Menicou et al (2014) there is a need for an economic analysis to reveal the financial attractiveness for energy upgrades in the residential sector in the absence of Government subsidies but also to evaluate current funding schemes in terms of effectiveness. This would facilitate local authorities and policy makers to develop such incentive schemes to constitute energy retrofits on residential buildings financially attractive to the general public and comply with European regulations.

Similarly, Nikolaidis et al. (2009), applied several retrofit strategies in a typical Greek building as a means to assess economic merits from alternative retrofit approaches. For the ranking of energy saving retrofit approaches, two evaluation criteria were used, namely, the Internal Rate of Return (IRR) criterion and the Net Present Value (NPV) criterion. Asadi et al. (2012), and Diakaki et al. (2008), used an alternative approach to this problem by applying multi-objective optimization techniques to a wide spectrum of alternative energy saving measures and to identify the most appropriate ones. However, many authors such as Menassa (2011), Gluch et al. 2004, Gough et al. 1996, Dowd 1998, Ye et al. 2000, Myers 1976, Luehrman 1998, Copland et al. 2004, and Dell'Isola 2003, state that the NPV approach in assessing energy retrofit projects has several limitations.

Methodology

The main aim of the current study is to evaluate the attractiveness of current funding schemes for energy efficiency projects in the residential sector in Cyprus, Greece and UK. As a first step the methodology is assessing the energy requirements of typical residential buildings in Cyprus, Greece and UK and the energy savings resulting from the application of retrofit strategies. For this reason a research on characteristics of each country's building stock that affect the energy performance of buildings has been conducted in order to identify a typical representative residential building to be used as a case study.

Thermal modelling of the representative building was used so as assess the energy savings potential and cost effectiveness of the application of retrofit strategies. In each case study the building can be described as typical in terms of age, location, construction characteristics and materials representing a considerable percentage of Cyprus, Greece and UK residential building stock, following evidence from various sources such as Statistical Services, scientific publications and outputs from research projects.TRNSYS v.17 was used to simulate heating and cooling energy consumption of the typical residential buildings over a 1 year period for several retrofit scenarios. In all three cases the same building was used in terms of type of construction (detached 2 story dwelling), size (205 m^2), orientation (South – Southwest), internal layout and number of occupants (family of 5) and differentiated in construction materials.

Five retrofit scenarios are considered based on the particulars of each funding scheme. The scenarios comprise improvements of the external walls' U-value by adding insulation (Scenario 1-S1), improvements of the roofs' U-value by adding insulation (Scenario 2-S2), improvements of the glazing by replacing old panes with energy efficient ones (Scenario 3-S3), improvements on the envelope of the building regarding opaque components (Scenario 4-Combined S1+S2) and finally improvements on the envelope of the building regarding opaque and transparent components (Scenario 5-Combined S1+S2+S3).

Monetary cost estimation of each retrofit scenario considered, marks the initialisation of the economic analysis for the base case economic scenario. Then, the percentage reduction in heating and cooling requirements to be brought about by each retrofit scenario is calculated. These percentages are utilised to estimate the annual expected monetary savings for each scenario considered. As soon as the annual expected savings are determined, a discounting factor is applied to calculate Net Present Value (NPV) of each retrofit scenario considered. Current funding schemes with the respective terms and conditions are applied in order to form economic scenarios for each retrofitting scenario in each country. Subsidies and remaining amounts based on the initial investment budget of each retrofit scenario are calculated. Last but not least, Present Worth is then computed so as to evaluate the funding schemes and compare them for each retrofit scenario in each country.

Energy savings potential

The assessment of the energy savings potential for the typical residential buildings in Cyprus, Greece and UK was performed through the modelling and simulation procedure. Focus has been given to the heating and cooling loads of the pre-retrofitting and post-retrofitting simulations. As seen through Fig. 1, Fig. 2 and Fig. 3, depicting the simulation results, the initial thermal loads are dependent on the initial construction characteristics revealing how energy intensive typical buildings are. The "Trend" at the graphs depicts the change in post-retrofitting heating and cooling loads.

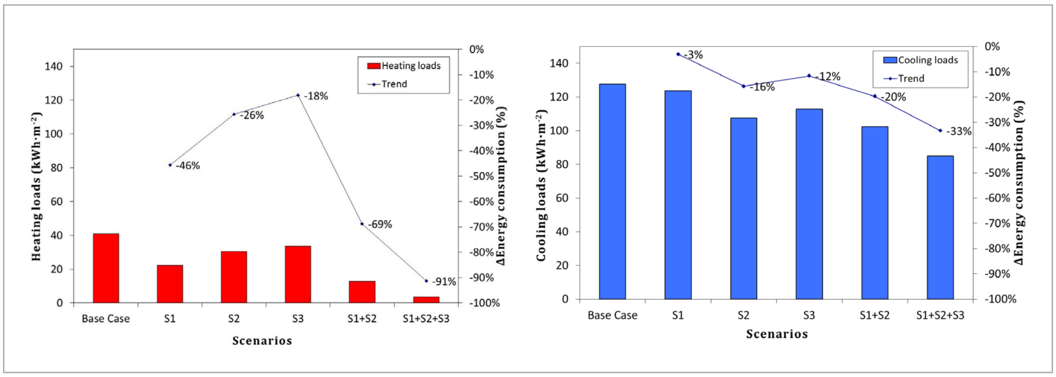

Fig. 1

Heating and cooling loads for the residential building in Cyprus and the respective energy demand change (Trend) for each scenario

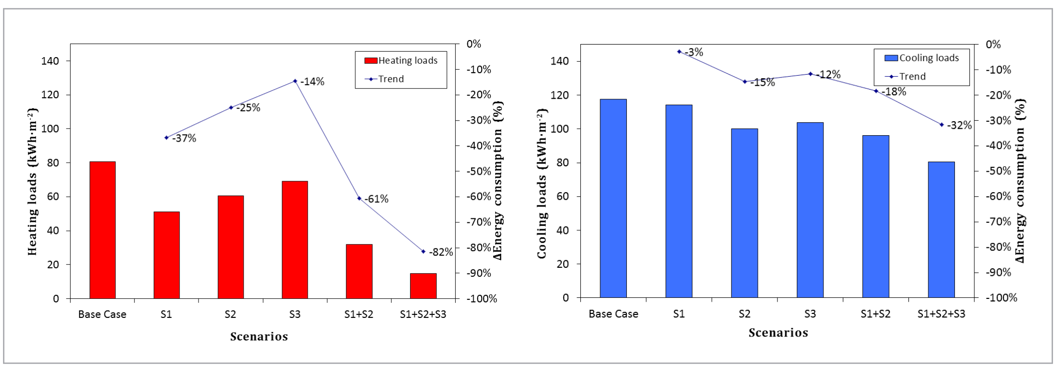

Fig. 2

Heating and cooling loads for the residential building in Greece and the respective energy demand change (Trend) for each scenario

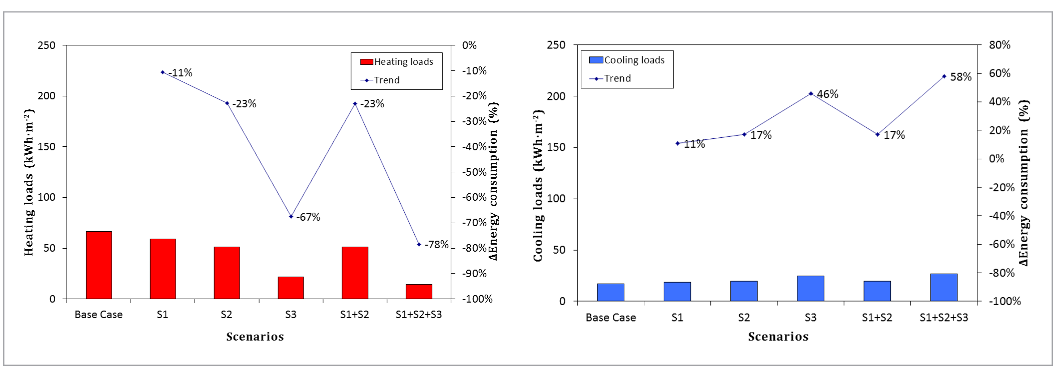

Fig. 3

Heating and cooling loads for the residential building in UK and the respective energy demand change (Trend) for each scenario

Economic Analysis

The aforementioned simulation results of the reference building and the respective scenarios are used as an input to the economic analysis. The investment budget (investment required) for each retrofit scenario was an outcome of the computation of the total cost of retrofitting measures (materials and labor) for each retrofit scenario depending on the market prices of each country (Cyprus, Greece, UK). Common values that apply for each retrofitting activity can be seen in Table 1. Statistical data on current household energy needs in terms of grid-supplied electricity and heating oil/ natural gas are used so as to calculate the estimated energy consumption reduction followed be the application of the energy demands reduction percentage.

Table 1

Key input data for Cyprus, Greece and UK

Energy & Investment Parameters	CYPRUS	GREECE	UK
Investment Horizon (Yrs)	30	30	30
Discounting Rate	6.4%	6.4%	6.4%
Inflation Rate of Cost Energy (Electricity & Heating Oil)	2.5%	2.5%	2.5%
External Wall Retrofitting Cost /m^2	€ 45.0	€ 50.0	€8.1
Roof Retrofitting Cost /m^2	€ 35.5	€ 40.0	€3.5
Glazing Dbl Low-e Cost /m^2	€ 234.0	€ 280.0	€291.0
Annual requirements in Heating oil/ Natural Gas (KWh)	**15271**	**21273**	**31019**
Price of Heating oil/ NG per KWh (Year zero)	€ 0.0971	€ 0.1262	€0.09
Annual Cost of Heating Oil/ NG (Year zero)	€ 1,482.62	€ 2,684.94	€2,697
Annual Requirements in Grid Supplied Electricity - Cooling (kWh)	**1,351**	**444**	**0**
Cost per kWh	€ 0.27	€ 0.15	€0.18
Annual Cost of Grid Supplied Electricity	€ 364.72	€ 66.65	€ 0.00

As a following step, detailed economic calculations took place so as to estimate the Net Present Value (NPV) and Internal Rate of Return (IRR). The Base-case economic scenario for the three countries refers to the energy upgrade project in the absence of funding schemes and the results of which can be seen in Fig. 4.

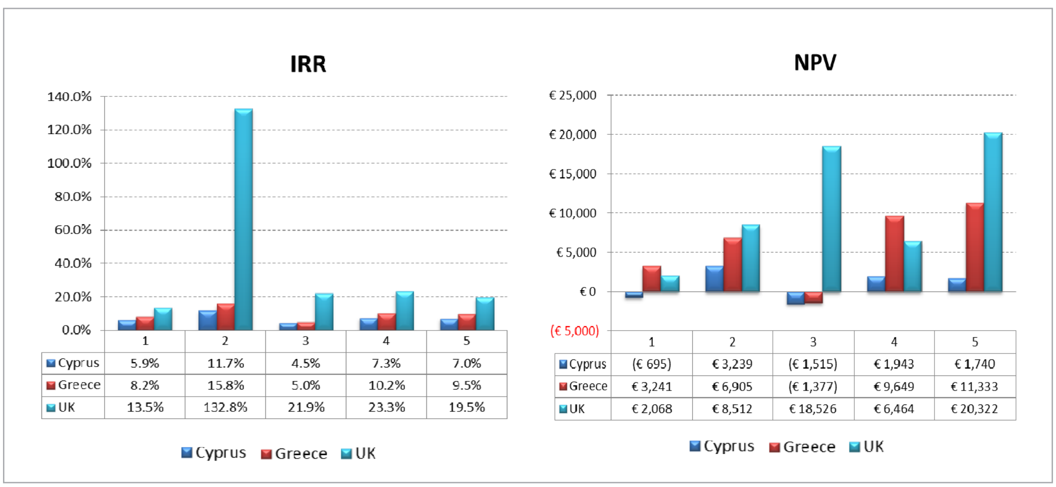

Fig. 4

Internal Rate of Return and Net Present Value results for the base-case economic scenario

Funding Schemes Integration

The Cypriot funding scheme “Eergy upgrade at Households”

The current scheme, which is the first integrated scheme for energy upgrades of residential buildings in Cyprus, was published by the Ministry of Energy, Commerce, Industry and Tourism during March 2015. The aim of the scheme is to promote energy efficiency through the implementation of large-scale energy upgrading interventions of the existing building stock in the country with a view to improving energy efficiency in households, including the use of Renewable Energy Sources (RES). The scheme is developed under the Operational Programme “Competitiveness and Sustainable Development” 2014-2020 with public expenditure of €16.5M for the respective programming period. It covers investments that concern the supply and installation of new equipment/

material and are mature technologies and not in the stage of research and development.

The funding programme refers to integrated energy upgrade of buildings or building units used as residences, to achieve energy efficiency class at least B in the Energy Performance Certificate (EPC) or to reduce energy consumption of at least 40% compared to the overall home energy consumption before the upgrade. The amount of public financing is 50% of the total approved budget. For cases of vulnerable consumers, the amount of public funding is increased to 75%. The grant amount for energy upgrade of each building can be up to € 15,000.

The Greek funding scheme “Energy Efficiency at Household Buildings”

The program “Energy Efficiency at Household Buildings”, published during May 2011 by the Ministry of Environment, Energy and Climate Change, was designed having as a goal the promotion of integrated energy-saving interventions in the residential building sector and with the main objective to reduce the energy requirements of buildings, the GHG emissions that contribute to the deterioration of global warming and to achieve a cleaner environment. It offered citizens incentives to carry out the most important interventions, aimed at improving their houses’ energy efficiency, while at the same time contributed to the achievement of Greece’s energy and environmental targets.

It is funded by the European Union (European Regional Development Fund) and National Resources, through the Regional Operational Programmes and the Operational Programmes “Competitiveness and Entrepreneurship”, “Environment and Sustainable Development” NSRF 2007-2013. The total public expenditure of the program is €396M. The eligibility of the program expenditure expired at the end of December 2015 and it will be completed no later than the end of 2017.

The funding subsidized categories were based on annual incomes and can be summarized in Table 2.

Table 2

Categories of the Greek funding scheme

Category	A1	A2	B
Personal Income	≤12.000€	12.000€ < P.I. ≤ 40.000€	40.000€ < P.I. ≤ 60.000€
Family Income	F.I. ≤ 20.000€	20.000€ < F.I. ≤ 60.000€	60.000€ < F.I. ≤ 80.000€
Subsidy	70% 30% interest-free loan (interest subsidy of 100% up to 31.12.2015)	35% 65% interest-free loan (interest subsidy of 100% up to 31.12.2015)	15% 85% interest-free loan (interest subsidy of 100% up to 31.12.2015)

The UK funding scheme “Green Deal”

The Green Deal is a UK government backed initiative, launched initially in October 2012 by the Department of Energy and Climate Change to permit loans for energy saving measures for properties in UK.

Through this scheme homeowners were able to understand the energy-saving improvements that can be applied to their homes and find companies to carry out the work, by giving access to a number of options for paying for the improvements, including Green Deal finance.

The uniqueness of the Green Deal stands in the fact that Green Deal loans are repaid through the electricity bill of the tenant. Another characteristic of the Green Deal contract is that it belongs to the property, meaning that the loan will be repaid by any tenant that resides in the property. A small amount is taken from the meter each day if there is a prepayment meter. If the occupant moves, he no longer benefits from the improvements and therefore stops paying for them. This system is known as the ‘Golden Rule’ - the annual repayments on the loan shouldn’t be more than the savings made on the energy bills.

Regarding interest rates, they are fixed for the full term of the plan so the repayments are fixed but there’s no set rate. The interest rate will be determined by the amount of the finance plan and are dependent on the provider.

Funding schemes under the Green Deal comprised 3 Offers:

Table 3

Funding scheme offers under the Green Deal

Funding scheme-Offer 1	Funding scheme-Offer 2	Funding scheme-Offer 3
Up to €1,115 subsidy towards the cost of installing any 2 of the following: _ a condensing gas boiler on mains gas _ glazing replacement _ energy efficient replacement external doors _ cavity wall insulation _ floor insulation _ flat-roof insulation _ insulation for a room in the roof _ a replacement warm air unit _ fan-assisted storage heaters _ a waste water heat recovery system	Up to €557 more if the application is made within 12 months of buying a home	Possible to claim back up to €111 towards the cost of the Green Deal assessment if energy-saving improvements are installed through the GDHIF (Green Deal Home Improvement Fund)

It is worth noting that there was previously a 4th Offer regarding solid wall insulation (internal or external) but currently the scheme is closed. Around 6.6 million homes in the UK have solid walls. The respective scheme funded 67% of the budget, up to a maximum of €4,460. The new program is focusing on cavity wall insulation and other measures.

Despite the fact that the Green Deal once presented and launched seemed highly promising in regards to the effects that the scheme will have in energy renovation of residential buildings, there were quite a few voices of doubt. There has been a wide discussion regarding the benefits, restrictions and gaps of the scheme. Common worries refer to the fact that the total cost of the parts, labor and finance should always be less than the total savings made. But the fact that interest is charged on the loan at about 7% suggests this is going to be hard to achieve.

Other uncertainties that arise, are based on the effect a Green Deal loan could have on a house sale. The loan is linked to the house, rather than to the individual, and as the scheme is still relatively new it is unclear whether this might make the property harder to sell.

Last but not least, since the energy savings are directly linked to the user in terms of different energy demands and thus different consumption, it can create a different outcome if another tenant occupies the house. The user's type and behavior is affecting a great deal the successfulness of the Green Deal scheme applied in a house.

However, after a series of amendments made in the basic core of the scheme, wide acceptance seemed to be gained by householders.

Summing up the three funding schemes that apply in Cyprus, Greece and UK used in the analysis, their particulars, encoded, can be seen in Table 4. The schemes are categorized into 6 groups, two

Table 4

Summary of funding schemes for each country (Cyprus, Greece, UK)

Abbreviation	Short description
CYP 1 (CYPRUS 1)	Vulnerable People (75%)
CYP 2 (CYPRUS 2)	Non-Vulnerable People (50%)
GR 1 (GREECE 1)	F.I. ≤ 20.000€ OR P.I.≤12.000€ (70% up to 10500€)
GR 2 (GREECE 2)	20.000€ < F.I. ≤ 60.000€ OR 12.000€ < P.I. ≤ 40.000€ (35% up to 5250€)
GR 3 (GREECE 3)	60.000€ < F.I. ≤ 80.000€ OR 40.000€ < P.I. ≤ 60.000€ (15% up to 2250€)
UK 1	Up to 1115€ for combination of at least two measures

for Cyprus based on the type of applicant (vulnerable or non-vulnerable category), three for Greece depending on annual income of the applicant and one for the UK.

Results and Discussion

Each funding scheme was applied to all three countries in order to evaluate the applicability of them in each country and compare them in terms of financial attractiveness within the investment horizon. Table 5, Table 6 and Table 7 present the particulars of each funding scheme when applied to each country. The investment required for each retrofit scenario varies depending on the country and thus the actual amount of grant is a different amount in each case. Loans are considered only in the case of the Greek funding scheme due to the fact that it is the only scheme that provides solid terms and reductions in interest rates in the case of loaning the remaining amount of the budget after the grant. Regarding the Remaining amount after the Grant, for the Cyprus and UK funding schemes; it is assumed that the applicant provides it. The same applies for the Greek funding scheme in case the Grant and Loan are not sufficient for the investment required.

Values with red color signify that this is the maximum amount that can be subsidized for the specific scenario regardless of the percentage of the subsidy. These amounts in red can be seen in the case of the Cypriot funding scheme in Scenarios 1, 2 and 3 due to a limitation of the scheme in subsidies regarding single measures in retrofitting (eg. Scenario 2: only roof insulation). In the case of the Greece and UK funding schemes it signifies that the maximum limit is reached which is occurring in Scenarios 4 (S1+S2) and 5 (S1+S2+S3) representing a combination of measures and not in single retrofitting measures. Greece and UK funding schemes have the same general maximum limit for all categories (Scenarios) of retrofitting in contrast with the Cyprus funding scheme where Scenarios 1, 2 and 3 have a different maximum limit from Scenarios 4 (S1+S2) and 5.

Observing the Tables it can be also noticed that the UK funding scheme is not applicable for Scenarios 1, 2 and 3 and this is because the Green Deal can only be applied when the investment refers to a combination of retrofitting measures and not in single measures.

According to Table 5, if the Greek funding scheme is applied to Cyprus, for Scenarios 1, 2 and 3 there is no remaining amount to be invested by the applicant. The interest rate is fully subsidized for a 6 year loan and thus it is the most attractive one in case the applicant is not capable in providing the remaining amount besides the Grant.

For the case of Greece (Table 6), the Greek funding scheme (Grant and Loan) is proved sufficient for Scenarios 1, 2, 3 and 4 and only Scenario 5 has a remaining amount to be covered by the applicant.

As observed in Table 7, for the case of UK, the UK funding scheme is the less attractive one in terms of subsidization amount. On the other hand, the Greek funding scheme covers all five scenarios (Grant and Loan) and the Cypriot funding scheme even if it does not provide terms for a loan, the remaining amount is considerably less than the one based on the UK funding scheme. However, it is worth noting that the Green Deal subsidized other interventions with different amounts in previous versions in the past.

Following the quantification of the Grant, Loan and Remaining amount that corresponds to each scenario for each country, the attractiveness of each funding scheme should be evaluated by an economic indicator taking into consideration the diminishing value of money over the predefined life-cycle of a building which corresponds to 30 years. Time value of money is addressed by applying a discounting factor to anticipated cash flows over the project's life considered (30 years). The Present Worth (PW) indicator is computed, which sums the anticipated cash flows over the project's life after applying this discounting factor. The computation of the PW indicator and a comparison between the funding schemes for each retrofit scenario for the case of Cyprus are depicted in Fig. 5.

Table 5. Application of funding schemes for the case of Cyprus

CYPRUS																
Investment Required		Scenario 1 (External Walls)			Scenario 2 (Roof)			Scenario 3 (Windows)			Scenario 4 (S1+S2)			Scenario 5 (S1+S2+S3)		
		€ 12,875			€ 4,530			€ 7,020			€ 17,404			€ 24,424		
		Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)
Cyprus Incentives	**CYP 1**	2,500	0	10,375	2,500	0	2,030	2,500	0	4,520	13,053	0	4,351	15,000	0	9,424
	CYP 2	2,500	0	10,375	2,500	0	2,030	2,500	0	4,520	8,702	0	8,702	12,212	0	12,212
Greece Incentives	**GR 1**	9,013	3,863	0	3,171	1,359	0	4,914	2,106	0	10,500	4,500	2,404	10,500	4,500	9,424
	GR 2	4,506	8,369	0	1,586	2,945	0	2,457	4,563	0	5,250	9,750	2,404	5,250	9,750	9,424
	GR 3	1,931	10,944	0	680	3,851	0	1,053	5,967	0	2,250	12,750	2,404	2,250	12,750	9,424
UK Incentives	**UK 1**	0	0	12,875	0	0	4,530	0	0	7,020	1,388	0	16,016	1,388	0	23,036

Table 6. Application of funding schemes for the case of Greece

GREECE																
Investment Required		Scenario 1 (External Walls)			Scenario 2 (Roof)			Scenario 3 (Windows)			Scenario 4 (S1+S2)			Scenario 5 (S1+S2+S3)		
		€ 8,400			€ 5,104			€ 14,305			€ 13,504			€ 27,809		
		Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)
Cyprus Incentives	**CYP 1**	2,500	0	5,900	2,500	0	2,604	2,500	0	11,805	10,128	0	3,376	15,000	0	12,809
	CYP 2	2,500	0	5,900	2,500	0	2,604	2,500	0	11,805	6,752	0	6,752	13,905	0	13,905
Greece Incentives	**GR 1**	5,880	2,520	0	3,573	1,531	0	10,014	4,292	0	9,453	4,051	0	10,500	4,500	12,809
	GR 2	2,940	5,460	0	1,786	3,318	0	5,007	9,298	0	4,726	8,778	0	5,250	9,750	12,809
	GR 3	1,260	7,140	0	766	4,338	0	2,146	12,159	0	2,026	11,478	0	2,250	12,750	12,809
UK Incentives	**UK 1**	0	0	8,400	0	0	5,104	0	0	14,305	1,388	0	12,116	1,388	0	26,421

Table 6. Application of funding schemes for the case of UK

UK																
Investment Required		Scenario 1 (External Walls)			Scenario 2 (Roof)			Scenario 3 (Windows)			Scenario 4 (S1+S2)			Scenario 5 (S1+S2+S3)		
		€ 2,089			€ 396			€ 7,830			€ 2,484			€ 10,314		
		Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)	Grant (€)	Loan (€)	Remain (€)
Cyprus Incentives	**CYP 1**	1,567	0	522	297	0	99	2,500	0	5,330	1,863	0	621	7,736	0	2,579
	CYP 2	1,045	0	1,045	198	0	198	2,500	0	5,330	1,242	0	1,242	5,157	0	5,157
Greece Incentives	**GR 1**	1,462	627	0	277	119	0	5,481	2,349	0	1,739	745	0	7,220	3,094	0
	GR 2	731	1,358	0	139	257	0	2,741	5,090	0	869	1,615	0	3,610	6,704	0
	GR 3	313	1,776	0	59	337	0	1,175	6,656	0	373	2,111	0	1,547	8,767	0
UK Incentives	**UK 1**	0	0	2,089	0	0	396	0	0	7,830	1,388	0	1,096	1,388	0	8,926

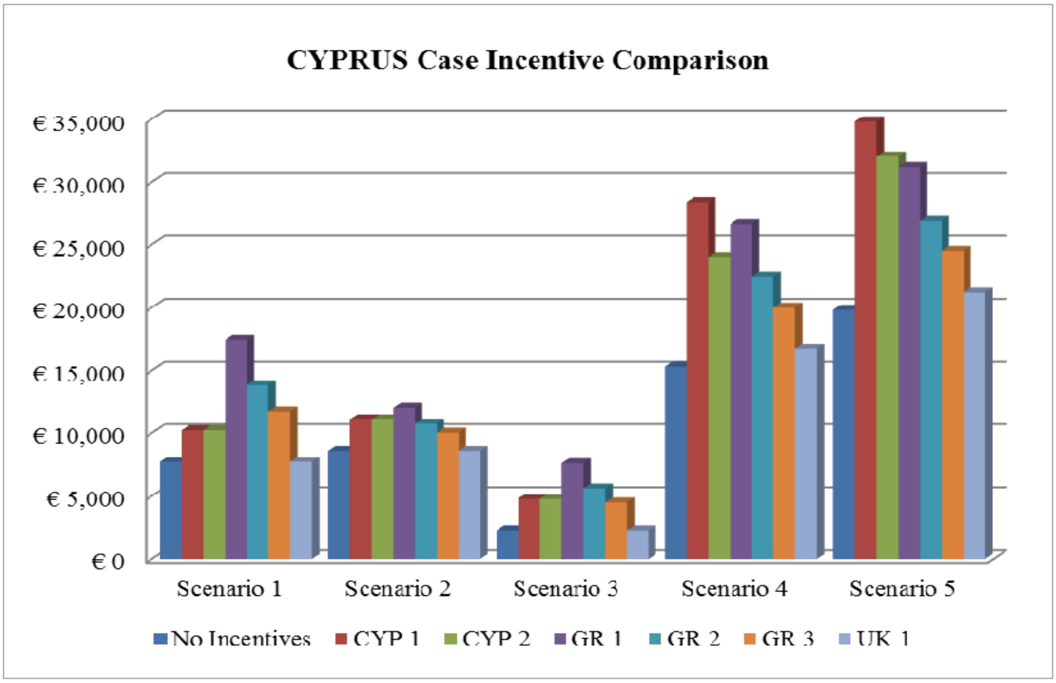

Fig. 5

Incentives comparison for the Cyprus case of retrofitting based on PW Indicator

For Scenario 1 which refers to external wall retrofitting, the Greek funding schemes stand out having the highest value of PW and followed by the Cyprus funding schemes. GR 1 seems to be the most profitable scheme of all and refers to applicants of lower annual income, up to 20000€ for Family Income and up to 12000€ for Personal Income. In these terms it can be compared with the CYP 1 standing for vulnerable people, although this category involves various types including disabled or families with many members besides annual income. Regarding Scenario 2, again GR 1 has the highest PW value. However in this case the 2nd and 3rd place occupy the CYP 1 and CYP 2 respectively and followed by GR 2 and GR 3. Scenario 3 has the lowest PW values of all Scenarios due to the high initial investment required. In this case the Greek funding schemes have higher values and are followed by the Cyprus funding schemes. For Scenarios 1, 2 and 3, the UK funding scheme is not applicable for single measures and thus has the same PW value with the "No incentives" value.

Scenarios 4 and 5 are the most profitable of all. For both Scenario 4 (S1+S2) and 5 (S1+S2+S3) the most attractive scheme is the CYP 1 followed, in Scenario 4 (S1+S2), by GR 1 and in Scenario 5 (S1+S2+S3) by CYP 2. In total, it can be concluded that for the Cyprus case of retrofitting residential buildings, the Cypriot funding schemes outbalance the rest in integrated energy upgrades with a combination of measures applied in the building envelope and openings. However, for single measures' application, the Greece funding schemes are more attractive.

For the case of retrofitting residential buildings in Greece, Fig. 6 depicts the computation of PW values for each retrofitting Scenario. As in the Cyprus case, GR 1 has the highest value for Scenarios 1 and 2 but the difference with the rest of the funding schemes has decreased here. Scenario 3 is the less profitable scenario as the cost of retrofitting is even bigger than in the case of Cyprus. Regarding Scenario 4 (S1+S2), GR 1 funding scheme is almost at the same level with CYP 1. The same outcomes can be observed in PW in Scenario 5 (S1+S2+S3) where CYP 1 and CYP 2 are slightly better than GR 1. In general for the case of Greece the Greek funding scheme GR1 for low income applicants is as attractive as the CYP 1 with slight differences comparing to the Cyprus case where the differences were more noticeable.

Concerning energy retrofitting of residential buildings in UK, there is a countable difference in the initial investment required for each retrofit Scenario. This lies in the fact that residential buildings

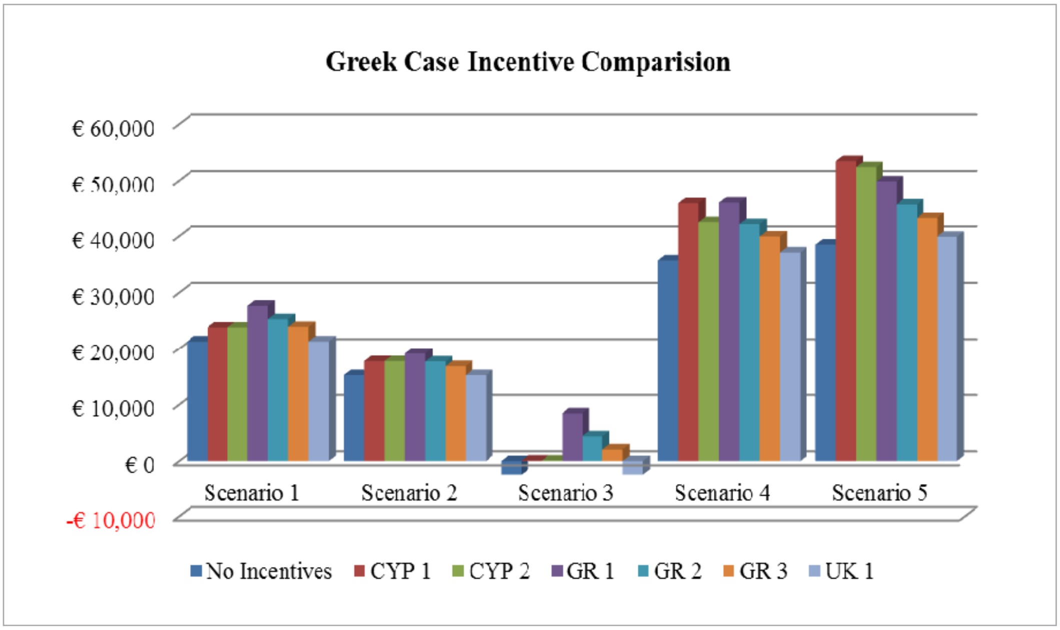

Fig. 6

Incentives comparison for the Greece case of retrofitting based on PW Indicator

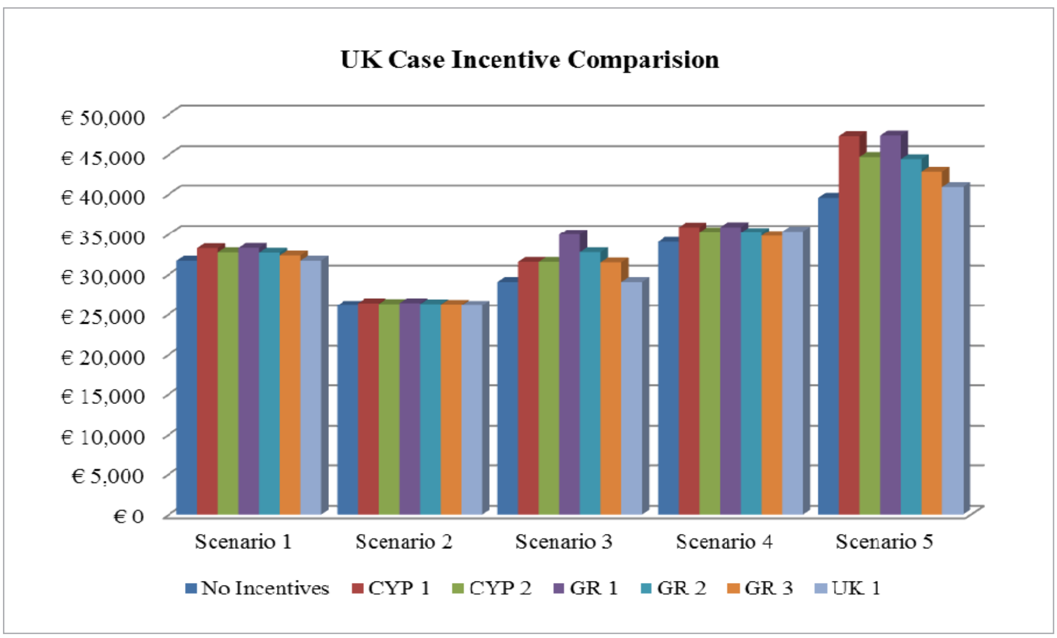

Fig. 7

Incentives comparison for the UK case of retrofitting based on PW Indicator

have different characteristics than the typical residential buildings that can be found in Cyprus and Greece and thus the procedures for retrofitting differ significantly. For example, cavity wall insulation is much cheaper than external wall insulation in Cyprus and Greece and much cheaper than solid wall insulation that a previous version of the Green Deal used to subsidize in the past. Regarding the attractiveness of funding schemes applied in energy upgrade projects in UK, Fig. 7 present the PW values computed for each retrofit scenario. PW values of funding schemes under Scenarios 1, 2 and 4 (S1+S2) have slight differences between them. Under Scenario 3 and Scenario 5 (S1+S2+S3), the funding scheme GR 1 is more attractive than the rest having however a slight difference with CYP 1 in the case of Scenario 5 (S1+S2+S3).

It must be noted here that for the case of the UK funding scheme, the Green Deal presented in the current report is a follow up of a series of funding schemes unlike the Greek funding scheme running for the past 4 years in Greece and the Cypriot funding scheme which is the first integrated funding scheme for energy upgrade projects in residential buildings in Cyprus. This means that past version of UK funding schemes offered great assistance to home owners subsidizing such projects.

Conclusions

The current work dealt with the applicability and attractiveness of funding mechanisms used by Cyprus, Greece and UK to not only improve the renovation rate in the residential building sector of their country but also to comply with the respective European Directives as Member States and contribute to EU efforts for achieving the energy efficiency targets.

Even though each policy package is different it seems that the Cypriot and Greek funding schemes have a strong effect when applied and evaluated in all three countries. Both Cyprus and Greece have a subcategory that involves low income householders that can benefit in different terms by the funding schemes. On the contrary, the UK's funding scheme, designed to serve UK's building stock, is not applicable in terms of profitability in the case of Greece and Cyprus due to the distinct method of retrofitting according to different building characteristics leading to high costs of initial investment capital.

An important conclusion drawn from this analysis is that even though each Member State can benefit from successful policy measures adopted by other Member States, the actual design of a funding scheme should be unique for each country taking into account political, economic and social aspects as well as the special features of its building stock. However, successful funding schemes can provide crucial insights for policy makers for the proper design of innovative financial instruments.

It is also worth mentioning that almost all retrofit scenarios considered they do have positive financial merits in the absence of financial incentives. This is a critical conclusion that justifies investment in energy retrofit projects. However, a major drawback is the considerable investment in the front and the extensive payback period.

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