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Financial Analysis of Solar Water Heating Systems during the Depression: Case Study of Greece

Jacob G. Fantidis, Dimitrios V. Bandekas, Constantinos Potolias, Nick Vordos, Kostas Karakoulidis

Kavala Institute of Technology
St. Lukas, Kavala 65404, Greece
e-mail: fantidis@yahoo.com, dbandek@teikav.edu.gr, cpotolias@yahoo.gr, nvordos@teikav.edu.gr, karakoul@teikav.edu.gr

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The use of solar thermal collectors is an economic alternative for water heating. In Greece more than 4 million m^2 of collector area has been installed; however, the financial and economic crisis has dealt the solar thermal market a heavy blow. The aim of the paper is twofold: firstly, to present the new legislations and combined efforts taken by the government in order to give the solar thermal market a boost; secondly, to evaluate the effect of these efforts and calculate the new financial data from the citizens. For the promotion of solar water heaters, new legislations and concerted efforts are taken by the government. The effect of the new incentive program on the payback time of a typical glazed solar hot water system in Greece was investigated in this work. Long-term meteorological data from 47 stations are analyzed in order to evaluate the potential of solar water heater application at each site in Greece. The RETScreen software was used to predict the financial viability and the green house gas emissions reductions. The economical indicators showed that Tymbakion was the best site and Ioannina the worst. From the environmental point of view, it was found that on an average an approximate quantity of 1.47 ton of green house gases can be avoided entering into the local atmosphere each year.

Keywords: *Solar water heaters, Renewable energy, Payback period, GHG Emissions, Greece*.

Introduction

The idea of using the sun to heat water is not a new concept. Black painted water tanks were used as solar water heaters more than 1000 years ago. The sun is clean, inexhaustible, environmentally friendly, and sustainable source of energy. According to Resch et al. the global theoretical potential of solar energy was estimated at 3900000 EJ, however, the technical potential of solar energy is 1600 EJ (Resch et al., 2008) . Solar water heating technology has greatly improved during the past century. Today, only in the European Union there are more than 35.9 million m^2 of installed solar collectors (EurObserv'ER, 2011).Solar energy on water heating has proved reliable and economical. Greece is located in SE Mediterranean area with an affluent and reliable supply of solar energy, even during the winter. The entire Greek territory is characterized by high solar irradiance, so the annual solar energy at horizontal plane varies between 1450 kWh/m^2 and 1800 kWh/m^2 (Figure 1) (PVGIS, 2008). Considering solar radiation and many incentives form the Greek governments, it is not a surprise that Greece occupies the third position in the European Union market of domestic solar collectors. In the present study the project takes for granted a typical glazed liquid flat-plate collector, which are commonly used as domestic hot water systems (DHWS) to calculate the financial viability and the emission reduction due to the DHWS. 47 locations in Greece are considered, both the economic analysis and the environmental considerations calculated using the RETScreen software. The RETScreen Clean Energy Project Analysis Software (RETScreen, 2011) is an advanced mathematical model to evaluate the energy production and savings costs, emission reductions, financial viability and risk for various types of Renewable-energy and Energy-efficient Technologies.

Case study (Greece)

It is widely acknowledged that Greece possesses an excellent solar energy potential according to the existing long-term measurements, as presented in Figure 1.

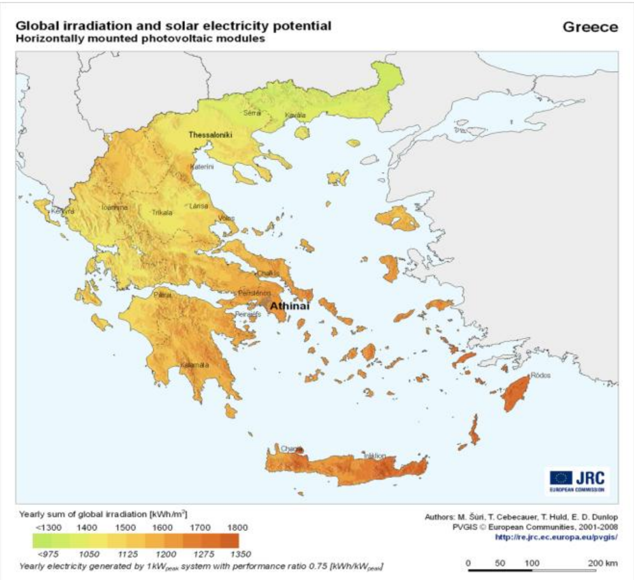

Figure 1. Global solar radiation in Greece

The economic viability of solar water heating systems is an old subject for the Greek researchers (Panteliou et al., 1990), (Haralambopoulos, Paparsenos and Kovras, 1997), (Diakoulaki et al, 2001), (Argiriou & Mirasgedis, 2003), (Kalogirou, 2009), (Tsilingiridis & Martinopoulos, 2010) Kaldellis et al. (Kaldellis, El-Samani & Koronakis, 2005), and Sidiras et al. (Sidiras & Koukios, 2005) presented the feasibility analysis of domestic solar water heating systems and the effect of the payback time on the spectacular diffusion of solar hot water systems in Greece. In this job the financial study has been realized not only on the famous Greek islands but also in many areas in the north Greece where solar radiation is smaller and the weather is colder. In addition, all the new financial data owing to the financial crisis were considered.

Greece is one of the most successful countries worldwide in the use of solar thermal energy. For many years, the number of installed systems of solar collectors per capita has been the highest within Europe (ESTIF, 2003)In the European Union, in terms of installed capacity Germany is the pioneer in the solar thermal collector capacity (in m^2 and in MWth) followed by Austria, Greece, Italy and Spain (Figure 2). However, if population numbers are considered Cyprus is the leader in front of Austria, Greece, Germany and Malta. The installed solar thermal collector in m^2 and kWth per capita is given in Figure 3. From the results it is obvious that Greece is in the third position in the country ranking (EurObserv'ER, 2011).

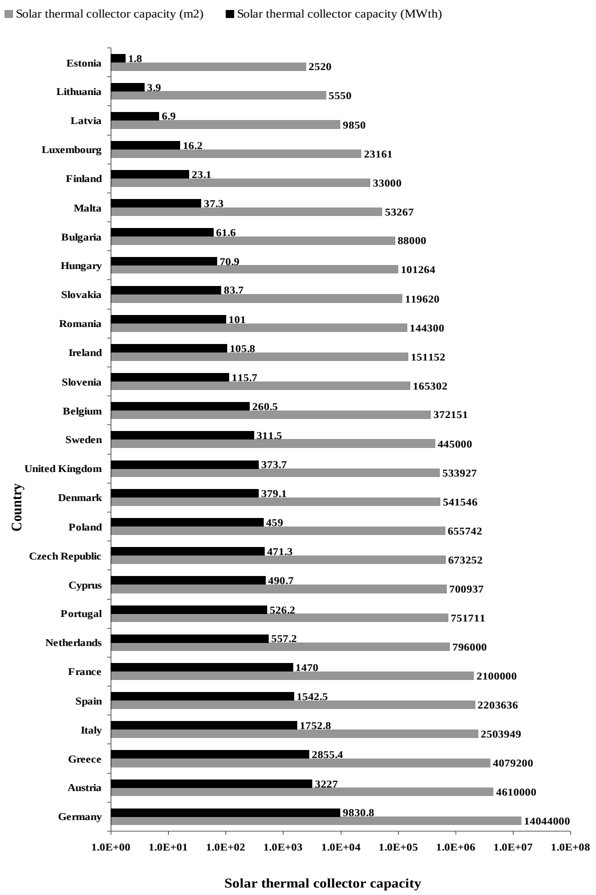

Figure 2. Total European Union solar thermal collector capacity installed by the end of 2010 (in m2 and in MWth)

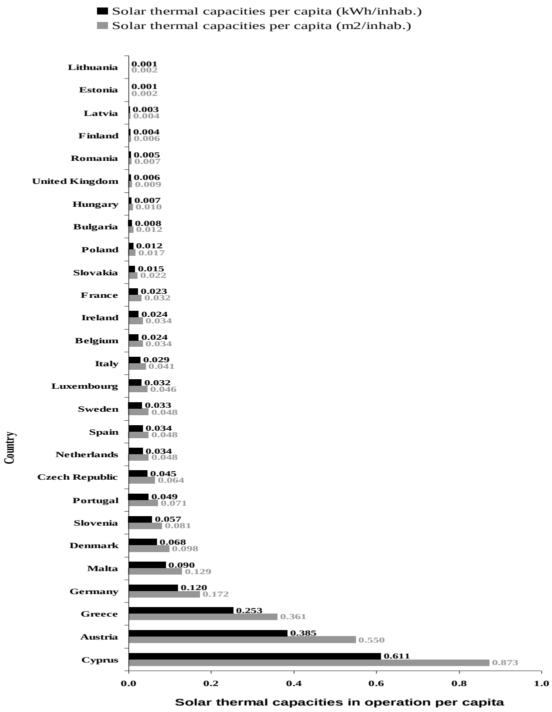

Figure 3. Solar thermal capacities capacity per 1000 EU inhabitants in 2010

In order to promote solar hot water systems (SHWS) Greek governments have offered a number of significant incentives, for examples Laws 814/1978, 849/1978, 1116/1981, 1262/82, 1473/84, 1892/1990, 2364/95 and 2601/98 support the DWHS market. More details there are on Ref. 13. However during the last 30 years the fiscal policy leads the country to the financial and economic crisis. This crisis has dealt the solar thermal market a heavy blow in Greece (which had 3500 jobs in 2008, and a major part of national output went for the export). According to the results (Figure 4), the market has dropped more than 30% in the last two years. In accordance with the EBHE (Greek Solar Industry Association) (ebhe, 2011) the main reason for this drop is that many families have decided to postpone their investments in a new solar hot water production system. In addition, the new bank loans are rather rarely owing to the fact that the cash flow of Greek banks is limited.

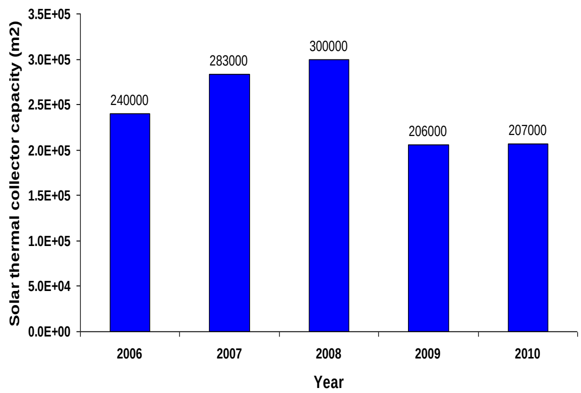

Figure 4. Solar thermal collector capacity installed in Greece from 2006 to 2010 (m^2)

In the effort to increase the sales of the DWHS two steps were taken from the relevant ministries. Firstly, Greek parliament passed a new Law (L3851/2010). According to the Law L3851/2010, since January 2011, all new (or redeveloped) buildings in Greece must cover at least 60% of their hot water requirements using solar energy (OJHR 3851, 2010). However, the EBHE states that the new legislation will have limited effects initially because of the construction market decline.

Secondly, with the intention to achieve energy saving for each of the 13 Greek administrative regions, there exists one regional programme covering: thermal insulations, biomass heating systems, passive solar heating systems, ground-source heat pump systems and SHWS (exoikonomisi, 2011). According to the program (EXOIKONOMISI), for the buildings with building licence before 01-01-1990 there is grant (35 % for family income up to 60000€ or 15 % for family income between 60000 € and 80000 €) and flat loan for loan up to 15000€. In all circumstances the government has implemented an incentive system for private householders based on a tax deduction scheme of 20 % of the installation cost. In any case, the tax relief cannot be above 700 €.

Climatic data

The performance from a SHWS is strongly dependent on the climatic conditions and accurate weather data in a targeted location is essential. In this study the long term (1955 – 1997) meteorological parameters for each of the 47 considered sites in Greece are obtained from the Hellenic National Meteorological Service (HNMS, 2011) and from the Technical Chamber of Greece (OJHR, 407,2010). The average daily solar radiation and the average temperature at these locations are given in Table 1. The geography in terms of latitude, longitude and elevation from the sea level is also presented in the same table.

Table 1

Long-term daily mean values of global solar radiation and air temperatures for 47 locations in Greece

N.	City	Latitude N	Longitude E	Elevation (m)	Daily solar radiation kWh/m²/day	Average air temperature (°C)
1	Agchialos	39° 13’	22° 48’	15.3	4.300	17.28
2	Agrinio	38° 37’	21° 23’	25	4.441	16.28
3	Alexandroupolis	40° 51’	25° 56’	3.5	4.118	15.01
4	Aliartos	38° 23’	23° 06’	110	4.399	16.74
5	Andravida	37° 55’	21° 17’	15.1	4.652	17.27
6	Araxos	38° 09’	21° 25’	11.5	4.445	17.84
7	Argos/Pirgela	37° 36’	22° 47’	11.2	4.661	16.94
8	Argostoli	38° 11’	20° 29’	22	4.585	18.13
9	Arta	37° 47’	20° 54’	7.9	4.421	16.58
10	Athens/Filadelfia	38° 03’	23° 40’	138	4.411	18.56
11	Athens/Hellenkio	37° 54’	23° 45’	15	4.475	18.56
12	Chania	35° 29’	24° 07’	150	4.660	18.50
13	Chios	38° 28’	26° 08’	5	4.549	17.29
14	Chrysopouli	40° 54’	24° 36’	5.4	4.156	15.08
15	Ierapetra	35° 00’	25° 44’	10	4.869	19.73
16	Ioannina	39° 42’	20° 49’	484	4.035	14.28
17	Iraklion	35° 20’	25° 11’	39.3	4.711	18.78
18	Kalamata	37° 04’	22° 00’	11.1	4.578	17.81
19	Kastoria	40° 27’	21° 17’	660.9	4.079	12.63
20	Kerkira	39° 37’	19° 55’	4	4.352	17.53
21	Kithira	36° 17’	23° 10’	316.6	4.672	17.69
22	Komotini	40° 18’	21° 47’	625	4.147	14.85
23	Konitsa	41° 07’	25° 24’	30	4.156	14.38
24	Korinthos/Velo	40° 03’	20° 45’	542	4.561	17.76
25	Lamia	38° 51’	22° 24’	17.4	4.284	16.59
26	Larisa	39° 39’	22° 27’	73.6	4.250	15.80
27	Limnos	39° 55’	25° 14’	4.6	4.331	15.95
28	Methoni	36° 50’	21° 42’	33	4.560	17.96
29	Milos	36° 43’	24° 27’	182	4.620	17.53
30	Mitilini	39° 04’	26° 36’	4	4.442	17.60
31	Naxos	37° 06’	25° 23’	9.8	4.593	18.21
32	Paros	37° 01’	25° 08’	33.5	4.646	17.93
33	Patra	38° 15’	21° 44’	1	4.393	17.87
34	Pirgos	37° 40’	21° 18’	12	4.606	17.52
35	Rethimno	35° 21’	24° 31’	7	4.614	19.41
36	Rhodes	36° 24’	28° 07’	11.5	4.701	19.14
37	Samos	37° 42’	26° 55’	7.3	4.729	18.58

N.	City	Latitude N	Longitude E	Elevation (m)	Daily solar radiation	Average air
38	Serres	41° 05’	23° 34’	34.5	4.052	15.18
39	Siros	37° 25’	24° 57’	72	4.625	18.71
40	Sitia	35° 12’	26° 06’	115.6	4.741	18.77
41	Skiros	38° 54’	24° 33’	17.9	4.315	17.24
42	Souda Bay	35° 33’	24° 07’	151.6	4.728	18.19
43	Tanagra	38° 19’	23° 33’	140.1	4.386	16.81
44	Thessaloniki	40° 31’	22° 58’	4.8	4.008	15.80
45	Trikala Imathias	40° 36’	22° 33’	0.8	4.074	15.15
46	Tymbakion	35° 00’	24° 46’	6.7	4.887	19.04
47	Zakinthos	39° 10’	21° 00’	10.5	4.376	17.93

The long-term seasonal variation of global solar radiation and the air temperature (°C) at 47 locations are shown in Figure 5 and Figure 6 correspondingly. From these figures, it is evident that higher values of radiation and higher temperatures were observed during summer months and lower in the Winter months. The study assumes a SWHS for a typical house with 4 occupants located for each of the 47 considered sites in Greece. The parameters of the investigated scenario are listed in Table 2 (Degelman, 2008).

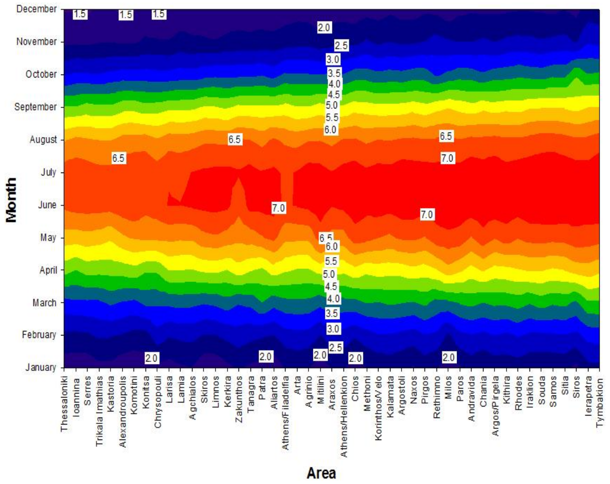

Figure 5. Monthly variation of global radiation for 47 locations in Greece

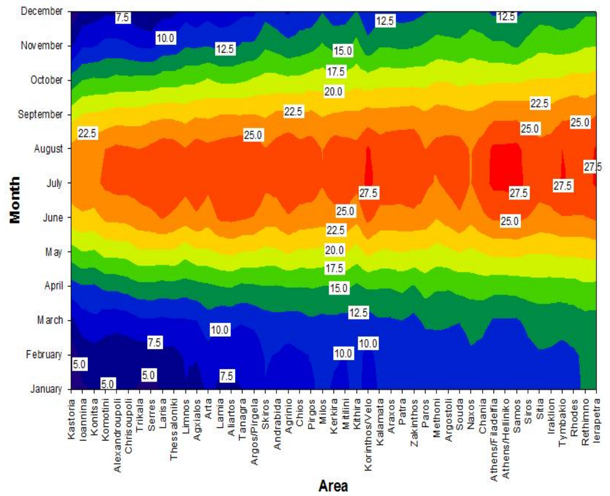

Figure 6. Monthly variation of air temperature for 47 locations in Greece

Table 2

Input parameters for the RETScreen software

Parameter	Value
Load type	House
Occupant	4
Occupancy rate	90%
Daily hot water use	216 L/d
Temperature	50 °C
Operating days per week	7 days
Water temperature – minimum	7 °C
Water temperature – maximum	29 °C
Solar water heater	
Type	Glazed
Gross area per solar collector	1.4 m²
Aperture area per solar collector	1.3 m²
Fr (tau alpha) coefficient	0.67
Fr UL coefficient	4.35 (W/m²)/°C
Temperature coefficient for Fr UL	0.013 W/m²)/°C²
Number of collectors	2
Solar collector area	2.8 m²
Capacity	1.82 kW
Miscellaneous losses	5%
Balance of system & miscellaneous	
Storage capacity / solar collector area	61.5 L/m²
Storage capacity	160 L
Heat exchanger efficiency	80%
Miscellaneous losses	5%
Pump power / solar collector area	5 W/m²
Electricity rate	0.078 €/kWh
GHG emission factor	0.664 tCO2/MWh
Financial parameters	
Inflation rate	4%
Project life	20 yr
Debt ratio	0%
Initial costs	1650€
Incentives and grants	0% or 15% or 35%
O&M (savings) costs	15€

RETScreen software

The RETScreen Software Solar Water Heating Project Model was used to perform the economics feasibility and emission reductions (RETScreen, 2011). The RETScreen can be used to evaluate solar water heating projects, from small-scale domestic hot water applications and swimming pools, to large-scale industrial process hot water systems (Gastli & Charabi 2011), (Houri, 2006).

The software contains six worksheets (Energy Model, Solar Resource and Heating Load Calculation, Cost Analysis, Greenhouse Gas Emission Reduction Analysis (GHG Analysis), Financial Summary and Sensitivity and Risk Analysis). The annual performance of a solar water heating system with a storage tank is dependent on system characteristics, solar radiation available, ambient air temperature and on heating load characteristics. The suggested values of daily hot water usage are derived from the tables published in the ASHRAE Applications Handbook (ASHRAE, 1995).

According to the Duffie and Beckman (Duffie & Beckman, 1991) glazed collectors are described by the equation:

$$\dot{Q}_{coll} = F_R(ta)G - F_R U_L \Delta T \quad (1)$$

where $\dot{Q}_{coll}$ is the energy collected per unit collector area per unit time, F_R is the collector's heat removal factor, t is the transmittance of the cover, α is the shortwave absorptivity of the absorber, G is the global incident solar radiation on the collector, U_L is the overall heat loss coefficient of the collector, and ΔT is the temperature differential between the working fluid entering the collectors and outside.

The performance of service hot water systems with storage is calculated with the *f-Chart* method. The intention of the method is to compute the fraction of the hot water load (*f*) that is provided by the solar heating system (*solar fraction*). The method enables the calculation of the monthly amount of energy delivered by hot water systems with storage, given monthly values of incident solar radiation, ambient temperature and load. The fraction f of the monthly total load supplied by the solar water heating system is described by the equation:

$$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3 \quad (2)$$

where X and Y are dimensionless parameters, which are defined as:

$$X = \frac{A_C F'_R U_L (T_{ref} - T_a)}{L} \quad (3)$$

$$Y = \frac{A_C F'_R \; \overline{ta} \; H_T N}{L} \quad (4)$$

A_c is the collector area, F'_R is the modified collector heat removal factor, T_{ref} is an empirical reference temperature equal to 100°C, T_a is the monthly average ambient temperature, L is the monthly total heating load, is the collector's monthly average transmittance-absorptance product, H_T is the monthly average daily radiation incident on the collector surface per unit area, and N is the number of days in the month (CEPA, 2005)

Results and discussion

Given the meteorological data at a certain site, the RETScreen calculates the pre-tax internal rate of return (IRR) on assets (%), the simple and equity payback periods (years) and the GHG emission reduction. IRR represents the true interest yield provided by the project assets over its life before income tax, simple payback period represents the length of time that it takes for a proposed project to recoup its own initial cost, out of the income or savings it generates and equity period represents the length of time that it takes for the owner of a project to recoup its own initial investment out of the project cash flows generated. IRR, simple and equity payback periods calculated for every area for 3 cases, with 15 % grant, with 35 % grant and without incentives and grants.

IRR values at 47 locations are given in Figure 7. As seen from this figure, the IRR increases directly with the increase in global solar radiation value. The Aegean Archipelagos islands are the more attractive areas, contrarily the lowest values are obtained in the North Greece. Without grants the IIR fluctuates among 9 and 13 % with average value approximately 11.5 %. With 15 % subsidy IRR varies from 11 up to 16.4 % (with mean value about of 13.8 %) and for financing equal to 35 % the IRR range from 14.9 up to 21.3 %. In all circumstances the maximum IRR is found at Tymbakion while the minimum IRR is found at Ioannina.

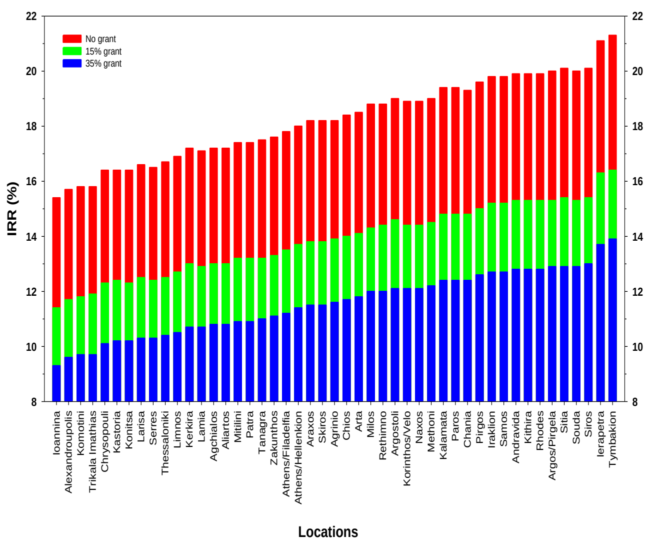

Figure 7. Internal rate of return values for 47 locations in Greece

Similarly, simple and equity payback periods are also mainly determined by the solar radiation. Both of these parameters are shown in Figure 8 and Figure 9 for all the locations. From these figures are obvious that areas with higher global solar radiation have the smallest payback periods. Minimum values of simple payback period of 5.7, 7.5 and 8.8 yr for grants 35 %, 15 % and 0 % respectively, were found for Tymbakion. The corresponding maximum values of 8, 10.5 and 12.3 yr were found at Ioannina. On an average, the simple payback period can be achieved in 6.8, 8.9 and 10.4 yr at any location, respectively. Equity payback is a better time indicator of the project merits than the simple payback. The simple payback is useful, however, as a secondary indicator to indicate the level of risk of an investment. As regards the equity payback period, the minimums values were found at Tymbakion (7.4 yr without grants, 6.4 yr for 15 % grant and 5.1 yr for 35 % grant) while the maximum values were found at Ioannina (9.9 yr without grants, 8.6 yr for 15 % subsidy and 6.8 yr for 35 % subsidy).

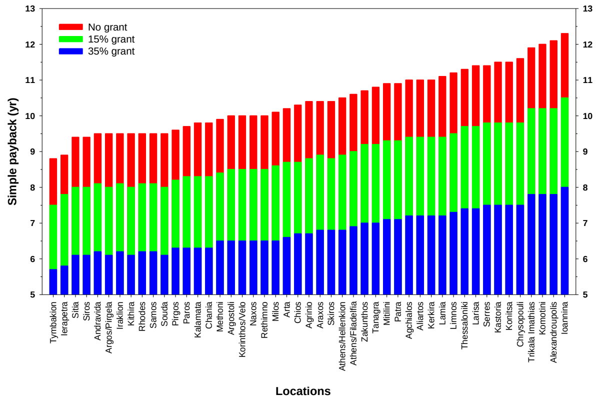

Figure 8. Simple payback period for 47 cities in Greece

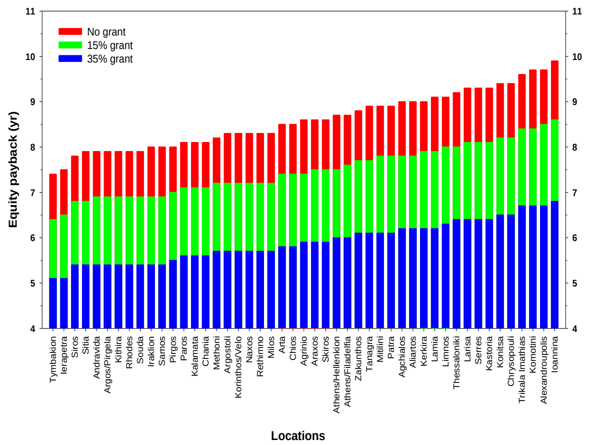

Figure 9. Equity payback period for 47 cities in Greece

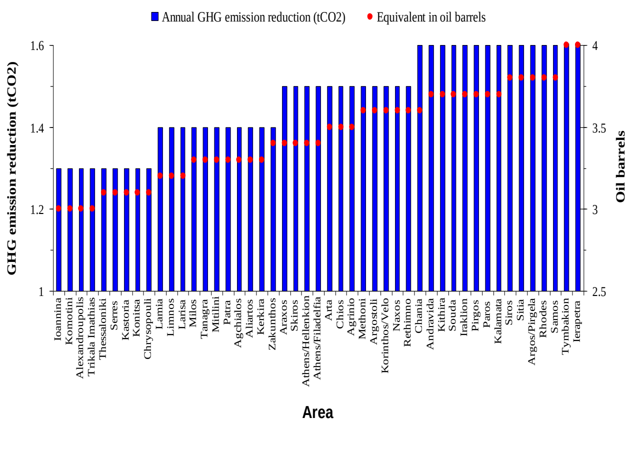

Figure 10. Green house gases reduction due usage of SWHS

The RETScreen is capable of estimating the amount of GHG which could be avoided as a result of usage of SWHS. The amount of GHG reduction and the equivalent in oil barrels for the 47 locations are presented in Figure 10. Based on Figure 10 the highest GHG emissions mitigation of 1.7 tons/year was observed at Ierapetra and Tymbakion. On an average more than 1.47 ton of green house gases each year can be avoided from entering into atmosphere from any location in the Greece from each SWHS

Conclusions

Greece has a high content of solar radiations all over the year and occupies the third position in the European Union market of domestic solar collectors. However many serious mistakes in fiscal policy lead the country to the financial and economic crisis. Despite the pecuniary problems, the Greek government tries to encourage the solar thermal market. For this direction there is a new incentive program for old houses and in the new buildings compulsory 60% of hot-water needs to be covered by solar thermal. The study carried out, aimed to present and evaluate, not only from economic view, the efforts from the Greek parliament. According to the new data this paper has investigated the financial prospects of using a SWHS in Greece. Using average daily meteorological data the study assumed a typical glazed SWHS at each of the 47 cities, to calculate the IRR, the simple payback period, the equity payback period and the potential emission reduction due to the SWHS.

Based on economical indicators, Tymbakion was found to be the best site for the installation of SWHS and Ioannina the worst. The mean value of IRR was found to be 11.6%, 13.9%, and 18.2% for grant 0%, 15% and 35% respectively. Even if there aren't grants the minimum IRR value are bigger than 9.3%. In all circumstances the simple payback period was smaller than 12.3 yr while the equity payback period varied between 7.4 and 9.9 yr in the case without grants. With 15% and 35% grants the maximum equity payback period is 8.6 and 6.8 yr correspondingly. From environmental point of view, it was found that on an average an approximate quantity of 1.47 ton of green house gases can be avoided entering into the local atmosphere each year from a typical glazed SWHS in any part of the Greece.

Considering that the bank loan is limited, owing to the financial crisis, the new energy saving programme is expected to support not only the sales of the solar hot water systems but also to provide jobs on more than 3500 labourer. At the same time it helps in the energy saving of the country and reduces the electricity bill for thousands consumers. Last but not the least, the SWHS offer many environmental benefits to the Greek citizens.

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Saulės vandens šildymo sistemų, ištikus depresijai finansinė analizė: Graikijos atvejis

Santrauka

Dabartinė situacija. Gerai žinoma, kad Graikijos saulės energijos potencialas pagal esamus ilgalaikius matavimus yra puikus: metinė saulės energija prilygsta 1 800 kWh m^2. Graikijos klimatas yra Viduržemio jūros, todėl vyrauja ilgos karštos sausos vasaros ir švelnios žiemos. Graikija yra kalnuota šalis su daugeliu išsiskirsčiusių salų. Tai sukuria mikroklimato ir vietinės įvairovės derinį. Pietinėje Graikijos dalyje, ypač Egėjaus archipegalo salose saulės radiacija aukščiausia, mažiau saulės yra šiaurinėje Graikijoje.

Po naftos krizės, 1970 m. Graikijos vyriausybė pateikė daugelį programų. Graikija tapo viena sėkmingiausių šalių pasaulyje, kuri panaudoja saulės energiją. 2010 m. pabaigoje Graikijoje buvo daugiau kaip 4 mln. m^2 saulės kolektorių. Remiantis Graikijos saulės pramonės asociacijos duomenimis, saulės kolektorių skaičius vienam gyventojui ilgą laiką Europoje buvo aukščiausias. Šiandien Graikija užima trečią vietą Europos Sąjungoje.

Saulės vandens šildymo sistemų galimybės nėra nauja tema mokslinėje literatūroje. Šis finansinės analizės tyrimas skirtas ne tik pietinės, bet ir Šiaurinės Graikijos padėčiai aptarti. Šioje Graikijos dalyje saulės mažiau, tačiau vanduo šaltesnis. Be to, buvo panaudoti nauji finansiniai duomenys,

susiję su krize. Ištikus finansinei ir ekonominei krizei, Graikijoje reikėjo padidinti mokesčius ir sumažintų išlaidas. Pasikeitė žmonių pragyvenimo lygis 2009–2010 m. saulės energijos rinka sumažėjo daugiau nei 30 proc., nors buvo didelis nuolaidos saulės energijos sistemoms.

2010 m. pab. vyriausybė priėmė naują įstatymą, pagal kurį visi nauji arba rekonstruoti pastatai Graikijoje turi sudaryti mažiausiai 60 proc. pagal jų saulės energijos panaudojimą. Tačiau šias priemones apribojo rinkos kritimas statybų srityje. Buvo parengta ir energijos taupymo bei naujų energetikos rūšių panaudojimo programa. Pagal šią programą senesnių namų gyventojai gavo papildomas kompensacijas ir galimybę gauti paskolą. Šios lengvatos buvo skirtos daugiau nei 90 proc. Graikijos gyventojų.

Tyrimo tikslas. Svarbiausias šio darbo tyrimo tikslas – apskaičiuoti naujosios programos finansinį efektą, kuris gaunamas dėl saulės karšto vandens sistemos Graikijoje. Šiame darbe panaudoti vidutiniai ilgalaikiai meteorologiniai duomenys (1955–1997) 47 Graikijos vietovėse. Ekonominė analizė ir aplinkos duomenys buvo gauti naudojantis kompiuterinėmis programomis. Švarios energijos projekto analizė yra pažangus matematinis metodas, skirtas švarios energijos technologijų galimybėms palengvinti. Tyrime nagrinėjamas tipinis skystųjų plokštelių kolektorius, kuris paprastai naudojamas kaip buitinė karšto vandens sistema tipiniuose namuose. Metinė tokia karšto vandens saulės sistema priklauso nuo sistemos charakteristikų, saulės radiacijos, oro temperatūros ir apkrovos pobūdžio. Dienos karšto vandens sunaudojimo apimtis paimta iš spausdinamų duomenų. Pagal skelbiamus duomenis saulės kolektorių darbą galima pavaizduoti šia lygtimi:

$\dot{Q}_{coll} = F_R(ta)G - F_R U_L \Delta T$; čia:

$\dot{Q}_{coll}$ – kolektoriaus energija per laiko vienetą; F_R – kolektoriaus šilumos davimo veiksnys; t – dangčio pralaidumas; a – absorberio galimybės; G – globalusis saulės poveikis kolektoriui; U_L – bendras kolektoriaus šilumos nuostolio koeficientas; ΔT – temperatūros skirtumas tarp įeinančio į kolektorių skysčio ir išorinės aplinkos.

Karšto vandens sistemų aptarnavimas su laikymu skaičiuojamas pagal *f* – lentelės metodą. Lygtis *f*, kuri parodo mėnesio saulės energijos vandens šildymo sistemos apkrovimą, taip pat apskaičiuojama pagal specialią lygtį.

Rezultatai ir išvados. Skaičiavimai, kurie buvo atlikti 47 vietovėse naudojant keturis parametrus; vidinis grįžtamųjų pajamų dydis (%), grįžtamųjų pajamų periodai ir dujų sunaudojimo sumažėjimas. Grįžtamosios pajamos yra pagrindinis projekto aspektas kolektoriaus gyvavimo laikotarpiu. Iš gautų pajamų ir santaupų prasideda projekto naudingumo efektas. Vidinės grįžtamosios pajamos ir dujų sunaudojimas yra tam tikra prasme analogiški, todėl pietinės Graikijos vietovės yra patrauklesnės saulės energijos panaudojimo galimybėmis, o šiltojo periodo nauda atitinka saulės radiacijos vertę.

Graikija, kurios saulės energijos potencialas didelis apskritus metus ir kuri užima trečią vietą Europos Sąjungos rinkoje pagal saulės kolektorių panaudojimą, turi problemų finansinėje politikoje. Tai skatina finansinę ir ekonominę krizę. Nepaisant to, Graikijos vyriausybė skatina saulės energijos panaudojimą plečiant šios energijos rinką. Remiantis naujai pateikta programa, 60 proc. karštas vanduo tiek seniems, tiek naujiems namams turi būti tiekiamas panaudojant saulės energiją. Šio tyrimo tikslas – pateikti ir įvertinti šias pastangas ne tik ekonominiu požiūriu.

Remiantis ekonominiais rodikliais Tymbakion sritis buvo įvertinta kaip geriausia vieta taisant saulės radiacijos energijos įrenginius. Mažiausia įrenginių vertė yra 11,6 proc., 13,9 proc., 18,2 proc. esant dotacijai 0 proc., 15 proc. ir 35 proc. atitinkamai. Net jeigu nėra dotacijų, minimali vertė yra didesnė nei 9,3 proc. Aplinkos požiūriu buvo pastebėta, kad galima mažiau naudoti dujas ir kitose srityse.

Kadangi banko paskolos yra ribotos dėl finansinės krizės, naujoji energijos taupymo programa turėtų remti ne tik saulės energijos karšto vandens sistemas, bet ir sukurti naujas darbo vietas daugiau nei 3 500 darbuotojų. Be to, tai padėtų taupyti šalies energetinius resursus ir sumažinti elektros mokesčius tūkstančiams vartotojų. Reikėtų pabrėžti ir aplinkos saugojimo naudą Graikijos gyventojams. Todėl vandens šildymas naudojant saulės energiją yra patikimas ir ekonomiškas.

Raktažodžiai: *saulės energijos vandens šildytuvai, atsinaujinusi energija, fondo grąžos periodas, Graikija, saulės energijos misija*.

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