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**Conference Paper — Digitized Version**

## Fighting the Financial Crisis with Alternative Forms of Energy in the Household Economics

*Suggested Citation:* Kyritsis, Kostas; Chytis, Evangelos; Karamanis, Kostas (2011) : Fighting the Financial Crisis with Alternative Forms of Energy in the Household Economics, In: Proceedings of the 4th International Conference Entrepreneurship in the Global Environment: New Challenges in the Post-Crisis Era, 13-14 October 2011, TEI of Epirus - Dept. of Accounting, ISBN 978-960-86583-7-0, TEI of Epirus, Dept. of Accounting, Preveza, Greece, pp. 277-288

This Version is available at:

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"Entrepreneurship in the Global Environment:  
New Challenges in the Post-Crisis Era"

Επιμέλεια έκδοσης: Αλίνα Χυζ, Ιωάννης Γκανάς  
Editors: Alina Hyz, Ioannis Ganas

October, 13 – 14, 2011  
Preveza, Greece



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Τμήμα Διεθνών Οικονομικών Σχέσεων, Πανεπιστήμιο Lodz

Μεταπτυχιακό Πρόγραμμα «Τραπεζική», ΕΑΠ

### **Organized by**

Department of Accounting, TEI of Epirus, Greece

Department of International Economic Relations, University of Lodz, Poland

Postgraduate course in banking, Hellenic Open University

<http://logistikis.teiep.gr/preveza2011/>

## ***Fighting the financial crisis with alternative forms of energy in the household economics.***

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### **Abstract**

We analyze how to fight the financial crisis at the level of Household Economics, by adopting environmental friendly alternative forms of energy, that reduce the CO<sub>2</sub> emissions and the cost of living. The value of such green solutions is multiple: at the level of a better and healthier quality of life, at the level of planetary global climate crisis, and at the level of Household Economics. We utilize a specially coded simulator to represent the randomness of the input solar radiation variance both seasonally and as 11 years solar sunspot cycle, so as to calculate the financial risk of the household income. We propose a new Bank's financial product that links the solar energy income with the house mortgage payments. The solar energy alone as investment is approximately a **57%** rate of return on equities or **20%** internal rate of return. If it is linked with purchasing of the house, it can buy at least **30%** of the house.

*JEL codes* O130, G170.

Key Words: Renewable energy, Household economics, Simulation.

### **1. Introduction**

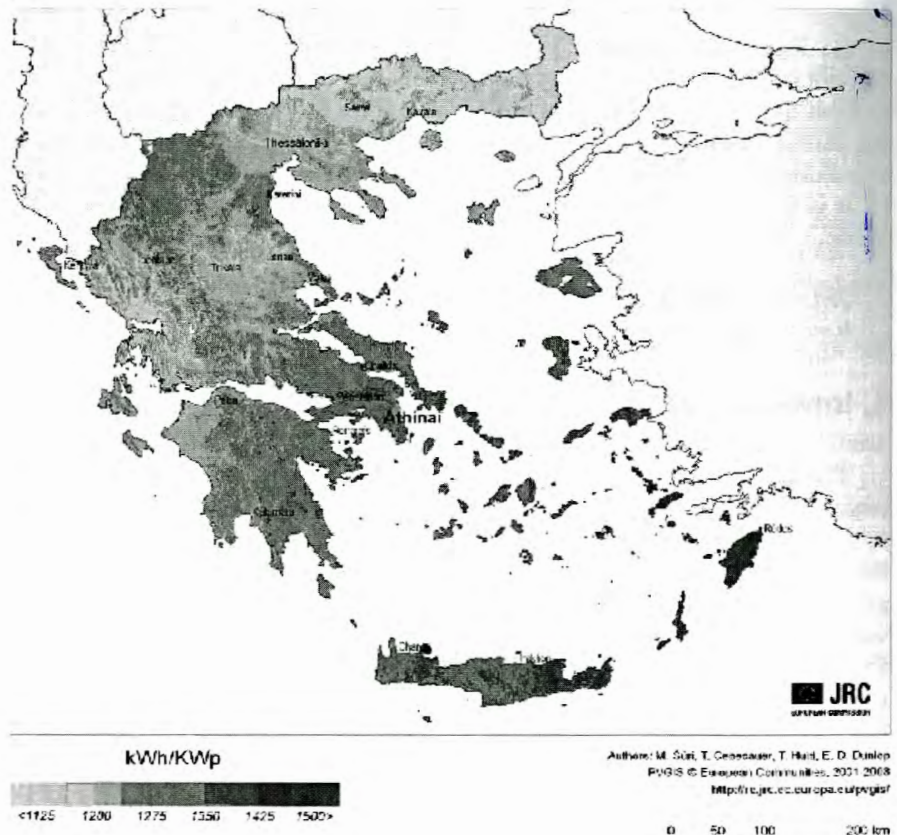
The development of the technology of the solar panels and other forms of renewable energy, together with new relevant laws, give very convenient opportunities for the householders: a) To fight the present financial crisis, b) Buy cheaper houses. Deal with and help to cure the major threats of: 1) The global climate crisis, 2) The environmental degradation. Although we discuss various types of alternative renewable energy solutions for the household, we focus quantitatively and financially on the solar panels electricity solutions. We utilize a specially coded (Monte Carlo) simulator in VBA of MS-EXCEL to reproduce the random variance of the input solar radiation. We specialize in altitudes and data of the Greek climate. We run simulations for the seasonal variation (Winter-Summer) which is about 50% variation and also for the 11.1 years global climate cycle that follows the sunspots concentration which is at least 0.1% of the long run systematic variation. We propose a new Bank's financial product that links the solar energy income with the house mortgage payments, so that solar energy is partly "buying" the house for the owner. We also assess the risk of the solar energy income solutions for the banks as being lower than the usual risk of real estate financing. Such a very low risk of financing is also very attractive for the banks, given the present financial crisis.

## 2. Solar electricity engineering concepts.

In order to understand the financial analysis of the household income of solar energy we need to understand at first, some elementary engineering concepts of the solar panels.

1) Solar panels come with a nominal power denoted by kWp (peak kilo wats) which is a measure under normal best conditions. A 1 kWp system of solar panels will produce in the average 1150-1500 kWh per year. (see references web link 1) While kW is a unit of power (energy per time unit , 1 watt is equal to 0.2389 calories per second, or 3.413 Btu/hour and 1kw=1,000 watts see e.g. D. Haliday--R. Resnick 1970 ) kWh is a unit of energy (what energy is produced by power 1kW in one hour) (See e.g. references web links 2 ).

For Greece data for average kWh/kWp for Si crystalline solar panels and optimal orientation can be found e.g. in the map below (see references web links 1 )



Graph 1

2) Solar panels are usually designed to last for 25 years so the calculations horizon of 25 years for financial decisions, is not unrealistic.

3) A 1kWp system requires approximately 7 to 8 square meters area.

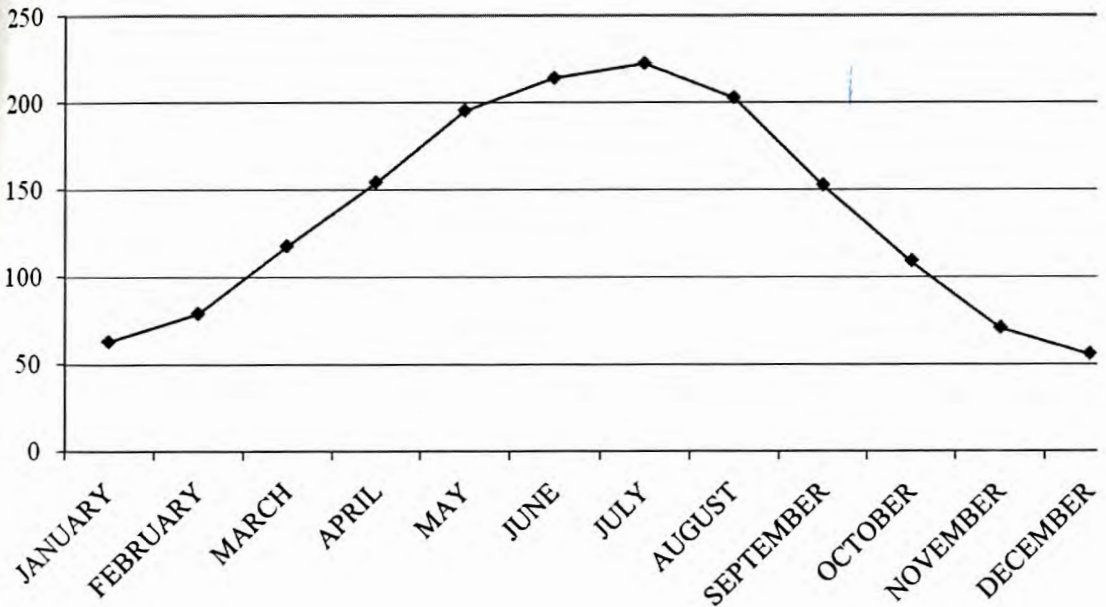
4) The efficiency for commercially available multicrystalline cells, solar panels is usually between 14%-19% (see references web links 3) This means that from the amount of solar radiation energy that hits upon 1 square meter of solar panel only 14%-19% of it is converted to electricity.

5) The price of a 10kWp solar panel system ranges between 30 to 40 thousands euros.

### 3. Solar radiation variation.

The average amount of solar radiation energy that passes per time unit and per square meter on the surface of earth (solar constant) is about 1.340 kW per square meter or 1.92 calories per minute per square centimetre . (see e.g. references web links 4 and also D. Haliday--R. Resnick 1970 page 797) This is an average measure. In reality it varies by geographic amplitude and from place to place. It depends also on the orientation, but mainly on the season of the year. In practice of solar panels calculations the round average value of  $1\text{kw/m}^2$  is accepted. We are interested here to account for the seasonal variations of the solar radiation input, that we will convert it to solar panel energy output. Data for the monthly variation of solar radiation input as  $\text{kWh/m}^2$  per month can be found e.g. in references web links 5. From these data we plot a for the area of Athens, the monthly variation of the average monthly solar radiation in kWh per square meter.

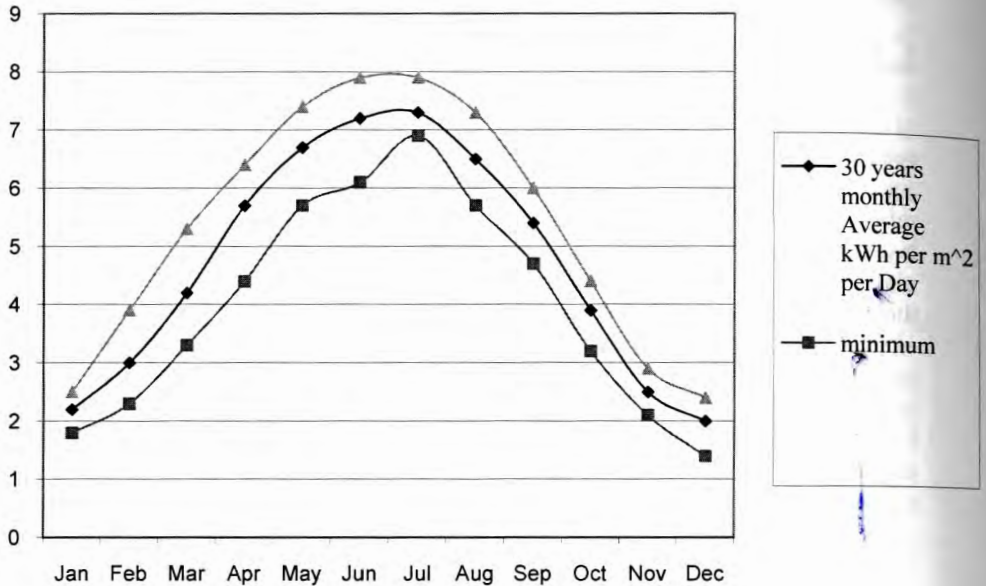
Athens Monthly Solar Radiation



Graph 2

We notice that the average monthly kWh ranges from 50% in winter to more than 200 in summer time.

Similar 30 years data for the American continent latitude 37 (San Francisco same latitude as Peloponissos) (see references web links 6) give the next shape for the average daily solar radiation in kWh per square meter



**Graph 3**

To this variation we must add the non-seasonal global climate variation due to the 11.1 years sunspots cycle. (see e.g. references web links 7) The latter is only 0.1%.

#### **4. Financial simulation analysis of solar energy household income.**

Based on the above data we run simulation for 25 years of the daily solar radiation variation, in a specially coded simulator in VBA language of MS-Excel.

The specifications of the simulation are:

1. The time steps are days. We normalize the year in to 12 months of 30 days thus 360 days. The simulation horizon is 9000 days or 300 months or 25 years. The seasonal period is exactly 12 months.
2. The amplitude of the seasonal variation is 2.8 kWh/m<sup>2</sup>
3. The cyclic behaviour is simulated with sin and cosine functions
4. The standard deviation of the random daily fluctuations is set to 10% of the amplitude. This is based on the data of maximum, minimum as in Graph 3 and it corresponds to 33% of the average maximum and

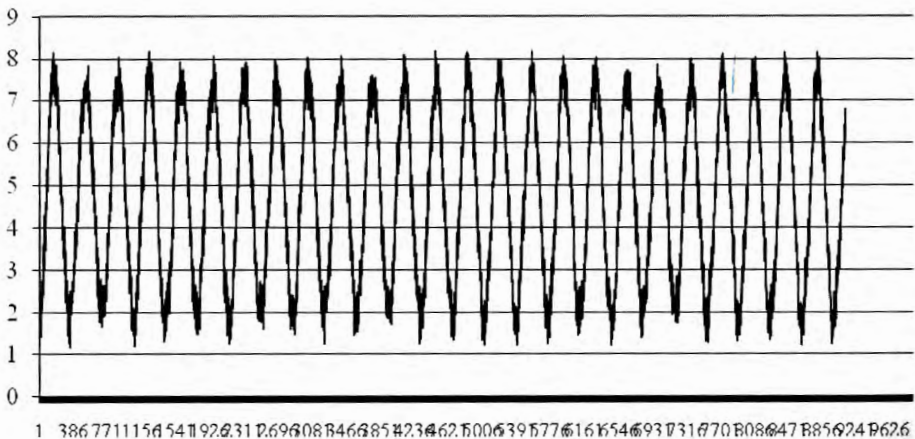


minimum deviation. The random fluctuation is simulated as normally distributed. In addition to the seasonal periodic variation we superimpose the 11 years sunspot variation with amplitude 0.0042 kWh/m<sup>2</sup>, which corresponds to the 0.1% solar variance as in the previous paragraph.

5. The standard deviation of the random daily fluctuations of the 11 years solar variance is set again to 10% of the above amplitude. The random fluctuation is simulated by the normal distribution
6. The period of the sunspot variance is set to 11 years or 132 months or 3960 days. The periodicity is simulated with the cosine function.
- 7.

We utilize the **Box-Muller method** to simulate the **normal distribution**. This means that we use the formulae  $R = \text{Sqr}(-2 * \text{Log}(\text{Rnd}))$ ,  $U = \text{Rnd}$   $\text{Normal\_random\_variable} = R * \text{Sin}(2 * \text{pi} * U)$  where pi is the number 3.14159265 Sqr is the square root function, Log the neperian natural logarithm function, Sin is the well known trigonometric function and Rnd is the [0,1) interval, uniform random variable that is generated by the computer (see also Morgan B.J.T. 1984 or references web links ). The daily results of the simulation are presented in the next Graph.

Daily Solar radiation in kWh per m<sup>2</sup>

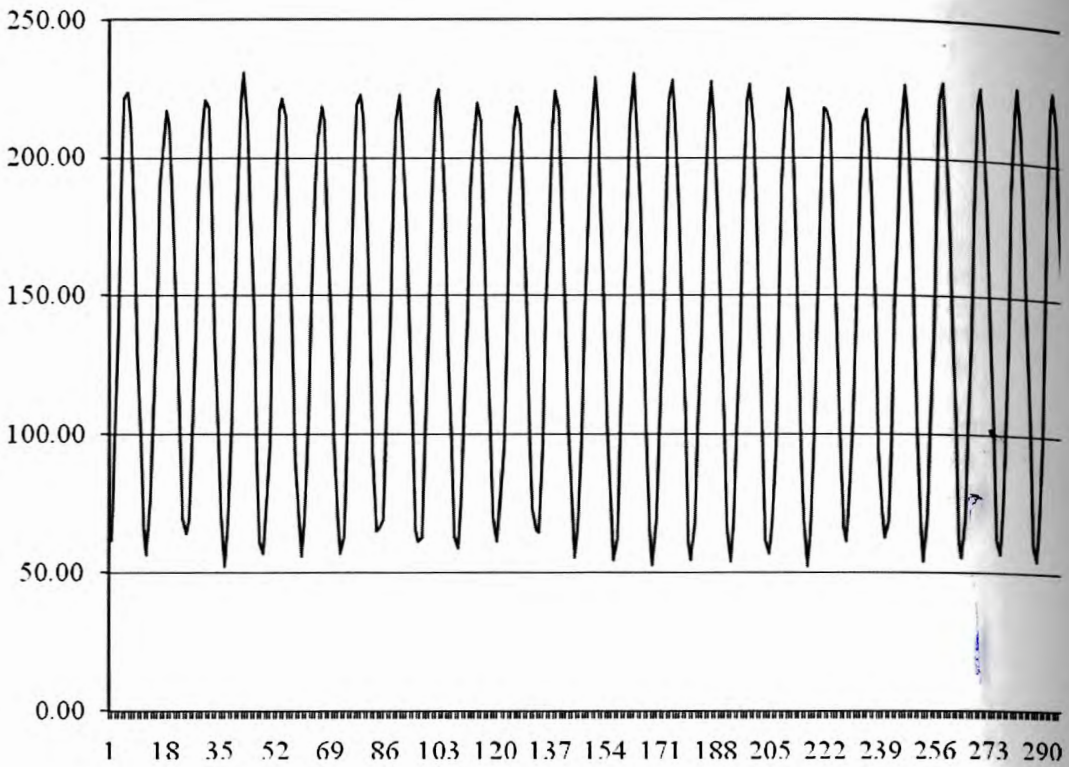


**Graph 4**

We notice the slight periodicity per 5.5 years half-period of the 11 years sunspot cycle.

These data are converted to monthly kWh/m<sup>2</sup> by adding for the 30 days of the month in the next Graph 5

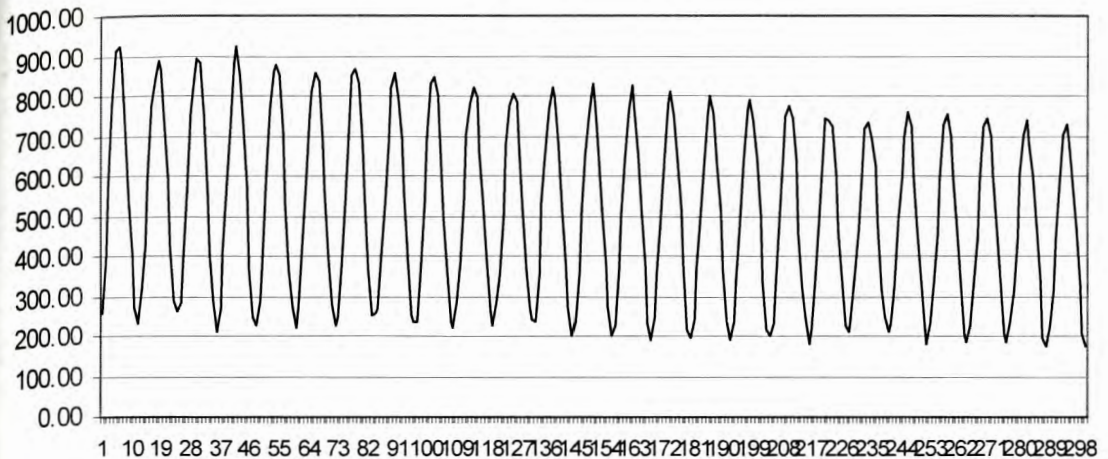
### Monthly kWh/m<sup>2</sup> output of 10kWp solar panel



**Graph 5**

The next step is to convert the above input solar radiation variation to solar panel output energy and with a price of **0.55** euro per 1 kWh which is the current price in Greece (2011) to get the euro revenue variation. . We Multiply with a coefficient of **7.5** so as to derive the solar output of 10kWp system monthly. We choose the above multiplier so as to have in the average the **1250 kWh per year for 10kWp** solar panel system in Greece. We consider a 1% annual decrease of the energy production capacity of the solar panels due to ageing. Finally we multiply with 0.55 euro per 1 kWh. The result is the next Graph 6

### Monthly revenue in euro of a 10kWp system in Greece



**Graph 6**

The average monthly revenue of the above system is **513.28 euro**.

Given that the price of a **10kWp** solar panel system is about **31,500** euros, and that a bank would finance **80%** of it (in other words 25,200 euros) with a current fixed interest rate of **8.3%** (we set it so high because of the condition to be fixed) and for a maximum period of 25 years, gives a fixed monthly payment of **194.5 euros**.

We use here the formula of the rands and Loans for the constant payment

$$R = \frac{A \cdot I_m \cdot (1 + I_m)^n}{(1 + I_m) - 1}$$

Where  $R$  is the monthly payment,  $A$  is the initial value of the loan,  $I_m$  is the monthly interest rate of the loan, and  $n$  is the number of months (here 300).

The monthly interest rate  $I_m$  of the loan is calculated from the annual interest rate  $I_a$  (here 8.3%) by the formula

$$I_m = \text{EXP}(\text{LN}(1 + I_a) / 12) - 1$$

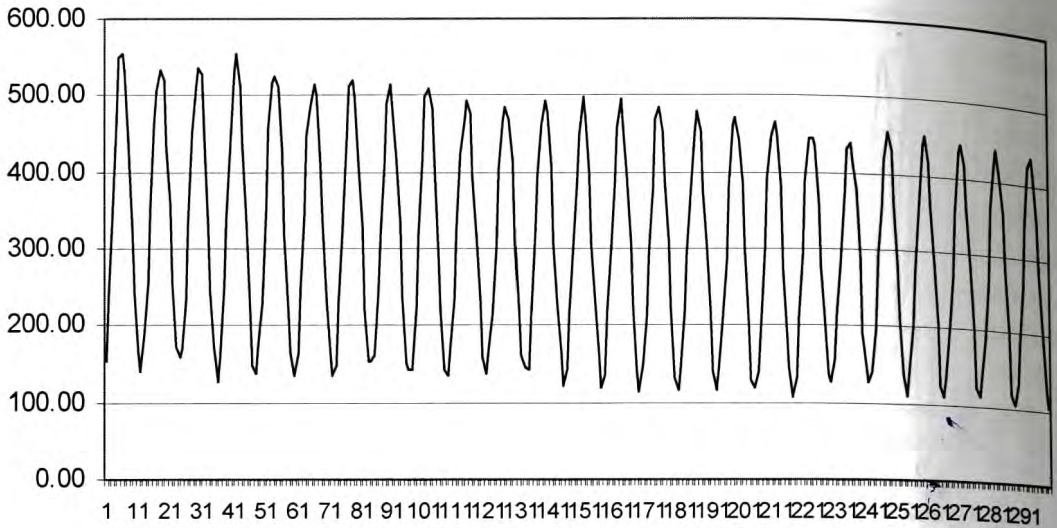
Where  $\text{EXP}$  and  $\text{LN}$  is the exponential and neperian logarithmic functions correspondingly.

Upon this payment we add **insurance and maintenance costs** that are estimated **15** euro monthly thus total  $194.5 + 15 = 209.5$  which is about **40%** of the average monthly revenue.

Therefore the average net monthly income of the household becomes **303.78**

We suggest her to divide the seasonal risk of variance among the household and the bank. A good practice for this is to ask for the household to pay a fixed percentage of its revenue as monthly payment to the bank, and with a final adjustment the last month so that the total annual payments is  $12 \cdot 209.5 = 2514$  euros. Here for simplicity a fixed percentage of 40% of the monthly revenue gives the desired annual sum result. So the net household income after the bank payments of 40% is the next Graph

### Net Monthly income after bank's payments and insurance-maintenance costs



**Graph 7**

The average net monthly income is here **303.78 euros**.

This means that we can estimate the average rate of return on equities. If  $31,500 - 25,200 = 6,300$  is the participation of the householder, and  $12 * 303.78 = 3645.36$  is the annual net return, then the **average rate of return on equities (ROE)** is  $3645.36 / 6,300 = 0.5786$  or about **57%** !

In the previous analysis is not included the household energy consumption, as this would occur this way or another, and we are interested for the incremental opportunity of gain of the households. Serious maintenance and repair cost are included in the insurance that banks generally force before financing. We do not include also value depletion or depreciation costs because provisions to sell and replace them say after 5 or 10 years with new technology panels would be inaccurate given that their prices fall with rapid rates.

Nevertheless because it is reasonable to sell in about 10 years, the solar panels and substitute them with new technology panels, and because there is also the option of variable bank's loan interest rate, we calculate and tabulate for comparison two more scenarios.

The capital leverage is defined by the ratio of the total purchase cost of the solar panels (assets) to the money that the householder must contribute, after the bank's loan contribution. Here we take that the bank's fund the 80% of the cost thus the capital leverage is 5.

The **internal rate of return IRR** is defined as that constant interest rate of the bank, that if all the annual revenues (no loan payments are considered here) were discounted with that rate, as present values at the start of the investment, give as total sum, the initial cost of the investment. To calculate it, we utilize the build-in function IRR of MS-Excel which with iterations and corrections finds this rate, even on variable annual revenues. We use here the average annual revenues.

The **return on equities ROE** is defined as the ratio of the average annual net income (after bank's payments and insurance-maintenance costs) to the initial net contribution of the householder to purchase the solar panels.

The **nominal payback period** is the minimum number of years required so that if the annual revenues are discounted with the risk-free rate as present values at the beginning of the investment, give the total purchase cost of the investment. The real payback period is the same, but we use the net-annual income, and must sum-up only to the contribution of the householder to purchase the solar panels.

|   | <b>Scenario 1</b> | <b>Scenario 2</b> | <b>Scenario 3</b> |
|---|-------------------|-------------------|-------------------|
| <b>Duration in years</b>  | 25                | 10                | 10                |
| <b>Solar panels costs</b>   | 31,500            | 31,500            | 31,500            |
| <b>Bank's loan annual interest rate</b>                                 | 8.3%              | 7.5%              | 6%                |
| <b>Capital leverage</b>   | 5 (80%)           | 5 (80%)           | 5 (80%)           |
| <b>Bank annual payment</b>  | 2,514             | 3,730.8           | 3,513.12          |
| <b>Average annual revenue</b>   | 6,159.36          | 6,652.08          | 6,652.08          |
| <b>IRR</b>  | 20%               | 17%               | 17%               |
| <b>ROE</b>  | 57%               | 46.36%            | 49.8%             |
| <b>ROA</b>  | 19.55%            | 19.55%            | 19.55%            |
| <b>Payback period of assets in years (nominal, risk-free rate 4.5%)</b> | 7                 | 6                 | 6                 |
| <b>Payback period of equities in years (real, risk-free rate 4.5%)</b>  | 2                 | 3                 | 2                 |

Table 1

## 5. Solar energy buys 30% of the house: New cheaper real estate bank financial products for the householders.

We suggest here that if a bank is financing the purchase of a residential real estate assets, that it automatically installs solar panels, so that the mortgage is partly paid by the solar energy revenue.

For example for a house that costs **160,000** and the bank is financing 80% of it (128,000) with an annual fixed rate of 8.3% for 25 years the monthly

payment is **987.83** euros. But if it packages it with a 10kWp solar panel system, then the total financing is  $128,000+25,200=153,200$  and the payment is  $987.83+209.5-513.28=684.05$ . And  $(987.83-684.05)/987.83=0.3$ .

**In other words the involvement of a 10kWp solar panel system in the purchase of such a house reduces the costs of mortgage payments by 30%!**

## **6. Other forms of household renewable green energy**

Solar panel energy is not the only form of renewable energy that can help the household to have a stable income and fight the financial crisis. Unfortunately in Greece only solar and wind energy is purchasable from the central organization of electricity. But other forms of renewable energy can be used to have stable and consistent savings. Examples of such other forms of renewable energy are

1. Solar Thermal (it utilizes mirrors and Stirling's steam engine see e.g. [http://www.ted.com/talks/bill\\_gross\\_on\\_new\\_energy.html](http://www.ted.com/talks/bill_gross_on_new_energy.html) )
2. Electricity from coasts small waves and water desalination
3. Ground source heat systems
4. Biomass
5. HHO (Oxyhydrogen) fuel
6. Electromagnetic free energy.

From all the above probably the most promising and interesting is the last, the renewable free energy from the (electromagnetic) field. It is financially very interesting as it can produce more than 3 times cheaper electricity with low technology compared to the electricity produced by oil, coal and lignite. Solar electricity is already more expensive than nuclear power and certainly much more expensive than electricity from oil, coal or lignite. But the free energy electricity does not require input fuel it is renewable and it is cheaper even from to the electricity produced by coal and lignite. It is at least half century old invention or discovery, it is low technology and safe. By the end of 2000 there were only a handful of inventors (E.g. J. Searl, B. Depalma, P. Baumann, P. Tewari etc) but by the end of 2010 there are more than 300 inventors all over the globe, and more than 10 companies that produce such generators. (see e.g. <http://www.free-energy-info.co.uk/> and a more quantitative site <http://jnaudin.free.fr/>)

Seemingly, the main obstruction that slows down dramatically the evolution of this category of solutions, is that it goes faster than the evolution of the academic knowledge. In other words the academic knowledge of the electromagnetic field cannot account for these inventions. According to the J. Maxwell's equations of electromagnetism such generators should not exist. Some Universities now are realizing that in order to include such inventions in their research, develop and optimize them, it is required.

a) To re-write the Maxwell's equations of electromagnetism from linear equations to non-linear

b) To re-write the Newton's and Einstein's equations of the gravitational field. (as it seems that such generators draw also energy from what traditionally we call potential energy of the gravitational field, and that traditionally also this should be impossible; see also references web links 9).

Because of this latter condition it is very probable that this development will take more time than the expected. But when it happens it will definitely give a new post-oil global energy model.

## 7. Conclusions and suggestions.

The times of financial crisis are the perfect times for new innovations and opportunities for small economic units like the household. Such innovative solutions not only can fight the financial crisis at the level of the household, but also can become pilot examples of clean green energy solutions that in the future can be transferred to larger scale. We have shown with quantitative simulation, that the benefits and household income from solar energy is robust and stable, and can be packaged in to a new cheaper financing product of the banks.

- 1) If only the income of the solar energy is of concern, then it is approximately a **57%** rate of return on equities investment or **20%** internal rate of return. These figures are really high compared to other forms of investments, and in addition renewable energy investments are of very low risk. The liabilities and maintenance costs are about **40%** on the revenues, and the nominal payback period of the assets about **7** years (while the real of the equities, is only 2 years).
- 2) We suggest a new financial product of the banks, that binds the financing of the purchase of a new house with solar panels income on it. Then solar energy can buy at least **30%** of the house.
- 3) Finally we suggest that the central electricity organization (DESMHE) that purchases renewable energy from households, should include in the relevant laws, the purchasing of a wider spectrum of forms of renewable energy, not only solar and wind energy.

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