

THE NEW STATUTORY FRAMEWORK FOR THE PROMOTION OF RES IN GREECE, THE CURRENT STATE OF THE PV MARKET AND ECONOMIC EVALUATION OF THE PV SUPPORT MEASURES

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ABSTRACT: This paper presents in short the new RES Law (3468/2006) for the promotion of RES in Greece, an overview of the current state of the PV market worldwide and in Greece. The old and new efforts for PV module and cell production are presented. The new licensing procedure is presented. A spreadsheet was developed that given economic, technical and irradiation parameters, it provides useful financial information necessary for the evaluation of an investment for a grid-connected PV system. The economic evaluation results for two cases indicate that the PV system payback time is under 6 years and the IRR is between 17 and 19% at 20 years. Both cases provide encouraging economic results that are attractive for investors.

Keywords: Funding and Incentives, Economic Analysis, PV Market.

1 INTRODUCTION

The Photovoltaic (PV) sector is one of the fastest developing industries at this moment, as an indication it is noted that the PV production increase for 2004 was 60% more than 2003 and 44% from 2004 to 2005 [1] as the Si feedstock supply shortage is temporarily slowing down the expansion. For the last ten years, the production of PV cells has increased regularly, at an annual average rate of 40%. This growth is not only led by progress in materials and the technology of manufacturing but mainly by the market introduction support programs for PV systems in several countries, particularly by the Germany, Japan, USA (California) and recently in Spain, Italy, France, Greece and Cyprus[2,3]. These programs contribute in the increase of demand for PV systems with a corresponding investment in mass production manufacturing lines that will lead to less expensive products because of the economy of scale that they will achieve. Currently, the manufacturing of solar cells is based on crystalline Silicon technologies which account for 93% of the world production of PV cells. The PV system technology constitute in the long run one of the more important renewable energy technologies for the production of electric energy, because it has the potential to be applied in autonomous systems, central systems, PV integrated in buildings (BIPV), producing locally energy that can be channeled into the grids. More important advantages constitute: the possibility of designing aesthetic solutions that do not burden particularly the environment and the modularity of the PV systems. Distributed generation energy units, like PV even, when they do not constitute structural element of buildings offer also the advantage of short time of installation and operation. The PV systems are reliable and friendly to the environment. The cell efficiency has improved reaching for the most advanced laboratory cells of crystalline Silicon, to more than 24%, while commercial crystalline silicon PV modules are made of cells with efficiency in the range from 11 to 20%.

The large introduction of PV of systems may replace or postpone the extension of conventional central stations of electricity production and the investment in grid

reinforcement having a positive overall economic impact. The PV system electric power is of particular value when it coincides with the peak demand, as during the summer afternoon peak due to the use of air conditioning units. Moreover, PV systems could also contribute to the improvement in power quality, the reduction of electricity transport losses by producing at the point of consumption and the increase of reliability of the electric power system. Although the scientific community is convinced of the benefits offered by distributed generation systems hard evidence that cannot be denied on the above issues is provided by recent European Commission funded projects like DISPOWER, DGFacts, MICROGRIDS and MORE-MICROGRIDS etc.

The dissemination programmes as well as the pressure from the White Paper goal for renewable energy production by all EU members, the Kyoto protocol emissions reduction obligations and the need to diversify our energy production mix, in combination with electricity market liberalization and the recent RES promotion Law has caught the attention of entrepreneurs and a few efforts are underway to establish photovoltaic wafer, cell and module production in Greece. Nevertheless, the markets that are created with political decisions and are subsidised cannot be maintained for ever. The goal of the programmes are to support the large introduction of the PV systems and in turn the mass production and the technology improvements and breakthroughs will eventually bring the cost of solar photovoltaic electricity to be comparable initially, in about 5-10 years, to peak power production and later to the bulk power production.

A new law (3468/2006, ΦΕΚ Α' 129/27.6.2006) for the promotion of electricity producing RES systems was passed in Greece in June 2006. The law foresees a Photovoltaic program for the introduction of PV systems in Greece that will be ending on the 31.12.2020 for a total installed capacity of at least 500 MW_p in the interconnected electrical system and at least 200 MW_p in the autonomous island systems. The PV electricity produced will be sold to the electric system operator between 40 and 50 € cent/kWh depending on the size and

the location of the PV installation (see the table below). Such a support scheme is attractive for the introduction of larger PV systems by enterprises in Greece. The support measures are not as appealing to private owners, as the private PV system owner is considered an auto-producer able to sell up to 20% of the annually produced electric energy to the grid. For private PV system owners there is a tax rebate of 500 Euro until the end of 2006, to be increased to 700 Euro after January 1st 2007. In addition, it is not clear how the VAT associated with the electricity income and the income itself from PV electricity will be handled by the government for the private PV system owners.

2 OVERVIEW OF THE GREEK PV MARKET

The installed PV systems in Greece are mainly privately owned autonomous systems in remote locations where there is no grid. The grid connected market, besides a few demonstration projects, is still small. Although there is a legal framework for the RES market since 1994 the lack of a significant support scheme running over a long time, the involvement of many public services in order to receive a large number of licences and the lack of concrete regulations for the market players have hampered the larger introduction of PV systems. The annual installed capacity of Photovoltaic systems up to now in Greece, if demonstration programs and research projects were excluded, does not exceed 150 to 200 kWp. Figure 1 presents the installed capacity of PV systems in Greece according to the estimates of CRES [4].

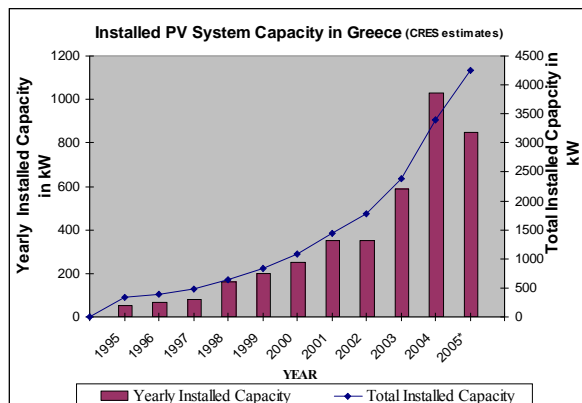


Figure 1: Yearly installed and total PV capacity in Greece according to CRES's estimates.

An important increase in capacity was observed in the last two years as a large number of autonomous PV hybrid systems were installed in remote locations is supplying base transmission stations of mobile telephony companies supported by the 3rd Community Operational Framework Programme, "Competitiveness" (E.P.An). During the past 3 years roughly 240 such systems were installed by the mobile phone companies, with a total PV capacity of 2,2 MWp. Until recently, the existing base stations were electrified by diesel-generators as they were installed in remote non-electrified locations. The objective of the particular action was the important reduction of the diesel-generator operation time so that important saving of fuel is achieved, with the corresponding environmental benefit. At the same time,

the PV-hybrid system offers higher flexibility and reliability. Furthermore, there is a reduction of technical crew visits because the need for frequent fuel replenishment is reduced as the fuel consumption and the corresponding necessity for maintenance are lower.

In the years between 1997 and 2001, three successive calls for proposals of the 2nd Community Operational Framework Programme "Energy" (KPS-2) were announced, the interest for the first two calls was small due to the low investment capital subsidy offered, varied with the geographical region of application, ranging between 40 and 55%. For the 3rd call a subsidy of 70% in the initial investment cost was announced concerning investments of enterprises in PV systems in the island of Crete. The interest was relatively strong and 45 applications for projects were submitted. After the proposal evaluation, 25 projects were approved for a total installed capacity of 2 MWp and a total budget roughly 15.26 million Euro. Finally, only 10 systems were materialized for a total installed capacity of 770 kWp. All, except one small 10kWp system, were connected to the island grid. The projects that were abandoned faced problems in the process of receiving the required licenses, while in certain cases the investors considered that the investment was not viable any more, as after the budget was drawn the PV module prices increased by 20-25% because the Drachma was gradually devaluated against the US Dollar by the same amount.

An important application in Greece since 25 years, although not very significantly in installed power, has been the electrification by PV systems of lighthouses, beacons and buoys located in islands, capes and in port entrances. The Service of Lighthouses of the Martial Navy responsible for the safe sea navigation in Greece has installed more than 1000 small PV systems of a total capacity more than 70 kWp and practically all remote lighthouses and beacons are being supplied by PV systems. Further analysis of the Greek PV market could be found in publication [5].

3 GREEK PV PRODUCTION CAPACITY

In anticipation of a support scheme for PV systems in Greece several efforts were made to establish PV module production in Greece, the most noted efforts were:

- Energy Solutions, 1 MWp/year c-Si module assembly in Bulgaria by VIOHALCO, a Greek Industrial group, producing since Feb. 2005
- Heliiodomi, 5 MWp a-Si, investment that started in 2001 but it is in hold as the mother company is in financial difficulty
- Solar Technologies S.A., 1.5 MWp/year c-Si, module assembly, producing modules since 2005.

In 2006, a new effort is in progress by the newly established company: Solar Cells Hellas SA. The investment amounts to 40 Meuro receiving support from the Greek investment law. The company will be producing Polycrystalline Silicon wafers and solar cells. CRES is the scientific and technical counselor of the company.

4 THE NEW GREEK LAW FOR RES

The Greek parliament voted the new RES law on June 27th 2006 (3468/2006) aiming to promote the introduction of renewables in Greece and attempting to simplify the licensing procedures and to reform the regulations governing the electric energy production from renewable energy sources. The feed-in tariffs are varying according the renewable energy source and the level of support it needs for its successful market introduction. The tariffs for PV are increased six times compared to the previous regime and they are guaranteed for 20 years. The law foresees that the Ministry of Development annually decides the increase of the feed-in tariffs up to 80% of the inflation rate or by the average rate of increase of the Public Power Corporation's (PPC) tariffs.

4.1 Summary of the introduced changes [6]:

1. A special program for photovoltaic systems was established expiring on 31/12/2020, whereas the tariffs for solar and photovoltaic systems are increased up to 600%.
2. Restructuring of the corresponding deadlines for installation & operation license permits in order to speed up the whole procedure.
3. Incorporation of the Preliminary Environmental Impact Appraisal into the operation permit, targeted to accelerate and rationalise the overall licensing procedure.
4. Increase of the upper limit for the power capacity of RES installations that are excluded from the operation licensing procedure. Specifically, are excluded from the licensing procedure RES power installations from:
 - a) geothermal energy with power capacity $\leq 0,5$ MWe,
 - b) biomass or biofuels with power capacity ≤ 100 kWe,
 - c) PV systems with power capacity ≤ 150 kWe,
 - d) wind energy with power capacity
 - ≤ 20 kWe for isolated autonomous microgrids
 - ≤ 40 kWe, for the not connected islands
 - ≤ 50 KWe, for grid connected installations
 - e) other RES technologies with power capacity ≤ 50 kWe.
5. Increase of the power capacity of small hydroelectric units from 10 MW to 20MW.
6. The RES-electricity production of an 'independent power producer', or the surplus electricity production of a RES 'autoproducer' up to 20%, is sold to the Hellenic Transmission System Operator (HTSO) or to PPC in the autonomous island systems at a predetermined buy-back rate, which is not dependent on the PPC's corresponding consumer electricity rate and can be varied in relation with applied RES technology.
7. The HTSO is obligated to enter into a 10-year contract (PPA) with the RES-electricity producer, for the purchase of his electricity. The contract always includes a unilateral renewal option for 10 more years.
8. Establishment of a licensing procedure for the operation of geothermal and hybrid plants.
9. Formation of expert committees for the evaluation and disengagement of large RES/CHP investments from bureaucratic procedures and delays towards the

immediate solution of the relevant license time constraints.

10. The harmonisation of RES-electricity tariffication system between 'autoproducers', i.e. RES producers consuming part of their electricity production and selling the surplus to the grid, and 'independent power producers', i.e. RES producers selling their entire electricity production to the grid.
11. The HTSO is obligated to grant priority access (priority in load dispatching) to RES electricity-producing installations without a limit to the power capacity.
12. The organisation of the relevant system for issuing guarantees of origin and the establishment of the relevant monitoring body.
13. Mandatory submission of the RES resource assessment measurements by a certified body.
14. Favourable treatment of petitions for RES electricity generation permits whereas the legal status of the RES project owner is of a public basis with the participation of municipality companies.

Moreover the projected time to acquire a license after the activation of the present law and relevant legal decisions from other ministries is expected to lead to:

- operation permit reception in less than 1 year, instead of the 3 years up to now
- less bureaucracy and arbitrariness since the list of the associated bodies for issuing the permit is shortened and only the relevant offices will be aware of the petition file

In addition, there is a list of tax incentives, to be instituted and becoming active from 1/1/2007, towards the promotion of the use of RES electricity, namely:

- 20% tax rebate for the purchase of solar thermal collectors and the installation of a central system with the use of natural gas or solar energy.
- up to a 20% tax rebate for non-connected RES electricity systems (e.g. PV, small wind turbines, RES microchip) and for the thermal insulation of buildings. The maximum deductible amount cannot be more than 500 €, or 700 € from 1/1/2007.

Table I: New pricing tariff system for electricity production from RES and CHP systems

Electricity production from:	tariffs (€/MWh)	
	mainland	non-interconnected islands
(a) wind energy	73	84,6
(b) off shore wind parks	90	
(c) hydroelectric units < 15 MWe	73	84,6
(d) PV systems <100 kW, installed at dwelling or neighbouring dwellings of the same owner	450	500
(e) PV systems >100 kW	400	450
(f) solar energy, besides PV	250	270

systems, with installed power capacity < 5 MWe		
(g) solar energy, besides PV systems, with installed power capacity > 5 MWe	230	250
(h) geothermal energy, biomass, waste incineration, biogas	73	84,6
(i) other RES technologies	73	84,6
(k) combined heat and power (CHP) units	73	84,6

Table II: Licensing procedure changes

old framework	new framework
Licensing procedure	
1) Installation permit	
Minimum 3 years from applying day until permit approval	New deadlines for permit procedure steps, ends to overall application permit period of less than 1 year
2) Exemption of installation, operation installation permits procedure for small RES systems	
RES systems up to 20kW	i) geothermal systems ≤ 0,5MW ii) biomass or biofuels ≤ 100kW iii) PV systems ≤ 150kW iv) wind energy systems <ul style="list-style-type: none"> ▪ Isolated microgrids: ≤ 20kW ▪ Grid-connected islands: ≤ 40kW ▪ Mainland grid: ≤ 50kW
3) Framework for permit procedure concerning offshore wind parks, geothermal plants, RES hybrid plants	
Not applicable due to lack of legislative framework	Especially for the hybrid systems, it is foreseen a periodic assessment and a compensation for the benefits that result at the autonomous island grids
4) Abatement of the 50MW upper limit for operation permits	

5) Favourable treatment of petitions for RES electricity generation permits whereas the legal status of the RES project owner is of a public basis with the participation of municipality companies	
Tariff system	
Tariffs are based to the PPC's pricing system	New tariffication system, independent of the PPC's pricing system and varying upon the applied technology for the production of electricity.
1) Autoproducers tariff system: same pricing system for the electricity surplus that they sell to the grid with the independent power producers' that are selling their entire electricity production to the grid.	
2) Contract agreement for the purchase of electricity from RES & CHP	
10-year contract with the RES-electricity producer, for the purchase of its electricity	10-year contract with the RES-electricity producer, for the purchase of his electricity. Renewal option for 10 more years
charge fee payed to the local authorities	
The special levy for the local authorities hosting such systems is 2% of total electricity sales before VAT	The special levy is raised to 3% of total electricity sales before VAT. The PV system owners are exempted.
Guarantees of Origin	
Not predicted	System of issuing guarantees of origin for RES electricity and the establishment of the relevant monitoring body

5 ECONOMIC EVALUATION OF PV SYSTEM INVESTMENT ACCORDING TO THE NEW RES LAW

A spreadsheet was developed that given economic, technical and irradiation parameters, it provides useful financial information necessary for the evaluation of an investment for a grid-connected PV system in the mainland or in the autonomous island electric systems. The time-series of savings and payments by the PV system user, the pay back time, the internal rate of return are calculated.

For the sake of this announcement we assume two cases. Both PV system produce 1500 kWh/kWp AC per year.

The yearly maintenance cost is taken as 1% of the initial system cost before subsidy deduction. The first system is a multi-hundred kWp system located in the mainland with an installation cost of 6000 €/kWp with 40% investment subsidy and the second system is installed in an autonomous island grid with a capacity of less than 150 kWp, the system cost per kWp in this case is 8000 €/kWp and the investment subsidy is taken 50%. The investment subsidy for PV may vary between 40% and 55% mainly according to the location of the PV system. The economic evaluation is performed per kWp of the system installed. In the calculation a small extra financial gain is considered due to the fact that the discount interest rate is negative (that is the interest rate you receive by having your money in the bank minus the rate of inflation). As the RES law foresees, an annual increase of the feed-in tariff by 2% is considered in the calculation.

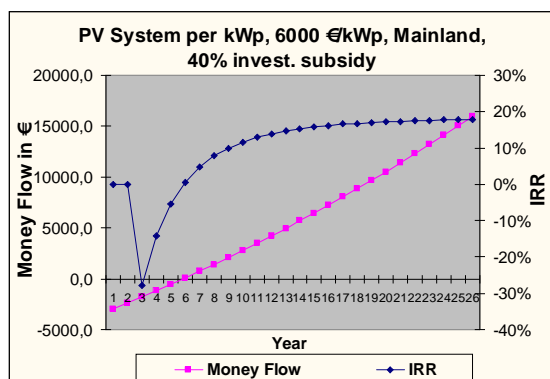


Figure 2: Multi-hundred PV system located in the mainland.

It is noted that the payback time for the PV system case in Figure 2 is under 6 years and the Internal Rate of Return (IRR) at 20 years is 17%.

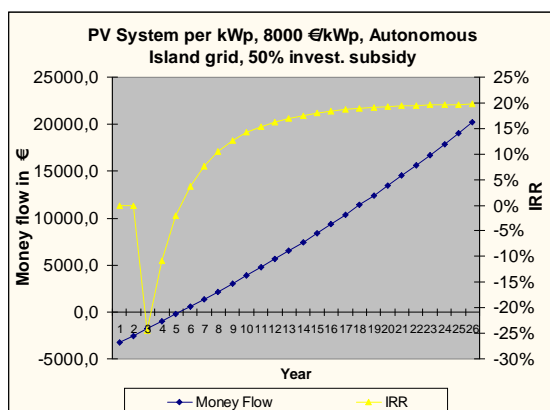


Figure 3: PV system capacity under 150 kWp located in an autonomous island grid.

The economic evaluation indicates that the PV system payback time is under 6 years and the IRR is 19% at 20 years. Both cases provide results that are attractive for an investor.

6 CONCLUSION

The new RES law (3468/2006) has changed the PV system investment opportunities in Greece for investors

as well as attracting new players in the Greek market such PV system components wholesalers, installers and PV module, cell and wafer producers. As an indication for the interest in the Greek PV program it is noted that until the end of August 2006 the Regulatory Energy Agency responsible to receive the Energy Production License has received about 100 applications totaling roughly 60 MWp. The introduced simplified licensing procedure has to prove in practice that it is leading in shorter procedure.

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