THE PV MARKET DEVELOPMENTS IN GREECE, NET-METERING STUDY CASES

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Abstract: This paper presents the state of the PV market in Greece, the achievements so far, the current situation and proposals for next years. The PV market environment in terms of new PV development policies is presented, such as net-metering. The net-metering long awaited program framework is expected to regenerate the PV market in Greece, It was finally introduced at the end of 2014 and the program procedures were put in operation in May 2015 for the low voltage PV systems. Study cases for the viability of the new PV net-metering program are presented for a household and a commercial enterprise.
Keywords: Greece, PV Market, Net-metering

1. OVERVIEW OF THE GREEK PV MARKET

In the following the PV market achievements so far, the current environment in terms of new PV development policies such as net-metering are going to be presented. During the period 2008-2013, the period of large introduction of photovoltaics in Greece, a total amount of around € 5 billion were invested and the cumulative installed capacity which is currently standing at 2600 MWp. For the year 2013, despite the economic crisis, the momentum due to the attractive feed-in tariff contracts that certain developers were still holding boosted the annual installed capacity to 1042.5 MWp. In the year 2013 the energy produced by photovoltaic systems in Greece reached 6.7% of the electricity consumed and for the year 2014 it was roughly 7%. The development of the annual and cumulative PV system capacity in Greece is presented in Figure 1. The installed capacity in 2014 collapsed to 16.95 MWp. For the year 2015, as the situation stands, the new installed capacity is not expected to surpass 20 MWp.

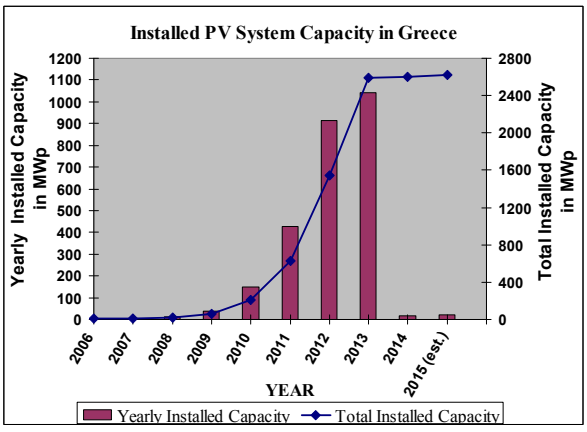

Figure 1: Historic PV market data, yearly and cumulative introduction of PV systems in Greece (CRES estimate for 2015).

Since 2010 the feed-tariffs (FiT) for new PV systems were reduced four times, the first time in 2010, then twice during 2012, and finally in May 2013. Now the current feed-in tariffs for PV systems under 100 kWp are standing at 1.2 times the System Marginal Price (SMP) of electricity of the previous year and for systems over 100 kWp, it is 1.1 times the System Marginal Price (SMP). For all PV systems in the non-interconnected system (islands) the feed-in tariff stands at 1.1 times the System Marginal Price (SMP). Given that the average SMP for 2014 was 57.53 Euro/MWh, it is calculated that for the year 2015 the FiTs in the Interconnected Electrical System for PV Systems under 100 kW stands at 69.04 Euro/MWh, while the for PV Systems over 100 kW it stands at 63.28 Euro/MWh. Regarding the feed-in-tariffs for new PV systems under 10 kWp on buildings, for the year 2015, the FiT is standing at 115 €/MWh, digressing to 80 €/MWh in the year 2019 [1].

Furthermore, the increasing penetration of PV systems should also push the authorities to study, plan and adopt technical and regulatory measures in order to allow higher penetration of RES in the electricity grids.

2. NEW ENERGY POLICY DEVELOPMENTS

As the Energy Union strategy [2] places consumers at the core of the EU energy policy, encouraging them to get involved in the energy transition, to benefit from new technologies to reduce their bills and participate actively in the market, while ensuring protection for vulnerable consumers. At the same time, the achievement of the Energy Union requires a fundamental transformation of Europe's energy system. Renewable energy is essential for this transformation to take place as it contributes to all of the Energy Union objectives:

- the delivery of security of supply,
- a transition to a sustainable energy system with reduced greenhouse gas emissions,
- industrial development leading to growth and jobs and lower energy costs for the EU economy.

Thanks to technology development and innovation driven by EU and national policies, over the last few years we have seen the realization of attractive renewable energy technologies, for both large and small-scale use, alongside considerable cost reductions such as the PV modules decreasing in cost by 80% between 2008 and 2012. As a result, businesses and households can increasingly produce and consume, some or all, of their own electricity, either instantaneously, by synchronizing their consumption, or in a deferred manner through decentralized storage, behind the connection point with the grid (i.e. the electricity meter). Through the process of 'self-consumption', passive consumers are therefore

becoming active 'prosumers', therefore producers and consumers of renewable energy.

3. NET-METERING PV SYSTEM PROGRAM

In the direction of empowering consumers a new law, 4203/2013 was passed by the Hellenic parliament that allows net-metering for PV systems. The net-metering long awaited program is expected to regenerate the PV market in Greece provided that the economy stabilizes from the current crisis. The net-metering operation framework was finally introduced at the end of 2014 with a Ministerial Decree [3] and the program procedures were put in operation in May 2015 for the low voltage PV systems. Study cases for the viability of the new PV net-metering program are presented below for a household and a commercial enterprise.
Net-metering for auto-producers is a regulatory framework under which the excess electricity injected into the grid can be used at a later time to offset consumption during times when their onsite renewable generation is absent or not sufficient.

The main features of the Hellenic PV Net-metering program are:

- The program concerns fixed photovoltaic systems with capacity under 20 kWp with a 25 year contract, which are installed on the same or adjacent surface area (owned or co-owned) with consumption facilities which they feed and are connected to the Network (network of low, medium and high voltage).
- The Photovoltaic systems can be mounted on buildings or on free land or other structures, according to current planning legislation.
- Eligible consumers are: private persons & legal entities, public or private
- Organizations seeking charitable activities or for other public interest purposes, at local or at country level, are allowed a maximum power capacity for the PV systems up to 100% of the agreed maximum contracted power but always under 500 kWp (mainland).
- For non-interconnected islands, PV systems with a power capacity up to 10kWp can be installed and especially for Crete up to 20 kWp.
- For Crete depending on contracted power the maximum photovoltaic system power limit is 50 kWp and 20 kWp for the other non-interconnected islands.
- Auto-producers pay the ETMEAR fee (the uniform fee for pollutants emissions) only for the electricity absorbed from the Network or System.
- Offset of the PV energy output from consumption is considered on an annual cycle.

4. SELF-CONSUMPTION VERSUS NET-METERING IN THE CONTEXT OF SMART GRIDS

As consumers have an interest in maximising the rate of energy self-consumption in order to increase their energy savings and reduce their exposure to electricity prices, preference for self-consumption over net-metering schemes should be widely incentivized in the future, as the net-metering scheme is not encouraging the increased use of local (synchronized) self produced electricity, as excess electricity is injected into the grid which can be used at a later time to offset consumption during times when their onsite renewable generation is absent or not sufficient. In other words, under the net-metering scheme, consumers use the grid as a backup system for their excess power production.
In the context of a smart grid environment, self-consumption has therefore the potential to drive consumers' uptake of flexibility measures, while at the same time help facilitating the system integration of variable renewable energy [4]. The PV Parity project has found that self-consumption extended by storage and demand response can reduce the additional system costs of the EU integration of solar PV at high penetration levels by around 20% [5]. Flexibility can be realized through two main set of measures: a) demand-side response through automated control of loads and b) energy storage, including thermal and electricity storage.

For example, there is an important potential for renewable energy production in buildings that can be realised if self-consumption is promoted and if cost-efficient procedures are in place for electricity needs not covered by renewables. Furthermore, access to capital and/or financing is a key issue of whether or not residential consumers can enjoy the benefits of self-consumption. The different tariff structure models should also correctly reflect the impact of the consumer on the electricity grid [6], while ensuring that regulated assets contribute to the energy transition by supporting the EU policy objectives on energy efficiency and renewable energy. Therefore, business models and financial instruments need to be developed to make self-consumption widely accessible to consumers from all income levels, including special programmes for vulnerable consumers.

Furthermore, it should be highlighted that complex and burdensome administrative and authorisation procedures still represent an important barrier for the competiveness of small-scale self-consumption projects. On-line information platforms and applications would be very helpful. So far they used in only a few Member States such as Portugal, Hungary, Italy and Sweden. While several Member States have introduced facilitated notification procedures for small renewable energy installations such as roof-top PV installations, additional national actions are required.

5. COST AND BENEFIT ANALYSIS OF TWO STUDY CASES FOR THE NEW PV NET-METERING PROGRAM

Given that the electricity offsetting is carried out on an annual basis and any energy surplus after the running year is not compensated, then the annual energy production by the photovoltaic system should not exceed the total annual consumption of the consumer. In an earlier article the annual PV generation per kWp was reported [7] for a number of large (>1 MWp) selected fixed PV systems using crystalline silicon modules. The annual energy production in various locations in Greece varied around 1541 kWh/kWp ± 140 kWh/kWp. Given

that in the net-metering program the PV systems may not be oriented at the optimum direction and they may also have temporary shadings due to adjacent buildings and vegetation, the former annual electricity production rate may be considered as the maximum. In any case, given the local situation the trained PV installers have the tools and the capacity to provide a good annual production estimate.

The net-metering program for PV systems allows also owners of existing PV systems already participating in the program of PV systems on buildings up to 10 kWp, to join the Net-Metering program if they wish. The right for participation is open for all natural persons, private and public legal entities that own or have the right to use the PV system installation site.

5.1 Study case 1: Household PV system.

In the case 1 a PV system of such capacity is considered in order to cover the average annual consumption for the whole duration of 25 years of the program. A household with a low voltage, 3-phase 15 kVA contracted capacity is considered with annual consumption of 4600 kWh. The following assumptions are also taken into account: The average yearly energy production is taken 1450 kWh/kWp, when the PV system is newly installed. With a digression of 0.5% in the annual productivity, the PV system always produces practically more than the annual average consumption for 25 years. The PV system cost, including 23% VAT, the connection cost and a new meter cost for the 3.6 kWp system is taken as 7032 Euro (1250 Euro/kWp + 23% VAT, plus 390 Euro for the new electricity meter). The maintenance and operation cost is taken as 1% of the initial system cost and the electricity tariffs face an average annual increase of 1%. The total system cost is covered by the owner. In the following the cost of the annual electricity bill is calculated twice, Figure 2, once for the case without PV and a second with a Net-Metering PV system.

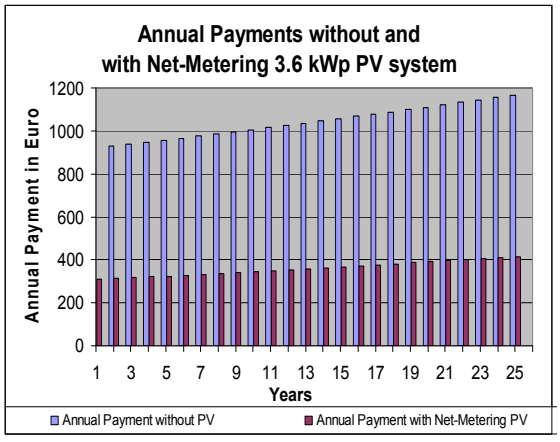

Figure 2: Annual payments without and with a 3.6 kWp Household Net-Metering PV system.

The self-consumption rate considered is 33.3%. Therefore, by further synchronizing PV production with consumption the economics may be improved. This can be achieved by using loads such as washing machines for dishes and clothes, water heating without any new investment. By using heat pumps, for heating and cooling, a new investment is needed and a new PV system sizing as well to cover the new electricity consumption.

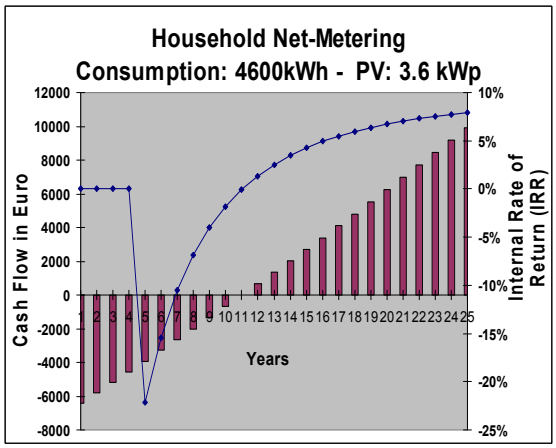

Figure 3: Cash flow and IRR development for 25 years for a household PV Net-Metering system.

In Figure 3, the cash flow and Internal Rate of Return (IRR) for 25 years are presented for the household Net-Metering PV system. The payback period is under 12 years and the IRR at 25 years is a respectful at 8%.

5.2 Study case 2: Commercial PV system.

In case 2 a PV system of 20 kWp nominal capacity is considered in order to cover the annual consumption for a commercial enterprise for the whole duration of 25 years of the program. The contracted power capacity considered for the enterprise is a 3-phase, 15 kVA, low voltage service, with an average annual consumption of 26000 kWh.

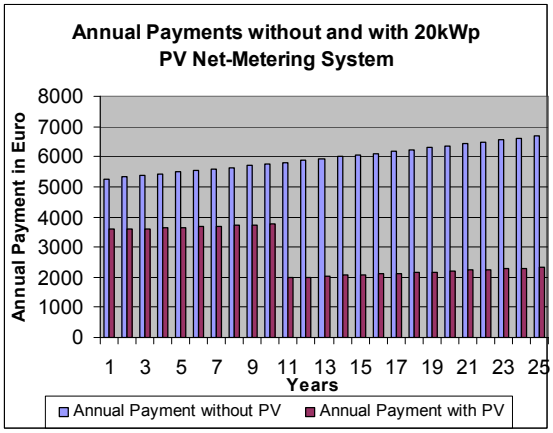

Figure 4: Annual payments without and with a 20 kWp Commercial Net-Metering PV system.

The following assumptions are also taken into account: The average yearly energy production is taken 1450 kWh/kWp, when the PV system is newly installed. A 0.5% annual productivity reduction is taken into account for the PV system, which for the whole duration of the 25 year program produces on an annual basis more than the annual average consumption of 26000 kWh. The PV system cost without VAT (VAT can be deducted by enterprises) including the connection and new meter cost for a 20 kWp system is taken as 25390 Euro (1250

Euro/kWp, plus 390 Euro for the new electricity meter). The maintenance and operation cost is taken as 1% of the initial system cost and the electricity tariffs face an average annual increase of 1%. The total system cost is covered 50% by a bank loan for 10 years and 7% interest rate and the remaining amount by the enterprise. In the following the cost of annual electricity bill is calculated twice, Figure 4, once for the case without PV and a second with a 20 kWp Net-Metering PV system. The drop in annual payments after the tenth year for the Ne-metering case is due to the total repayment of the loan.

The self-consumption rate considered is 38% as commercial activities are primarily during daytime hours. The self-consumption rate may be improved by synchronizing PV production with consumption activities and by investing in heat pumps, for heating and cooling, but in this case a new feasibility study has to be performed under the new circumstances for consumption, production and contracted electricity service terms.

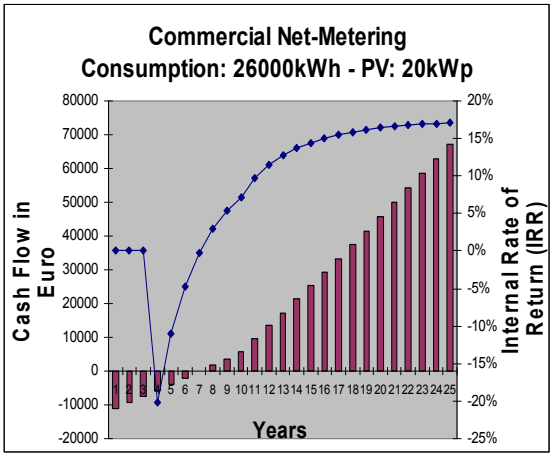

Figure 5: Cash flow and IRR development for 25 years for a Commercial PV Net-Metering system.

In Figure 5, the cash flow and IRR for 25 years are presented for the commercial Net-Metering PV system. The payback period is under 8 years and the IRR at 25 years is a very attractive at 17%.
As it was proved by the study cases the PV Net-Metering program is financially attractive provided the economic environment in Greece improves and authorities simplify the administrative and authorisation procedures for small-scale PV (RES) projects. The existing experience and know how of member states with on-line information platforms and application procedures should be investigated.

6. PV MARKET SUSTAINABILITY PROPOSALS AND CONCLUSIONS

Regarding the sustainability of the PV market in Greece it is noted that as the FiT for 2015 will be 1.1 to 1.2 times the average System Marginal Price in the previous year (2014) which was 57.53 €/MWh. Therefore, FiTs of 63 to 69 €/MWh are very low values as for new investments under the economic environment in Greece. Therefore, the FiTs should be reconsidered in order to render the investments in PV systems attractive. In comparison, it is mentioned that the FiTs for wind and other mature RES technologies range between 82 and 105 €/MWh in the mainland, depending on installed system capacity and whether there is a subsidy on initial investment or not. Furthermore, a study carried out by the firm Booz & Co on behalf the electricity utility Public Power Corporation (PPC) concerning the comparison of the cost of electricity production from lignite in Europe. It was estimated that the final full cost of producing electricity from lignite in Greece for the year 2012 was 60 €/MWh.
While considering that the cost of electricity production by gas plants is exceeding 110 €/MWh, it is reasonable to support a solar kWh compensated in the range of 80 to 100 €/MWh.
It is noted that according to the National Renewable Energy Action Plan (NREAP) [8], the total PV capacity in Greece, except the PV systems on buildings under 10 kWp, in the year 2020 should reach 2200 MWp. As this target for 2020 was reached at the end of 2013, it is proposed to have a NREAP policy revisit and update in order to take into account the current situation. Therefore, the government has to update its NREAP policy and targets considering the attractiveness of the technology and the potential for employment and development, as up to the year 2013, several thousand companies were active and more than 25.000 people were employed in the PV market sector. Furthermore, it has to take into consideration also all benefits and charges of all forms of energy and the initiative to transform the electricity market into a simple, transparent and fair operating scheme for all players, including the consumers.
On the other hand, the new Net-Metering PV program as proved by the study cases is considered attractive and given the right economic environment it could become a significant market segment in the following years. The existing experience and know how of member states with on-line information platforms and application procedures for small scale RES projects should be investigated.
As consumers have an interest in maximising the rate of energy self-consumption in order to increase their energy savings and reduce their exposure to electricity prices, preference for self-consumption over net-metering schemes should be widely incentivized in the future. In the context of a smart grid environment, self-consumption has the potential to drive consumers' uptake of flexibility measures, while at the same time help facilitating the system integration of variable renewable energy.
Finally, attention and a special FiT should be given to the developing sector of Building Integrated PV systems (BIPV). The integration gives added value to the PV system and promotes the involvement of architects, thus introducing BIPV in the mainstream of building design. In any case, action should be taken to modify the building code in Greece in order to allow PV integration on buildings.

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