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Project PV-NET: Promotion of photovoltaic energy through net metering optimization

***Abstract**. The project "Promotion of photovoltaic (PV) energy through net metering optimization" with the acronym PV-NET is a new technology project which can contribute to the goals of the EU strategy on "Climate change and energy". The data and experiences gained through the project are used to build typical end users consumption patterns for the development of a transnational optimal net metering mode, to improve understanding of the impact of local conditions on energy consumption/generation profiles.*

***Streszczenie.** Prezentowany w artykule projekt badawczy "Projekt PV-NET: promocja energii fotowoltaicznej poprzez optymalizację pomiarów sieciowych" jest nowym projektem technicznym, będącym wkładem w strategię unijną „Zmiana klimatu i energia". Dane i doświadczenie uzyskane w projekcie są używane w budowie wzorców konsumpcji końcowych użytkowników. Ma to służyć rozwojowi optymalnej, międzypaństwowej sieci pomiarowej oraz poprawić rozumienie wpływu warunków lokalnych na relacje konsumowanej i generowanej energii. (**Projekt PV-NET: promocja energii fotowoltaicznej poprzez optymalizację pomiarów sieciowych**)*

Keywords: photovoltaics, energy production, energy consumption, net metering.
Słowa kluczowe: fotowoltaika, produkcja energii, konsumpcja energii, pomiary sieciowe.

Introduction

The Feed-in-tariff (FIT) scheme for the installation of photovoltaic (PV) power plant has been adopted by the majority of the EU countries as a cost effective measure to increase the number of installed PV systems, at a time when the technology was not competitive. Over time and given the high solar potential in the Mediterranean and the fact that the area has already reached grid parity, the PV technology is no longer in need of any form of subsidization.

Smart net metering can be a very good energy policy for the promotion of renewable electricity and offers the possibility of measuring and managing the electrical energy consumed in buildings by subtracting the energy produced by the installed PV system.

Seven partners from six different countries participate in the project: Cyprus, Spain (Andalusia), Greece (Thessaloniki), Slovenia (Maribor), Portugal (Algarve) and France (Rhône-Alpes). The project PV-NET aims at developing a better energy policy for the promotion of renewable energy sources (RES) in the Mediterranean area, targeting the best and most cost-efficient use of PV technology through the utilization of smart net metering.

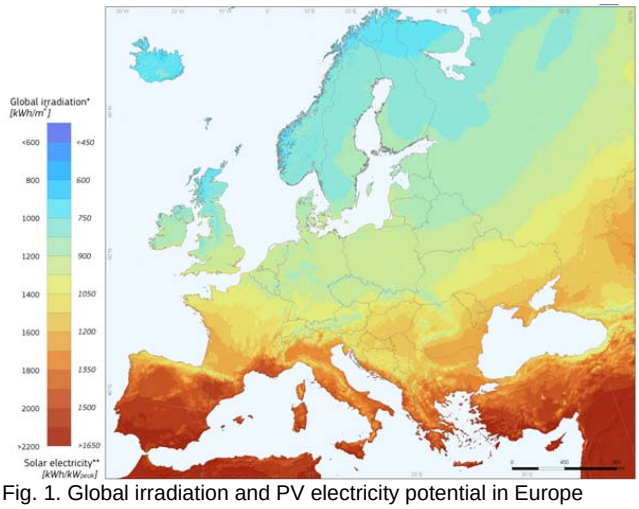

Fig. 1. Global irradiation and PV electricity potential in Europe

Photovoltaic geographical information system [1] is on-line tool providing the solar resource for the countries of Europe and Africa. The yearly sum of global irradiation in kWh/m^2 and the solar electricity generated in kWh/kWp for horizontally mounted PV systems for Europe is shown in Fig. 1 [2-4]. The electricity price breakdown for selected tariff in Slovenia is presented in Table 1.

Table 1: Electricity price breakdown per kWh in Slovenia

	%	€/kWh
Production Cost	41.0	0.0583
Network Cost	26.3	0.0374
Standing Fees	7.0	0.0099
Taxes & VAT	25.8	0.0367
Total	100	0.1423

Innovative aspects

The major innovation of this project stems from the adoption of new technology for the cost-effective incorporation of RES in existing electric grids. Other innovative aspects are:

1. The development of a tool for the analysis and optimisation of net-metering schemes for Mediterranean countries that will assist in the incorporation of RES, and in particular PV into the grid.
2. The use of smart net-metering with remote data access as a means to encourage the take-up of PV energy systems in the Mediterranean region.
3. The promotion of RES through pilot programmes to demonstrate the benefits to ordinary citizens.
4. The use of high-profile campaigns to create a groundswell of support for PV amongst the end-users of RES.
5. The development of a new, transnational alliance of utilities and stakeholders across the Mediterranean with the aim of removing barriers to widespread adoption of small-scale PV within electricity grids.
6. The development of a data collection system for use at the point of generation to provide key performance metrics to producers/consumers (prosumers) in order to effect behaviour change in consumption.
7. The development of a remote data access and storage system in order to collect and analyse data from a number of installations in different countries across the Mediterranean.
8. The installation of pilot demonstration sites in different countries across the Mediterranean, studying the differences in consumption and generation of electricity in residential, commercial, industrial, and public buildings.

Environmental incidences

Environmental influences of the project are broken down to the five points [5]:

1. The move to a more sustainable and clean energy supply through encouraging RES adoption which will eventually translate into more environmentally-friendly consumer energy behaviours.
2. Support to the improved prospects for green sustainable growth and development by triggering a widespread adoption of RES within a competitive electricity market based on significant PV penetration in the energy mix. This results in creating a dynamic marketplace with associated increases in employment opportunities within the renewable energy sector as well as a boost in the PV and smart metering industry.
3. Support to reduction of emissions of greenhouse gasses and air pollutants through supporting a rapid move towards RES and the consequent reduction of electricity generated using fossil fuels.
4. Improvement of energy efficiency through adoption by consumers of more efficient energy consumption profiles, as well as increased self-consumption of electricity generated by PV.
5. Positive impact on the environment and the regional fauna/flora which is particularly sensitive to climate changes and directly linked to extreme natural phenomena (drought, floods, and fires), urbanization, air pollution and water contamination. PV-NET indirectly supports minimizing the climate warming effect thus helping in natural habitat preservation and better protection of water quality in the Mediterranean rivers, lakes, and open sea, which are already plagued by high pollution levels.

Implementation

The current connection schemes allowed in Slovenia are presented in Fig.2, Fig.3 and Fig.4. The most appropriate scheme for the implementation of the net metering system is P X.3 scheme (Fig.4).

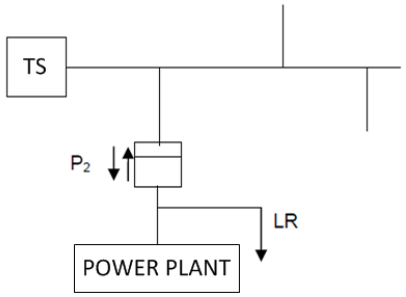

Fig.2. Power plant grid connection scheme P X.1

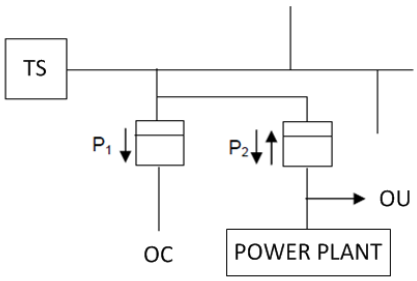

Fig.3. Power plant grid connection scheme P X.2

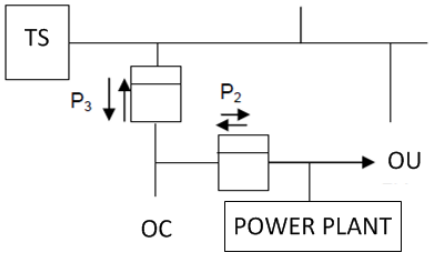

Fig.4. Power plant grid connection scheme P X.3

Pilot PV net metering systems have been installed in Cyprus, Slovenia and Portugal on different types of buildings (residential, commercial, industrial, etc.). The aim is to study the energy policy of each region in order to develop the most optimum PV net metering model and to analyse the data generated by the pilot power plants. The purpose of pilots is to demonstrate and prove the benefits for net metering by validating and optimizing the models generated.

The majority of PV systems installed in Slovenia are grid connected. The support schemes for residential PV systems in Slovenia are the Feed-in-Tariff and Premium-Tariff. The prosumer under the Premium-Tariff scheme is paid for the net amount of generated electricity which the producers themselves sell on the market or use for their own consumption.

Results and discussion

Monthly plane of array (POA) irradiance and AC energy yield from a 1 kWp PV system in Slovenia for the year 2013 is presented in Table 2.

Table 2. Monthly POA irradiance and AC energy yield from a 1 kWp PV system in Slovenia

	Jan	Feb	Mar	Apr	May	Jun
$E_{generated}$ (kWh)	50	77	107	124	144	141
G_{POA} (kWh/m2)	55	86	125	149	179	177
	Jul	Aug	Sep	Oct	Nov	Dec
$E_{generated}$ (kWh)	152	139	117	78	48	43
G_{POA} (kWh/m2)	191	175	142	92	179	177

One of six pilot sites in Slovenia, where the equipment for analysing the net metering was installed, is presented in Fig.5 and Fig.6. Figure 5 presents both, electric energy consumption meter and electric energy meter for PV production.

Fig.5. Pilot site - photovoltaic power plant with pyranometer

Fig.6. Pilot site – electric energy meter for electricity production and consumption

Figure 7 and Fig. 8 present the difference betweeen produced power with PV power plant and consumed power. Figure 7 presents weekly measurements and Fig.8 monthly measurements. It can be seen that the most important task in the net metering optimization is to move the surpluss of PV energy to the time periods where the energy for building is taken from the grid. This idea arises among the prosumers not only for the solution with the connection to the grid but also with the complete disconnection from the grid. The latest option demands the energy storage, which presents additional cost to the prosumers, but with unclear long-term energy policy we can expect that the number of disconnections will increase. It is therefore important that we find the technical and legislative solution which could enable prosumers to “store” the surplus PV energy into the power system. Appropriate developed net metering is for sure one of the most promising solutions.

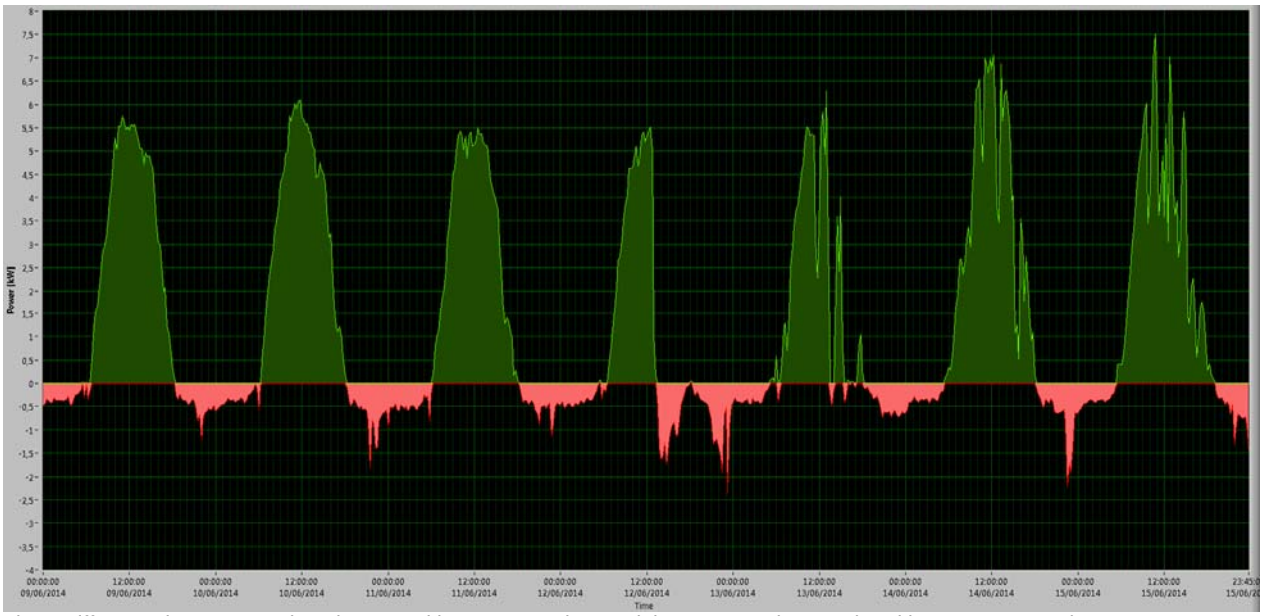

Fig.7. Difference between produced power with PV power plant and the consumed power (weekly measurements)

Fig.8. Difference between produced power with PV power plant and the consumed power (weekly measurements)

Conclusions

Analyses, pilot sites, measurements and data analysis show that net metering is very promising system of production and consumption of electrical energy and with developed and installed systems presents the platform for further development of smart cities and communities and also smart, intelligent and energy efficient homes.

Future impact of the PV-NET project is connected with the assessment of the effectiveness of current RES support measures in triggering PV uptake, highlighting failures/bottlenecks of the measures and supporting legal frameworks. A realization of PV smart net-metering pilot schemes in 3 countries demonstrates viability of net metering for cost-efficient grid integration of RES. Implementation of remote data access systems enables the monitoring of energy consumption and generation profiles by consumers and utilities. Increased public awareness on the benefits of PV implementation for electricity generation and consumption can lead to "smarter" energy-conscious consumers thus improving energy efficiency, and a boost in market demand required for the substantial raising of PV competitiveness in the region. The development of optimized PV metering scenarios for both prosumers (producers-consumers) and utilities, based on net metering, could be adjusted to the specific RES characteristics (potential, targets, etc.) of each country and optimized using the data from the PV pilot installations. Reports for utilities and policy stakeholders in each country with recommendations on optimal net metering implementation and publications to the broader energy and RES scientific communities is the way for promotion and rising awareness. Through dissemination a transfer of know-how, methodologies and best practices developed within the project, the support to create/strengthen cooperation networks targeting optimum implementation of PV in the Mediterranean area can be achieved.

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