Solar PV on the Distribution Grid: Smart Integrated Solutions of Distributed Generation based on Solar PV, Energy Storage Devices and Active Demand Management

The Most Promising Prosumer Solutions for PV

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iDistributedPV. The Project and the Consortium

Participant Nº	Participant organisation name	Country
1 Coordinator	Asociación de Empresas de Energías Renovables (APPA)	Spain
2	Institute of Power Engineering (IEN)	Poland
3	Enea Operator Sp. z o.o. (EnOp)	Poland
4	ExideTechnologies (Exide)	Germany
5	Kostal Solar Electric Iberia, S.L. (Kostal)	Spain
6	Fraunhofer-Institut für Solare Energiesysteme ISE (Fraunhofer)	Germany
7	Deloitte Advisory, S.L. (Deloitte)	Spain
8	Institute of Communication and Computer Systems - National Technical University of Athens (ICCS -NTUA)	Greece
9	Hellenic Electricity Distribution Network Operator S.A (HEDNO)	Greece
10	Lietuvos energetikos institutas (LEI)	Lithuania
11	Renerga UAB (Renerga)	Lithuania
12	Novareckon S.R.L. (Novareckon)	Italy

iDistributedPV. Objetives I

- To **propose the development of integrated solutions** to enhance the large penetration of solar PV distributed generation (e.g. households/larger buildings/park areas) in safe mode and according to market criteria.

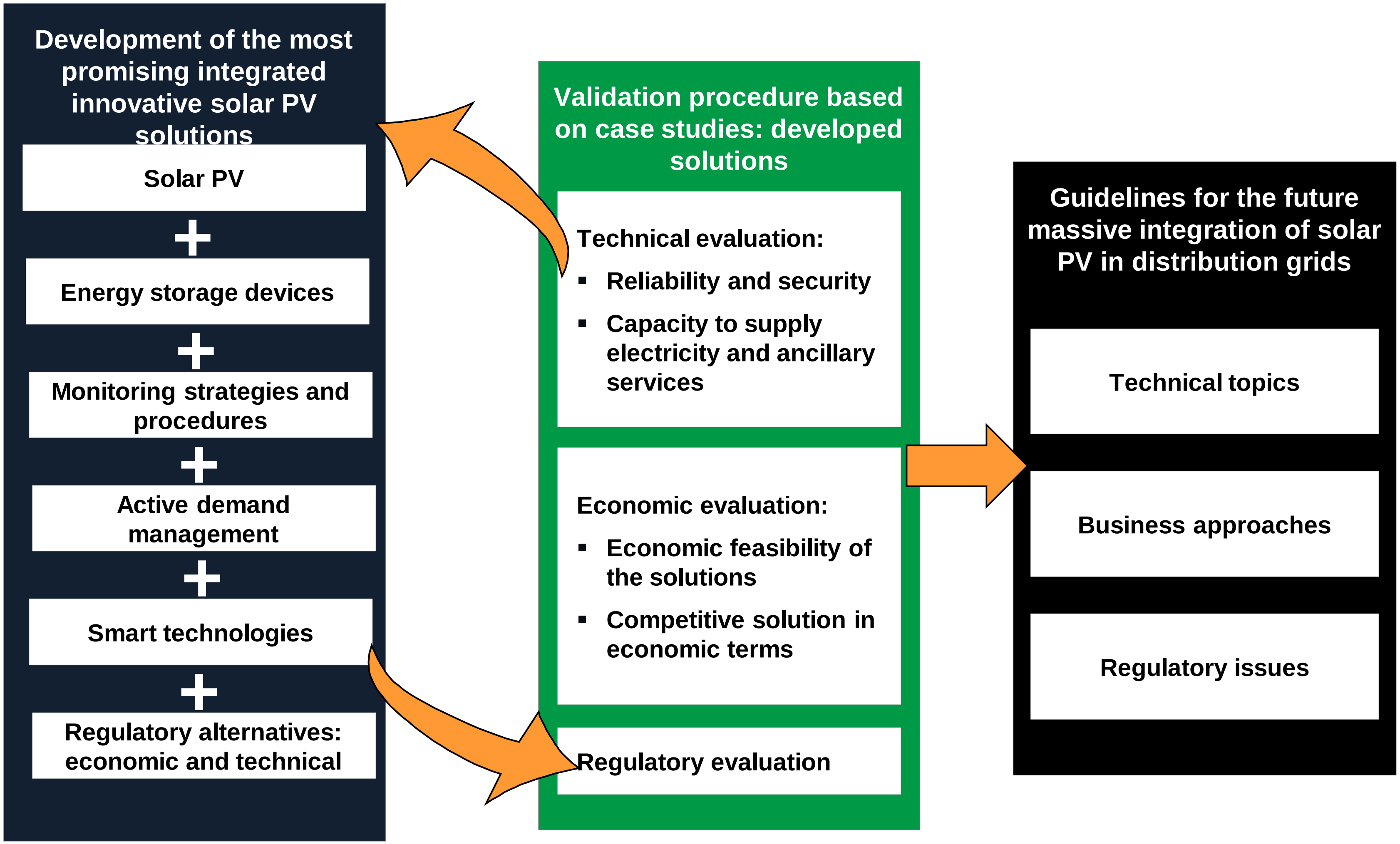
- To **develop the concept of "prosumer",** a player that consumes and produces electricity in his facilities, using solar PV and energy storage equipment, and smart technologies that allow to carry out active demand management.

iDistributedPV. Objetives II

- The promising solutions will **integrate solar PV generation, energy solar PV production equipment**, inverters, storage devices, smart technologies, active demand management approaches, monitoring strategy and procedures, grid operation procedures and criteria, and regulatory models.

- Based on market criteria, **it will propose effective approaches for the integration of these solutions with the rest of the electricity system**: electricity demand/supply of excess of production, provision of ancillary services, energy flows and economic flows, operative procedures, and telecommunication standards.

iDistributedPV. The Scope



The Outputs

- **Technical recommendations for R&D providers and manufacturers about solutions, equipment and components and standards.**
- **Regulatory recommendations regarding the role of the different players** (DSO, prosumer, players who aggregate a portfolio of prosumers, etc.) **and their revenue model.**
- **Regulatory recommendations focused on the operation and control procedures** for the integration approach of the distributed generation with the system operation, etc.

The Outputs

- **Business and management models for the effective integration of distributed generation based on solar PV.**

- **Economic, environmental and social impact assessments: stakeholders, policy decision markers, politicians and regulatory bodies.**

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Prosumer Solutions.

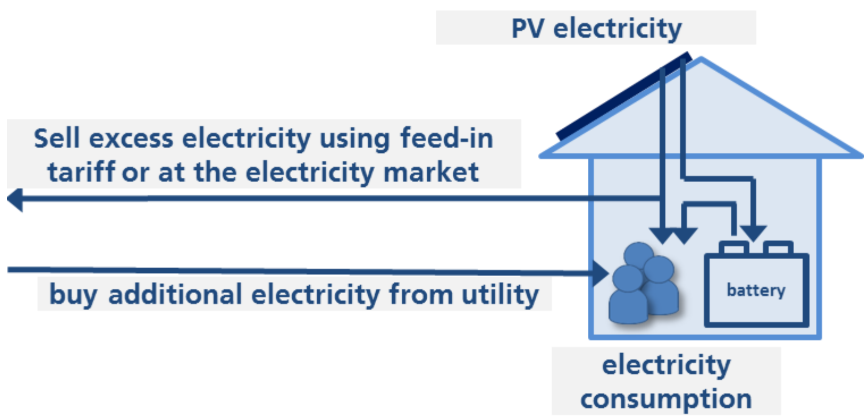
Definition

- “A “solution” in the context of the *iDistributedPV* project refers to a **combination of a PV system and a load** which is connected to the **distribution grid**, optionally supplemented by a battery system and/or demand side management technology.
- A solution is also specified by the **application** in which the system is operated (e.g. apartment building).
- The solutions encompass **all sizes** (e.g. a small PV home storage system for own consumption increase or large scale PV system on a retailer company’s roof), as long as the **generated electricity is (partially) consumed on site**.”

Overview

	Solution	Sub-solution
1	homeowner - single family house	
2	company as investor	e.g. company, office building, hotel, supermarket, farm…
3	contractor concept	e.g. company, office building, shopping mall, hotel, supermarket, farm…
4	municipal buildings (state as investor)	e.g. schools, hospitals
5	controllable load	e.g. water pumping (with a water tank as storage), EV charging
6	multi-family house (investor sells electricity to tenants)	
7	community storage (shared storage)	
8	virtual power plant	e.g. peer-to-peer, FCR, SCR, energy wholesale market

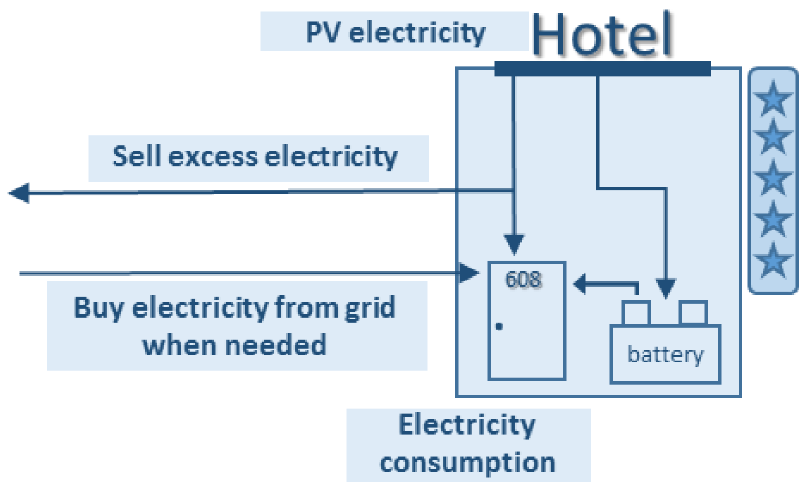
1. Homeowner-single family house



- Self-consumption when possible, excess sold to the grid, optionally stored in a battery

+ Savings due to less grid electricity purchase
+ Partial independence from electricity service provider
+ Contribution to the energy system transition

2. Company as investor



- Investor is consumer
- Self-consumption and grid feed-in possible

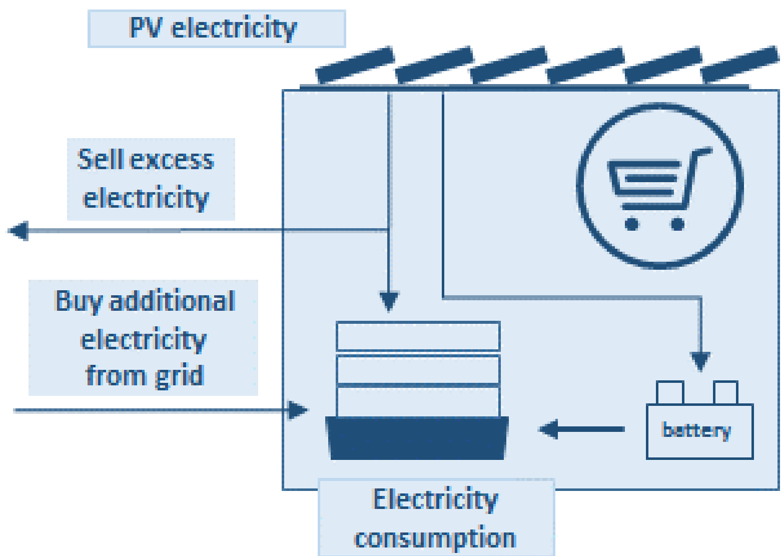
\+ Savings due to less grid electricity purchase

\+ Possibly reduction of peak demand

\+ Green image

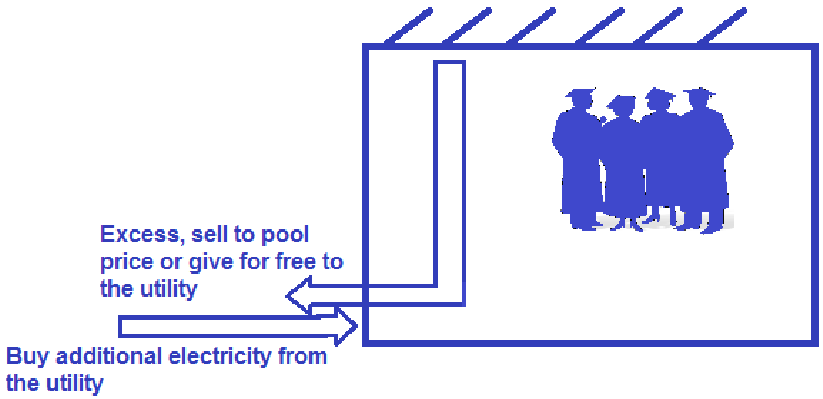
✓ Applicable to hotels, office buildings, supermarkets, other industry, trade, commercial or service companies, farms...

3. Contractor concept



- Contractor invests in the PV-(battery-)system and sells the electricity to the building's occupant
- Consumer has savings due to lower electricity price at no financial risk
- Investor profits from selling electricity
- Applicable to hotels, office buildings, supermarkets, other industry, trade, commercial or service companies, farms…

4. Municipal buildings



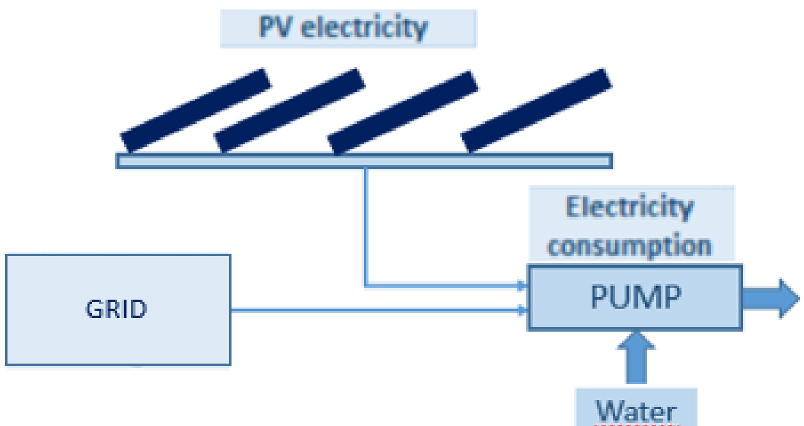
- Municipality is investor and consumer

+ Savings due to less electricity purchase

+ Public showcases can support energy transition

✓ Applicable to schools, hospitals and other public buildings

5. Controllable load

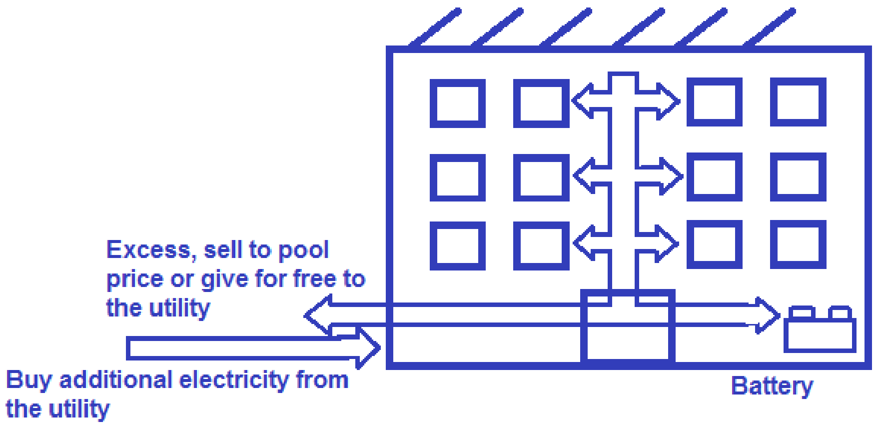


- Investor is the operator of a controllable load

+ Controllable load can be adapted to the PV electricity generation -> high own consumption rate possible

✓ Applicable to pumping systems and irrigation, electric vehicle charging, refrigerator systems, sewage plants…

6. Multi-family house

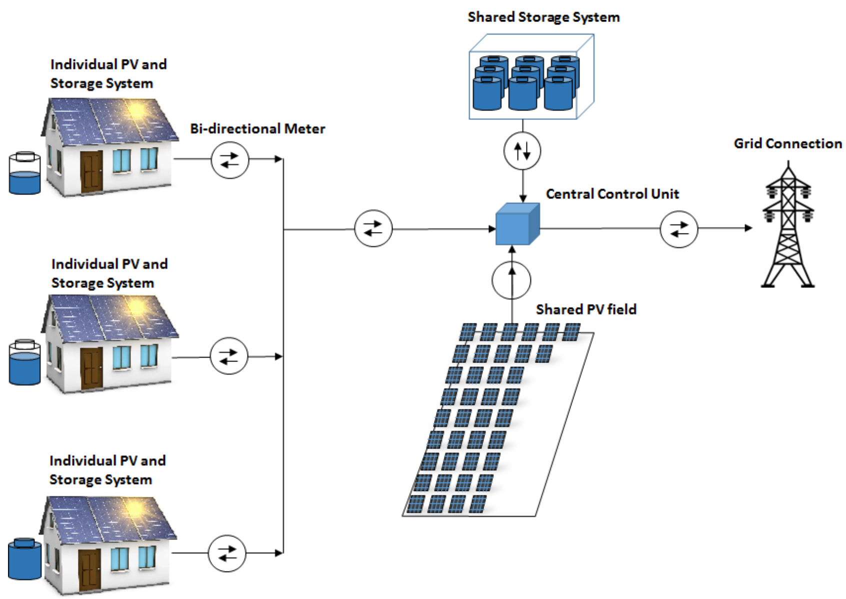


- Investor sells electricity to the residents of the building

+ Tenants have savings due to less electricity purchase
+ Investor profits from selling PV electricity
+ Adding value to the building

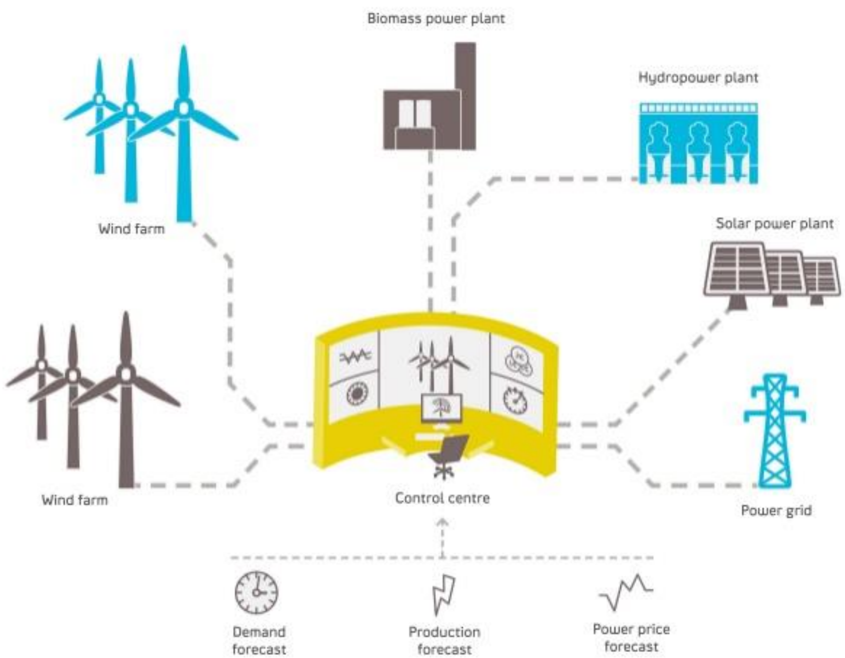
✓ Applicable to multi-family buildings

7. Community storage (shared storage)



- Communal storage is used by the residents of an area
  - Lower specific cost of the commonly used storage system
  - Higher own consumption rates possible by sharing the storage
- ✓ Applicable to residential or commercial communities

8. Virtual power plant

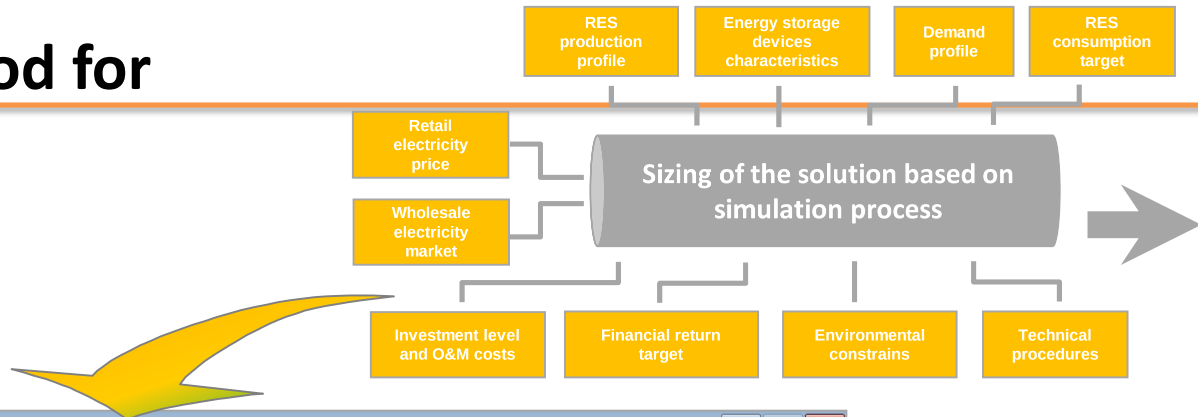


- Several renewable energy sources are combined to a virtual power plant
- The investor operates the system and sells the electricity to the market

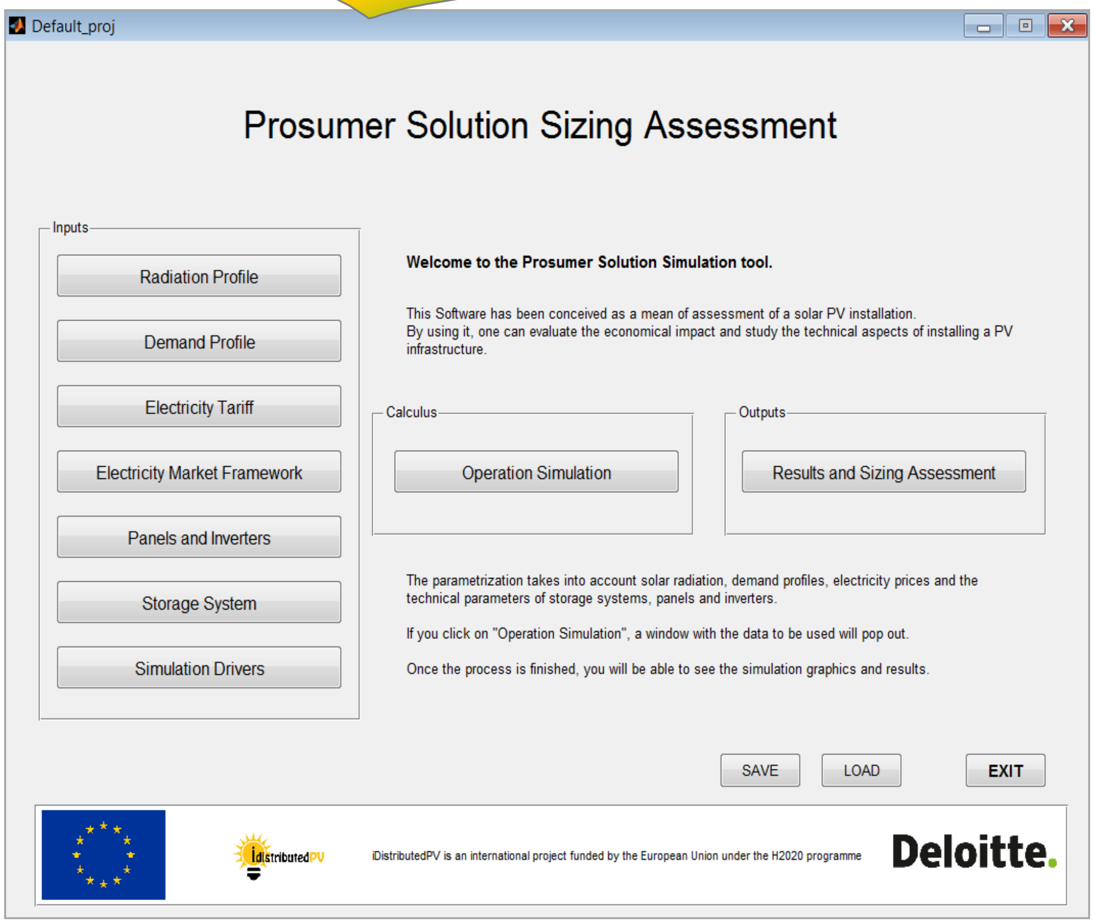
\+ VPP operator can maximize profit by using the combination of several technologies

✓ Applicable to any type of technology or as a combination of several solutions

The method for sizing the solution



- RES consumption: self production
- Solution performance
- IRR of the project
- Environmental impact



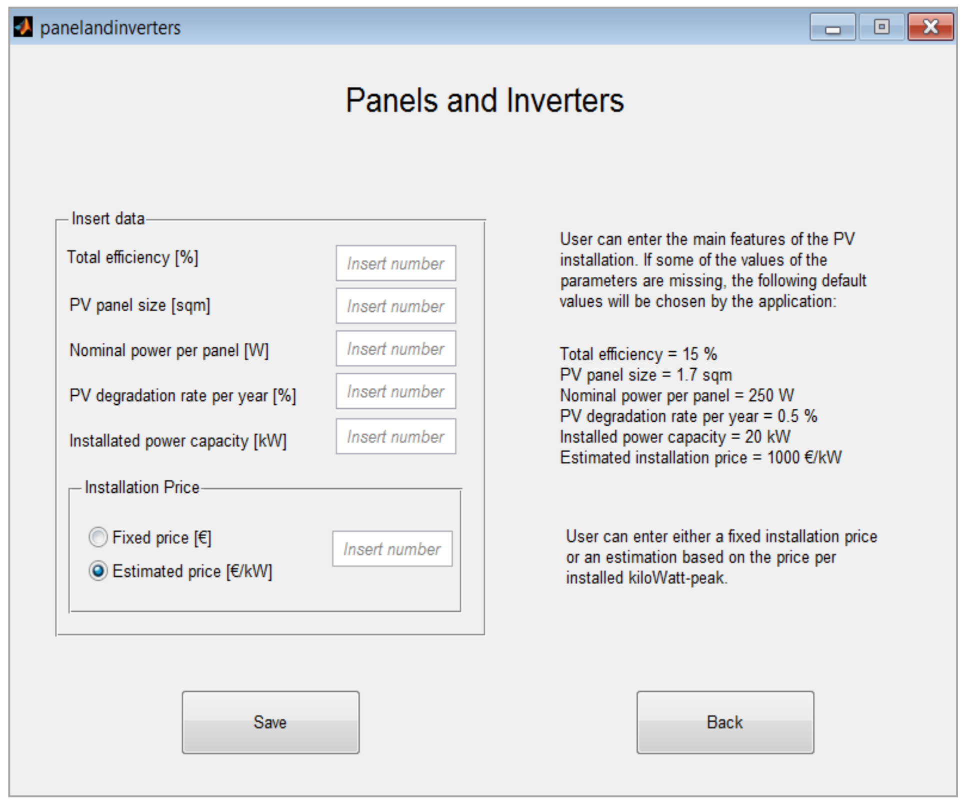
Software tool, supported by MATLAB, that simulates the operative of an integrated prosumer: consumption, generation and storage

The method for sizing the solution: the inputs

Production profile

Profile based on: technical characteristics of the equipment (performance), the irradiation pattern and its volatility

Solar PV performance level based on particular characteristics of the equipment

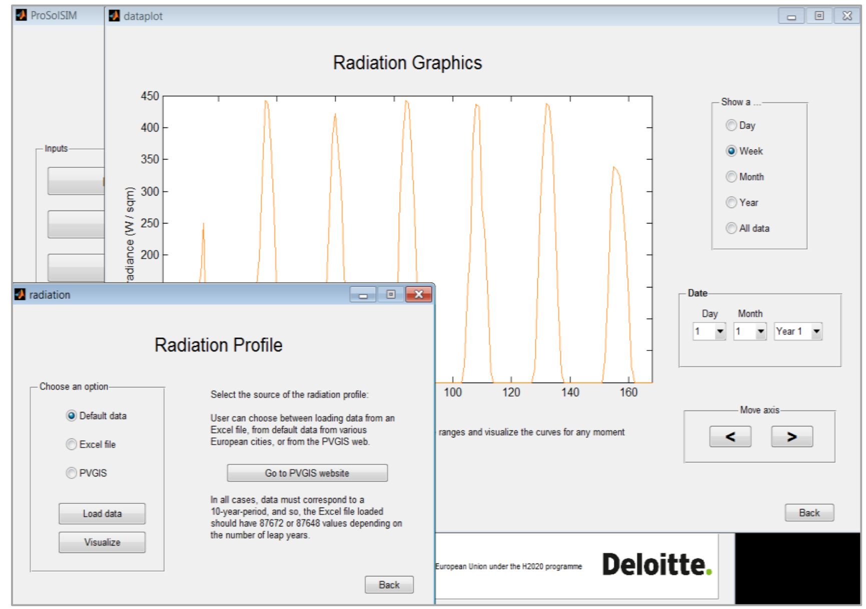


The method for sizing the solution: the inputs

Production profile

Production source, different alternatives:

- Estimation due to radiation profiles:
  - ✓ Directly from an Excel file (e.g. based on historical data)
  - ✓ Directly from PVGIS
  - ✓ Library of irradiation



Volatility of the production

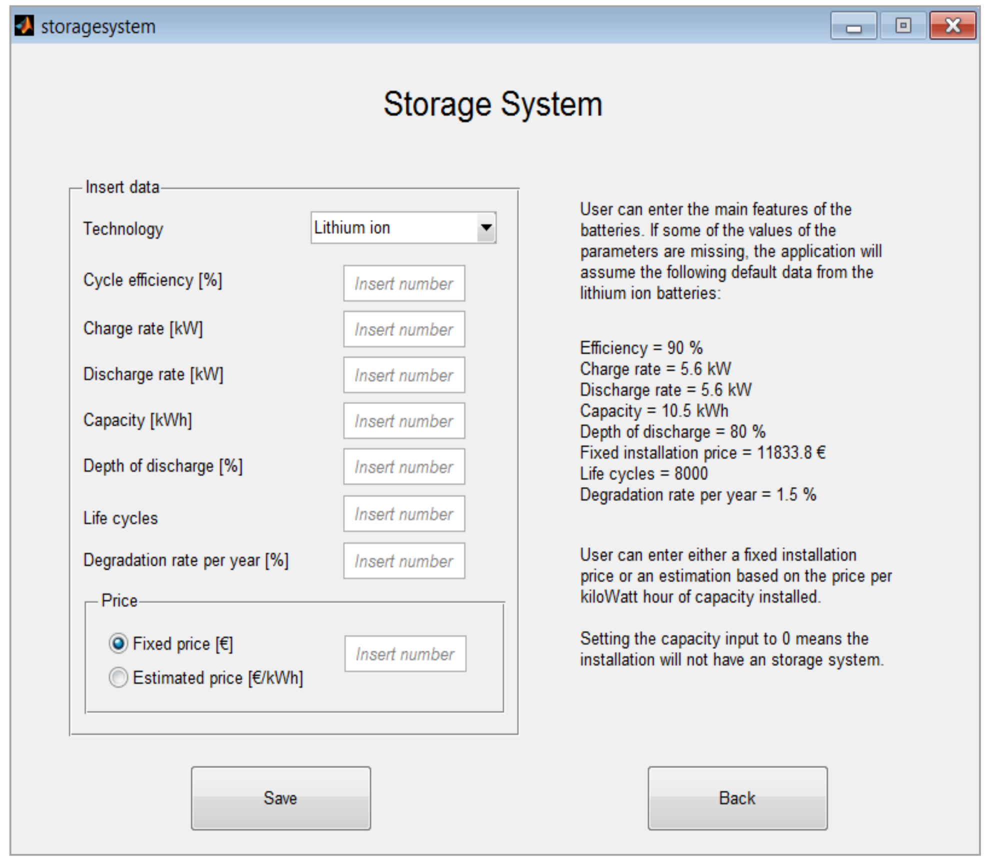
1. Gather hourly information on the last 10 years
2. Split the information in weeks
3. All the days in a week have a similar profile
4. Simulate weekly production profile based on this information (Monte Carlo simulation).

The method for sizing the solution: the inputs

Energy storage systems

Technical parameters of the equipment:

- Technology
- Efficiency (losses)
- Storage capacity
- Charge and discharge rates
- Life cycle



The method for sizing the solution: the inputs

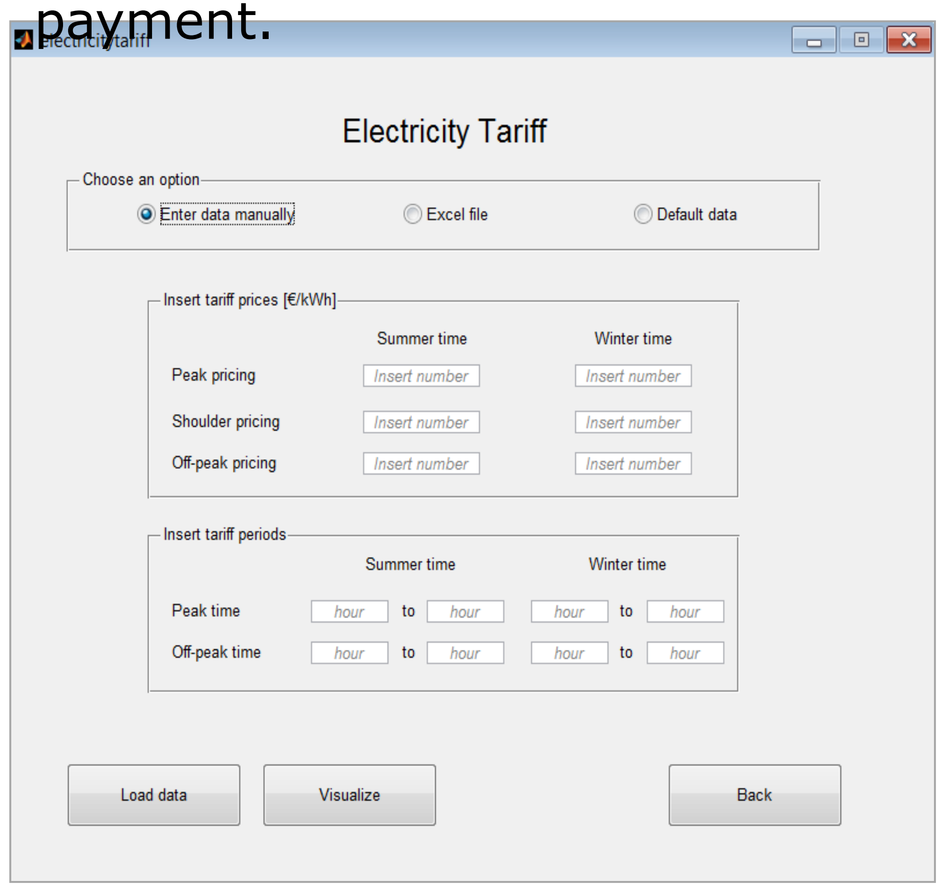
The retail electricity market price

Hypothesis: the prosumer will pay the electricity that he imports from the grid according to the retail electricity market price (at distribution level).

The tool will allow to upload the prices from a MS Excel file or introduce them directly in the screen.

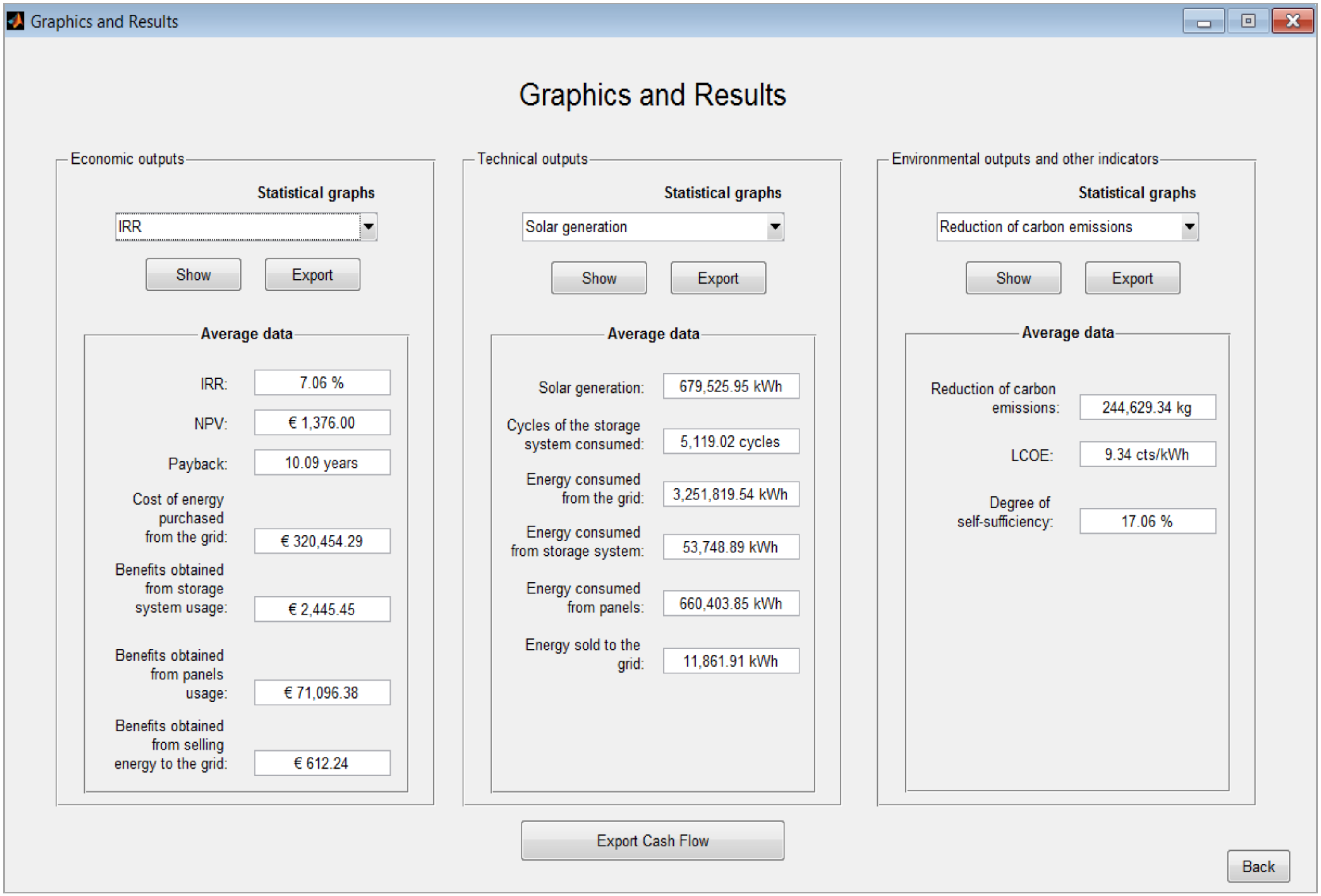
The price can be loaded taking into consideration hourly and seasonally criteria.

The method will allow to include reductions in the fix capacity payment.



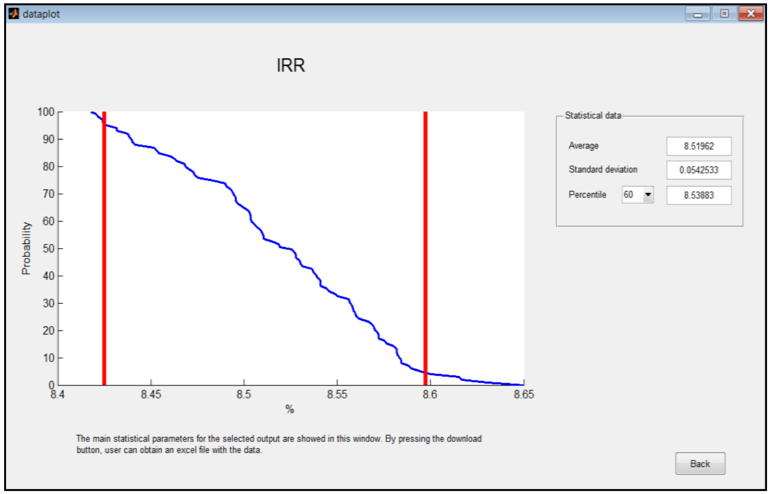
The method for sizing the solution: the outputs

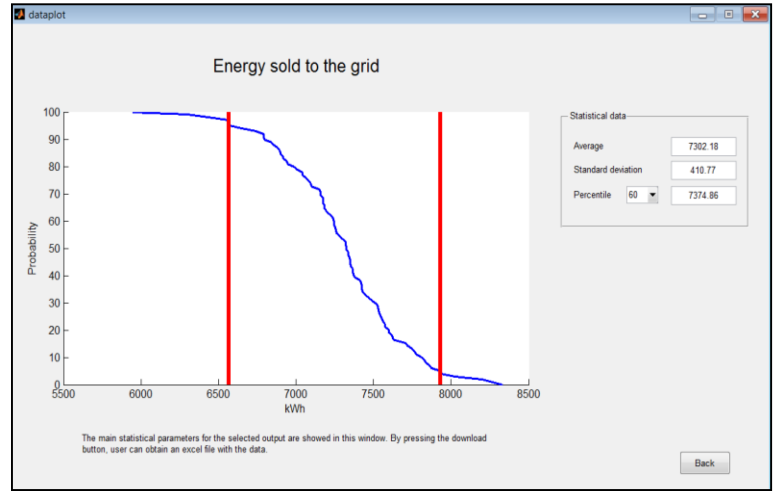
The average

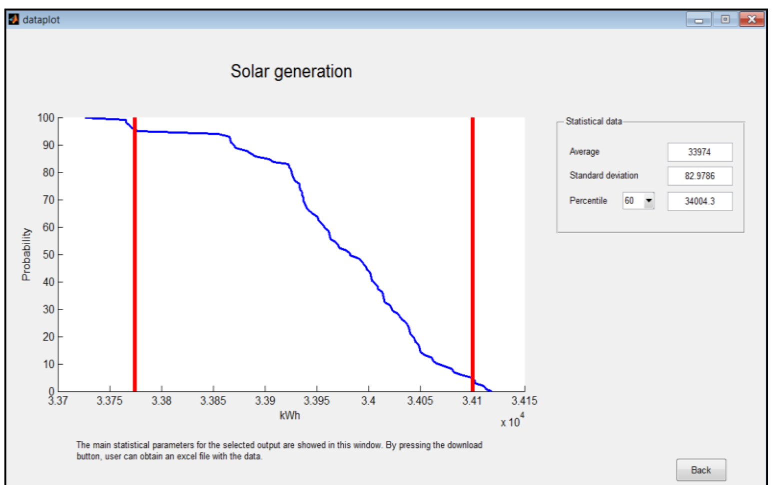


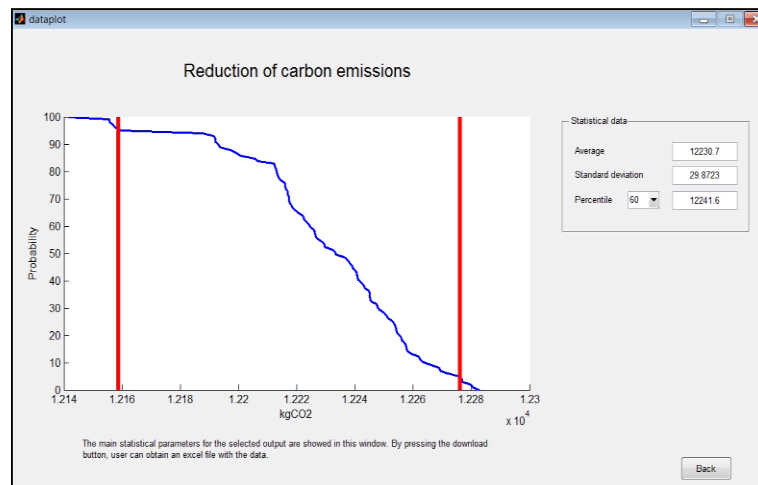
The method for sizing the solution: the outputs

The average









Thank you
for your attention!

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