



#### Effective integration of Distributed Solar PV

Project summary





























# The environment

- Reduction of solar PV investment
  - Competitive LCOE compared with other technologies
- Improvement in monitoring solutions
- Enhancement of the technology characteristics



# The environment

- Investment:
  €600-1,000/kW
- Production in Madrid area: 1,700 kWh/kW
- Useful life: 20-30 years
- Maintenance cost: no relevant

# The scope: distributed solar PV

- Integration approach: demand + solar
  PV + batteries
- Optimal sizing of solar PV equipment and storage devices according to consumption patterns and radiation profile: affordable business models
- Impact on wholesale market price
- Impact of the solution on the electricity system reliability: static and dynamic assessment
- Recommendations: business, regulation and technical

Test in different EU environments:

- Greece
- Poland
- Lithuania
- Germany
- Spain

### The method for sizing the solution

The solution is sized according to the consumption profile, the irradiation pattern (electricity production) and the energy storage devices characteristics, taking into consideration different regulatory frameworks: net metering, feed in tariff, the retail and wholesale electricity prices, etc.



# The case studies

More than 80 case studies



Winter week: production vs demand





Self-consumption



Summer week: production vs demand





Example: Residential prosumer in Germany

- Economic affordable solution, IRR higher than 7% (in some EU locations higher than 10%)
  - Relevant self-sufficiency. Depending on the consumption profile, up to 60%
- The effectiveness of the solution is based on selfconsumption rather export energy to the market
- Currently, the storage reduces the return of the investment

# The impact of the distributed solar PV on the wholesale market



2016	Day_Ahead_Auction	Model_Price	NoPV_Model_Price
Mean Price	28.98	28.98	33.96
Peak Price	31.93	31.83	41.14
None Peak Pric	e 26.03	26.14	26.78

2017	$Day\_Ahead\_Auction$	Model_Price	NoPV_Model_Price
Mean Price	34.20	34.19	40.47
Peak Price	37.99	37.90	49.67
None Peak Pric	ce 30.41	30.48	31.28



Simulating the Spanish pool with 1 TWh of distributed solar PV, the price had dropped:

- €0.44/MWh in 2015
- €0.37/MWh in 2016
- €0.35/MWh in 2017

Germany

# The impact of the distributed solar PV on reliability of the system

Static and dynamic assessment, simulating the impact of different levels of distributed

ΡV

penetration

on the

electricity

flows

- Voltage control: reduction of this variable volatility with reference to the voltage reference
- Reduction of losses in the transmission and distribution grid
  - Reduction of the load of circuits
  - Reduction of risk exposure with reference to incidents in the system (contingencies)
  - Solar PV increases the impact of frequency drops. Batteries mitigate this impact.







## Recommendations

In progress

 The solar PV panels can cover most of the demand at sunlight hours while the rest of the time the electricity is purchased from the grid: self-consumption

Relevant economic savings in the variable and fixed prices.

- Clustering prosumers is an effective approach: optimization in the investment process and in the self-consumption (reduction of electricity excesses).
- Net metering approach could promote the installation of distributed solar PV, but it is not an optimal method.
- The effective integration of prosumers to provide energy/services to the market/system operators require to establish intermediaries (aggregator): optimizing.

### Recommendations

In progress

- It is necessary to establish a regulatory framework for the aggregators activities (integration with the market and system operators).
- In order to incentivise the distributors to collaborate in the large penetration of distributed generation, economic incentives has to be established based on the positive impact of this solution.
- It is pending to decide the information flow of the distributed solar PV with the DSO and TSO, and the monitoring process.
- The usage of batteries to enable the penetration of distributed solar PV requires the reduction of its costs to around €120/kWh

Batteries is an accurate solution to provide frequency control services.

 The effective management of the electricity system requires to establish connection grid criteria for large distributed solar PV penetration.



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