FOSS Research Centre for Sustainable Energy

Technical University of Denmark

15/12/2016

Workshop on photovoltaics, grid integration and funding of the next wave of PV expansion in Cyprus

University of Cyprus Microgrid

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AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

WinPV

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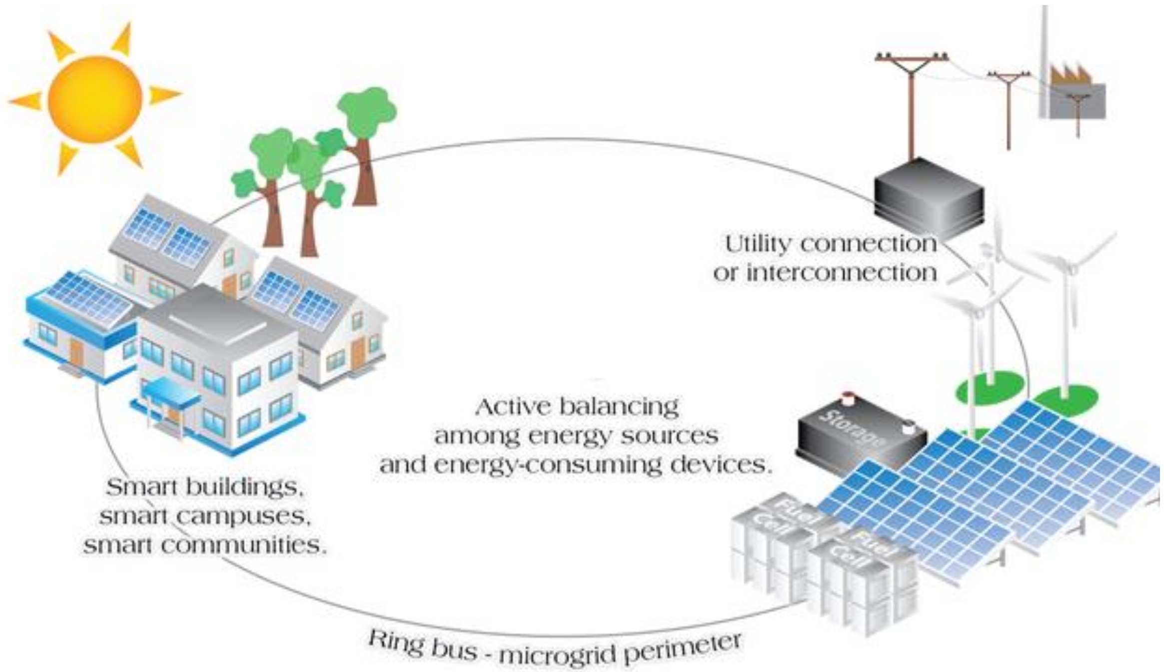
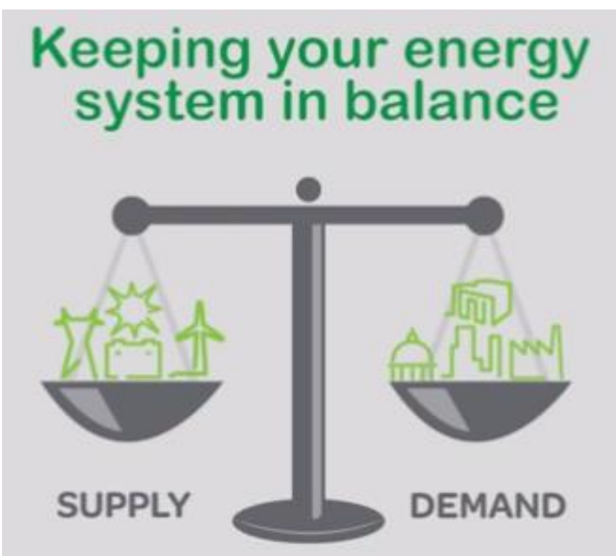
UCy is building the infrastructure so that the energy needs of the new university campus can efficiently be met through a full functioning microgrid infrastructure – More over, the infrastructure will be developed with such architecture so that it can fulfil the requirements to be a test bed for related technologies and systems to facilitate development, offer training and education possibilities to the students of the university with state of the art technologies.

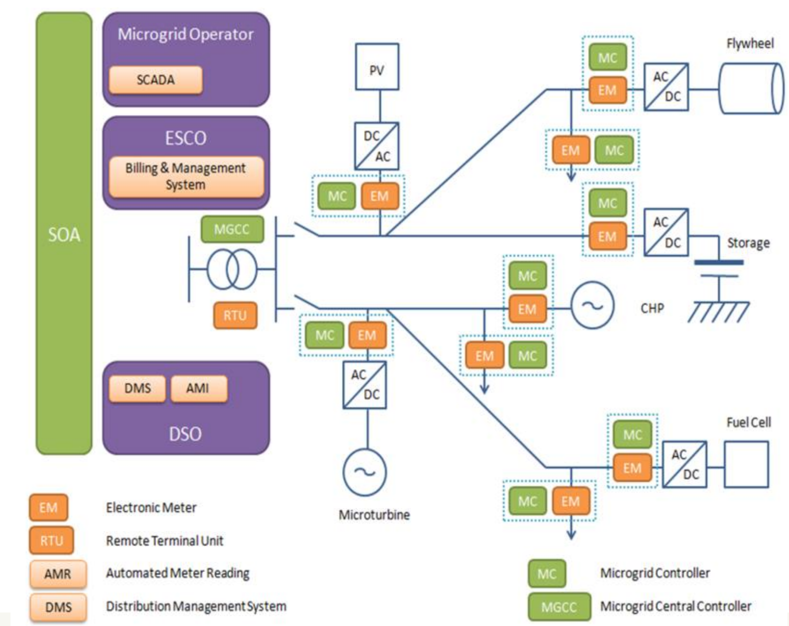
University of Cyprus PV Technology



Scope

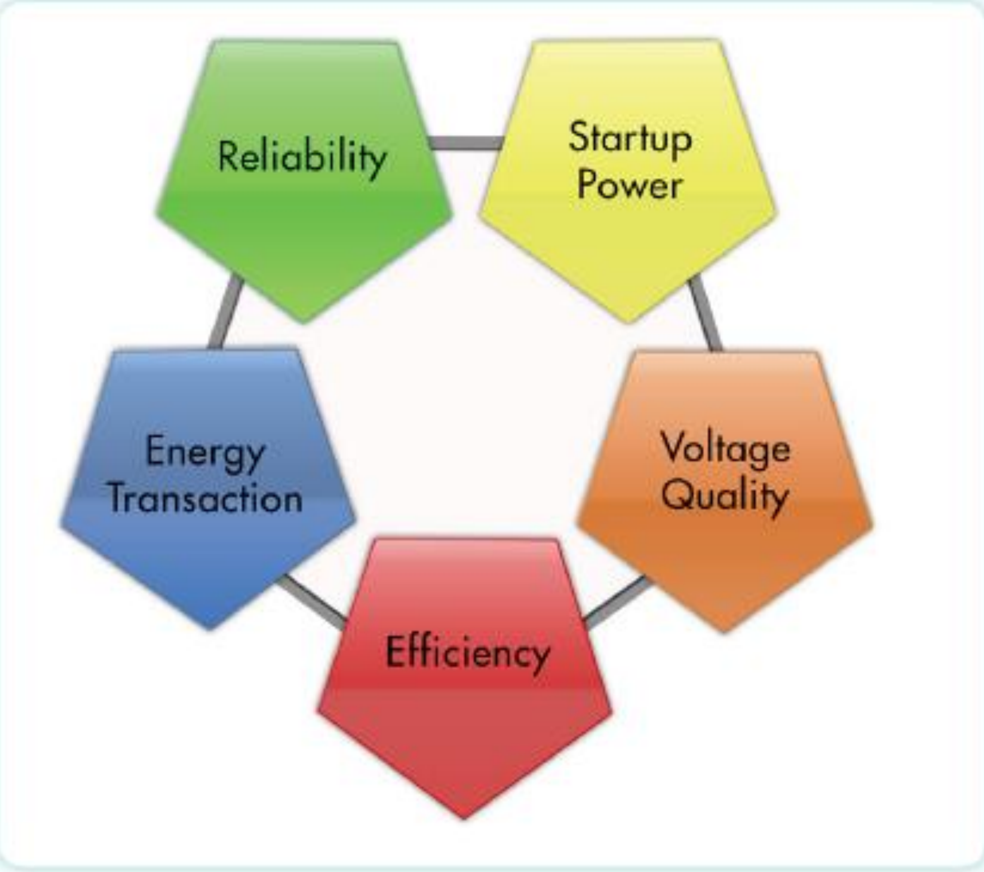
- Transform the University of Cyprus into an energy optimal microgrid in the scope of improving the energy efficiency of the campus and its zero energy green objectives.
- Keep balance of energy supply and demand and improve end use for to achieve the demand response objectives offering flexibility for improved security of supply.
- Test bed for innovation, development and research for the University of Cyprus on related novel technologies that will support the educational objectives of UCy.





Value of Grid Service: Five Primary Benefits

The full value of a grid connection is not fully understood. Grid-provided energy (kWh) offers clearly recognized value, but grid connectivity serves roles that are important beyond providing energy. Grid capacity provides needed power for overload capacity, may absorb energy during over-generation, and supports stable voltage and frequency.



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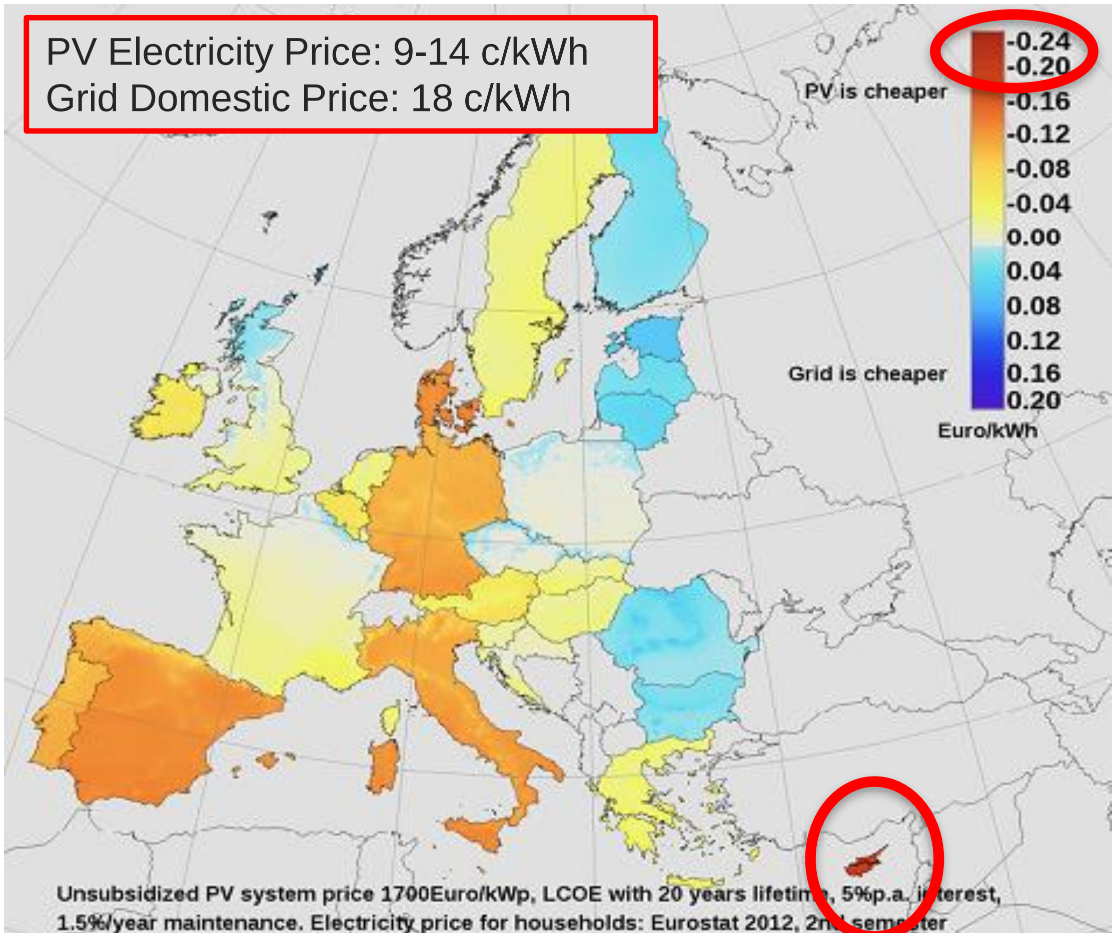
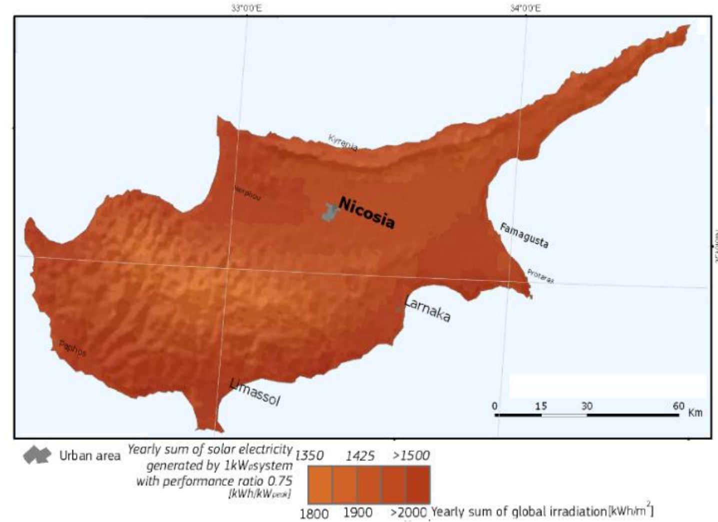
Why Solar Energy?





Solar resource of Cyprus

$$2000 \frac{kWh/m^2}{year}$$

Annual PV energy yield of Cyprus :

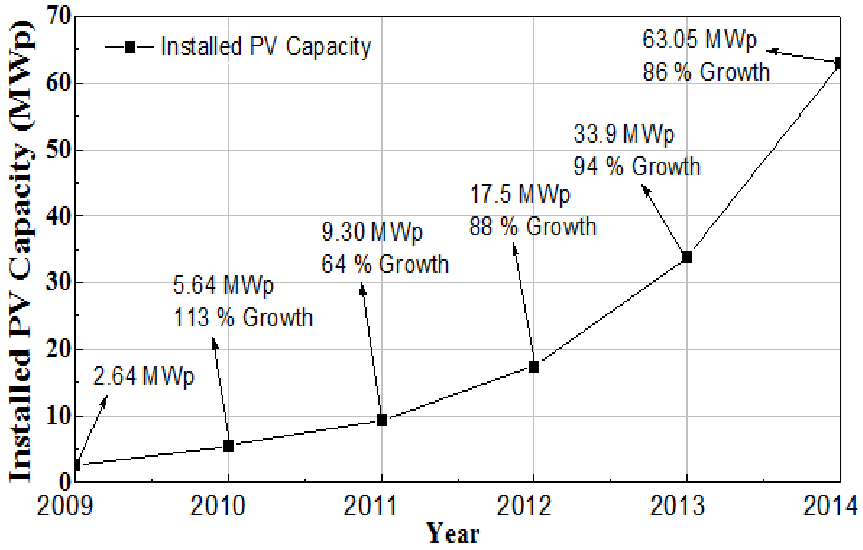
$$1600 - 1700 \frac{kWh}{kW_p}$$

Photovoltaic Park Tseriou (3 MWp)

‘Special Fund for Renewable Energy Sources and Energy Conservation’ (2012):
PV parks of a total capacity of 50 MW

EPC Contractor: AKTOR ATE Power

selling price: 86 €/MWh



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Data collection configuration

Prosumer (Producer + consumer)

Datasets:

- PV production
- Import/export

Datasets from PV and import/export energy from grid

University of Cyprus PV Technology

Datasets from smart meters

Datasets synchronization

AHK

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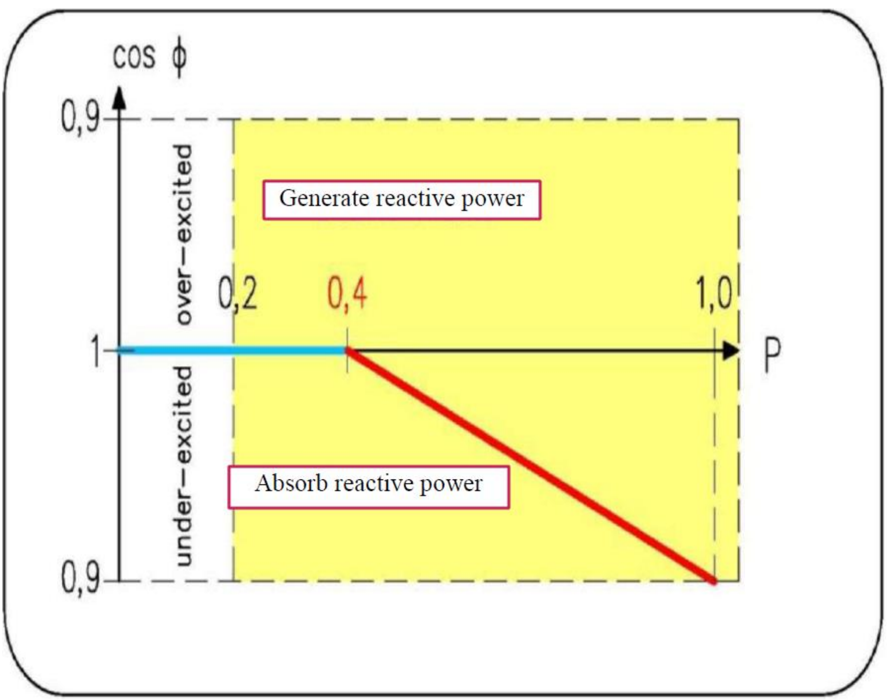
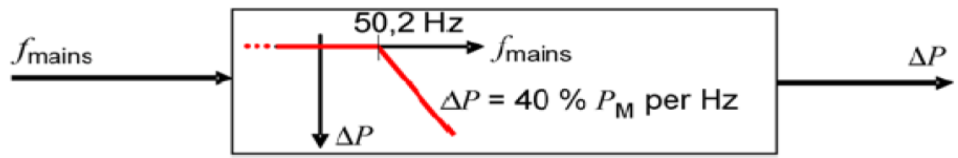
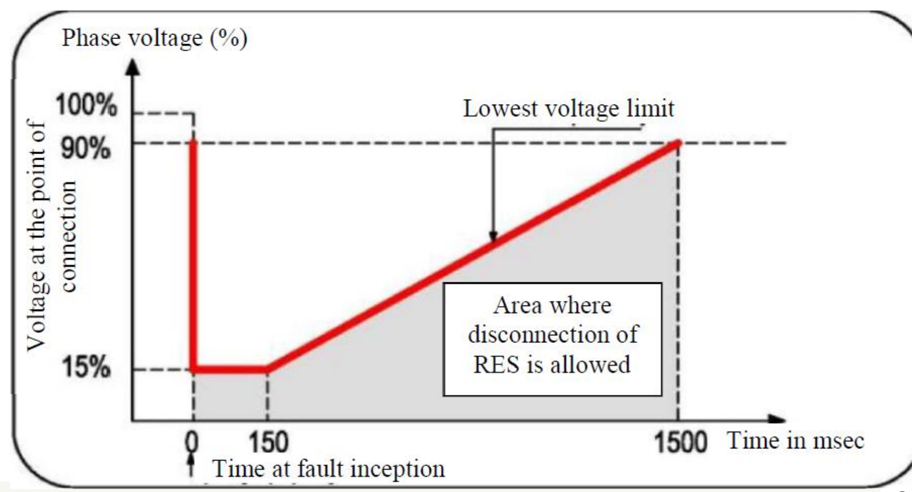
Use of advanced features of inverters for managing quality of supply at point of connection and supporting the grid

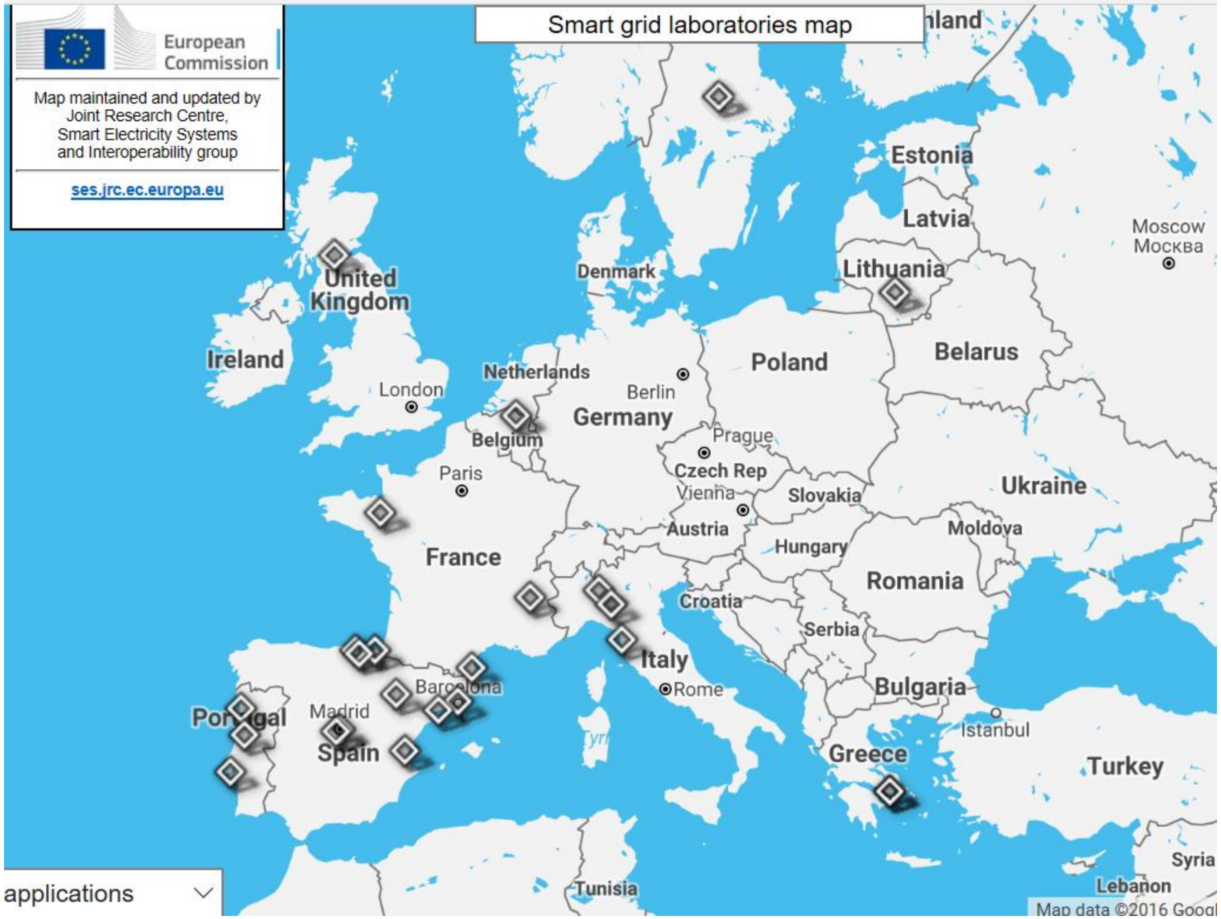




$$\Delta P = 20\, P_M \frac{50{,}2\ \text{Hz} - f_{mains}}{50\ \text{Hz}} \quad \text{for } 50{,}2\ \text{Hz} \le f_{mains} \le 51{,}5\ \text{Hz}$$



JRC report: Smart Grid Laboratories



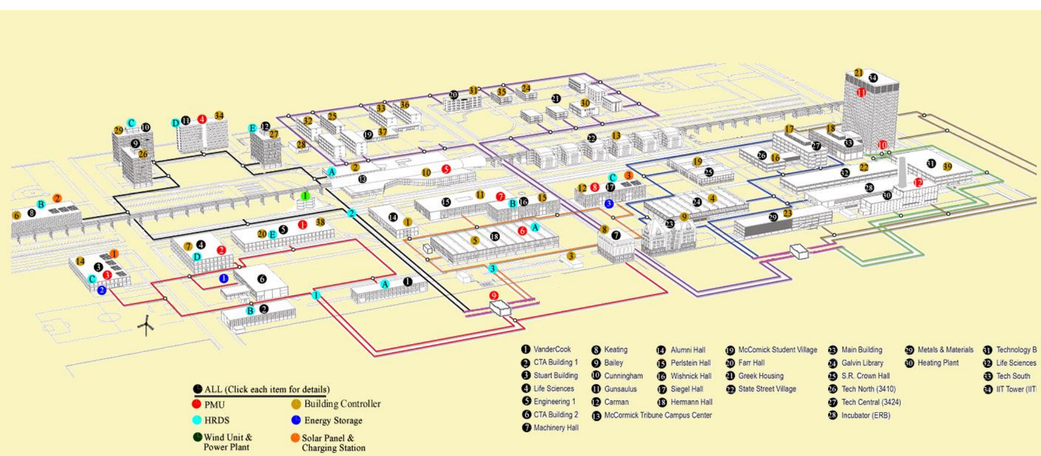
Outcome of the first JRC Smart Grids Laboratories Inventory 2015

- The **main customers** of the smart grid labs are **industrial companies**, followed by **utilities, academia and governments**.
- ***Areas that 26 organisations*** cover: Distribution Automation, Grid Side Management, Storage, Sustainability, Market, Generation and distributed energy resources (DER), Electromobility, Smart Home/Buildings, Smart Cities, Demand Response, Information and Communications Technologies, Cybersecurity, and Advance Metering Infrastructure.
- FOSS target is to cover all above and to compliment in house capabilities with sharing resources first with our partners AIT and DTU and secondly with other partners under DERlab.

Real life success stories from completed projects around the world

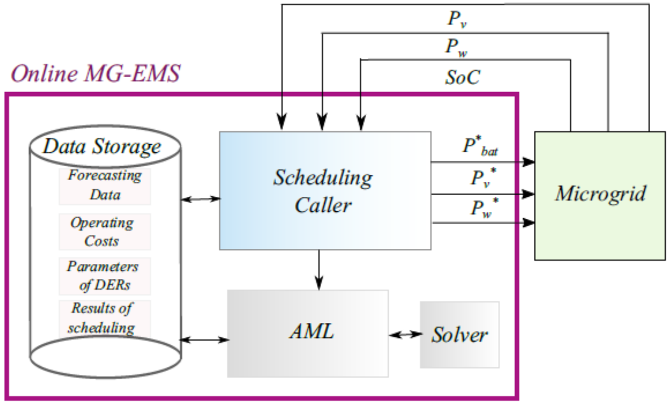
- University of Genoa.
- Prinsceton University.
- Clarkson University and National Renewable Energy Laboratory.
- Illinois Institute of Technology (IIT).

Benefits: Capital cost $12M - Payback period ~5 years (from onetime and annual savings)



Business Plan - Technical

- Smart controllers and sensors for data and local control for effective demand side management policy.



- Local PV generation directly connected to the local grid (400 kWp already connected and operated as self-consumption – 10 MWp planned to be operational by 2017).
- Thermal and electrochemical storage facilities (≈2 MWh).
- 4 heat pumps of total capacity 1 MW for improved efficiencies.
- Charging infrastructure for electric vehicles.
- Full broad band connectivity with the local DSO for improved data management and in support of the research activities in support of the grid.

Additional plan in the pipe line

- A combined heat and power unit of size 800 kW to compliment the heating, cooling and electricity needs of the university.
- A new faculty building for Biology (scheduled to be completed by 2020) equipped with
  - A PV system of size 138 kWp
  - A solar thermal system for domestic hot water needs
- A new solar system to satisfy the cooling and heating needs of the Students Residence.

Horizon 2020 projects in support

- Generalized Operational FLEXibility for Integrating Renewables in the Distribution Grid. The GOFLEX project will innovate, integrate, further develop and demonstrate a group of electricity smart-grid technologies, enabling the cost effective use of demand response in distribution grids, increasing the grids' available adaptation capacity and safely supporting an increasing share of renewable electricity generation.
- Integrated Smart GRID Cross-Functional Solutions for Optimized Synergetic Energy Distribution, Utilization. InteGRIDy aims to integrate cutting-edge technologies, solutions and mechanisms in a scalable Cross-Functional Platform connecting energy networks with diverse stakeholders, facilitating optimal and dynamic operation of the Distribution Grid, fostering the stability and coordination of distributed energy resources and enabling collaborative storage schemes within an increasing share of renewables.

Microgrid Plan - Financial

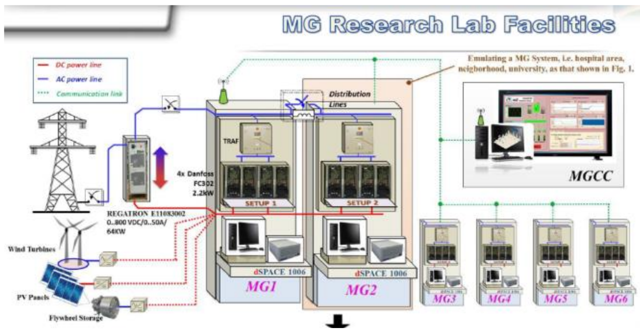
- UCY Microgrid:
  - Capital cost: **€ 4,000,000** (Initial system cost, engineering, development and O&M)
  - IRR: **~ 9 %**
  - Payback: **~ 11-12 years without quantifying added benefits through diversified research activity and the added value for educational excellence**

Notes (Conservative Scenario):
Energy efficiency: 20 %
Yearly Consumption conservation: 3,400,000 kWh/year (€ 340,000)
Grid electricity cost 0.10 €/kWh
- UCY campus on Commercial 63 EAC tariff 11 - 16 c/kWh (plus fuel cost 1 – 5 c/kWh)

Detailed design is in progress

- DG mix selection, smart meters / sensors, Technology Selection, tariff design, Protection and Power Quality
- Primary frequency and voltage control: DG droop control, coordinated voltage/frequency support
- Secondary control: Design of MGCC, forecasting, unit commitment, economic dispatch, security
- Consumers: Load Management via electronic meters to achieve flexible demand response,
- Storage size and options: transition to island mode, Ancillary services in grid connected mode

Potential / Advantages



University of Cyprus

- Supply and demand balance/improved energy efficiency
- Cheaper electricity bills
- Create a greener campus
- Testbed for research and education at the University of Cyprus

Citizens/Country

- Onsite resources to ease pressure on the grid
- Improve reliability and resilience of grid
- Support the grid for the penetration of more renewables
- Support the sustainable policies of the Country

Environment

- 2500 t/CO_2 per year
- 250 Hectares of forest absorbing CO_2
- €57,500 per year revenue (GHG reduction credit)

Electricity directive is discussing Local energy communities

- Member States shall ensure that local energy communities:
  - are entitled to undertake all their activities, without discriminatory administrative or regulatory obligations and costs, including in terms of licensing, permitting and grid connection.
  - are entitled to establish community networks and to autonomously manage them;
  - are entitled to purchase and sell electricity in all organised markets either directly or through aggregators or suppliers.
- Local energy communities shall comply with Article 34 on unbundling of distribution system operators if they are distribution system operators according to this Directive.

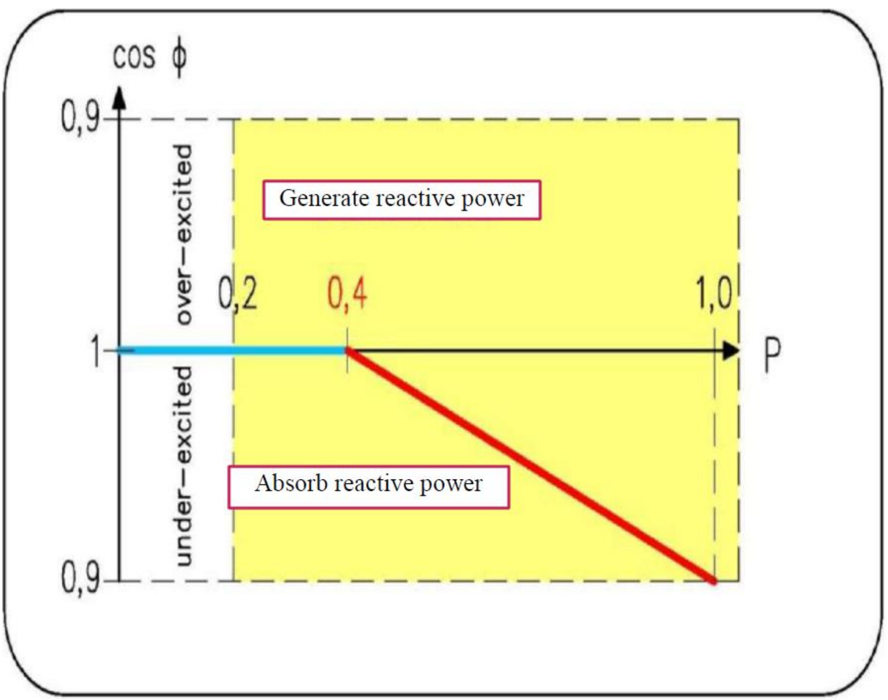
Closed distribution systems-Microgrids

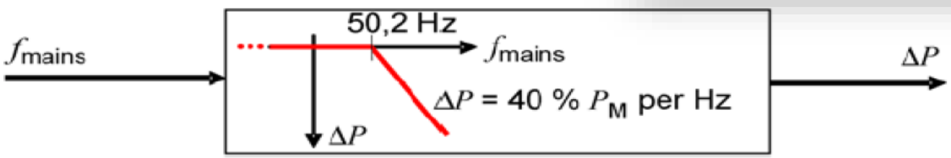
- Member States may provide for national regulatory authorities or other competent authorities to classify a system which distributes electricity within a geographically confined industrial, commercial or shared services site and does not, without prejudice to paragraph 4, supply household customers, as a closed distribution system if:
  - for specific technical or safety reasons, the operations or the production process of the users of that system are integrated; or
  - that system distributes electricity primarily to the owner or operator of the system or their related undertakings.
- Closed distribution systems shall be considered as distribution system operators for the purpose of the Directive.

Operational details of µGs

- Member States may provide for national regulatory authorities to exempt the operator of a closed distribution system from:
  - the requirement under Article 30(5) to procure the energy it uses to cover energy losses and reserve capacity in its system according to transparent, non-discriminatory and market based procedures;
  - the requirement under Article 30(1) that tariffs, or the methodologies underlying their calculation, are approved prior to their entry into force in accordance with Article 58

Thank you !!
Any Questions





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