

DOCTORATE PROGRAM IN **ELECTRONIC ENGINEERING**

DOCTORAL TRAINING SEMINARS: RESEARCH PROJECTS IN
THE DEPARTMENT OF ELECTRONIC ENGINEERING

Energy Management for Grid-PV-Diesel Hybrid Systems

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March 27th , 2014

Energy Management for Grid-PV-Diesel Hybrid Systems

OUTLINE

1. Introduction – The MED-Solar Project
2. Electric energy production in target countries
3. Proposed energy supply system
4. Proposed Energy Management System (EMS)
5. EMS simulation
6. Future steps



Project
funded by the
EUROPEAN UNION



REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA



**ENPI
CBCMED**
CROSS-BORDER COOPERATION
IN THE MEDITERRANEAN

1. Introduction – The MED-Solar Project

- Linked to the multilateral Cross-Border Cooperation in the Mediterranean Sea Basin Program (CBCMED)
- Funded by the European Neighborhood and Partnership Instrument (ENPI)
- The Autonomous Region of Sardinia is the Joint Managing Authority (responsible of operational and financial management)



<http://www.medsolarproject.com>



Project
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REGIONE AUTONOMA DELLA SARDEGNA

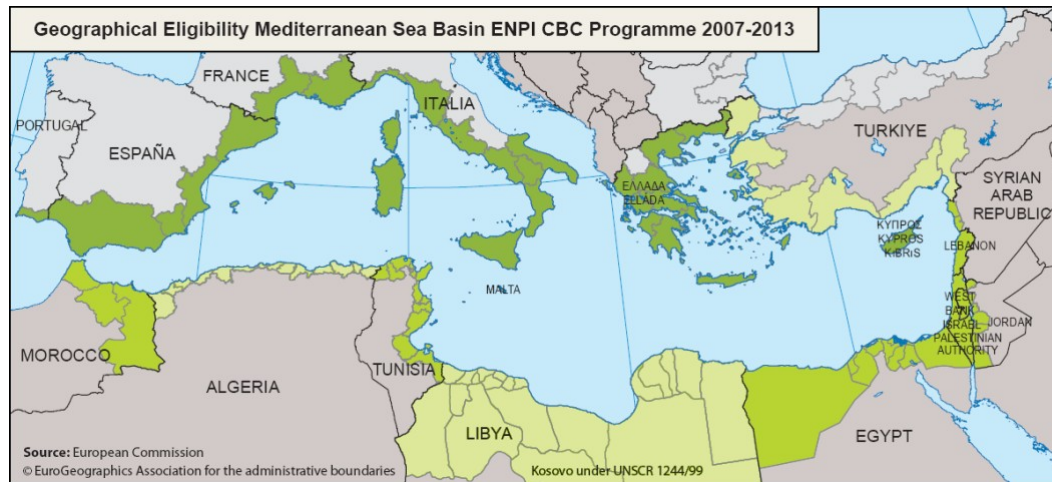


**ENPI
CBCMED**
CROSS-BORDER COOPERATION
IN THE MEDITERRANEAN

1. Introduction – The MED-Solar Project

ENPI-CBCMED program main objective:

Promoting and reinforcing the sustainable and harmonious cooperation process between the European Union and partner country regions placed along the shores of the Mediterranean Sea





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**ENPI
CBCMED**
CROSS-BORDER COOPERATION
IN THE MEDITERRANEAN

1. Introduction – The MED-Solar Project

The MED-Solar project is inscribed in the second priority of the ENPI-CBCMED program:

Promotion of environmental sustainability at the Mediterranean Basin level, pursued through the preservation of natural common heritage, the reduction of risk factors for the environment, the improvement of energy efficiency and the promotion of the use of renewable energy sources

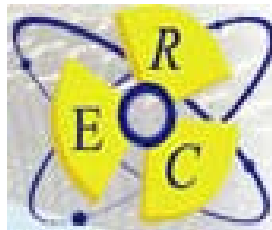


1. Introduction – The MED-Solar Project

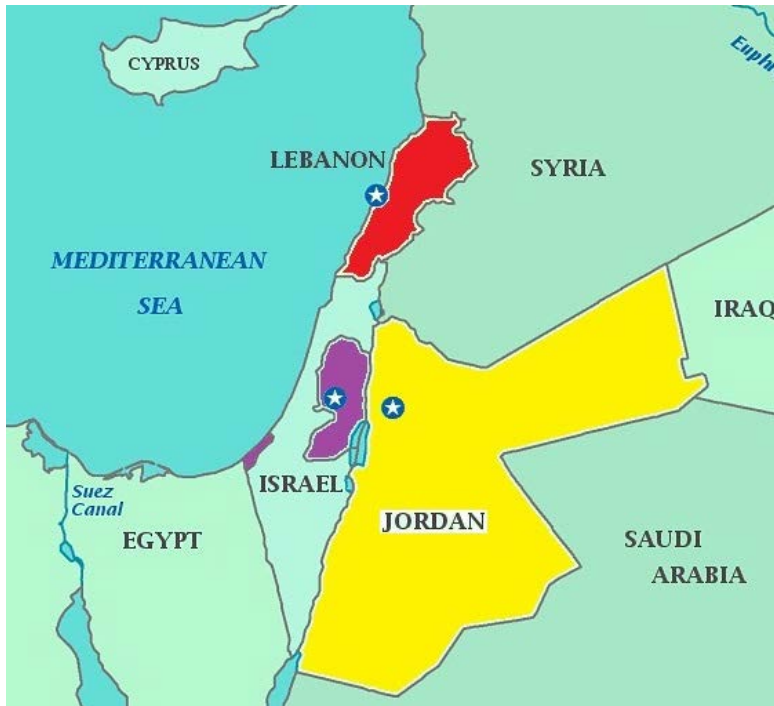
The MED-Solar partnership:



UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH



2. Electric energy production in target countries



Main similarity

Electricity production based on diesel generators



- High dependence on foreign countries
- High cost of operation
- Air and noise pollution

2. Electric energy production in target countries

MED-Solar project actuation

Reduce the use of fuel using:

- PV power plants
- Energy transient storage systems



- Increment on power supply security
- Reduction on operation cost
- Promotion of SMEs development
- Increment on air quality

2. Electric energy production in target countries

Jordan:



Data source:

**National Electric Power
Company (NEPCO)**

Annual Report 2012



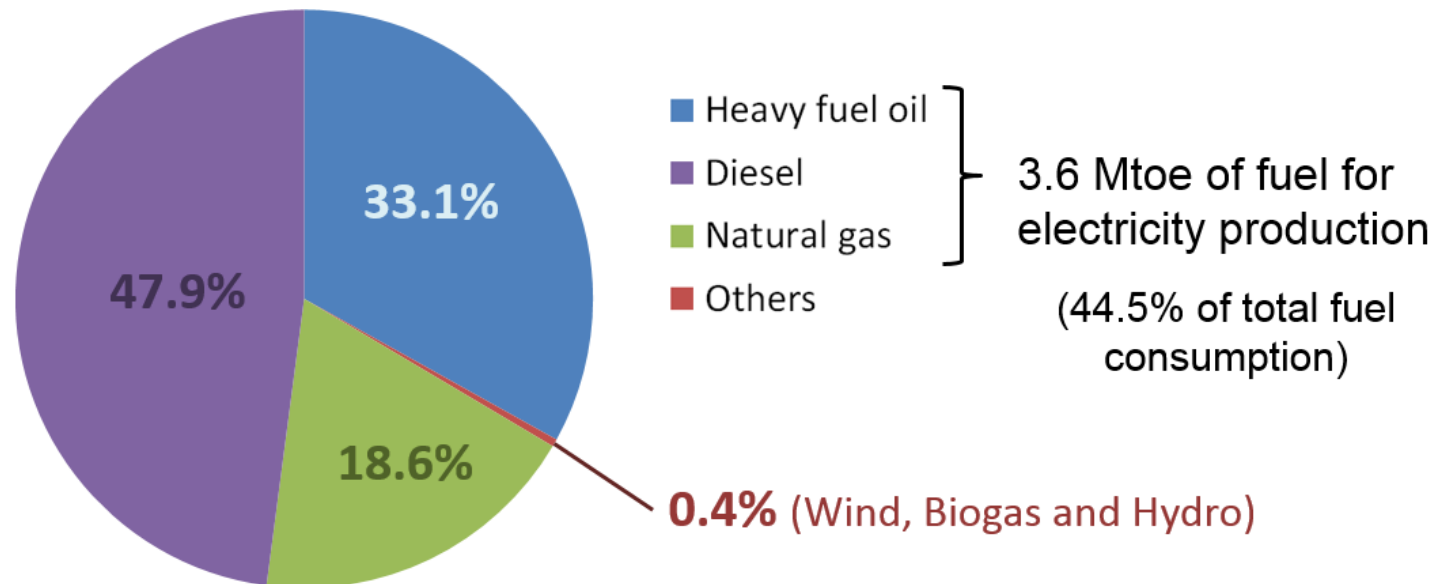
2. Electric energy production in target countries

Jordan:	Electric power:	Total capacity:	3.6 GW
		Peak load:	2.9 GW
	Imported electric energy:		680 GWh (4.1 %)
	Electric energy production:		16.6 TWh

2. Electric energy production in target countries

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2. Electric energy production in target countries

Lebanon:




Data source:

**International Energy
Agency (IEA)**

Lebanon Statistics 2010



2. Electric energy production in target countries

Lebanon:	Electric power:	Total capacity:	1.7 GW
		Peak load:	2.8 GW
			
		Power gap:	1.1 GW

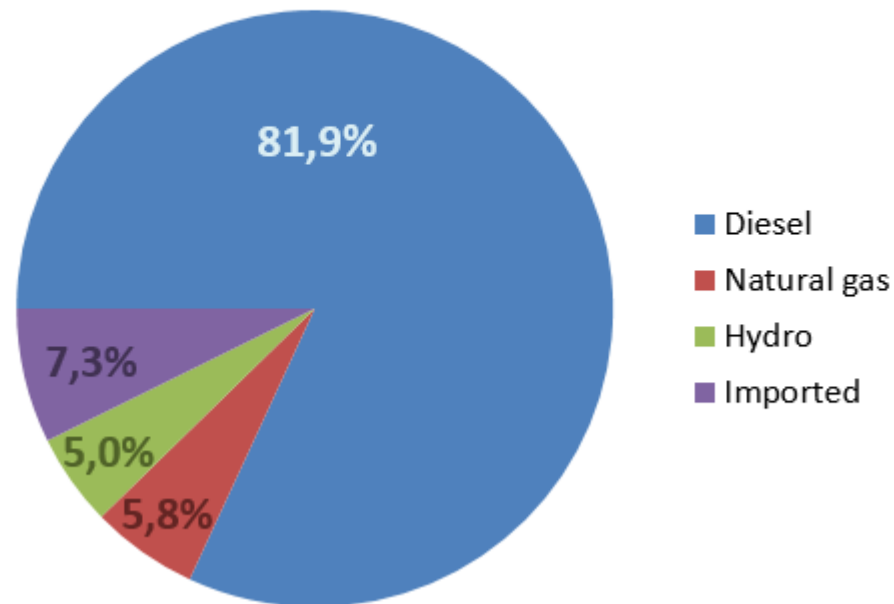


- Systematic power cuts across the country (Between 3 and 12 hours a day)
- Extensive use of private diesel generators

2. Electric energy production in target countries

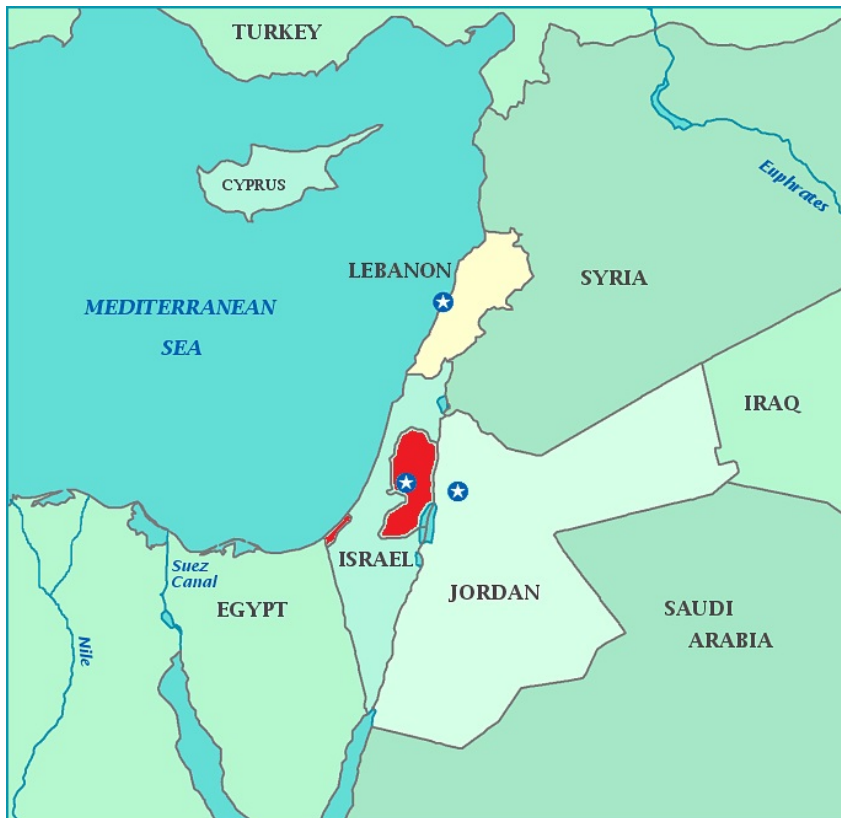
Lebanon:

Electric energy provided: 11.5 TWh



2. Electric energy production in target countries

Palestine:



Data source:

**Palestinian Central
Bureau of Statistics
(PCBS)**

Annual Energy Balance
2011

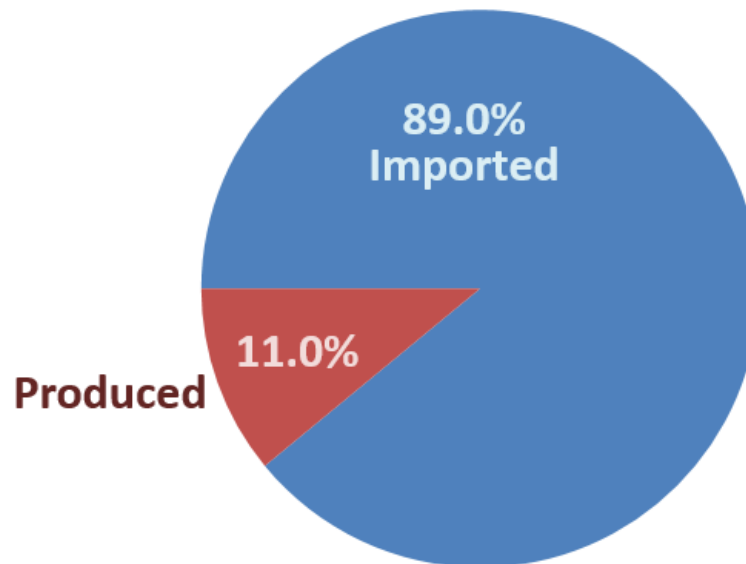


2. Electric energy production in target countries

Palestine:

Electric energy provided:

5.2 TWh




Electricity importation:

Gaza Strip	
Israel	62.5 %
Egypt	6.7 %
Palestine	30.8%
The West Bank	
Israel	97.8 %
Jordan	2.2 %

2. Electric energy production in target countries

Summary:

Country	Generation [TWh]	Fossil fuel	Electricity Imports	Net metering	Outages * per month	Typical ** outage duration
Jordan	16.6	99.6 %	4.1 %	yes	0.9	0.7 h
Lebanon	11.5	94.6 %	7.3 %	yes	Daily	7.0 h
Palestine	5.2	100 %	89.0 %	yes	8.7	3.7 h

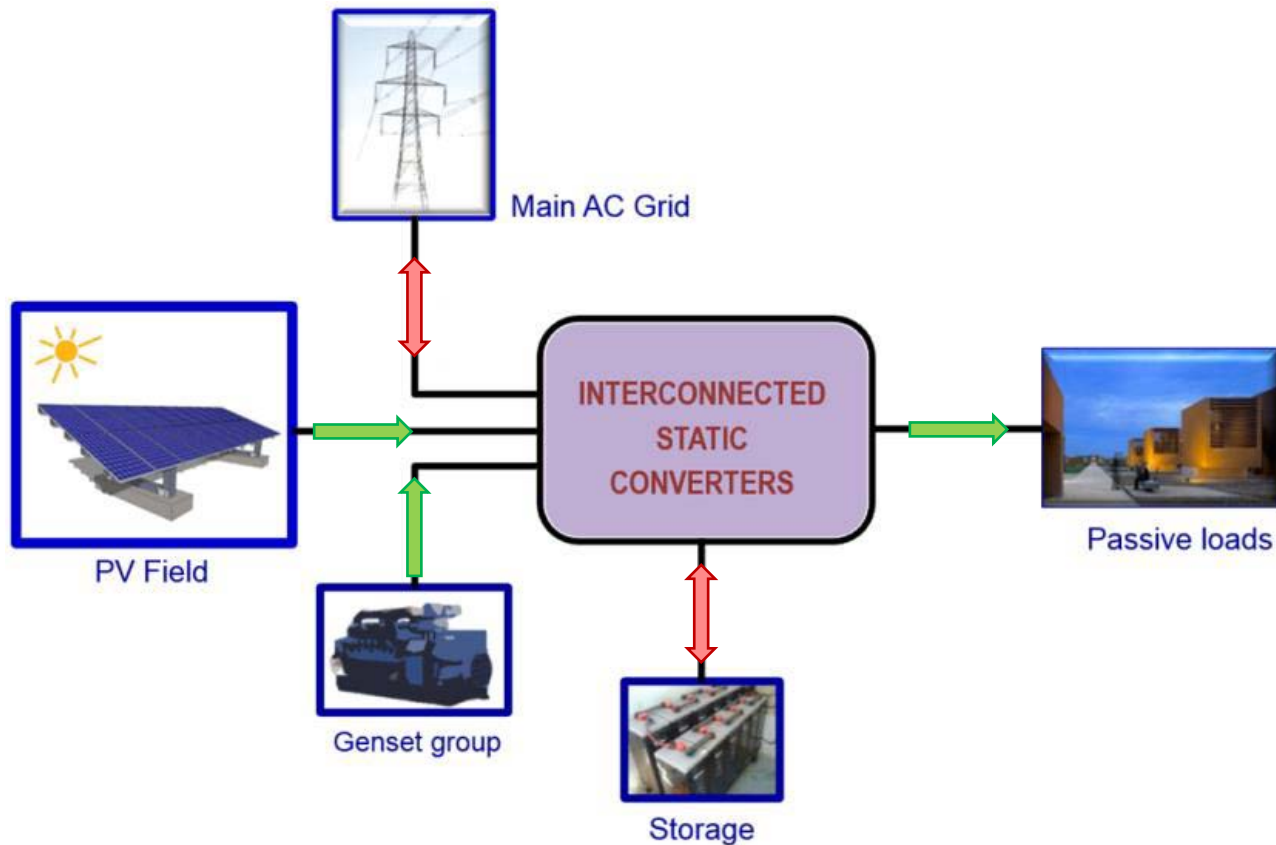


* Number of electrical outages in a typical month

** Duration of a typical electrical outage

3. Proposed energy supply system

Components of the energetic system:



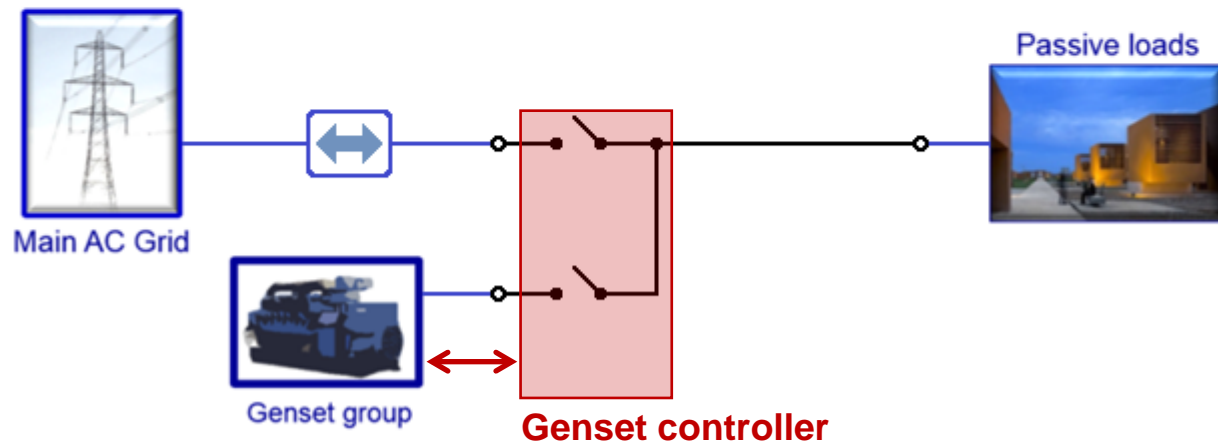
3. Proposed energy supply system

Premises:

- Take full advantage of existing facilities
 - Diesel generators, grid connections ...
 - Distribution lines
- High modularity on integration of:
 - PV system
 - Storage system
 - Priority loads management
- Solution based on commercial equipment
- Minimum development efforts

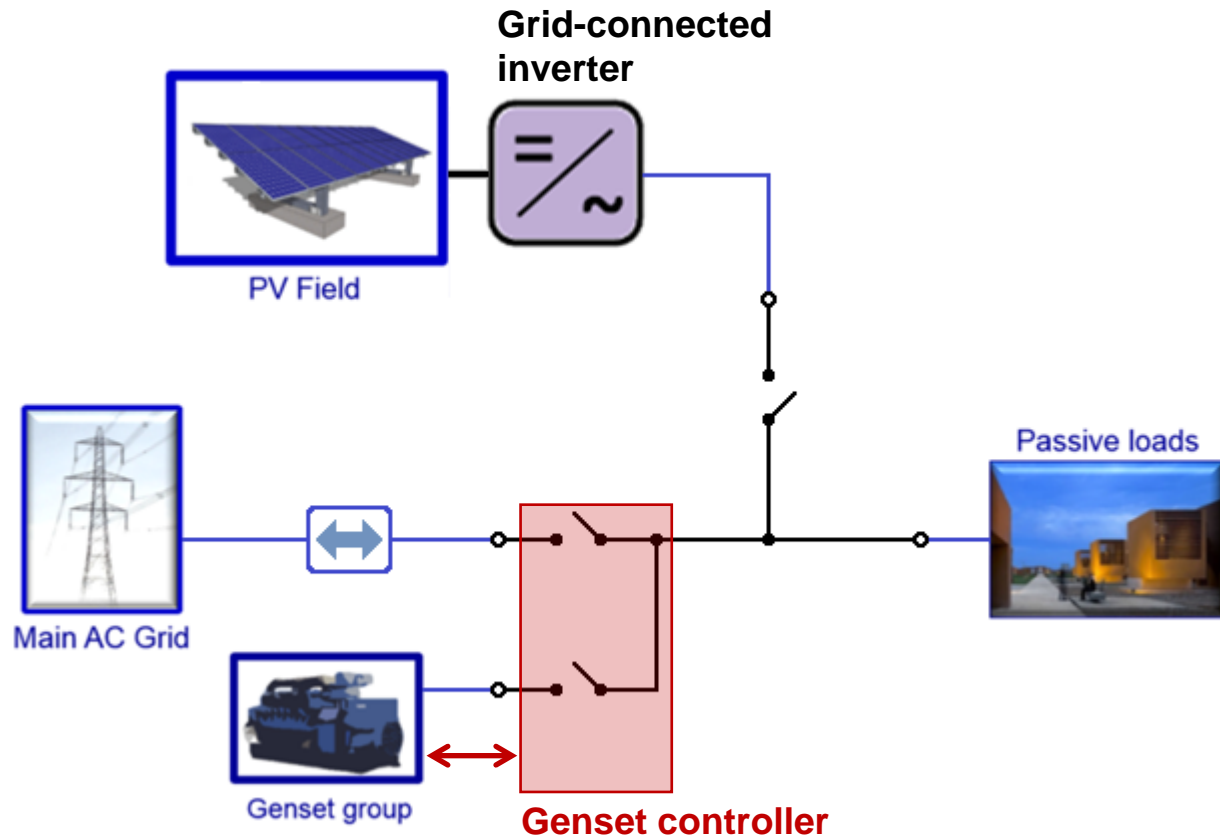
3. Proposed energy supply system

Initial architecture:



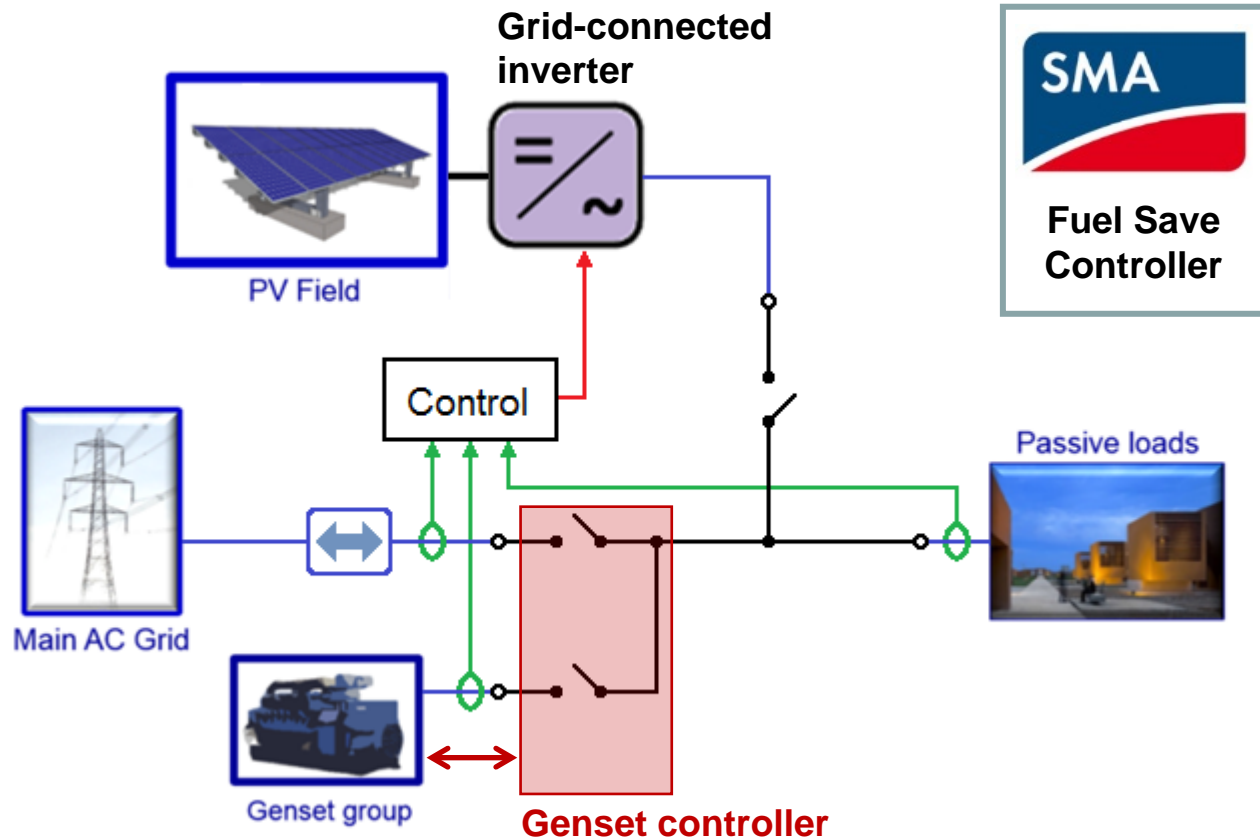
3. Proposed energy supply system

Direct PV integration (penetration up to 20 %)



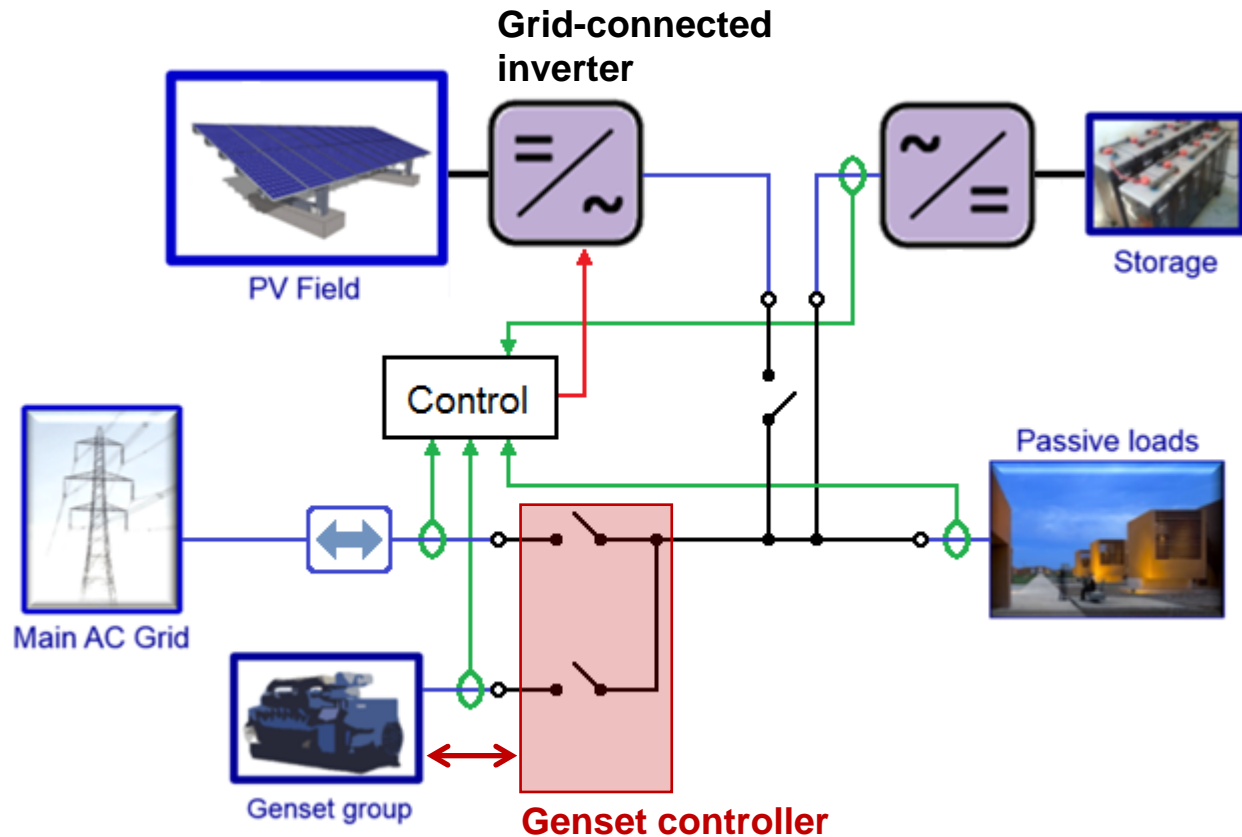
3. Proposed energy supply system

Controlled PV integration (penetration up to 60 %)



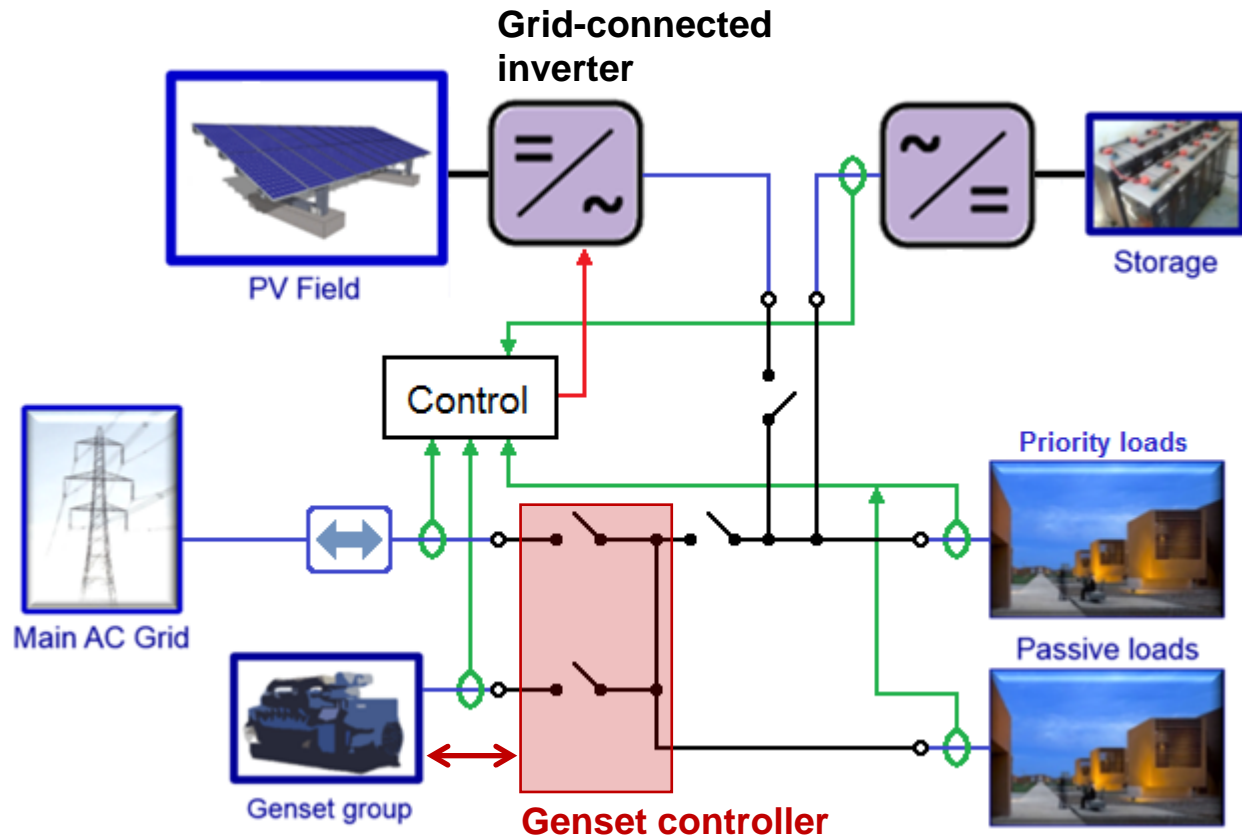
3. Proposed energy supply system

Storage system integration



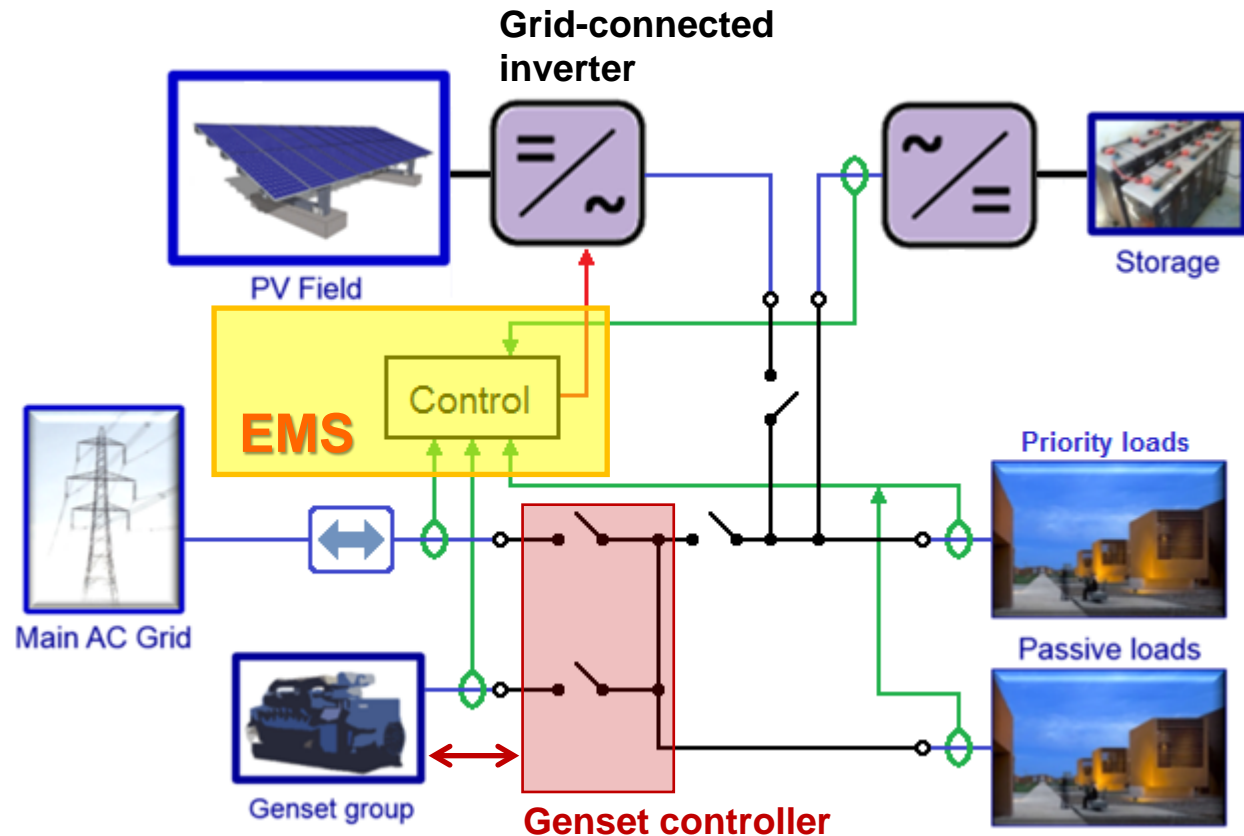
3. Proposed energy supply system

Priority loads management



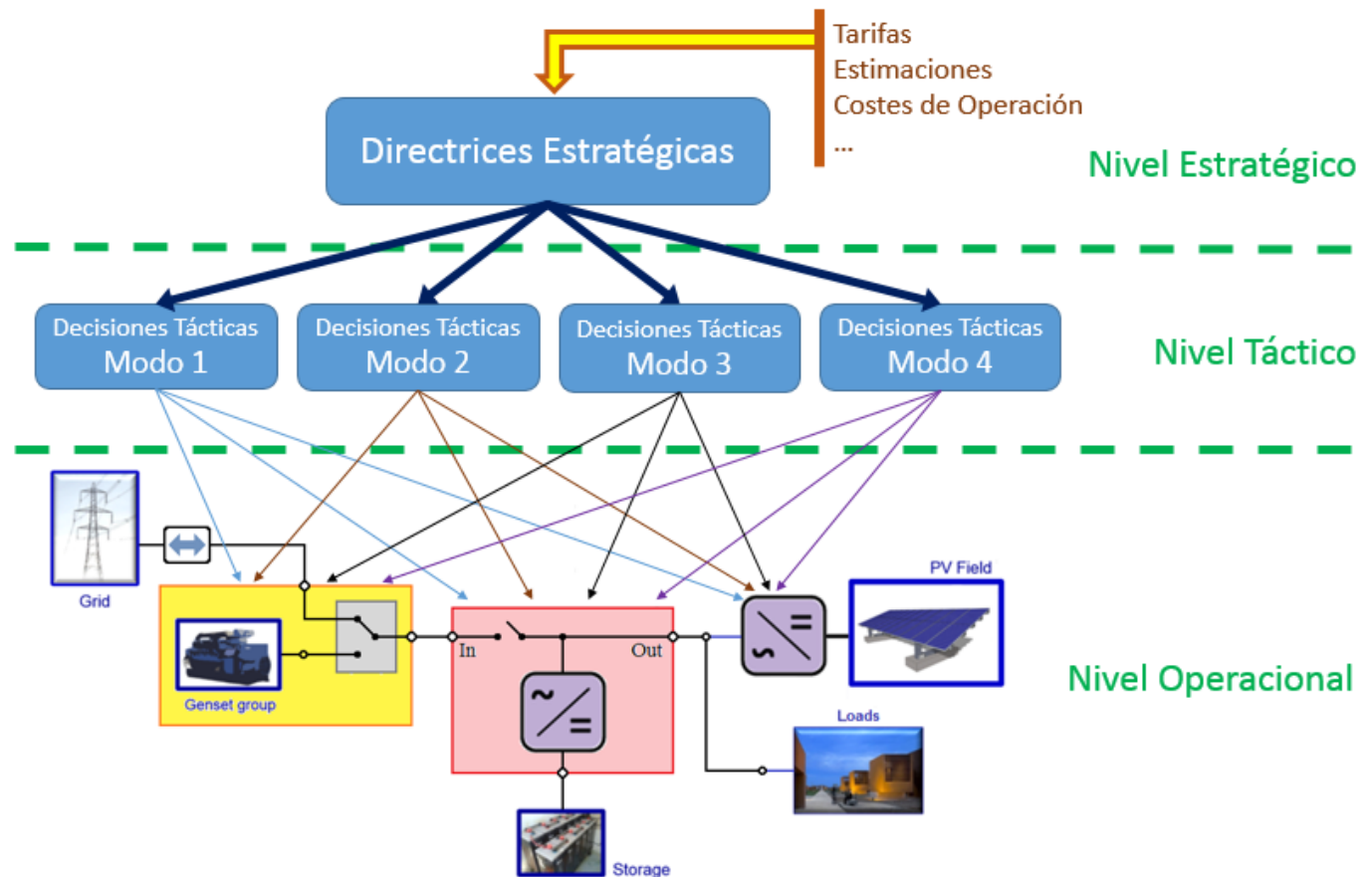
4. Proposed Energy Management System

EMS



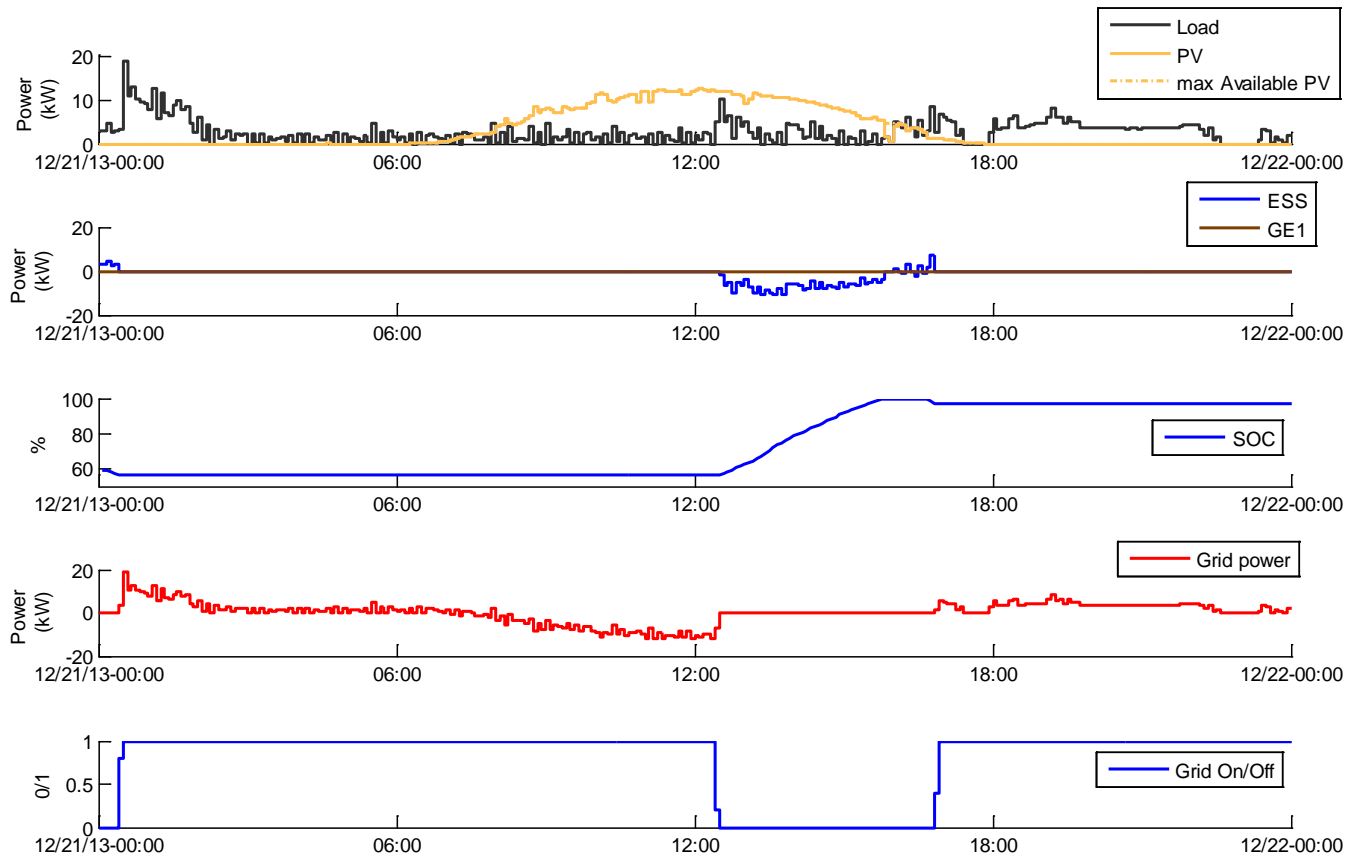
4. Proposed Energy Management System

Based on 3 levels architecture



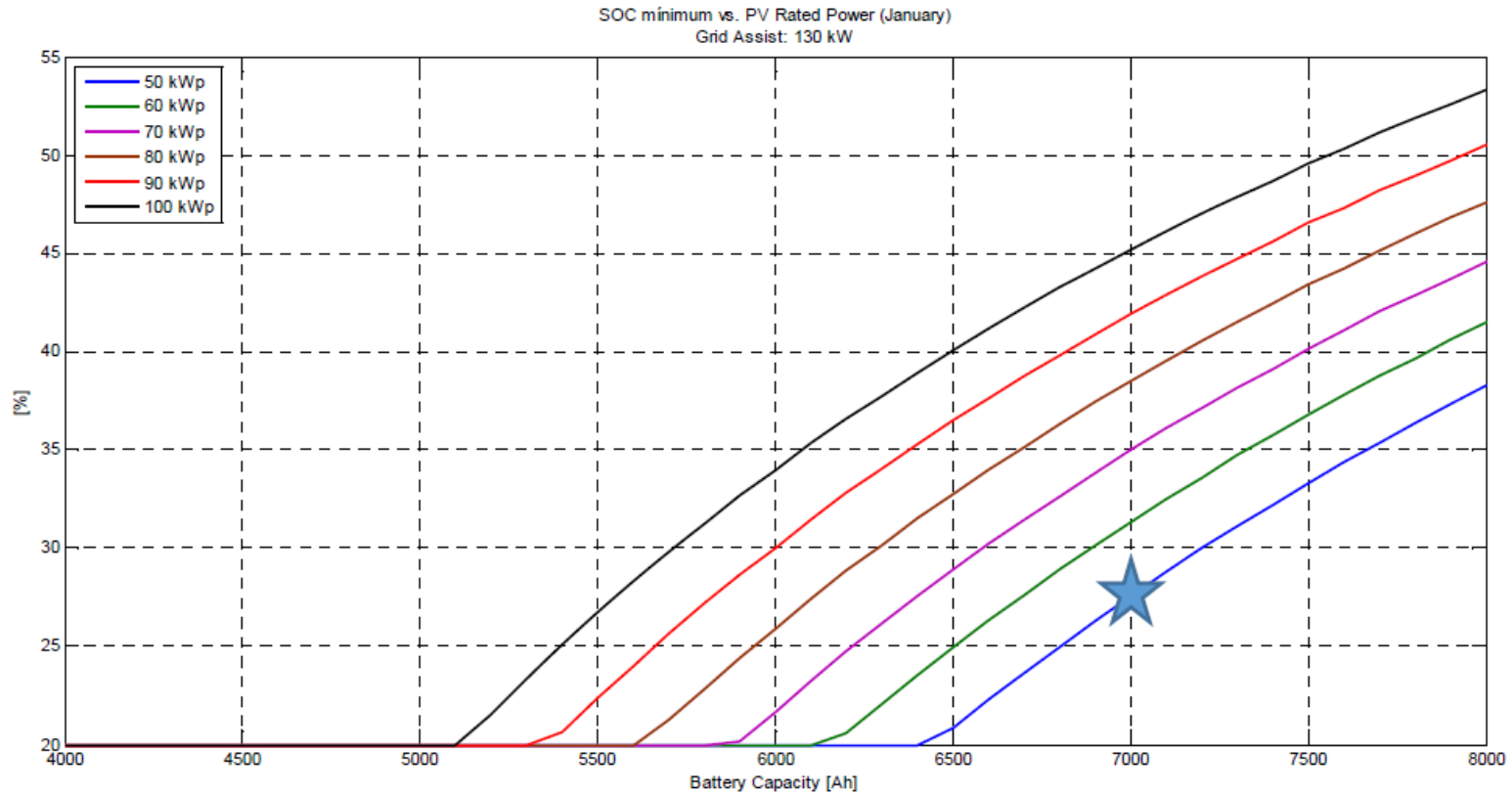
5. EMS simulation

Simulations from CEA



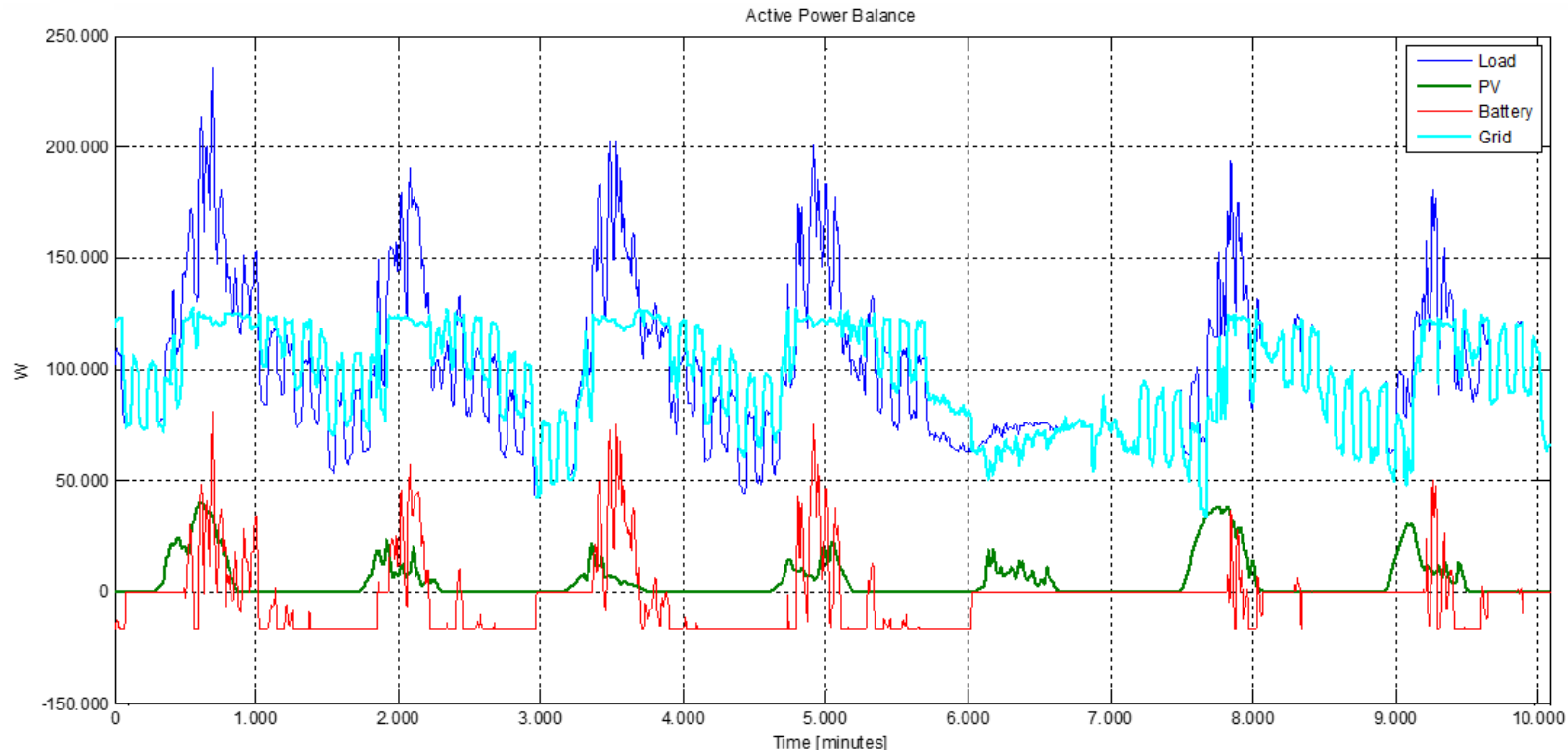
5. EMS simulation

Simulations from UPC



5. EMS simulation

Simulations from UPC



6. Future steps

- Selection of hardware platform for the EMS implementation
- Tendering and construction of four energetic systems in target countries
- Definition of training needs and activities in each target country
- Technical monitoring of pilot plants

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Thank you for your attention



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PROGRAMA DE DOCTORAT EN **ENGINYERIA ELECTRÒNICA**

Jornades formatives 2014: Projectes de recerca al Departament d'Enginyeria Electrònica