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# SARDINIA - THE EUROPEAN ISLAND WHERE ENERGY IS GOING SMART

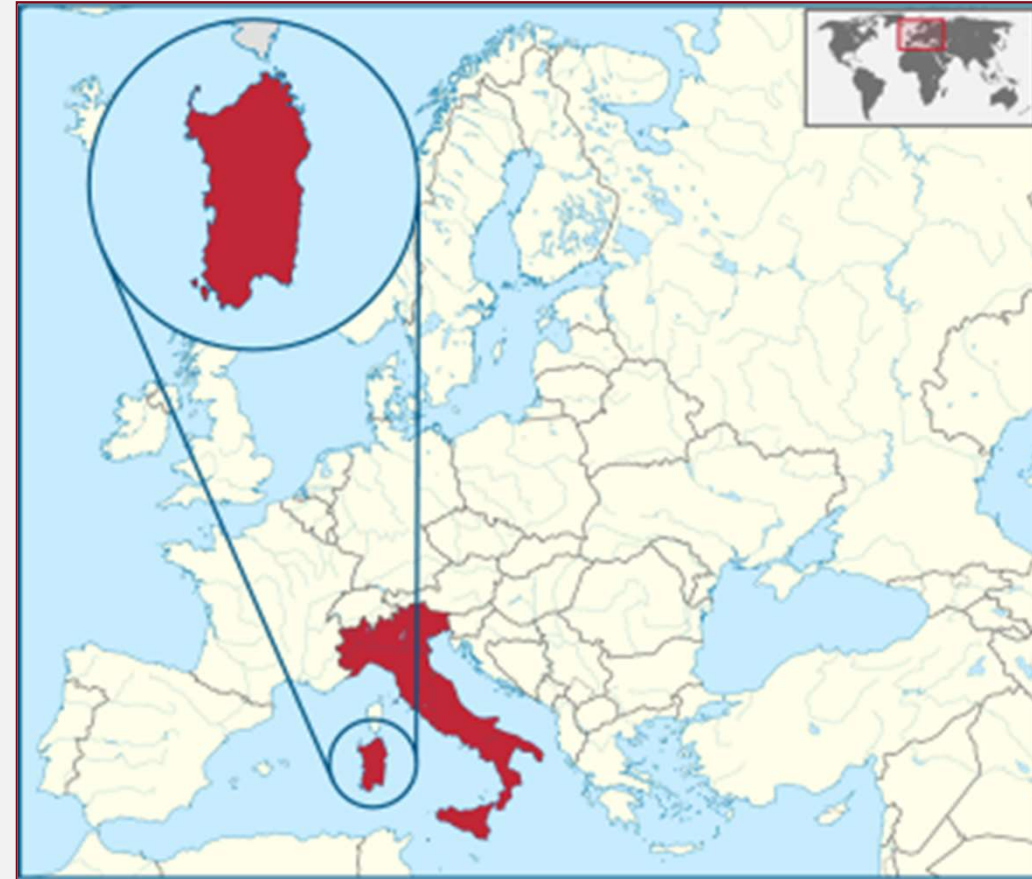
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Sardegna Ricerche, Piattaforma Energie Rinnovabili, Uta, Italy



# IS SARDINIA THE RIGHT PLACE FOR IMPLEMENTING SUSTAINABLE PARADIGMS ?

- Sardinia is in the center of the Mediterranean sea
- It is big enough: surface of 24090 km<sup>2</sup> population of 1.675.411
- It is a semi-closed energy system characterized by a significant electricity demand
- It is weakly interconnected - no natural gas interconnection and electrical interconnection reinforced just in 2005 by means of a 500+500 MW HVDC cable



This makes Sardinia particularly interesting for analyzing the evolution of the energy system under specific energy policy and for implementing novel energy paradigm!



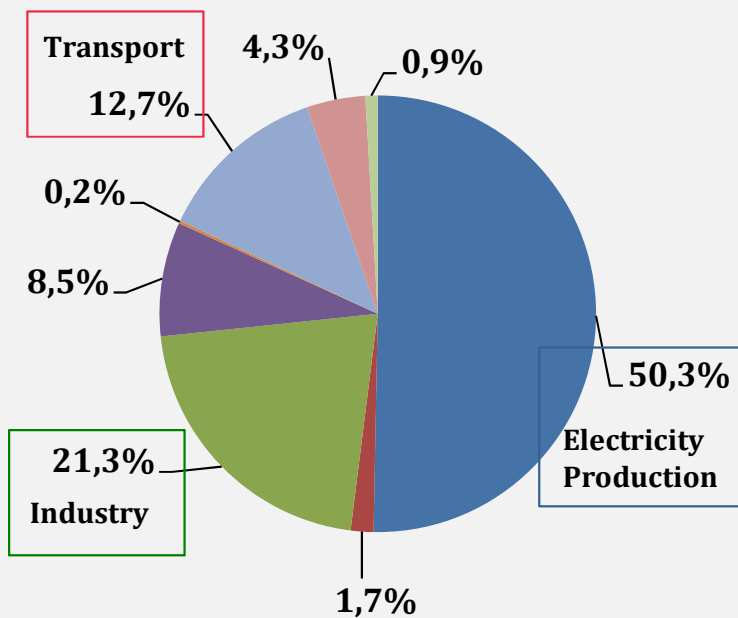
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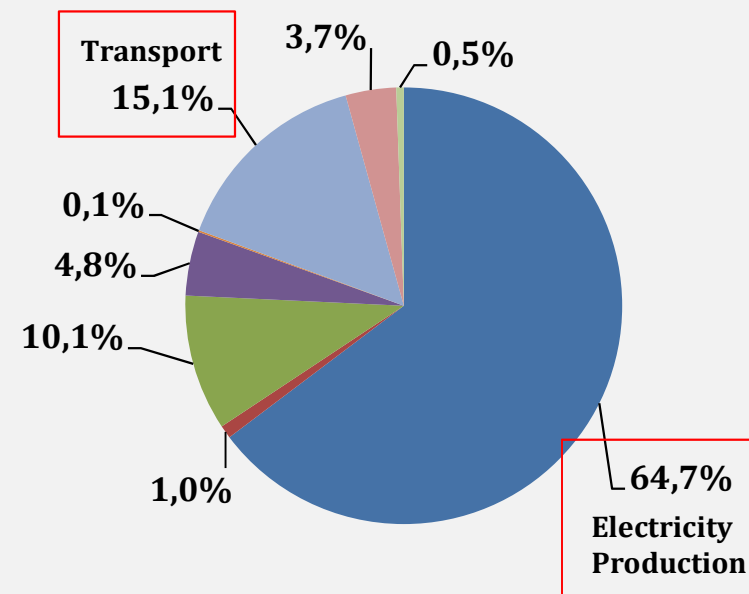


# CO<sub>2</sub> EMISSION EVOLUTION IN SARDINIA

Emission in 1990 – 16 MTON



Emission in 2010 – 18,1 MTON

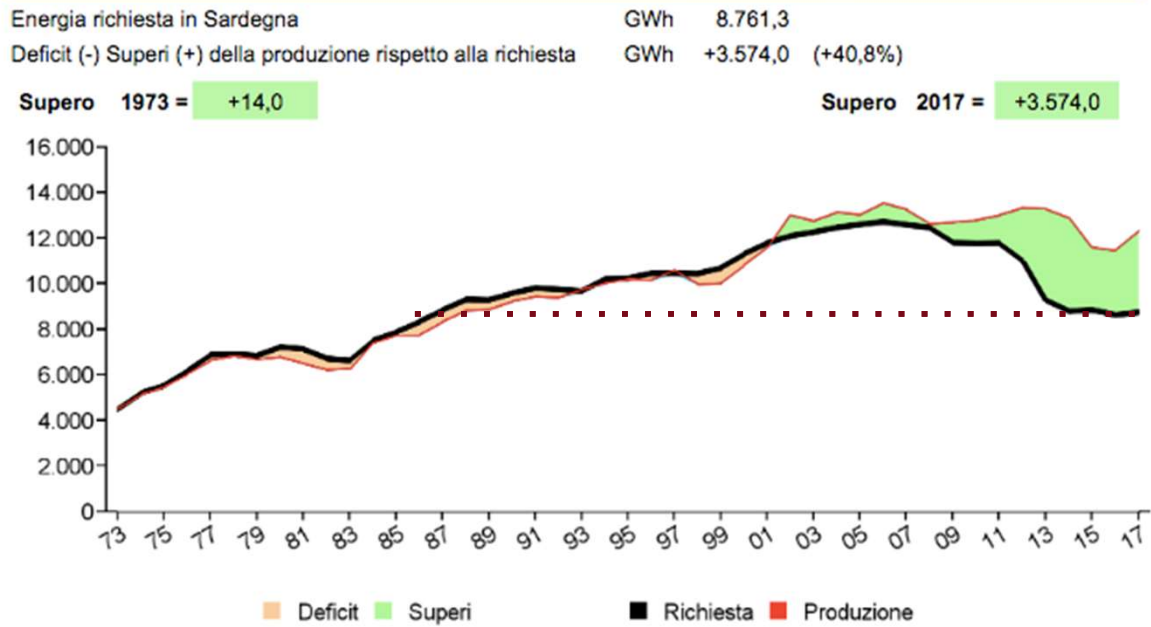


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# EVOLUTION OF ENERGY SYSTEM IN SARDINIA

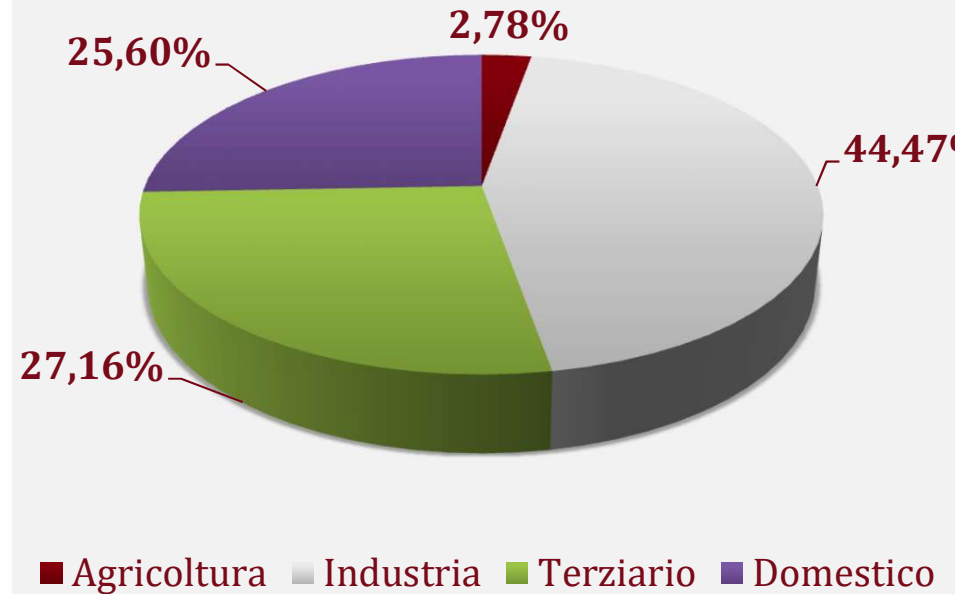
## Energia richiesta



Consumi: complessivi 8.426,0 GWh; per abitante 5.106 kWh

### Consumi per categoria di utilizzatori e provincia

GWh	Agricoltura	Industria	Terziario <sup>1</sup>	Domestico	Totale <sup>1</sup>
Cagliari	15,8	2.089,2	659,6	588,9	3.353,5
Nuoro	35,8	139,4	237,9	241,1	654,3
Oristano	68,8	111,4	188,1	189,5	557,8
Sassari	52,2	393,8	783,9	706,8	1.936,7
Sud Sardegna	61,8	1.012,7	419,0	430,3	1.923,8
<b>Totale</b>	<b>234,4</b>	<b>3.746,5</b>	<b>2.288,5</b>	<b>2.156,6</b>	<b>8.426,0</b>



Net Production: 12,44 TWh/y  
 Power Plants prod.: 9,4 TWh/y – 75,56%  
 0,9 + 0,33 TWh – Demand PP + losses  
 Export 3,5 TWh - 28 %

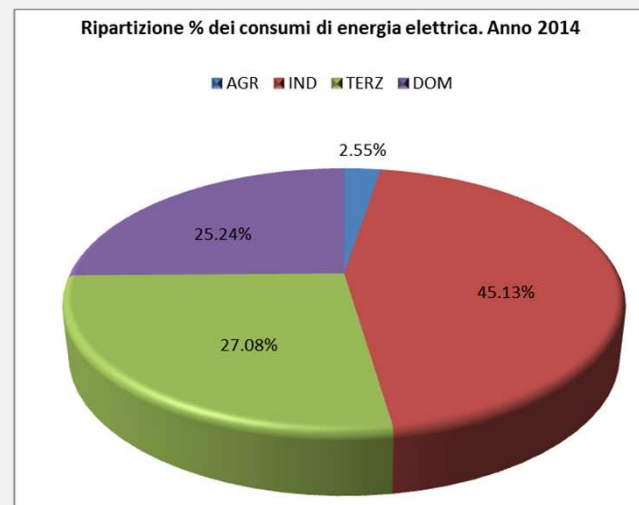
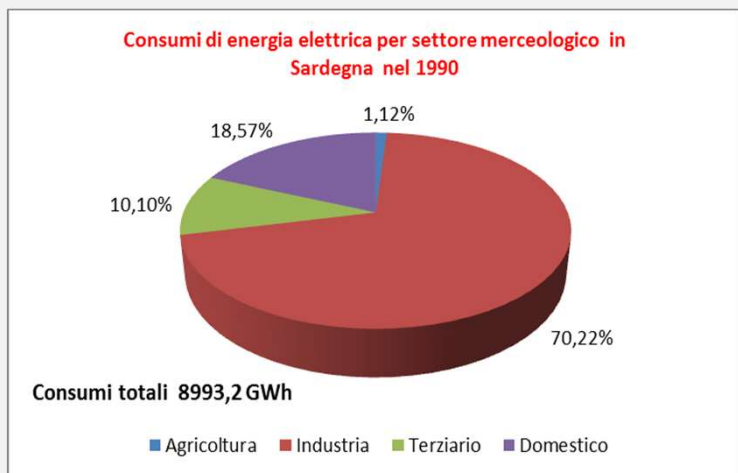


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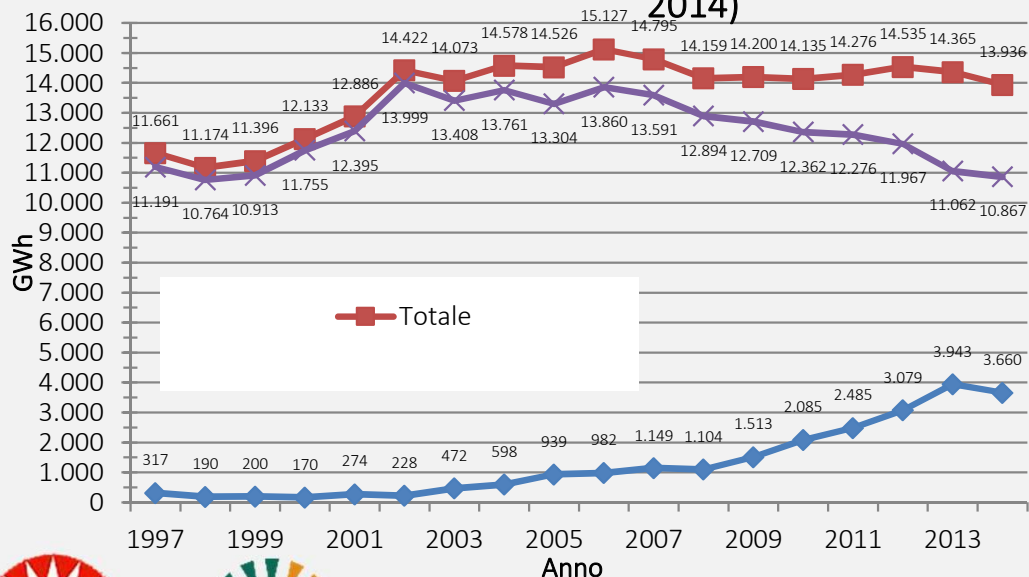
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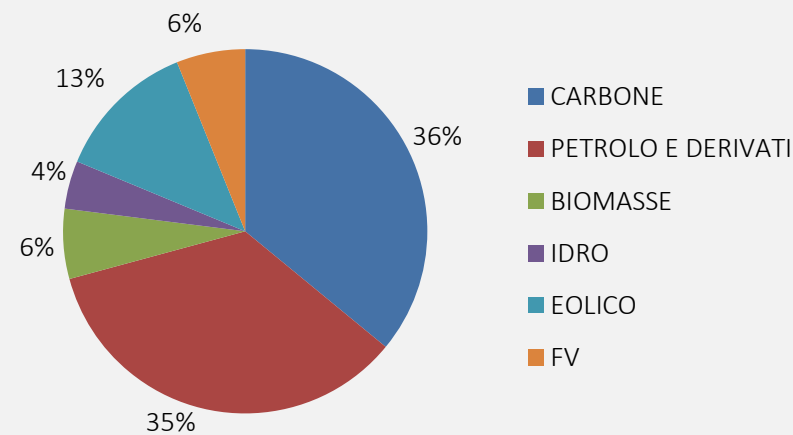
# EVOLUTION OF DEMAND AND PRODUCTION OF ELECTRICITY IN SARDINIA



Evolution of electric generation in Sardinia (1997-2014)



Distribution of power generation in 2013



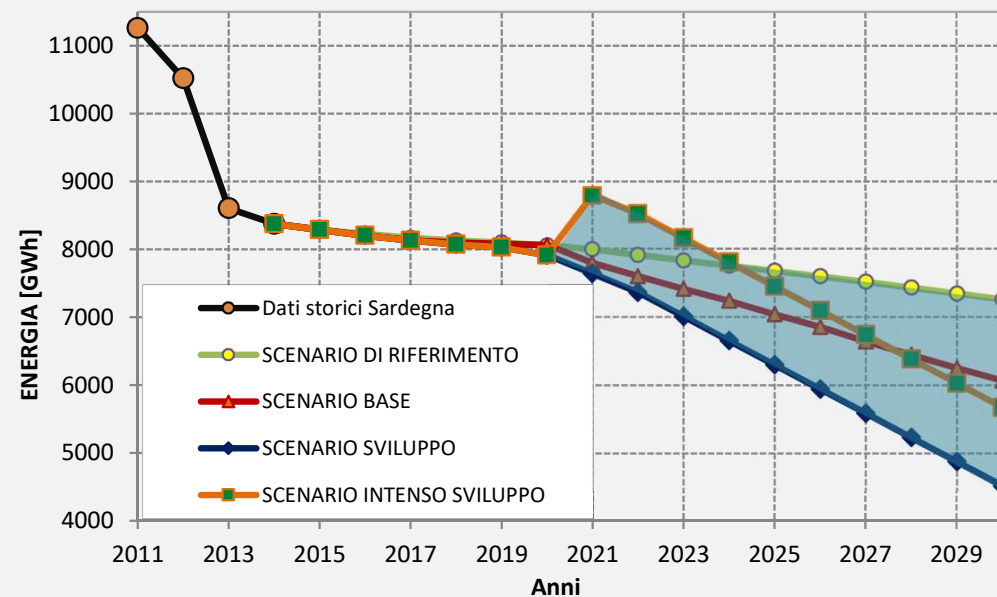
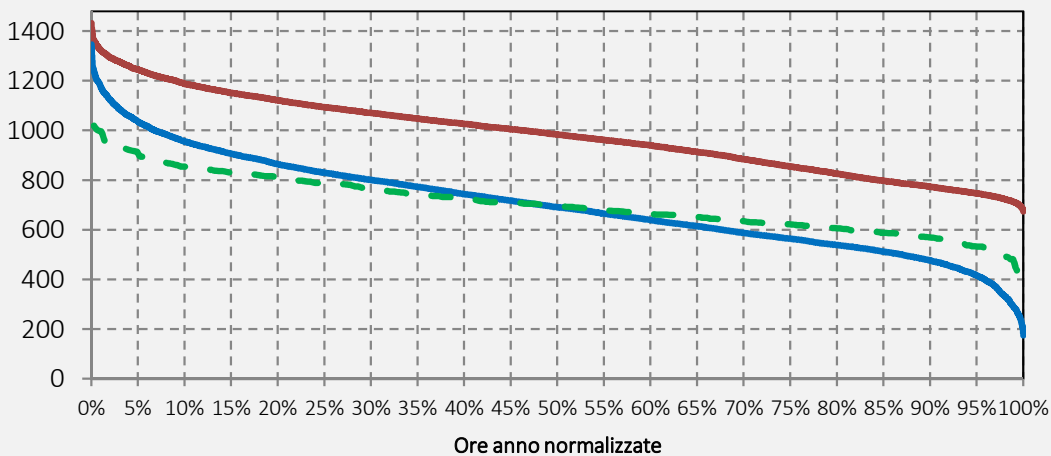
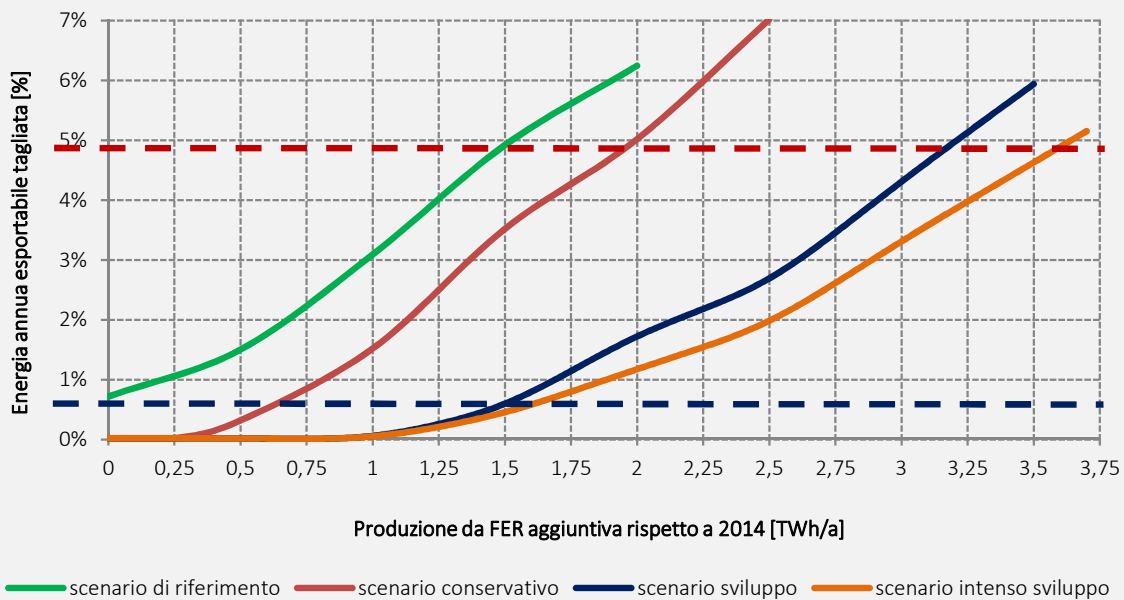
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# IMPLEMENTATION OF SMART CONCEPT- IS IT THE SOLUTION?



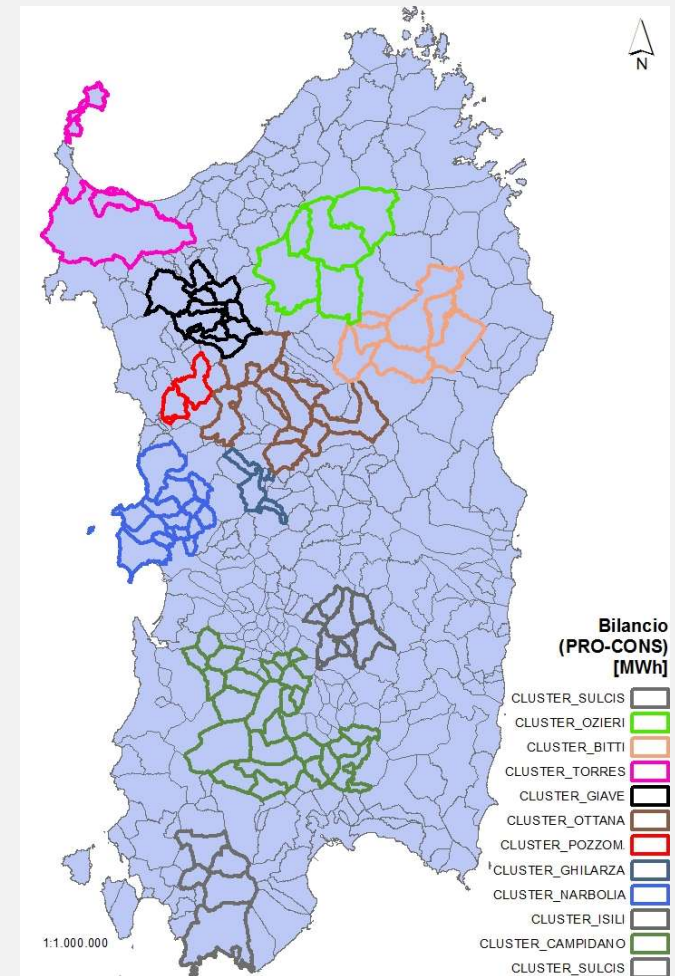
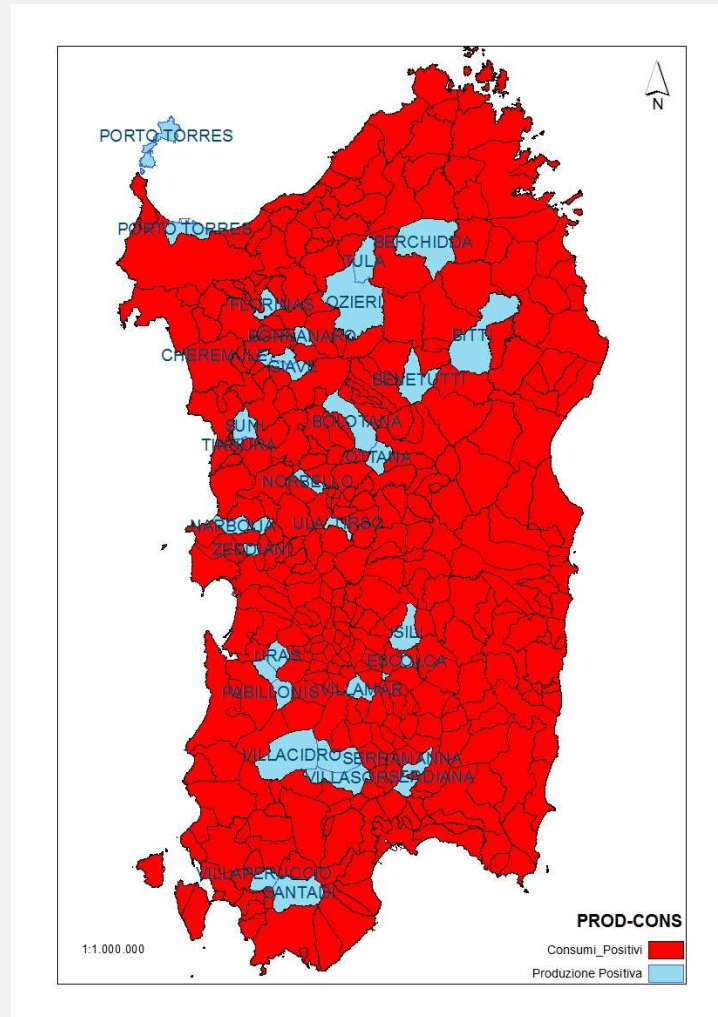
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# WHERE TO START?

11 Energy district  
in which there is a  
good matching  
between local  
production and  
demand

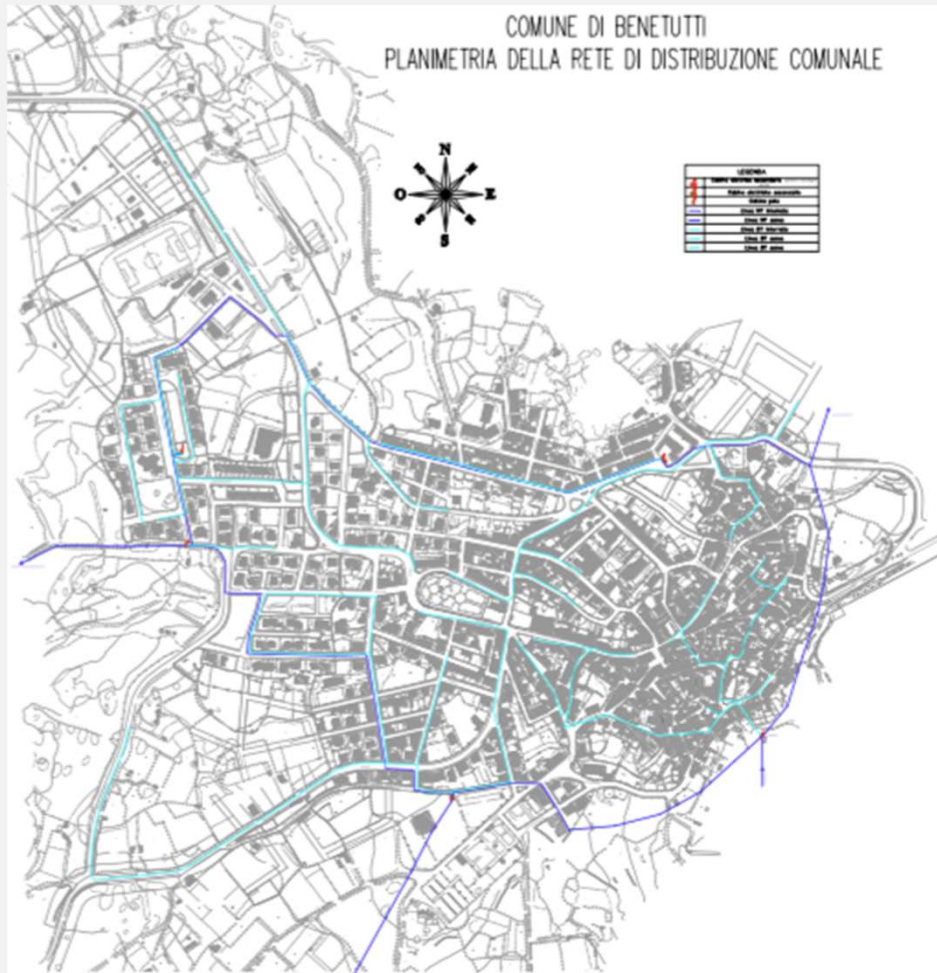


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# A SUITABLE PLACE – MUNICIPALITY OF BENETUTTI



## Municipality of Benetutti

- 90 PV power plants installed for a cumulative power of 1,5 MW<sub>p</sub>
- The installed distributed generation is characterised by 89 PV power plants under 20kW;
- The municipality is also the DSO
- There are 1200 users for a contract power of 4,5 MW
- Electricity Demand :2140 MWh



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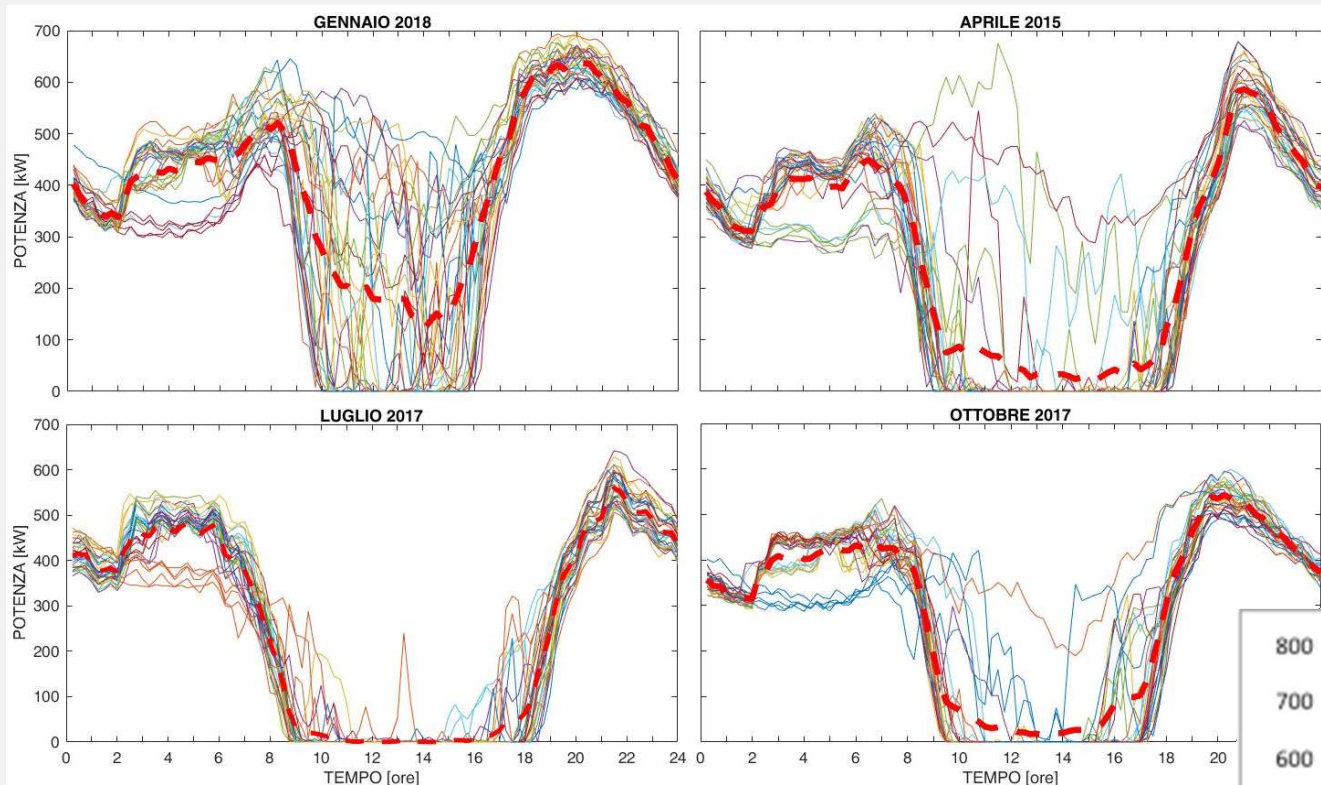
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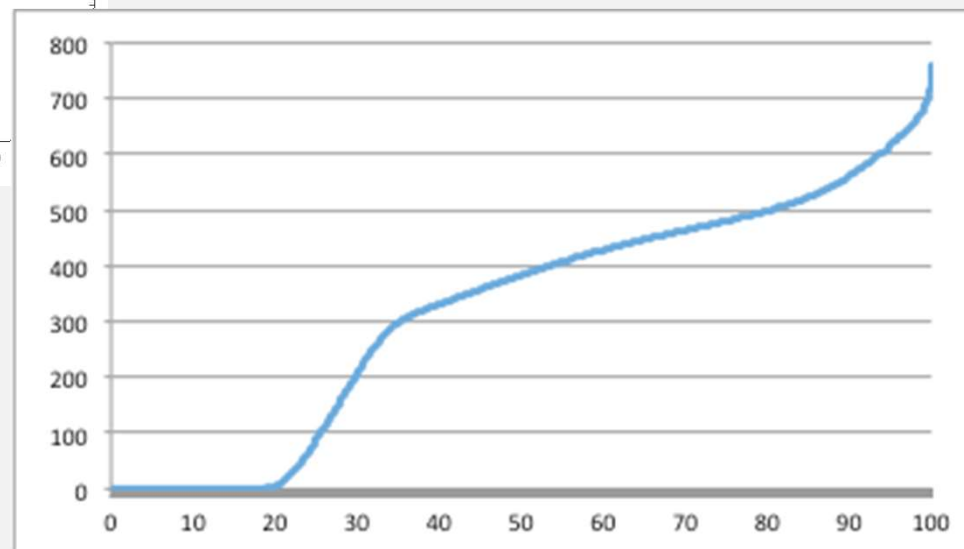




# A SUITABLE PLACE – MUNICIPALITY OF BENETUTTI



- Delivered : 708,22 MWh/y
- Withdraw: 2.820,00 MWh/y

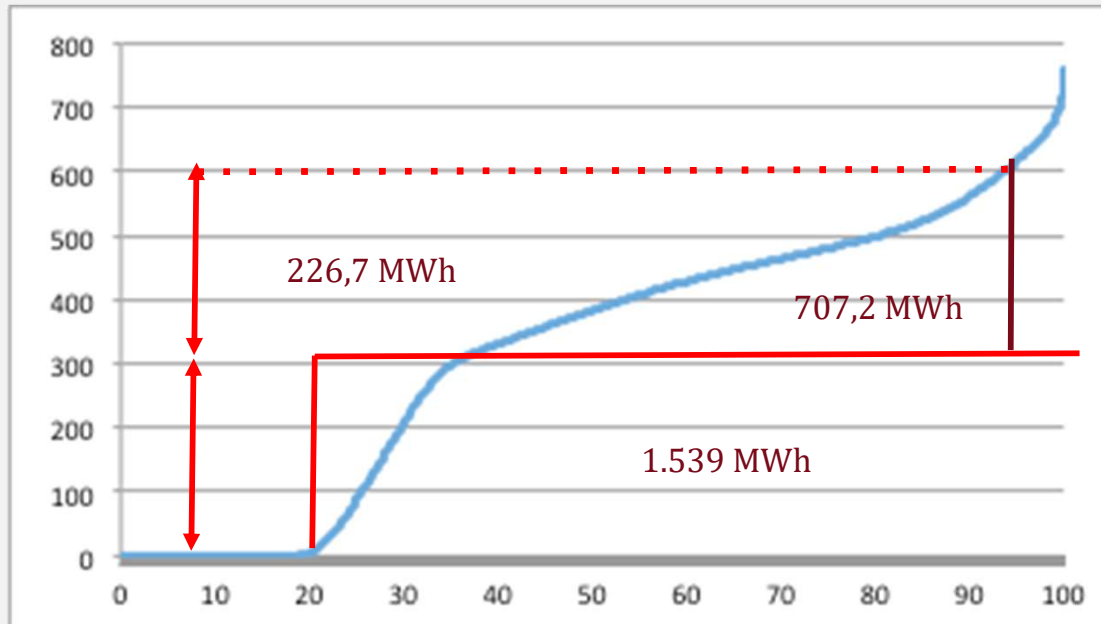


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# A PROPOSAL FOR BENETUTTI SMART ENERGY COMMUNITY



- Centralized Energy Storage: 300 kWh
- Anaerobic biomass power plant of 400 kW using the available residual biomass
- Implementation of Energy Management systems
- Implementation of Sharing Energy production models

Delivered Electricity : 330 MWh/y respect to 708,22 MWh/y

Withdraw Electricity : 180 MWh/anno respect to 2.820,00 MWh/y

Peak power required 200kW respect to 700

**The municipality of Benetutti can be the first Sustainable island of Sardinia**



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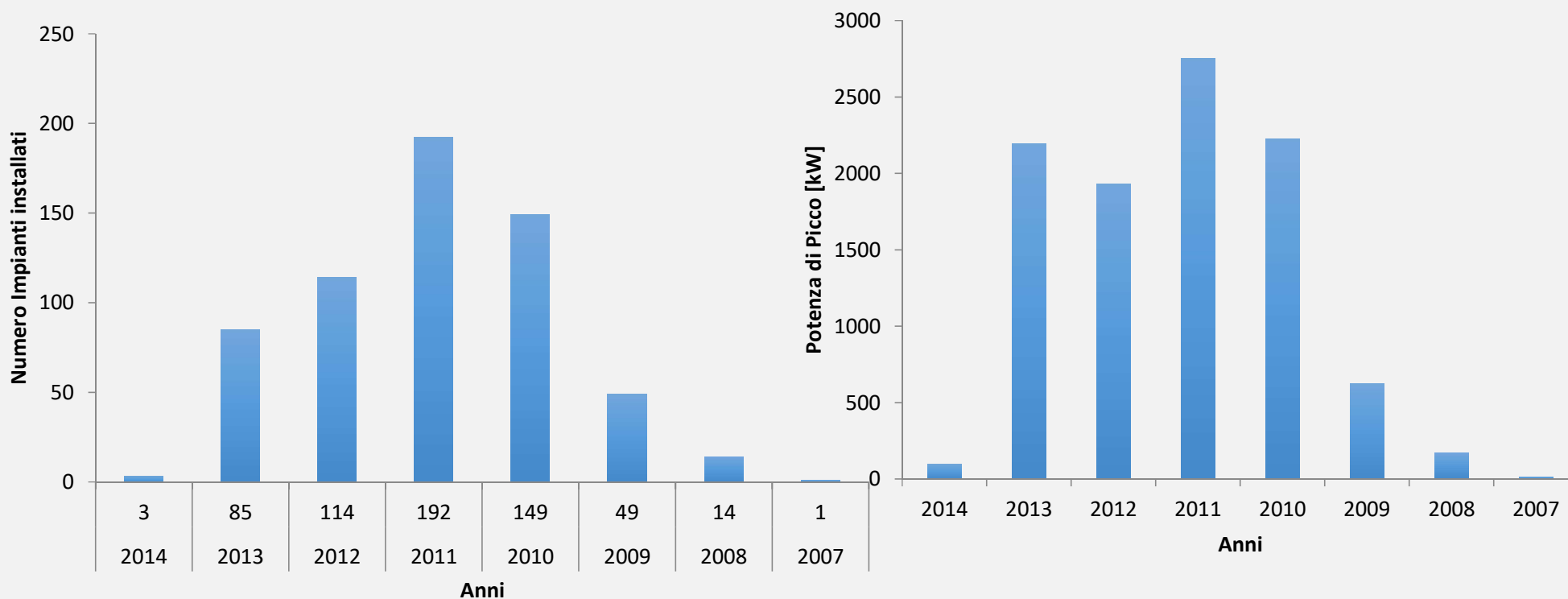
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# THE MICROGRID PROJECT OF SARDINIA REGION

600 PV power plants already installed in public building. Cumulative power 10 MW



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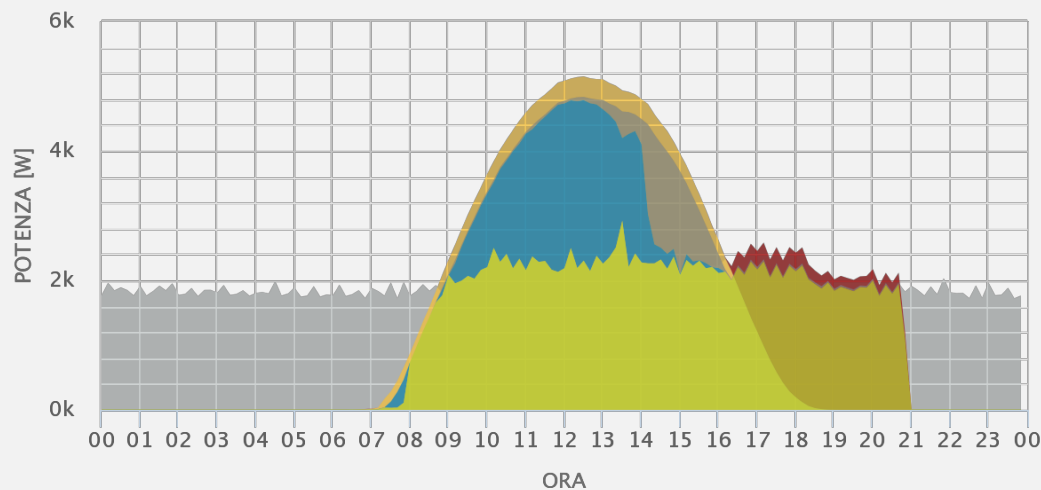


# THE MICROGRID PROJECT OF SARDINIA REGION

Proposal: valorisation of energy use of PV production by means the upgrading of the old PV inverter with a storage system connected in DC oriented to increase the self-consumption to a minimum value of 50%.

### RESOCONTO POTENZA GIORNALIERA

27/02/2017



#### Shockwave

- Potenza FV
- Charging battery (Power)
- Discharging battery (Power)
- Potenza autoconsumo
- Consumo domestico (Potenza)
- Grid feed-in
- Potenza AC



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# THE MICROGRID PROJECT OF SARDINIA REGION

## Tender for public building which has already installed PV

Development of the project	09.2016-02.2017
Presentation of the Tender	03.2017-04.2017
Public tender of public Administration	05.2017-06.2017
Analysis of the proposal	07.2017
Publication of results	07.2017-09.2017

**More that 70 micro-grids installed, tested and in operation.  
The micro-grids have been planned to be on line managed.**

**The system is ready to be managed by an aggregator .**

**A great potential for testing in public building the VPP, the  
Demand Side Management and so on**



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# ARE WE ABLE TO DEVELOP THE SMART GRID?

## The NETfficient Project

Energy and economic efficiency for today's smart communities through integrated multi storage technologies

- EU, H2020-LCE-2014-3, € 11.440.648,00
- Jan. 2015 - Dec. 2018
- 13 partners (10 companies)
- <http://netfficient-project.eu/>



Project funded by the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°646463



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# THE H2020 NETEFFICIENT PROJECT

## Peak Shaving and Ancillary Services

Connecting an HESS (Li-ion BP + UM) to the medium voltage grid on Borkum in order to make the grid function more efficient and stable (peak shaving, increased RES exploitation, primary and instantaneous reserve)

## Homes

40 homes will be supplied with a set of devices, among which PV panels, hydrogen conversion and storage, Li-ion batteries, HESS and second life batteries. Several targets are considered (self-consumption, dependence on electricity tariffs, remote control and supervision of energy resources, etc.)

## Buildings

The Use Case "Buildings" is similar to the Use Case "Homes" as it is based on the same basic installation set up. The difference is mainly the size and number of devices, but also a number of other aspects (legal and billing contract problems)

## Public Lighting

Consuming the energy supplied by the sun during daytime for lighting at night, improving the street lighting system maintenance service at the same time. Some scenarios will be analyzed (self-consumption of locally produced energy, grid support, remote control and supervision of energy resources)

## Aquarium Water Temperature Regulation

Regulating the water of the Borkum aquarium at a constant temperature of 12°C using PV energy and – by the help of thermal energy storage – applying this green energy even if there is no PV production at that moment



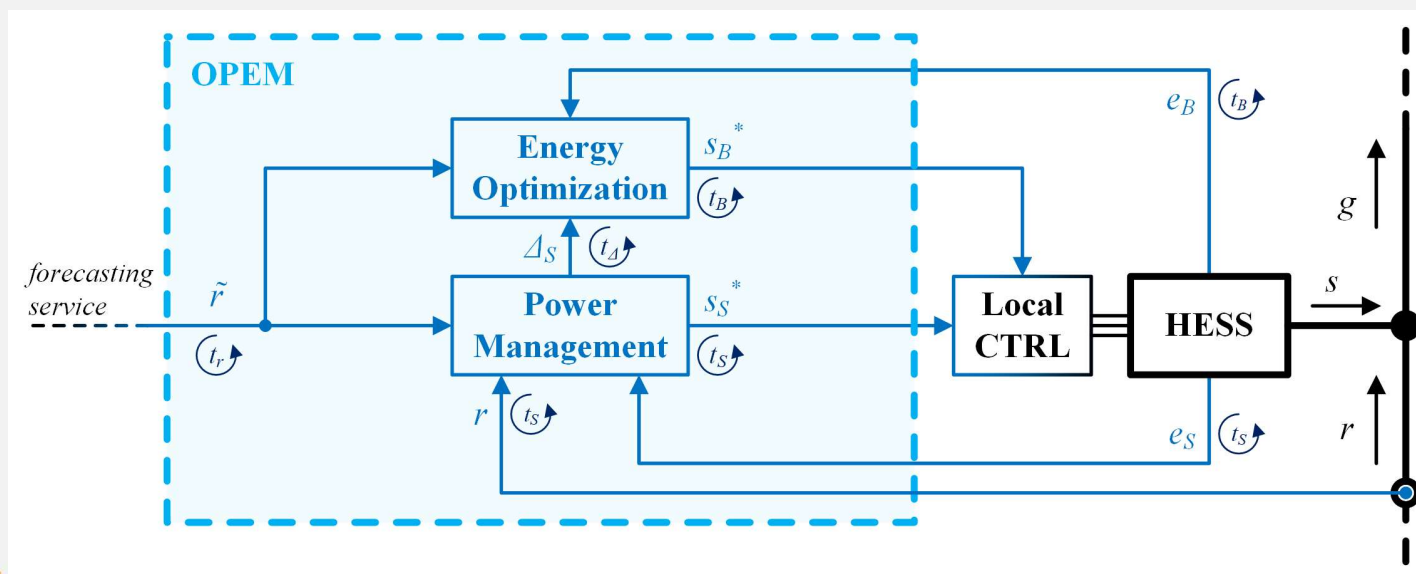




# THE H2020 NETFFICIENT PROJECT

## Optimal Power and Energy Management (OPEM) of the Medium Voltage HESS (UC 1)

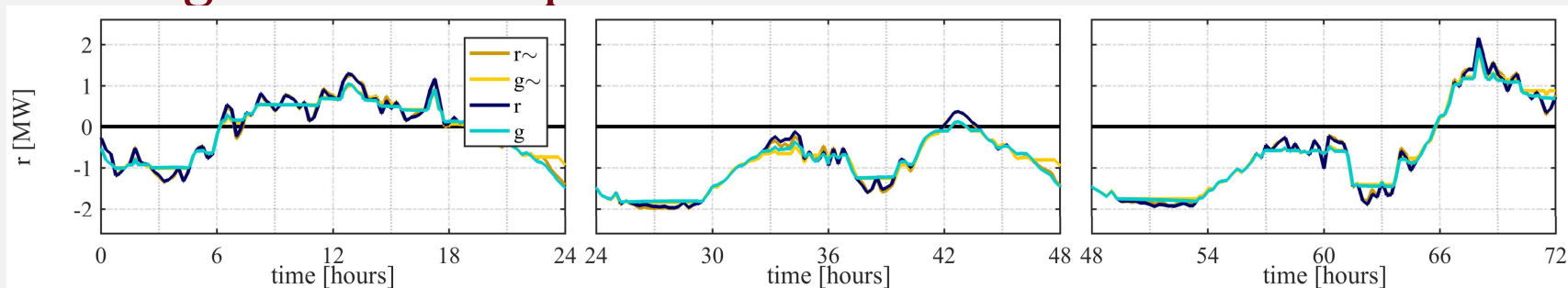
- Li-ion BP (500 kWh, 250 kW) provide peak shaving over a rolling time horizon
- UM (9 kWh, 1 MW) is employed for power quality and short-term forecasting error compensation
- BP and UM support themselves to each other in providing both energy and power service to the microgrid



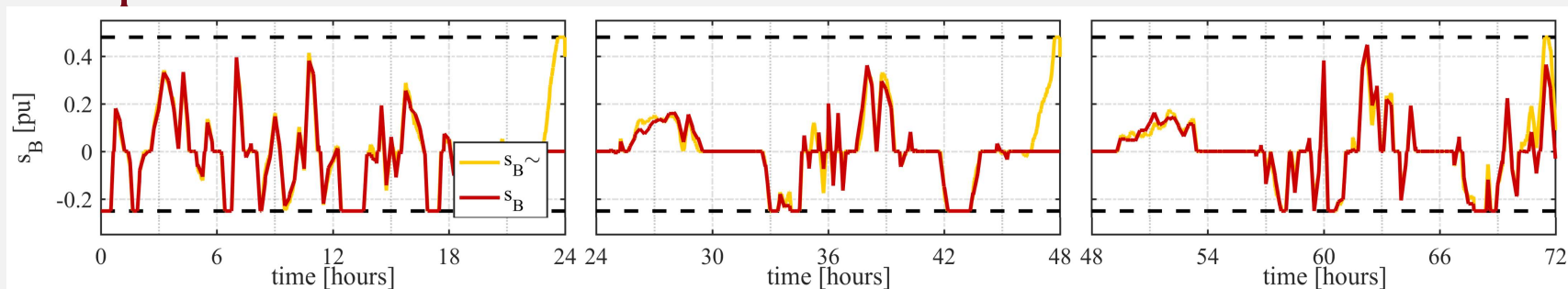


# THE H2020 NETFFICIENT PROJECT

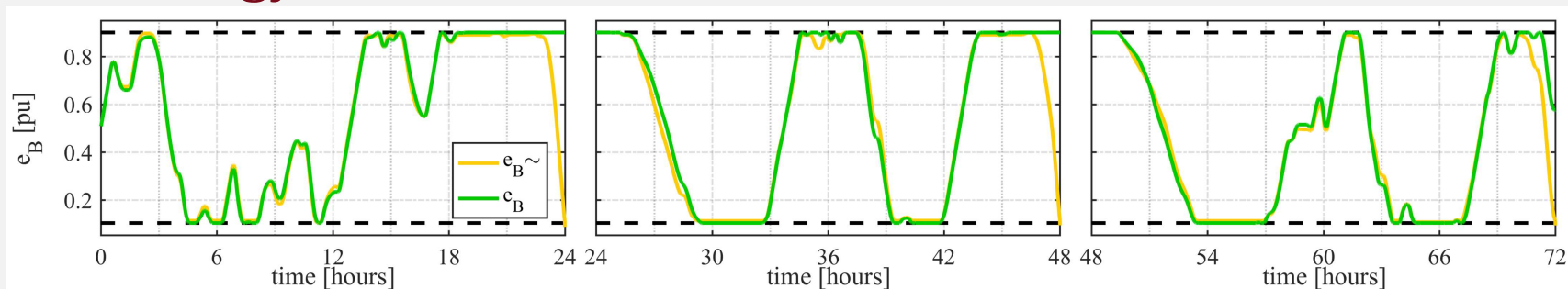
## Microgrid residual power



## BP power



## BP energy

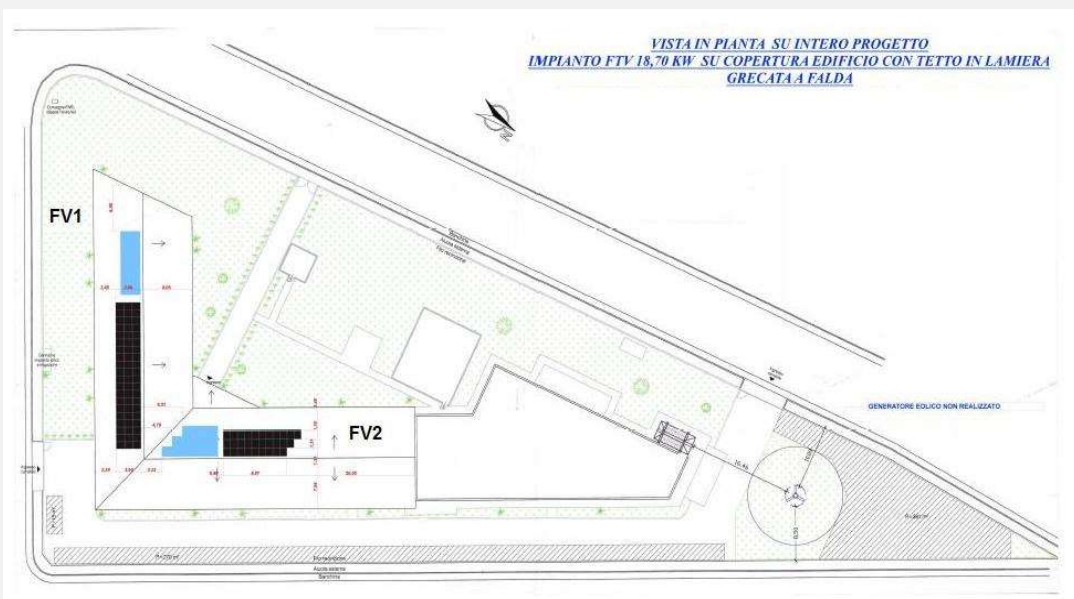


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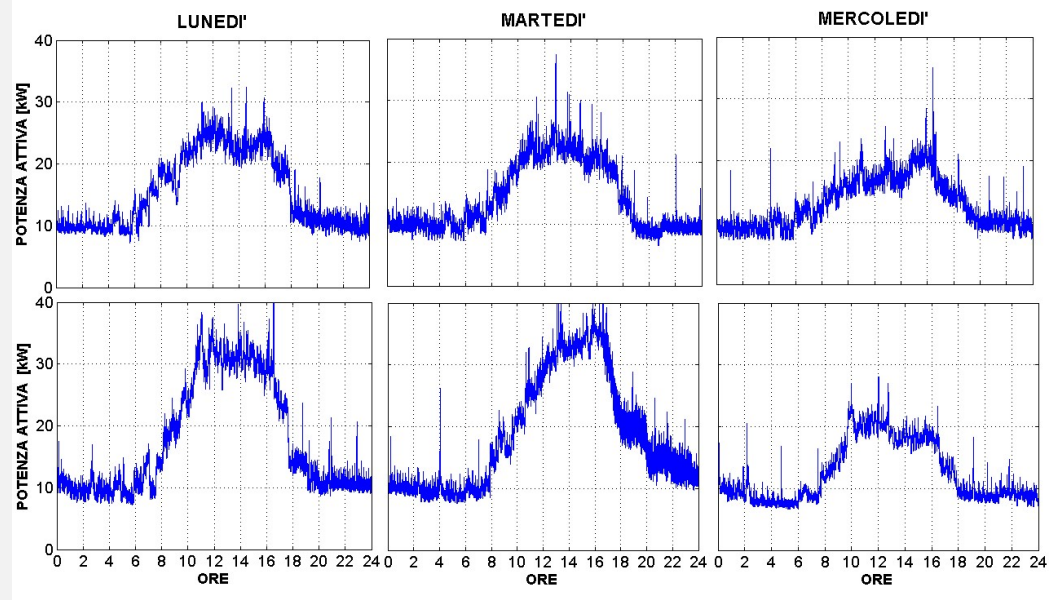


# THE PIATTAFORMA ENERGIE RINNOVABILI MICRO-GRID



- PV cristalline 18.70kW<sub>p</sub>
- Concentrating PV 6.2kW<sub>p</sub>.
- No power and energy balancing

- Constant power demand 10kW<sub>e</sub>
- Power peak 35 kW<sub>e</sub>.

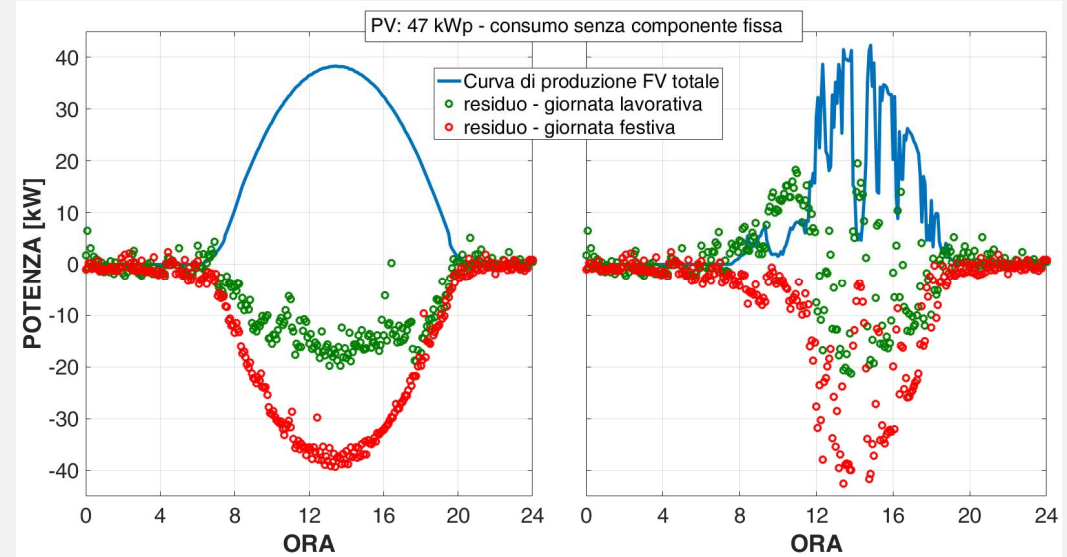
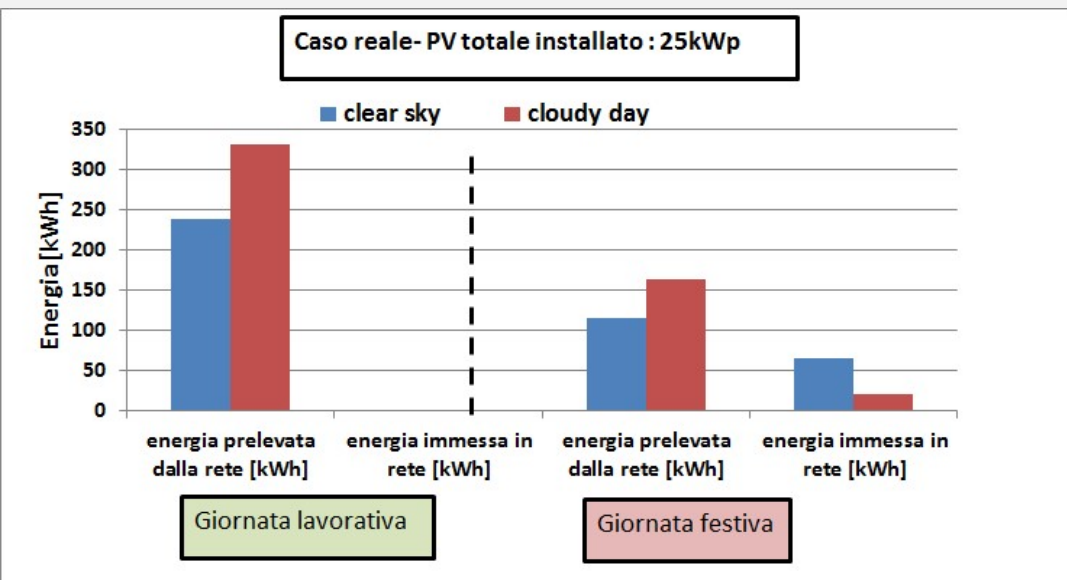


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# THE PIATTAFORMA ENERGIE RINNOVABILI MICRO-GRID



- **Compensazione della componente continua della Potenza richiesta con una cella a combustibile SOFC da 9 kW**
- **incremento della potenza fotovoltaica installata per il raggiungimento di una potenza cumulata pari ad almeno 47 kW<sub>p</sub>**
- **Integrazione del sistema di accumulo elettrochimico (Potenza 40 kW<sub>p</sub> e capacità 60 kWh)**



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# THE OTTANA SOLAR POWER PLANT

The Ottana CSP-CPV pilot plant

The Ottana pilot solar plant enterprise started in 2011 in the framework of the European Regional Development Fund 2007-2013 Sardinia, Axis III Energy

The Ottana pilot solar plant has an overall power of about 1000 kWe and is composed by two distinct sections:

- CSP section of 630 kWe with a two tanks TES system of about 15.2 MWh
- CPV section of about 400 kWe with a molten-salt battery system of about 430 kWh



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# THE OTTANA SOLAR POWER PLANT



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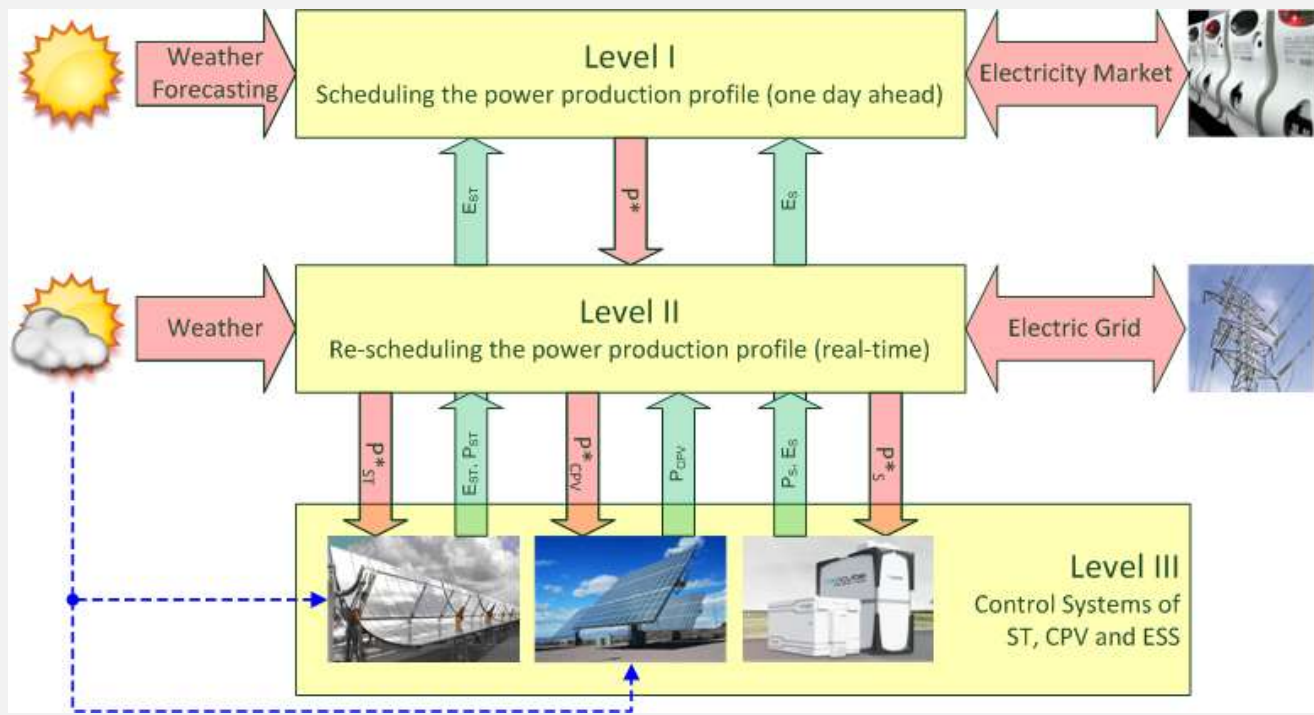
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# THE OTTANA SOLAR POWER PLANT

## Control Scheme of the proposed ancillary storage system



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**Grazie per la cortese attenzione**  
**Thank you for your kind attention**



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