

# RENEWABLE ENERGY SOLUTION

SOLAR, WIND AND  
HYDRO ENERGY.  
CHP AND FUEL CELL.



## EEI'S SMART GRID SOLUTIONS



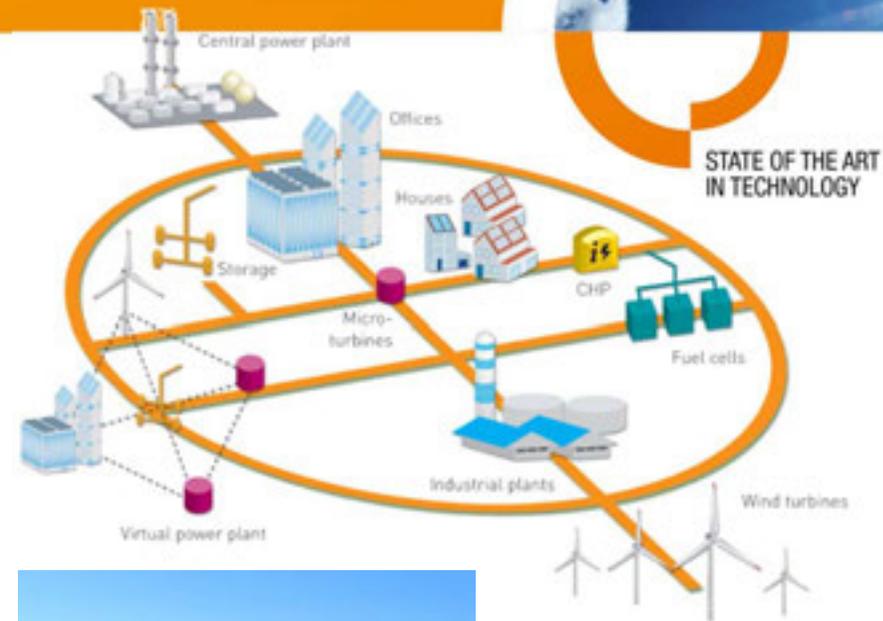
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# Smart Grid

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In recent years, the “Smart Grid” is developing as an innovative concept in the management of energy flows.

- Final domestic users
- Industrial users
- Programmable Energy Sources
- Non-programmable Energy Sources
- Storage systems
- E – mobility



# EEL for the Smart Grid: Solutions for all users ...

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## Energy Producers

- Possibility of predictable production profile
- Improvement of output quality
  - Power Factor correction
  - Low Voltage Ride Through
  - Management of output V, f
  - Harmonic content reduction
- Upgrade to new Grid Codes

## Grid Manager – Utilities

- Grid back-up
- Peak shaving and load levelling
- Improvement of output quality
- Correction of unbalanced phase
- Power Factor correction
- Harmonic content reduction

## Final user

- Peak-shaving and load levelling
- Power Supply in case of grid failure
- Management of unbalanced loads
- Management of Active and Reactive power
- Power Factor Correction
- Harmonic Compensation
- Flickering Compensation
- LVRT Function

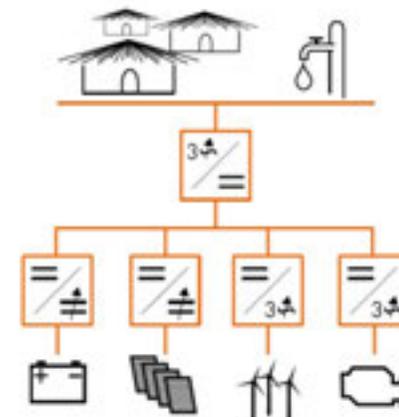
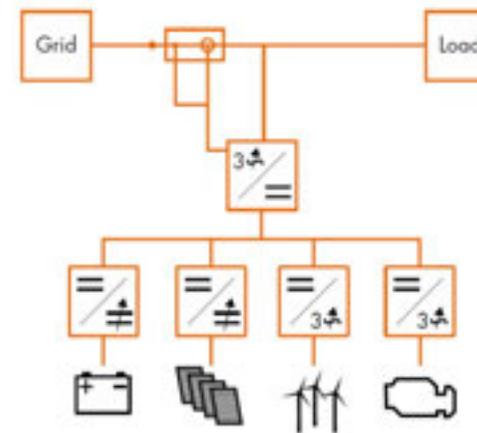


# And for all the grids ... Hybrid and Off grid Solutions

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- Hybrid Systems
  - Simultaneous use and optimization of several energy sources
- Off-grid
  - Rural electrification
  - Telecom/military
  - Reduction of energy costs



# EEI Solution for Smart Grid

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## Standardized EEI ESS series

- Power Output range from 30 to 600 kVA
- Control of active and reactive power
- UPS mode

Complete customized solutions up to 1,2MVA in one enclosure, or multi-MW with a modular solution.



# EEl Solution for Smart Grid

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## COMPARING TYPICAL INVERTER FOR PV APPLICATION & SMART GRID INVERTER

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FEATURES	TYP. INVERTER FOR PV APPLICATION	SMART GRID INVERTER
POWER LIMITING / POWER SETPOINT	YES (FIXED) / UNCOMMON	YES FULLY CONFIGURABLE
ADJUSTABLE POWER FACTOR	YES (FIXED)	YES FULLY CONFIGURABLE
EXTENDED CAPABILITY	NO / UNCOMMON	YES
FREQUENCY DROP CONTROLLER	YES (FIXED)	YES FULLY CONFIGURABLE
MANAGEMENT OF UNBALANCED LOAD	NO / UNCOMMON	YES
UPS FUNCTION	NO	YES
BLACK START	NO	YES
HARMONIC COMPENSATOR	NO	YES



# EEl'S ESS: Special Features

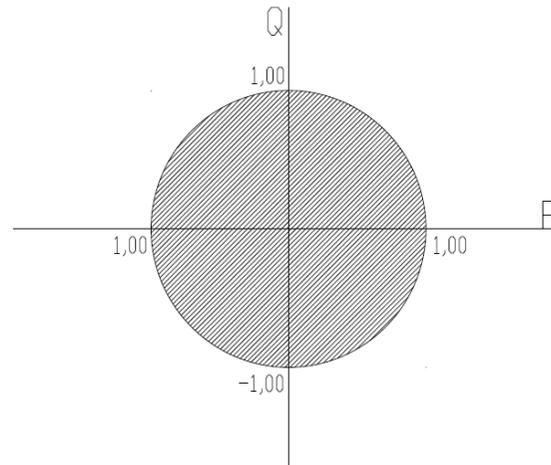
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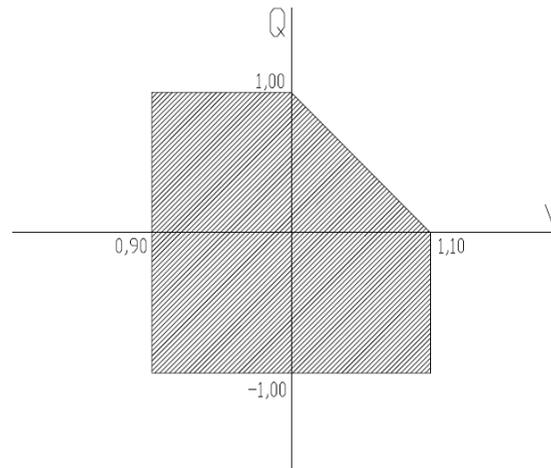
## POWER SETPOINTS

ACTIVE & REACTIVE POWER SETPOINTS  
ADJUSTABLE POWER FACTOR

ALL THESE PARAMETERS CAN BE MANAGED  
BY AN EXTERNAL DCS



## EXTENDED Q-V CAPABILITY FOR VOLTAGE REGULATION



# EEI'S ESS: Special Features

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## FREQUENCY REGULATION

FREQUENCY DROP CONTROLLER  
WITH FIXED OR VARIABLE DROOP

CONFIGURABLE DIAGRAM  
 $P = \text{function}(f)$

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## HARMONIC COMPENSATOR

5° - 7° - 11° HARMONIC COMPENSATION

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## BLACK START

START INVERTER AFTER A GRID FAULT FOR  
FREQUENCY REFERENCE.  
VERY HIGH PRECISION AND STABILITY IN  
FREQUENCY

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## VOLTAGE REGULATION

LINEAR CONTROL

CONFIGURABLE DIAGRAM  
 $P = \text{function}(f)$

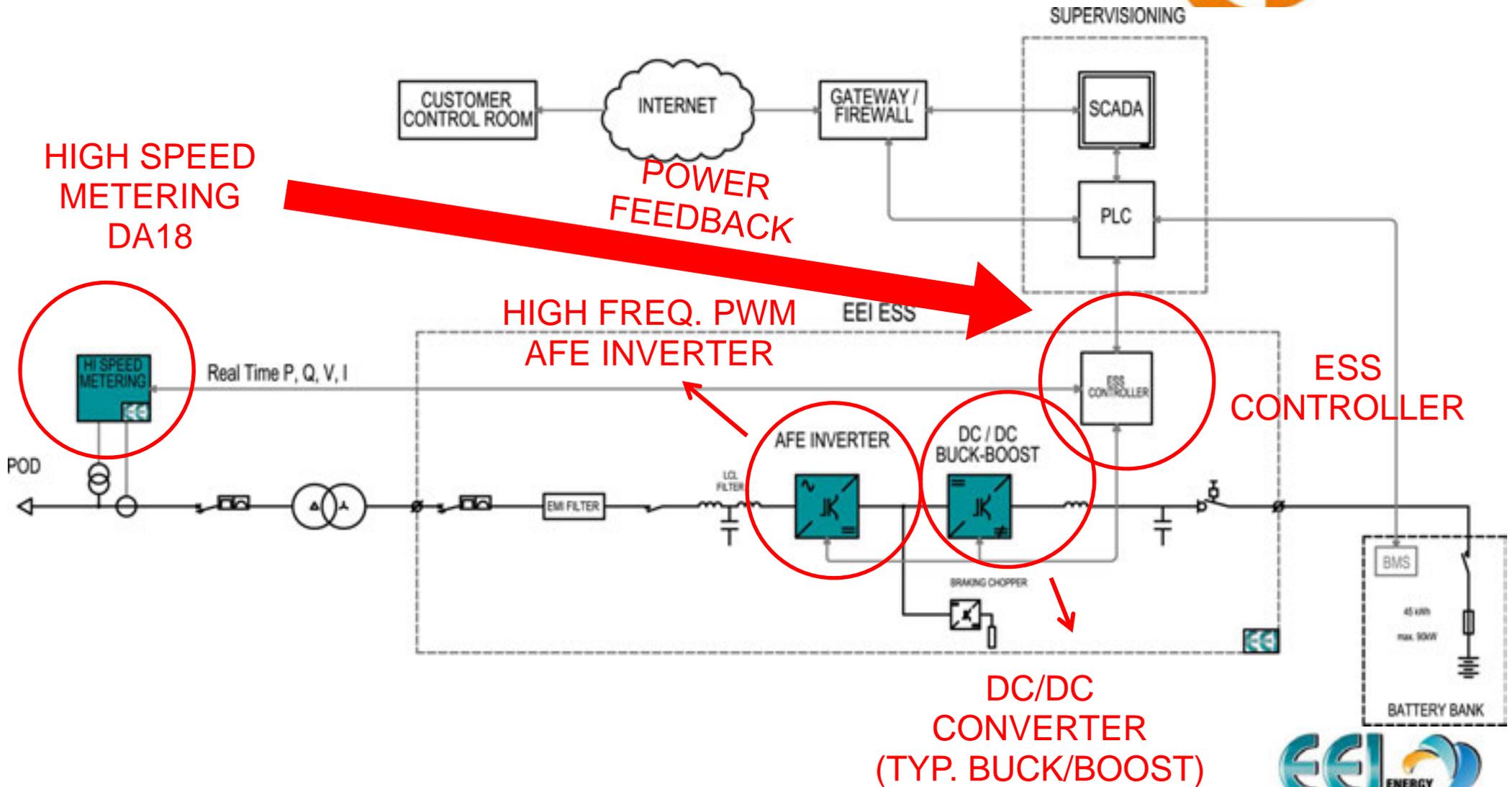
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## IMBALANCE OF PHASES

VOLTAGE DIP COMPENSATION



# EEI's ESS – Typical layout



# EEI'S ESS: Batteries interface

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**WHICH IS THE BEST BATTERY ?**



**IT DEPENDS BY THE PROJECT**

**THANKS TO OUR FLEXIBILITY WE CAN MANAGE:**

**LEAD ACID BATTERY**

**LITHIUM-ION BATTERY**

**LITHIUM POLYMER BATTERY**

**LITHIUM –YTTRIUM BATTERY**

**LITHIUM IRON PHOSPHATE BATTERY**

**SODIUM BATTERY (NAS – SONICK)**

**FUELL CELL**

**AND MANY OTHERS KIND OF BATTERIES**



# OUR COLLABORATIONS

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LG CHEM  
SAMSUNG  
SAFT  
KOKAM

Lithium-ion  
Li-Po

MIDAC  
FIAMM

Lead Acid

Lithium yttrium  
& LiFePO<sub>4</sub>

WINSTON BATTERY

FIAMM Sonick<sup>®</sup>  
GE Durathon<sup>®</sup>

Sodium



# RENEWABLE ENERGY SOLUTION

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**ENEL Distribuzione  
ESS in Campi Salentina  
in collaboration with  
SAET Padova**



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# Enel distribuzione Campi Salentina

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2MVA / 1MWh system

EEl provided

8 x 250kW customized inverters

and high-speed metering system for power feedback

- Customer: SAET Padova
- Batteries Li-po / SAFT
- Final Customer: Enel
- Delivered in September 2013
- In operation

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# Enel Distribuzione Campi Salentina

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EEL provided the inverters and the metering systems

The whole system made by SAET, Padova, Italy

Pictures, courtesy of Saet Padova



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## PROJECT «NAVICELLI» PISA



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# Case History – Pisa (2012)

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## System Function

- Injection of active or reactive power upon utility request
- Back-up of 1MW for 8sec
- Voltage regulation through statism algorithm
- Power factor correction
- Active filtering

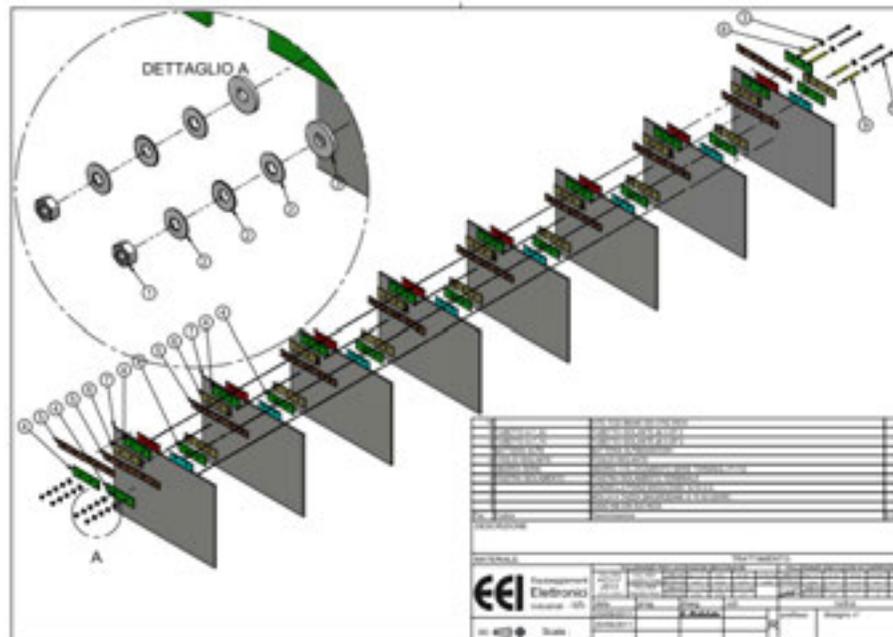
EEL provided the turn-key solution, including the development of a BMS for the Kokam's Li-Po cells



# EEL experience: Development of BMS

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**BATTERY EQUALIZER**  
**ACTIVE BALANCING OF ENERGY STORED IN EACH CELL OR BATTERY**  
**STATE OF CHARGE ESTIMATOR**  
**LI-PO CELLS MANUFACTURED BY KOKAM**



# Li-po Batteries by EEI

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- Li-po batteries with BMS
- Optimized for EEI ESS series cabinet
- Easy battery insertion/disinsertion System
  
- EEI ACC 9
  - 9 batteries
  - 27 kWh
- EEI ACC 18
  - 18 batteries
  - 55 kWh

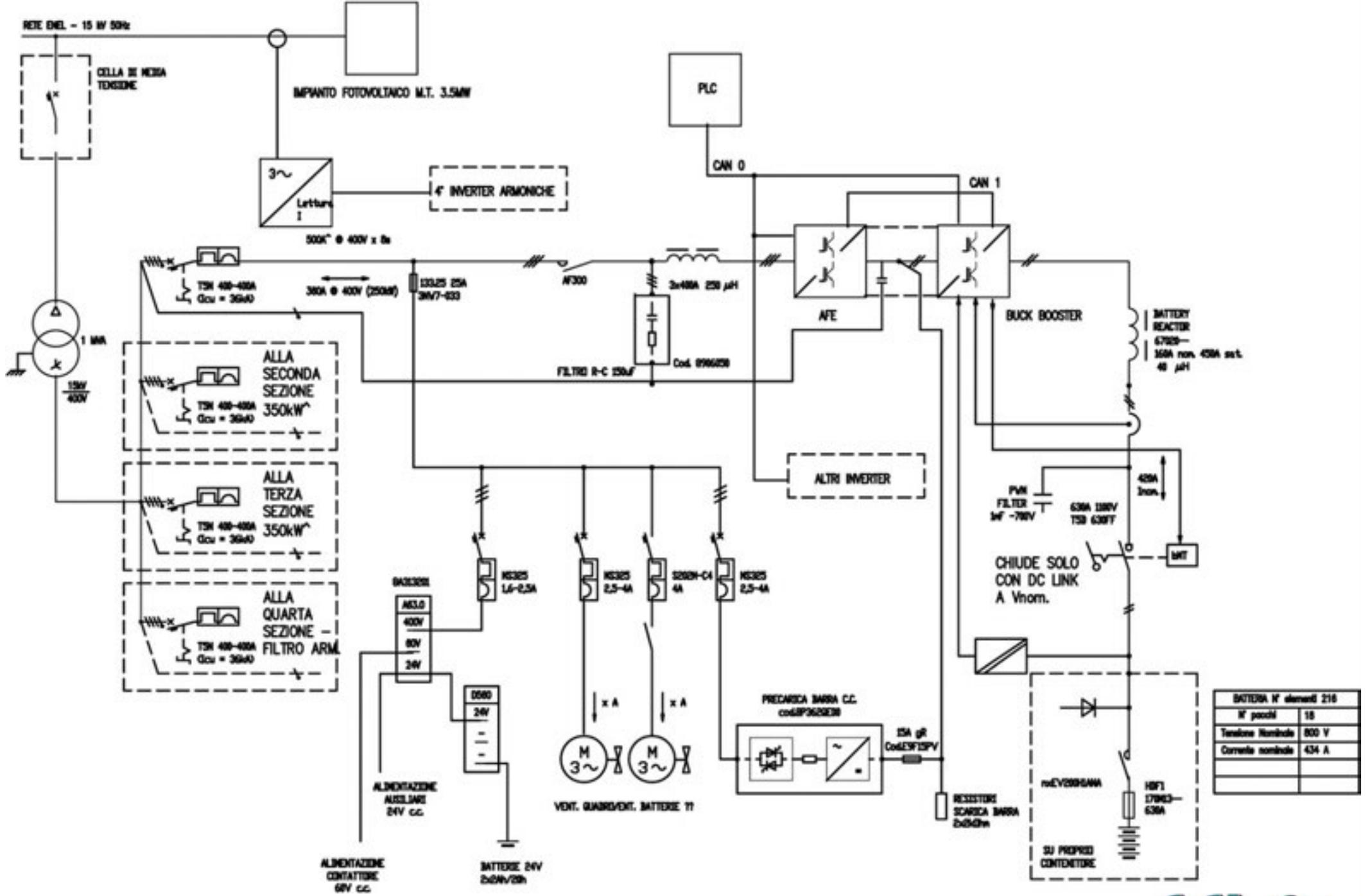


# PISA - Inauguration and press-conference

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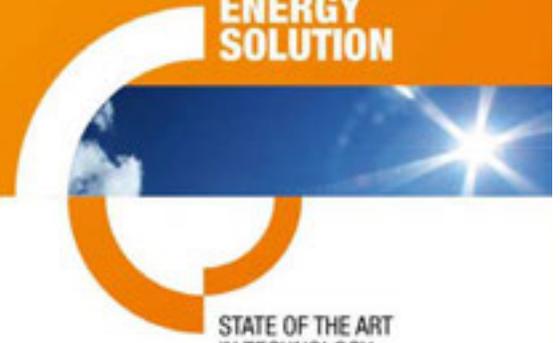
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# Conversion Cabinet

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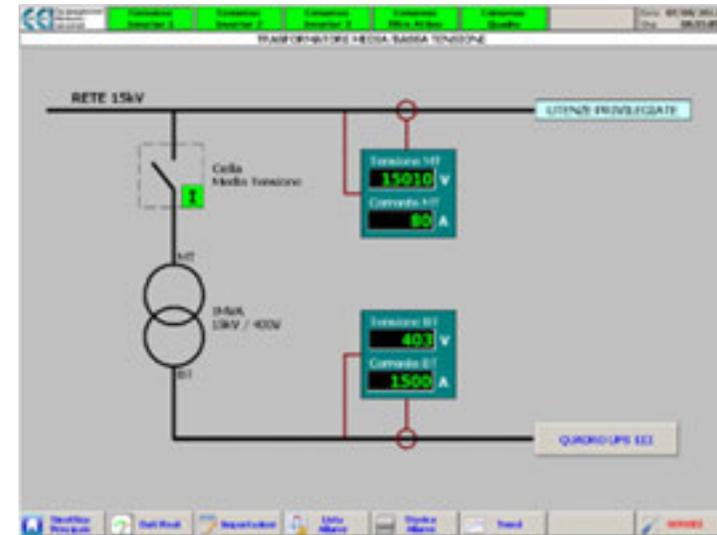
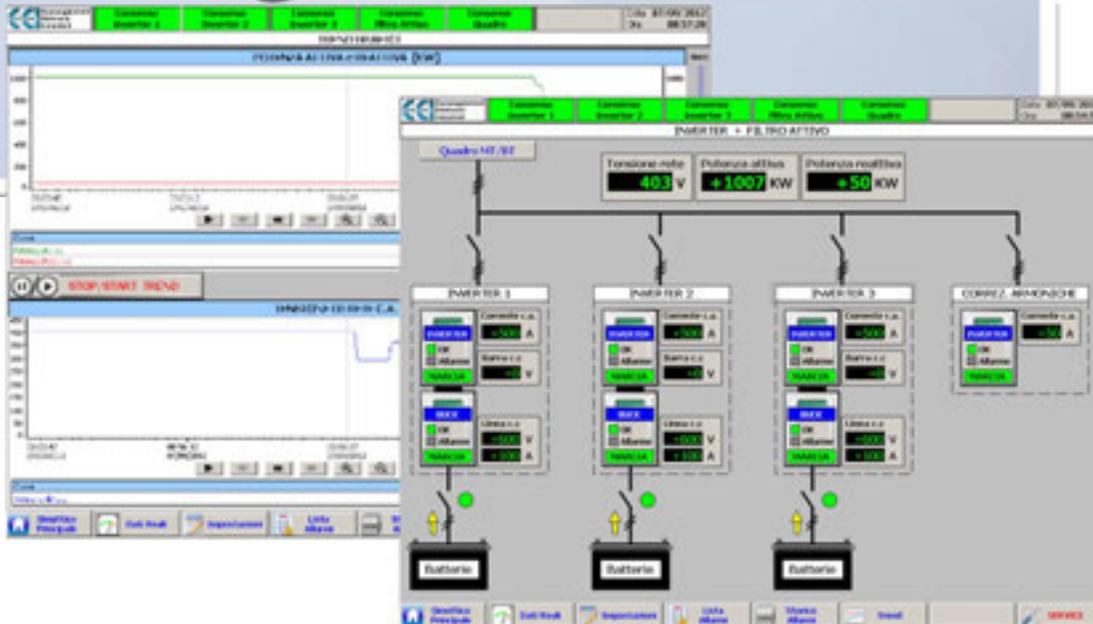
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# Control system

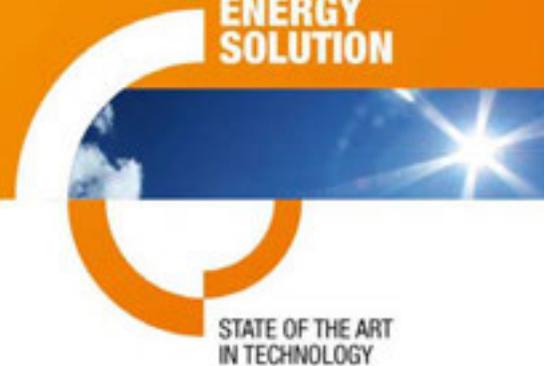


Controls and manages the power between the different energy sources, to ensure maximum stability and improve energy saving.



# PISA – ESS on site

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**Hybrid Generation System  
Diesel Genset + Storage  
for Mining operations**



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# Off-Grid Hybrid Generation System

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Multiple units each with:  
2 X 300 kVA Diesel Genset + 1 X 100 kVA ESS  
Energy Storage with 100 kWh LiFePO4  
Containerized solution

Functions:  
Peak shaving, Grid Stabilization



In collaboration with Margen, Maranello Generatori (ITA)



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## ENEL PROJECT GRID 4U

In collaboration with  
Loccioni Group / Samsung



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# Enel – Project GRID4U Loccioni Group

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1MVA / 1MWh system

EEl provided

5 x 200 kW customized inverters

and high-speed metering system for power feedback

- Customer: General Impianti / Loccioni Group
- Batteries : Samsung
- Final Customer: Enel
- Delivered in November 2013
- In operation



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## ENERTRONICA ERITREA 1

Capacity building for public  
administration in Eritrea

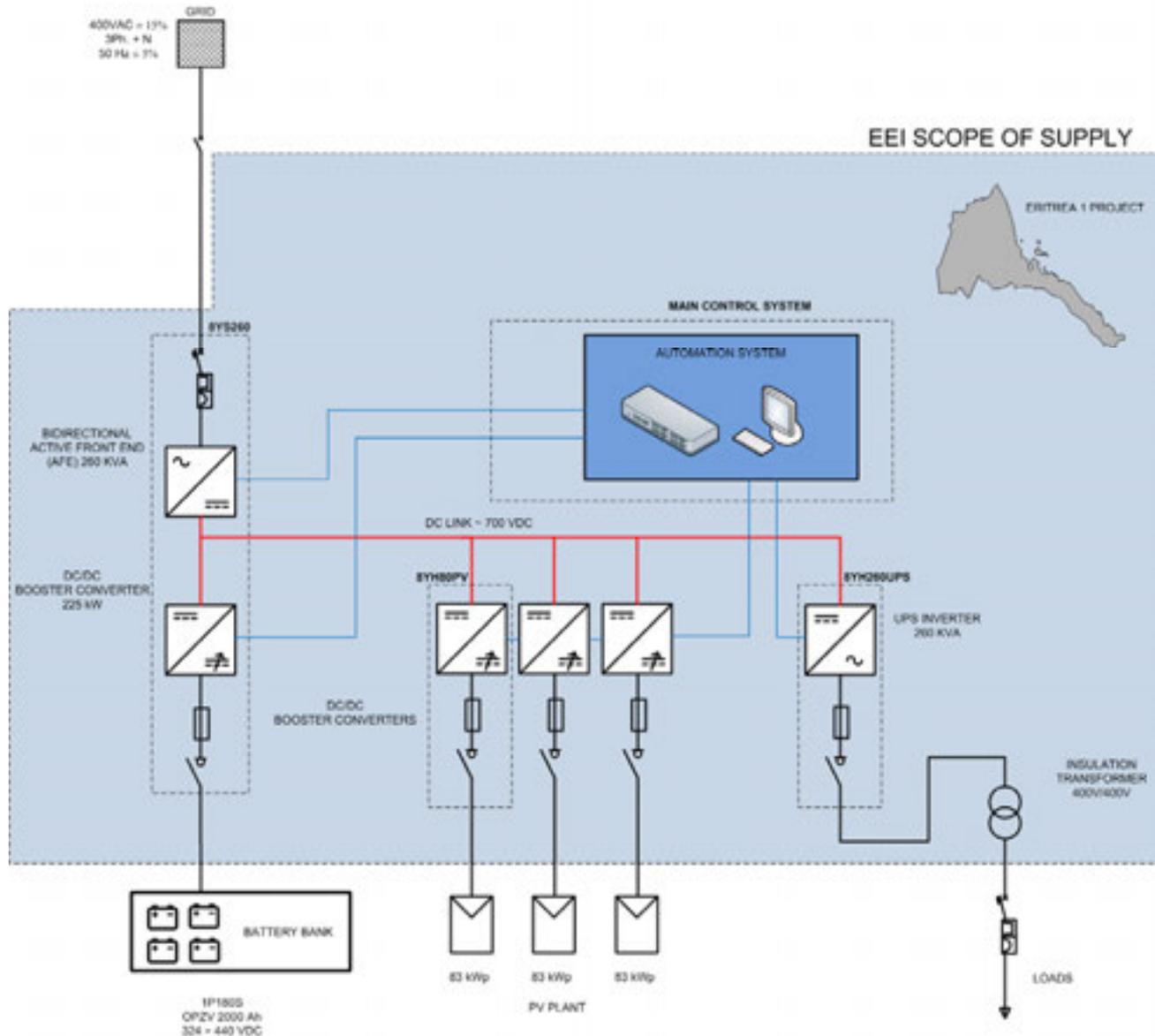


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# ERITREA 1 delivery September 2015

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In collaboration with  
Enertronica Spa - Frosinone



# ERITREA 1 delivery September 2015

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Tests at EEL's workshop

All in one inverter with the following features:

- 400 VAC INPUT 250 kVA bidirectional (GRID)
- 400 VAC OUTPUT (loads)
- 3 X 120 kWp Photovoltaic input
- 1 X 200 kW bidirectional Battery input
- Embedded Automation System

In collaboration with  
Enertronica Spa - Frosinone



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## RES NOVAE PROJECT BARI

General Electric International Inc.



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# Res Novae Project - GE

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100 kW / 200 kWh Sodium Chloride

100 kW / 150 kWh Lithium

**EEl provided:**

**2 x 100 kW CEI 0-21 inverters 8YS100**

**+ high-speed metering system for power feedback**

- Customer: Ge Int. Inc.
- Batteries : Durathon GE, LG Chem
- Final Customer: GE- Enel
- Delivered in: May 2015 and September 2015
- In operation



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## ATB BERGAMO



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# ATB BERGAMO

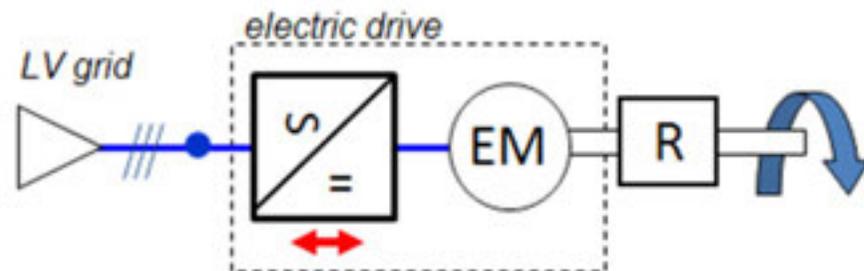
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## Before

- Solution with inverter
- Peak power absorption of 200 kW
- No remuneration of braking energy recovered from the system and regenerated toward the grid



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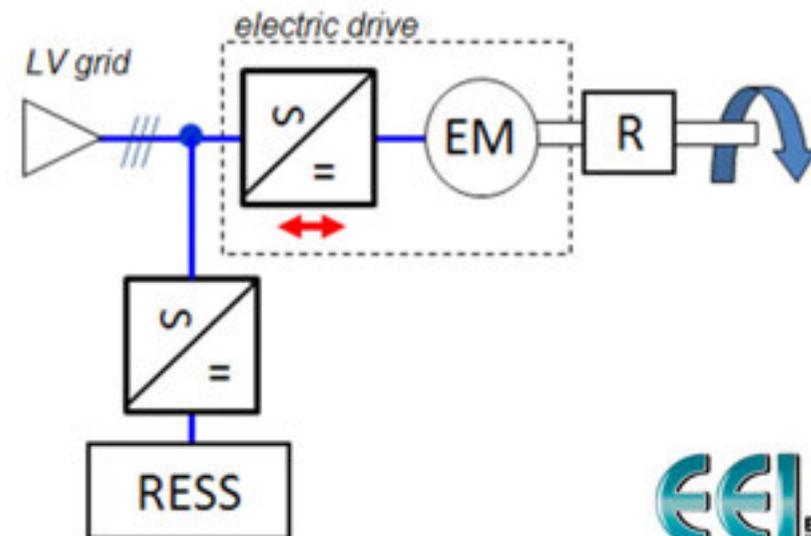


## After

- Solution with inverter and Energy Storage System
- Peak power absorption reduced to 100 kW
- Braking energy stored and re-used inside the funicular
- Total energy savings up to 40%



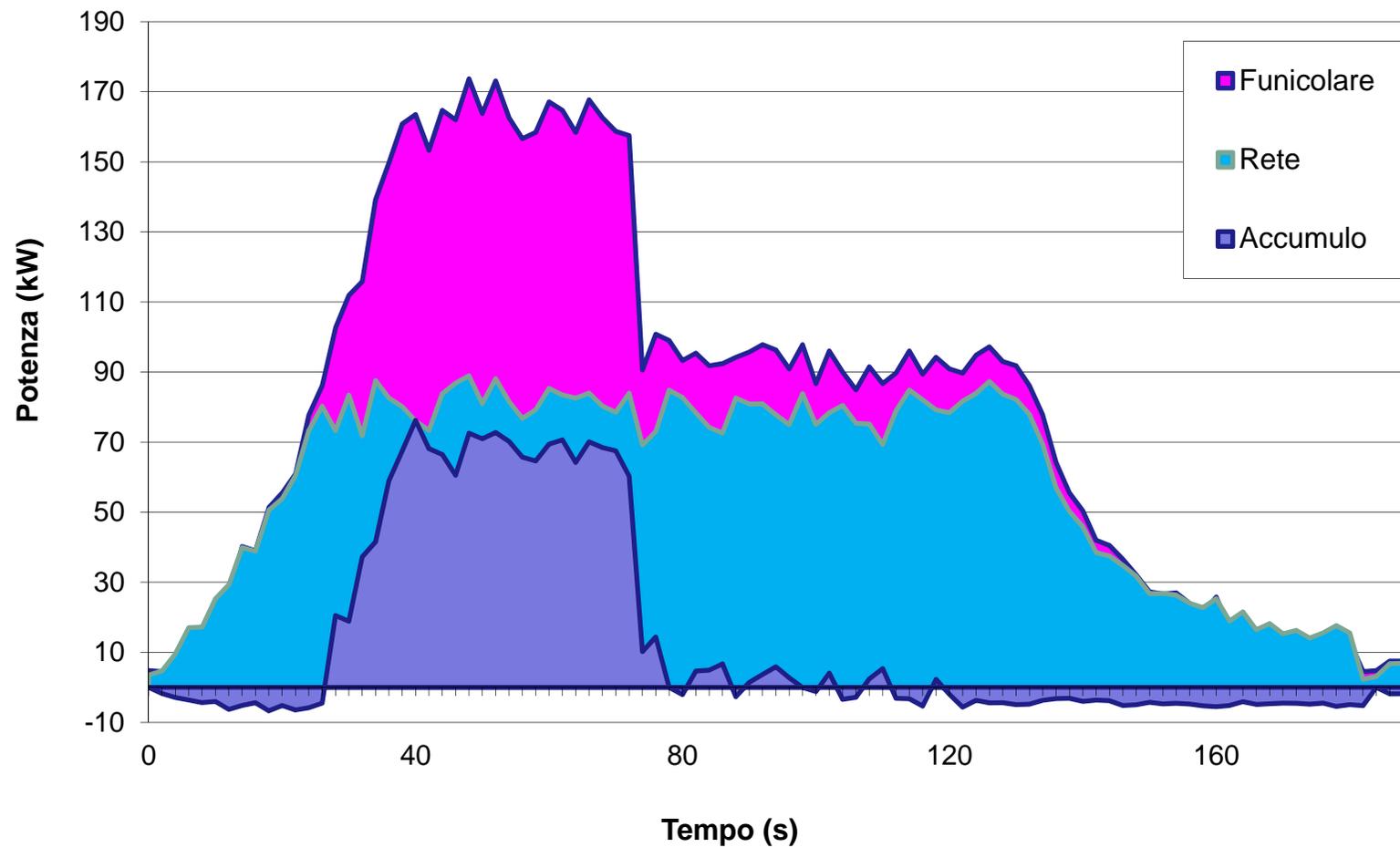
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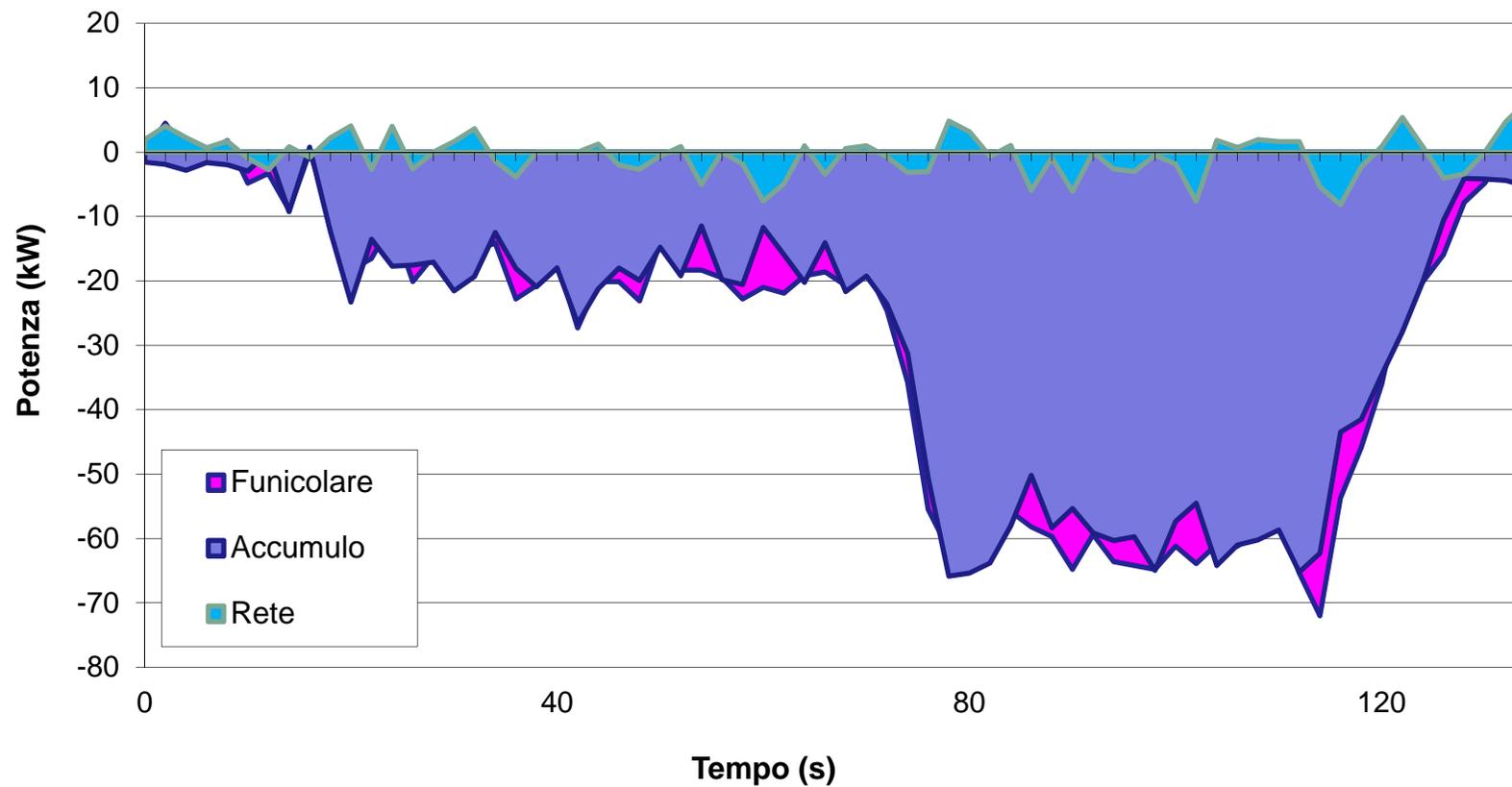
# Energy Flux during Climb

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# Energy Flux during Descent



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## OTHER PROJECTS



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# Spain 2012 – Proyecto iSare

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Microgrid with different  
renewable energy producers

EEl provided:

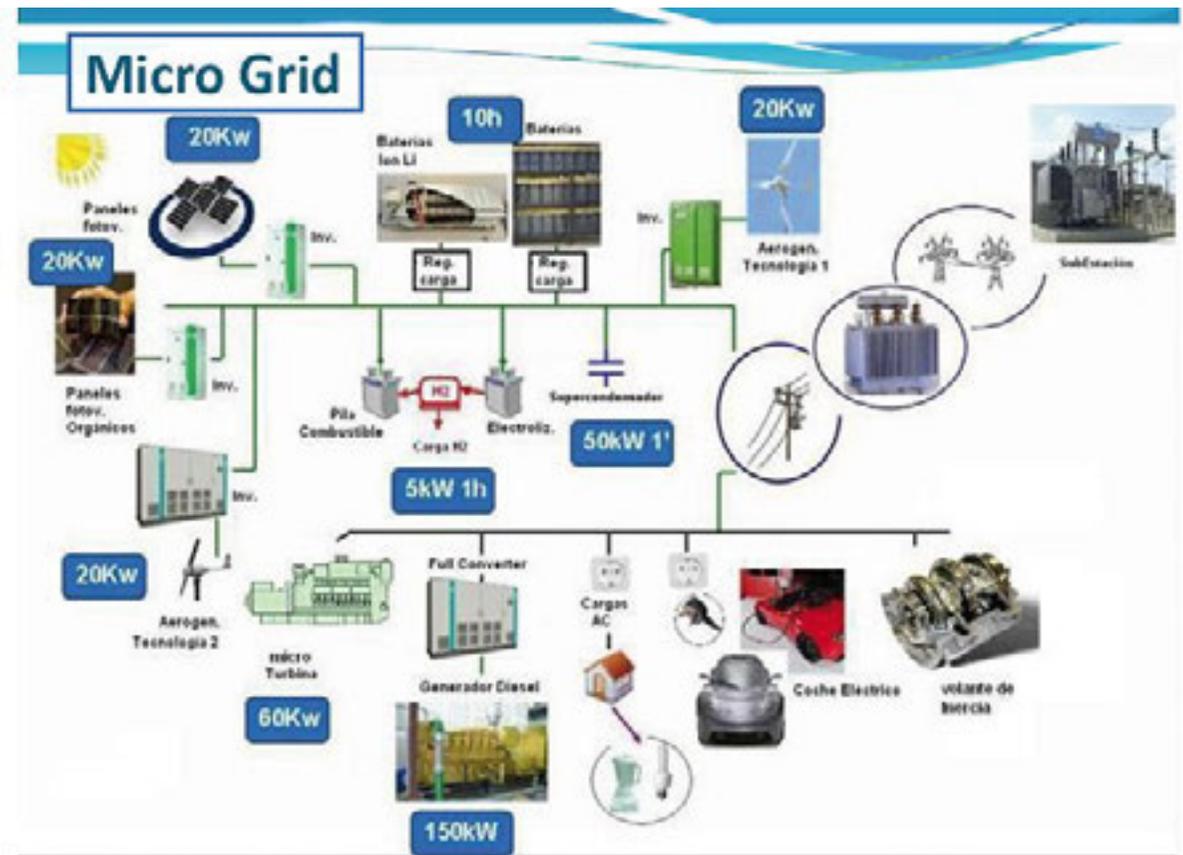
No.1 Energy Storage 100kW  
with Li-ion batteries

No.1 Energy Storage 80 KW  
with Lead Acid batteries

Functions:

Peak-shaving and grid balancing

Black start



In collaboration with Ormazabal - Spain



# WORK IN PROGRESS

## LANDIS+GYR / TOSHIBA TTDE

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### First Battery Energy Storage System for Frequency Adjustment in Nordic Countries (Finland)

1200 kW / 600 kWh SCiB™ lithium-ion

EEl provides:

- 2 x 600 kW inverters 8YS600 (customized for Toshiba)
- high-speed metering system for power feedback
- Container and battery racks
- MV/LV transformer
- Firefighting and cooling system
- 40°C to +40°C temperature range

Customer: Toshiba TTDE  
Batteries : Toshiba SCiB™ lithium-ion  
Final Customer: Helen  
Delivered in: January 2016



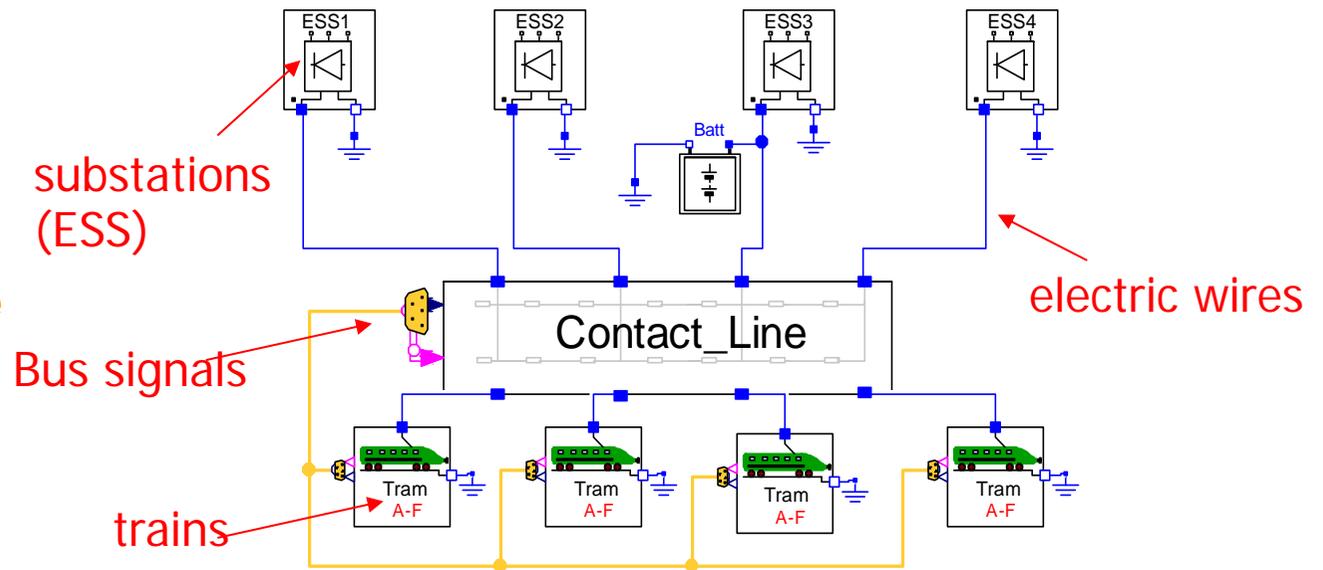
# WORK IN PROGRESS...

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## Public Transportation

### Regenerative system for Bergamo tramline

The feeding network will be equipped with some storage system, to recover the energy during braking of some trains, and send back to the others when required.



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# Thank you for your attention

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