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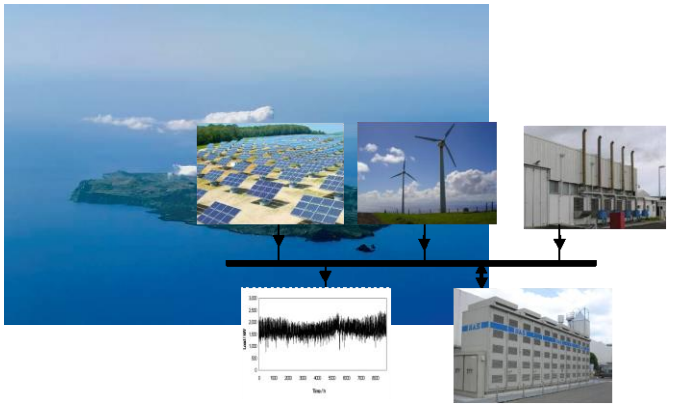
REDES ENERGÉTICAS DO FUTURO

12./13. Dez. 2011

Clemens Triebel, Younicos

Younicos develops applications of storage & grid management technologies



6 Wh → 1 kWh → 100 kWh → 6 MWh

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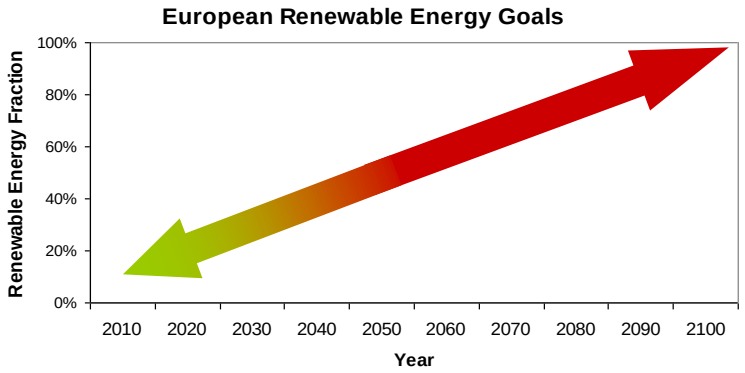
VISION: Future energy supply shall rely on Renewable Energy (RE) worldwide

Example: European RE targets (20% in 2020, 30% in 2030, ….)

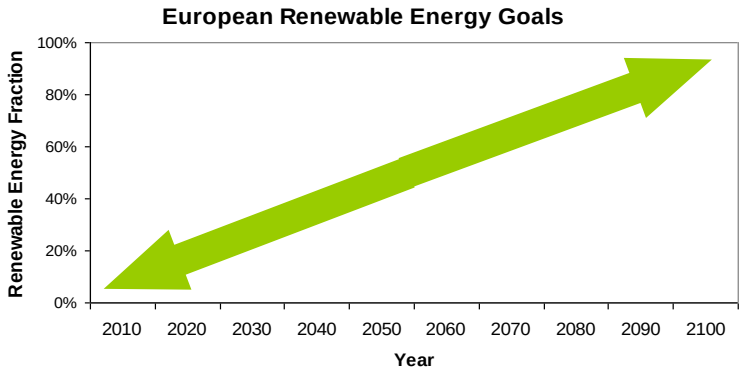
For a **stable** grid based on renewable energies

- Storage Technologies
- New Control strategies

are required



Stable
Instable



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The ISLAND case

While in the mainland grid, instability due to major contribution to renewables is a challenge of **TOMORROW**

Islands experience these future challenges of the European grid already **TODAY**

Therefore, they are the ideal platform to develop **TODAY** the energy concepts of **TOMORROW**

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Example: Graciosa Island (Azores)

Inhabitants: 4500

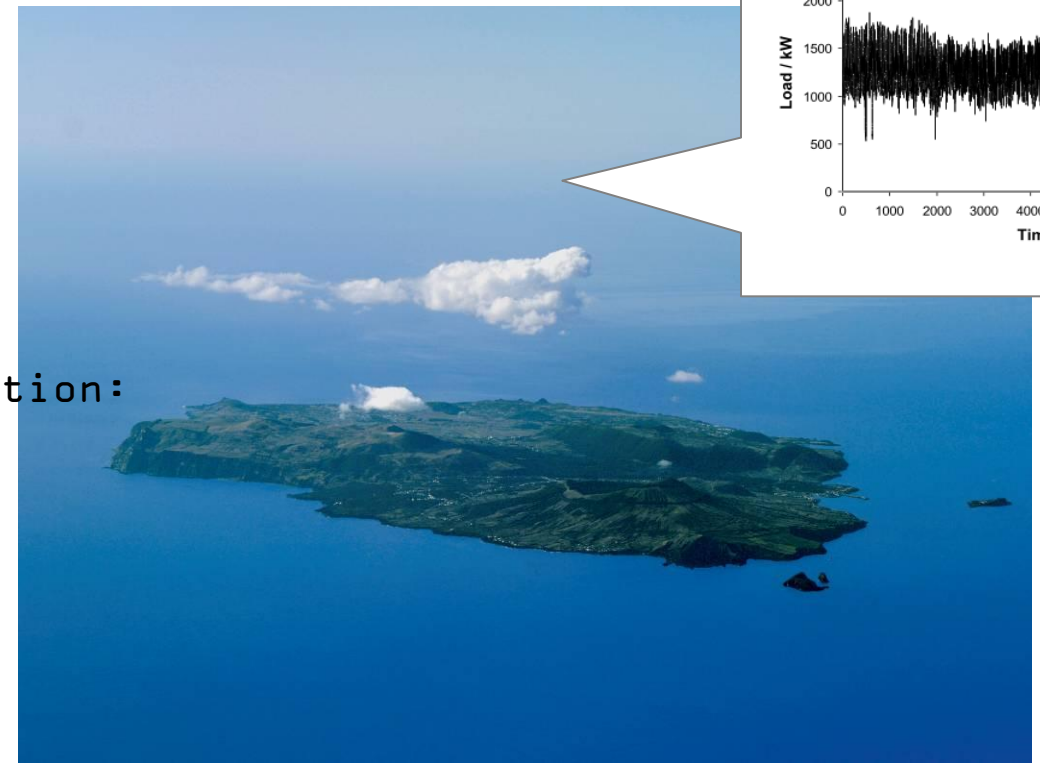
Area: 67 km^2

Peak load: ~ 3 MW

Electricity consumption:
~14 GWh

Energy supply:
Fossil fuels (85%)
Wind power (15%)

Local Utility: EDA



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Graciosa Today's Power System

Power Station 4200 kW

(Fuel consumption ~ 4 Mio. l/a)

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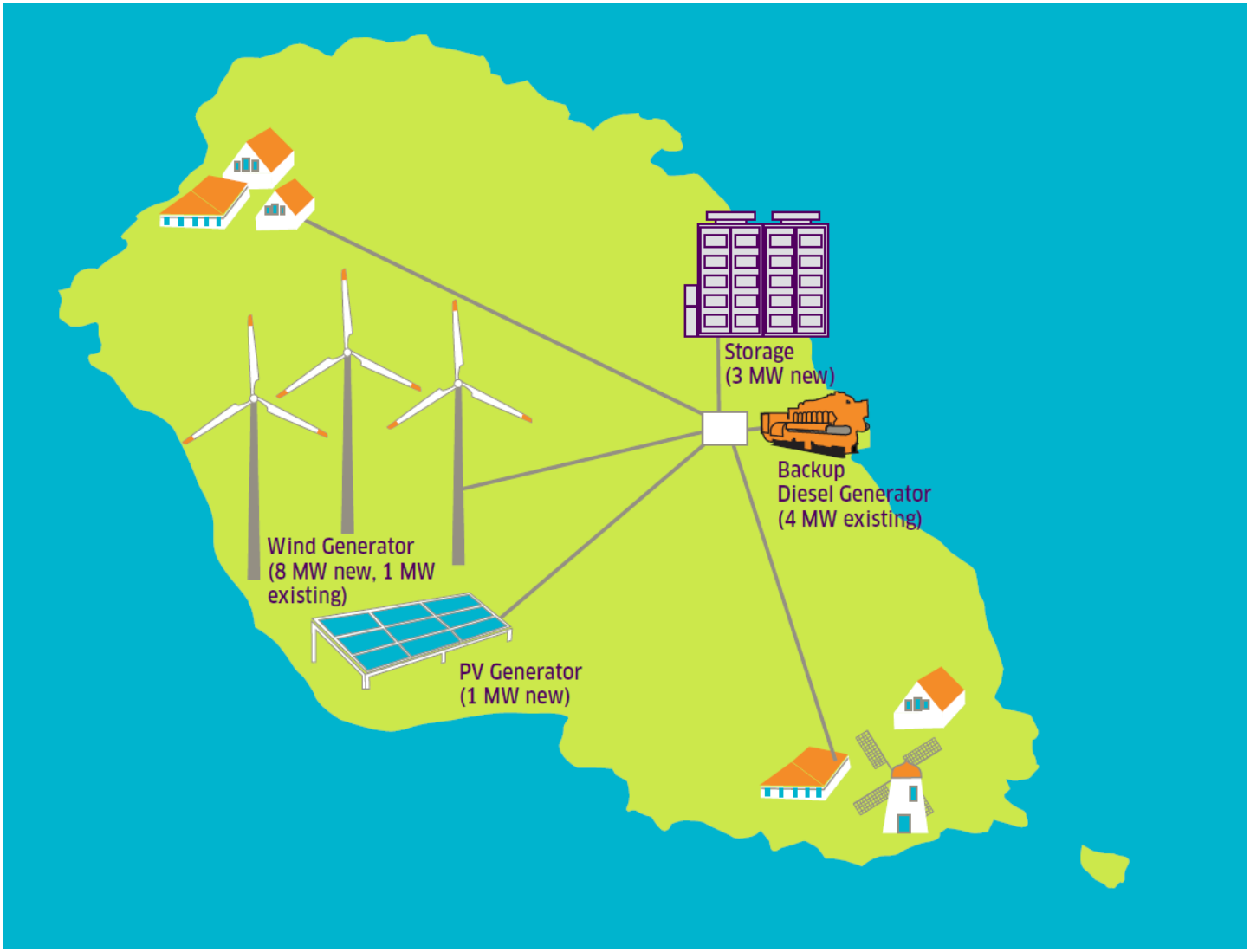
Pilot Project Graciosa: 70-80% Renewables



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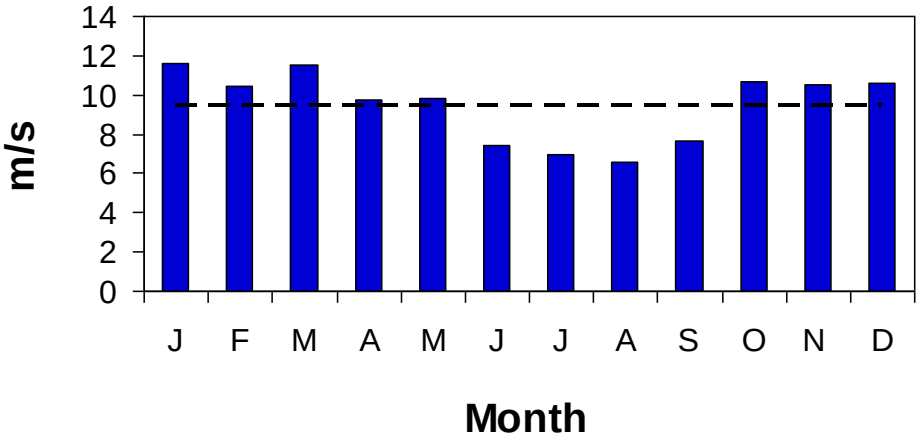
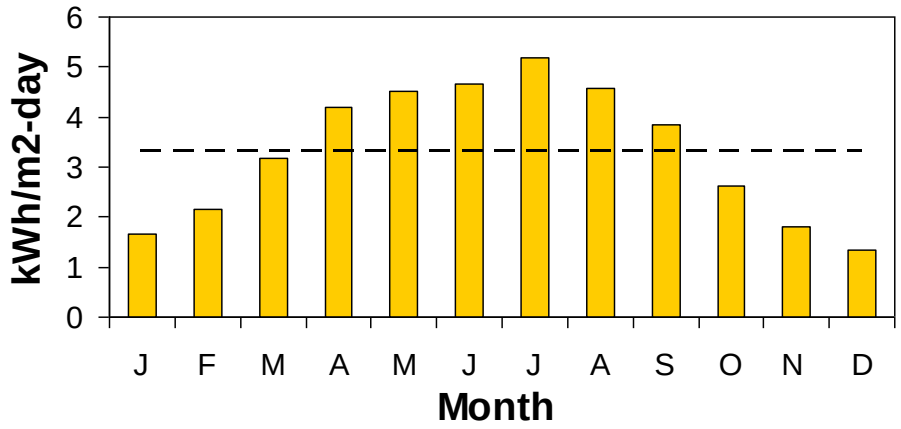
Potential for wind and solar energy



Wind

Wind speed @ 15 m	> 9	m/s
estim. yield	3.0	MWh/kW



Solar radiation

daily average	3.3	kWh/m²d
estim. yield	1.3	MWh/kW

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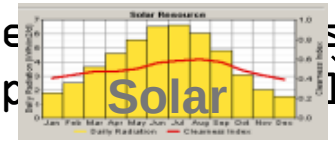
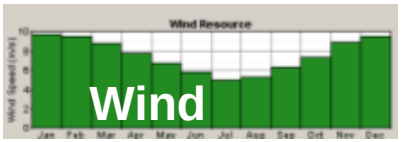
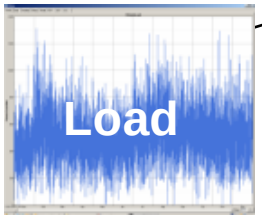
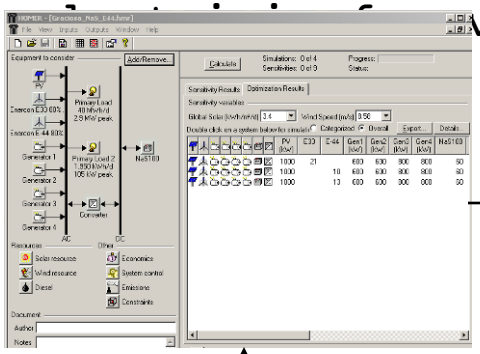
Graciosa Renewable Energy System Layout

- Database: Load, irradiation and wind data from EDA
- Tool: HOMER - a simulation tool from NREL for the design and optimization of renewable energy systems
- Simulation: Hour by hour energy balance for the energy various possible supply system layouts
- Re st of various possible supp layou









- size of wind and PV power plant and battery
- cost of electricity for hybrid system

€ economic data

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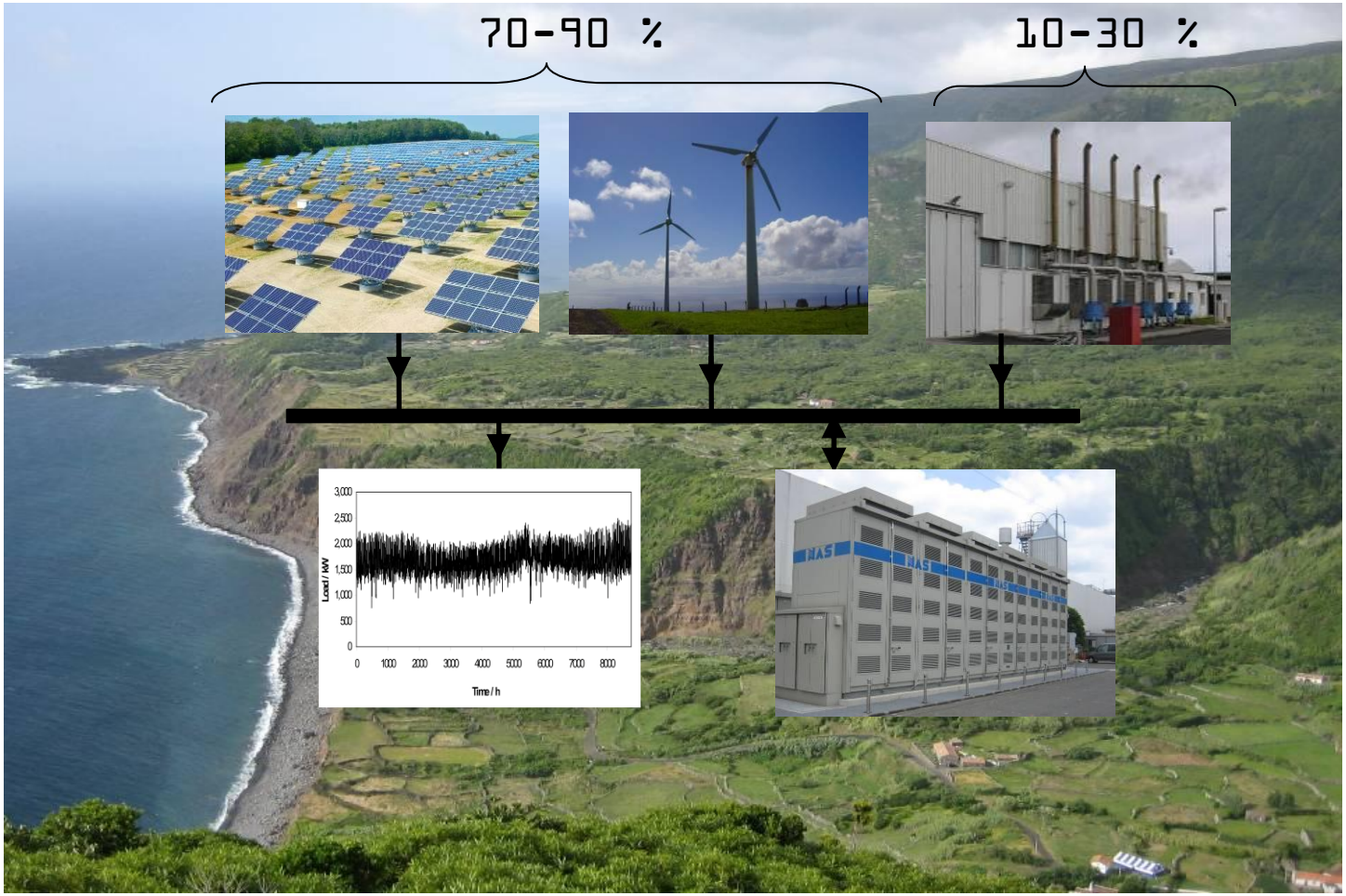
Target Renewable Energy Supply System Layout



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Assumptions - Technical

Target Renewable energy share: **~80%**

Example Configuration

- Wind: 7 MW
- PV (fix tilt): 1 MW
- NaS Battery: 3 MW / 18 MWh

(15 years life expectancy)

- Dieselgenerators: 4,2 MW

(existing Diesel as back-up)

- SCADA System and Project Development

→

Total Investment: ~36 Mio. €

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Assumptions - Economic

- Interest (term loan): 5%
- Equity Ratio: 20%
- Equity IRR: 10%
- Project Life time: 20 years
- Fuel Price (2012) 0.65 €/l
- Fuel price Increase Rate: 7%

(based on the past 20 years, see next slide)

- Administration Cost included
- Maintenance Cost included
- Battery exchanged after 12 years
- Exisiting Stuff trained employed for maintenance of the new equipment

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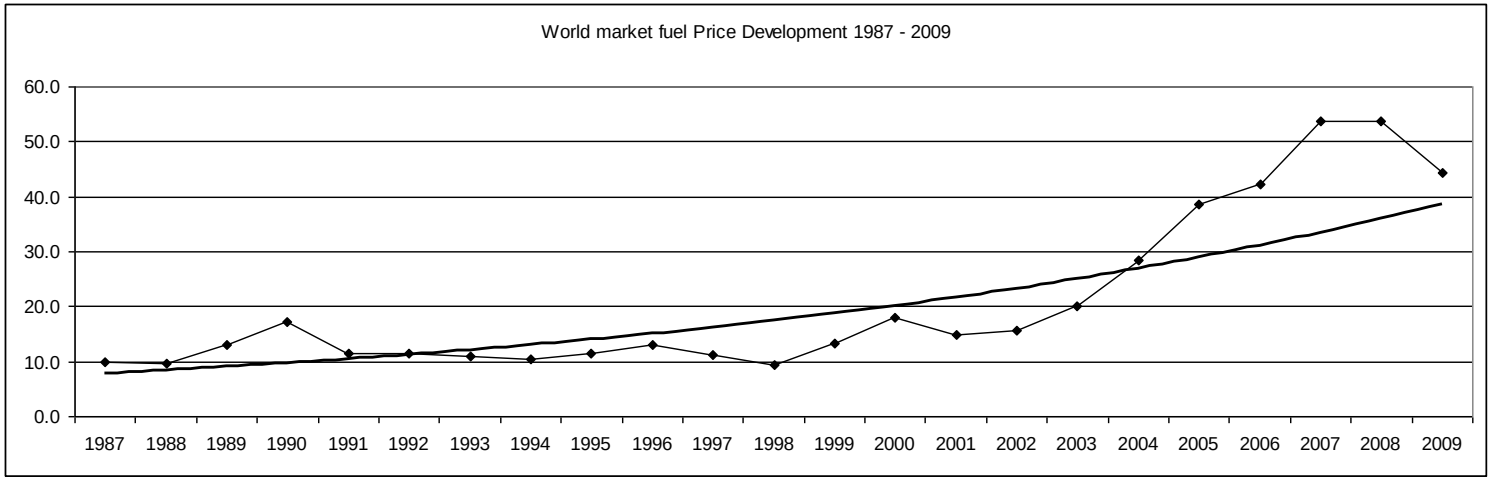
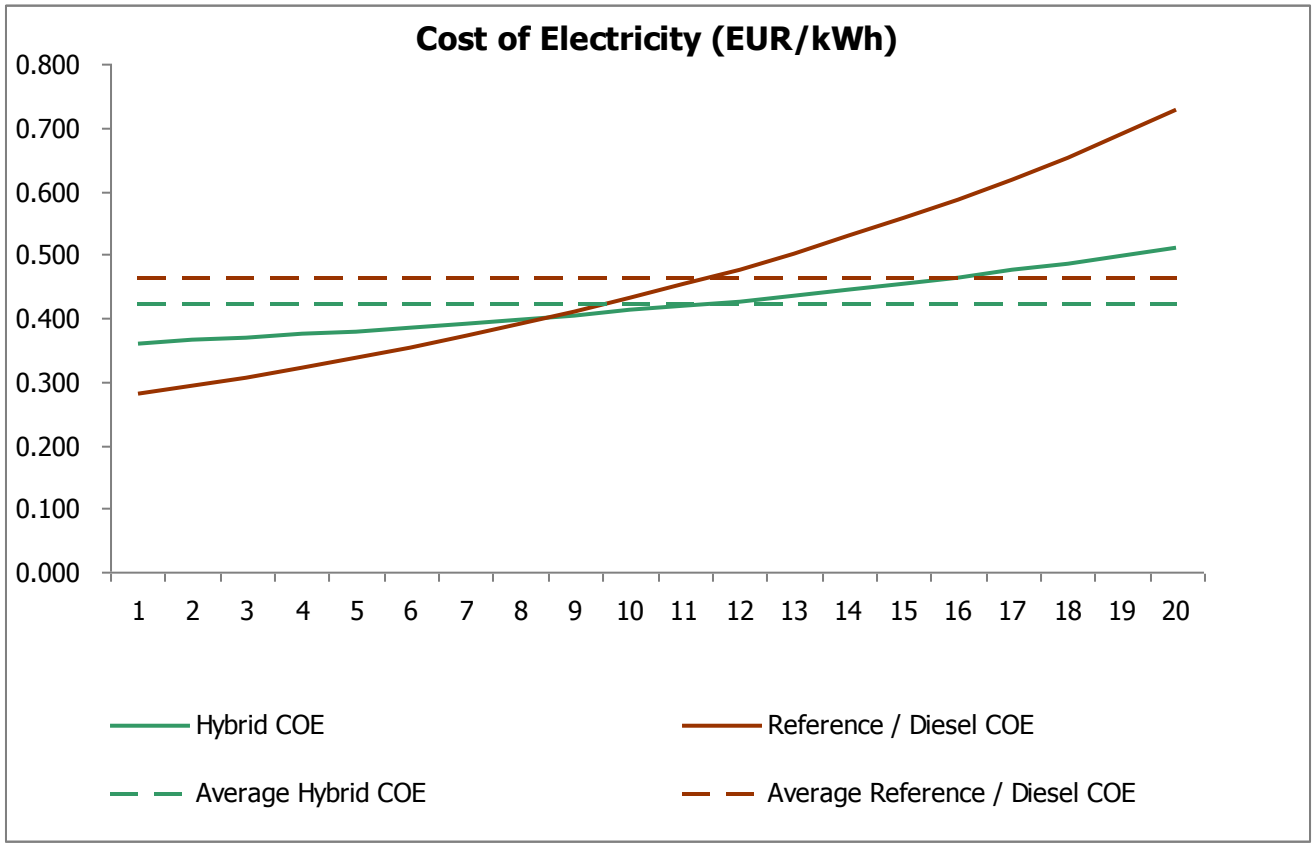
Historic fuel price development

Fuel Price Increase Statistics

		Increase Rate Based on exponential fit		Geometric Mean Anual Fuel Price Increase Rate	
from	to	WORLD	AZORES	WORLD	AZORES
1987	2009	7.5%	-	7.8%	-
1995	2009	13.7%	10.2%	10.1%	7.9%



Cost of Electricity – high price stability



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Challenges to be addressed on the way towards 100% renewable energy

1. Application of reliable large scale storage solutions for the compensation of renewable energies
2. Development of fast inverter control schemes to assure the same stability as provided by conventional rotating generators
3. Assurence of reliable transport of information between the distributed sources
4. Development of disptach and optimization schemes taking into account also the new players in the game (cars, smart load, storage,…)
5. Development of standardized communication interfaces
6. Assure safe grid operation in fault conditions

ISLAND Test Site

To address the technical issues in island projects, Younicos is setting up the ISLAND Test Site to simulate up to 100% renewable energy based grids, using wind, irradiation and load measurements from any location

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Inside View

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2 x 500 kW NaS Battery

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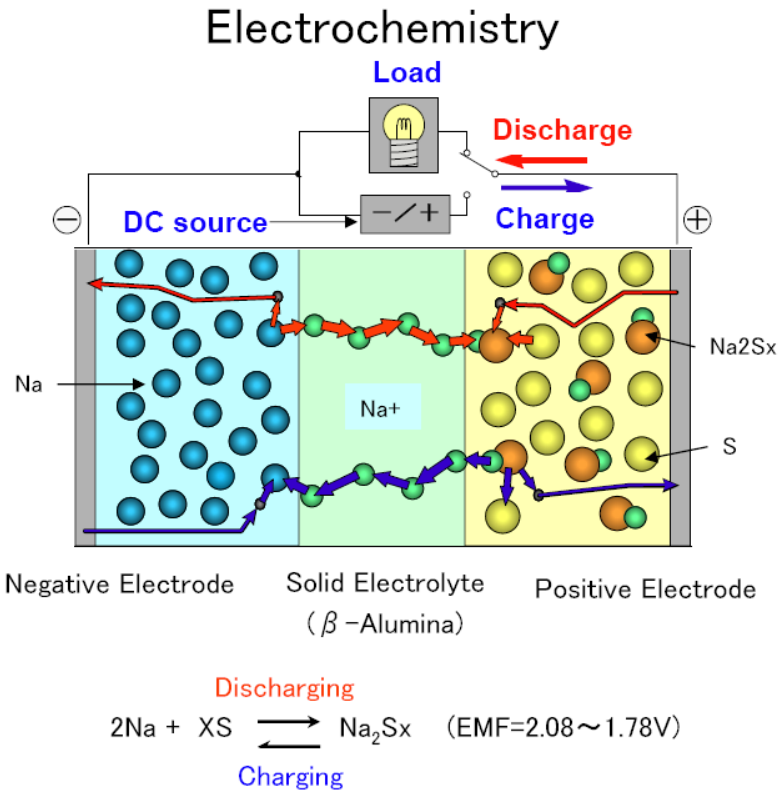
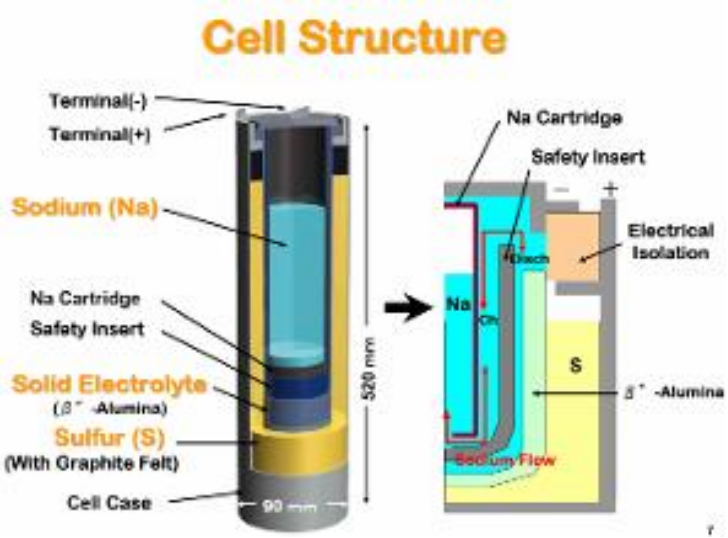
Electrochemistry → Cell





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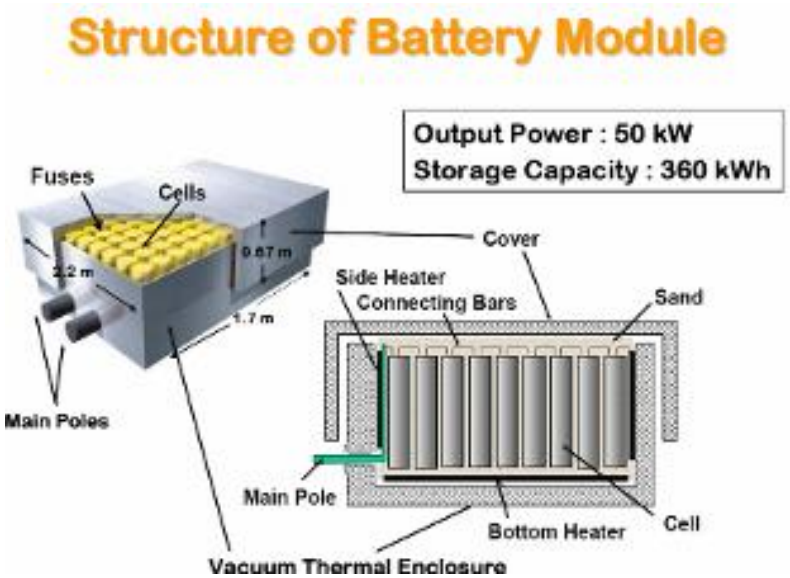
Cell → Module → Battery



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NaS Battery Features

High Energy Density	About 3 x that of Lead-Acid
High Capacity	Up to 6 Hours continuous discharging
Long Expected Life	Up to15 years, 4500 cycles
High Energy Efficiency	85% DC Efficiency
No Self Discharge	
No Memory Effect	
Proven Technology	270 MW installation records
Easy Maintenance	Inspection every 3 years only
Fast Response	2 ms
Operating Temperature	300 °C

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Conventional Market - Reverences

Wasseraufbereitungsanlage

Universität

Umspannstation, USA

Große Fabrikanlage

Vergnügungspark

Umspannstation, Japan

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1 MW Diesel Generator

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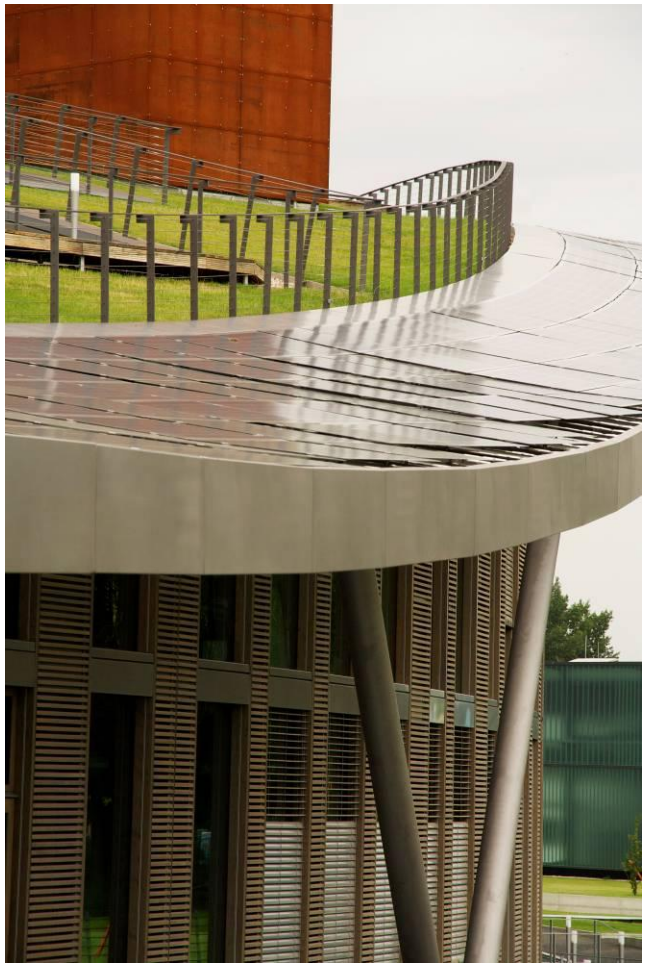
210 kW PV power plant (SOLON SE)



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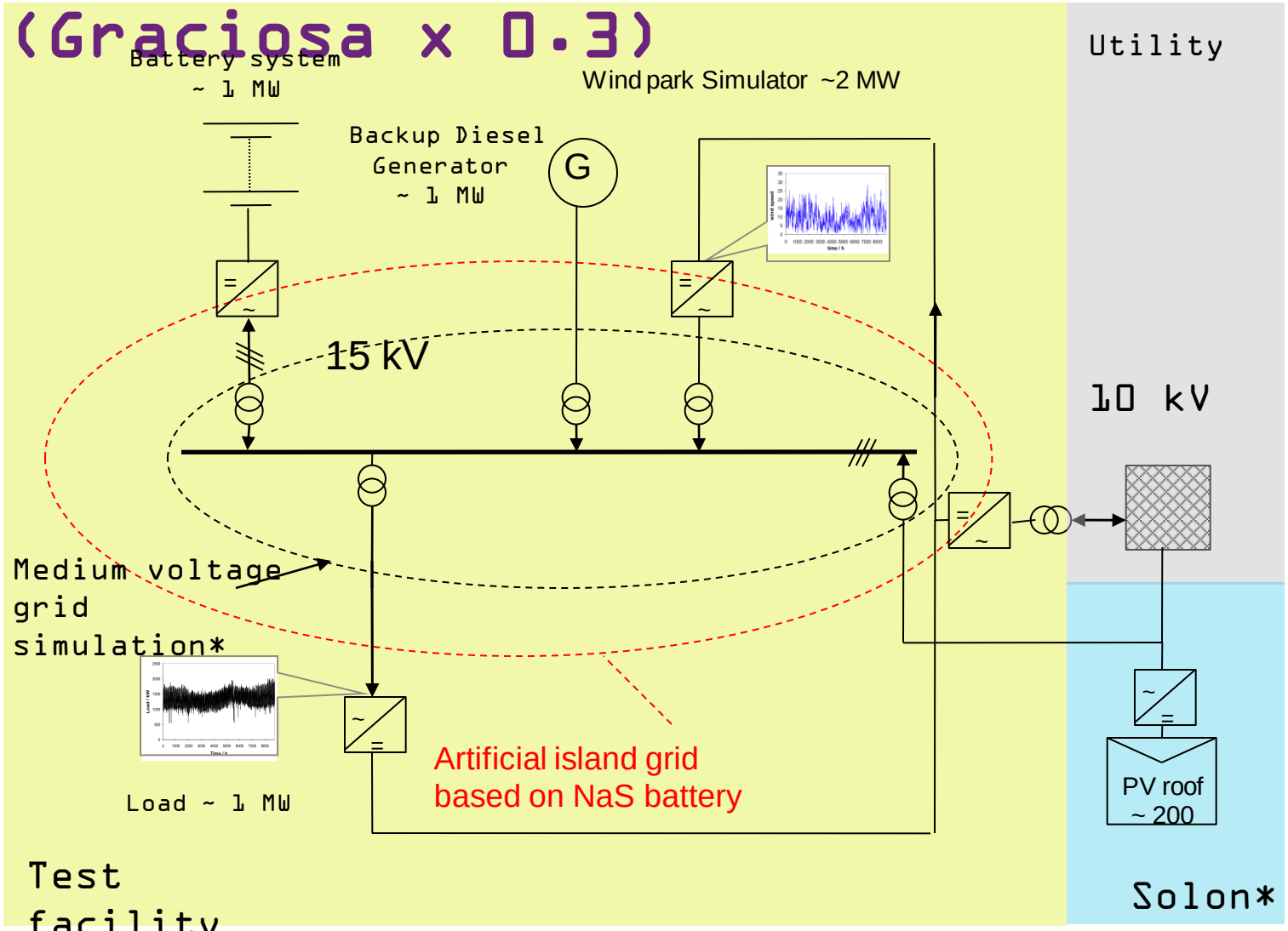
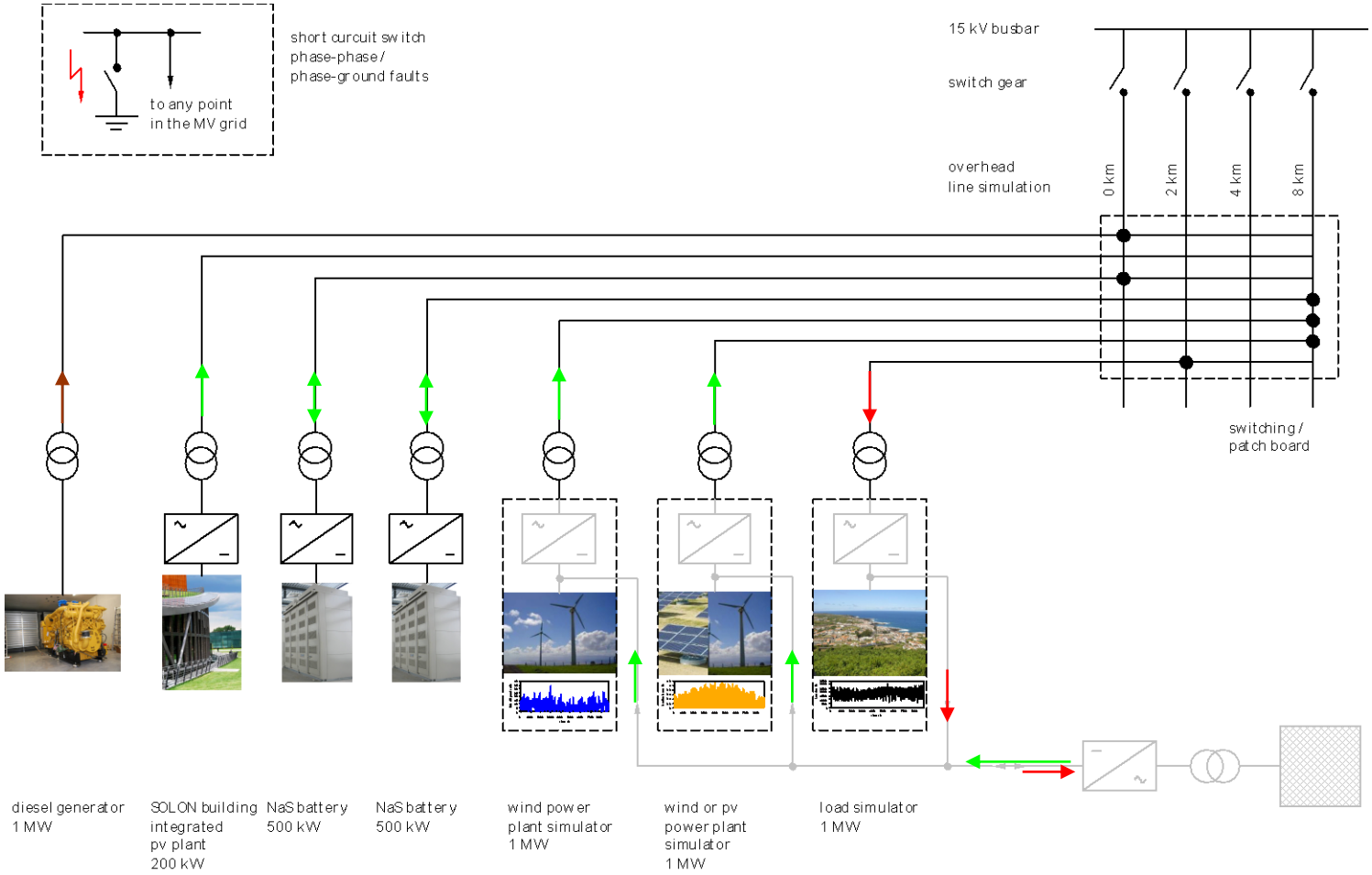
Island Grid Test Site (Graciosa x 0.3)



ISLAND Test Site – for tests of grid stability and security of supply



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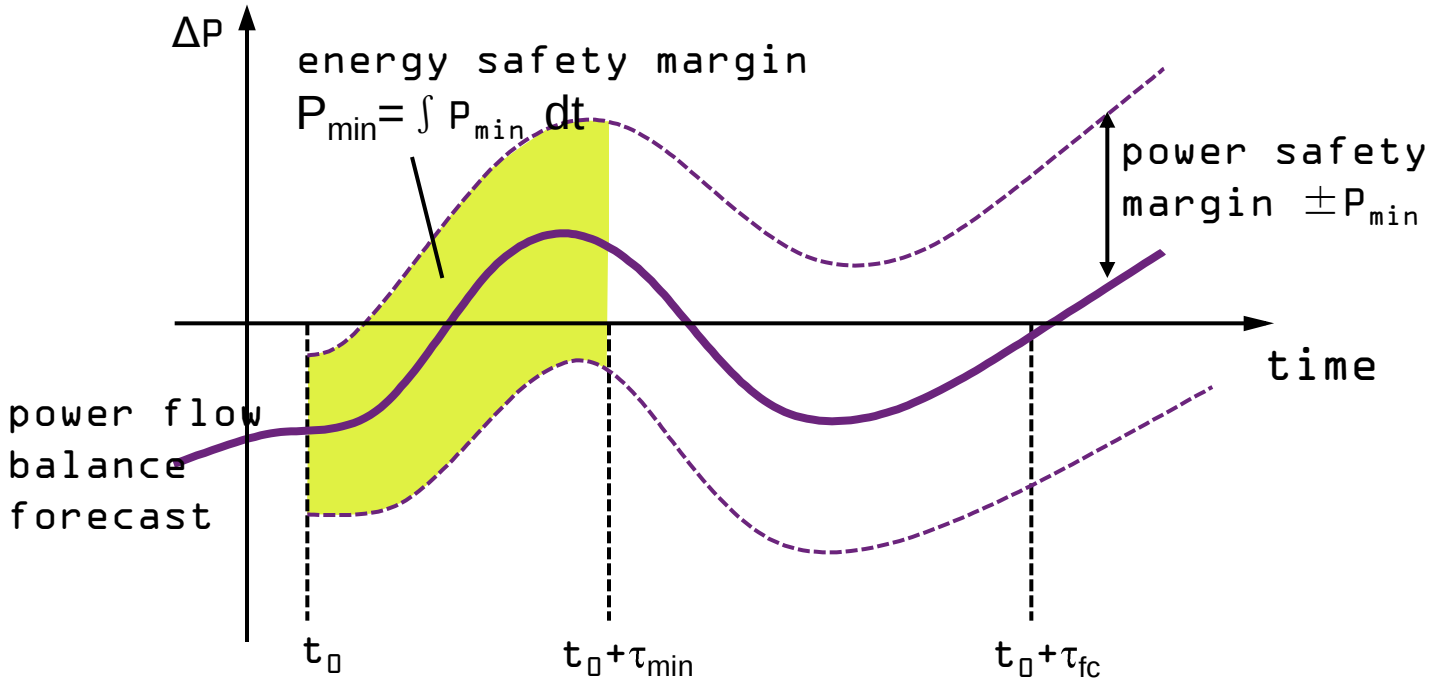
Prediction based Energy Management



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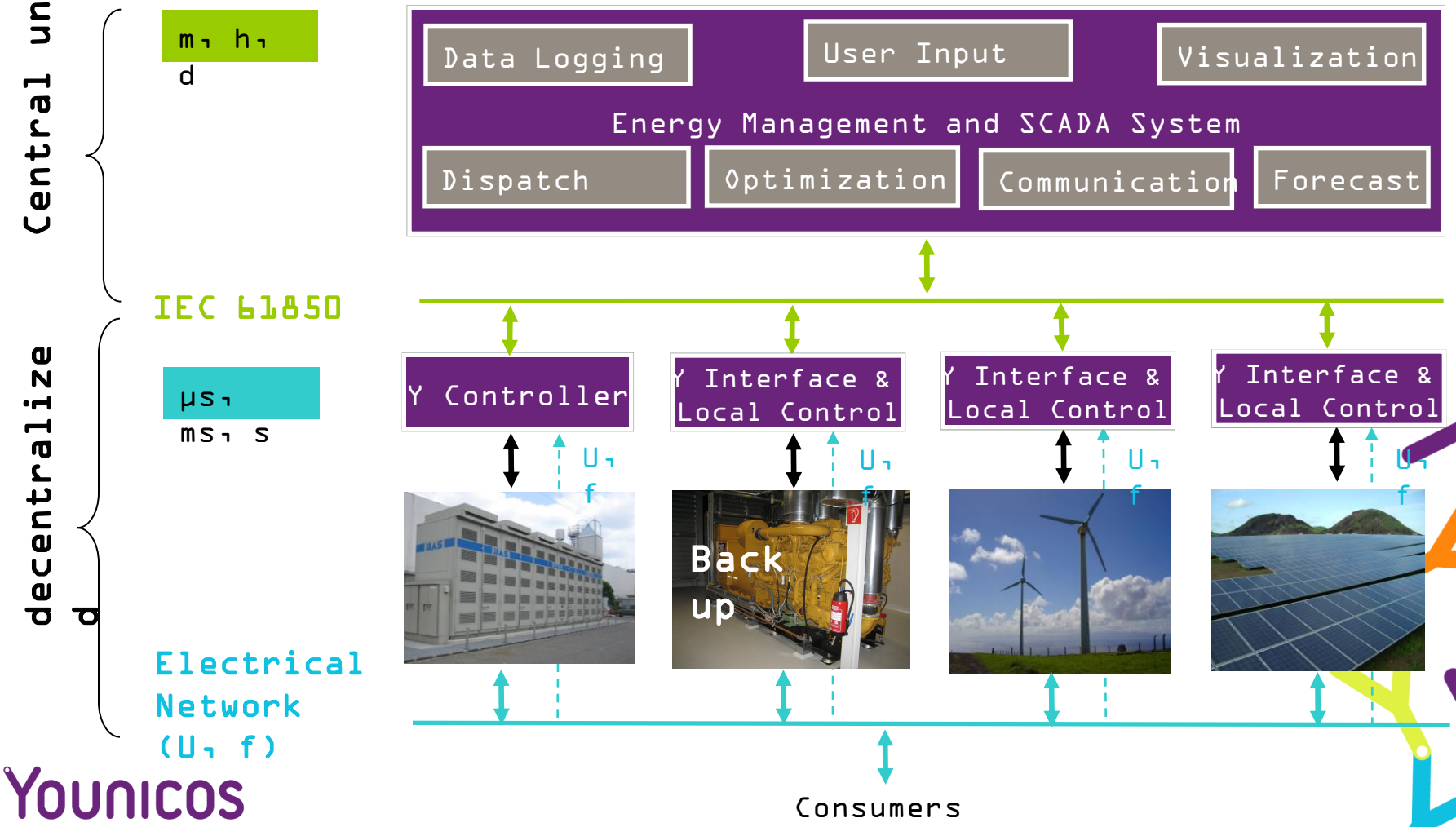
Younicos System Control and Energy Management System



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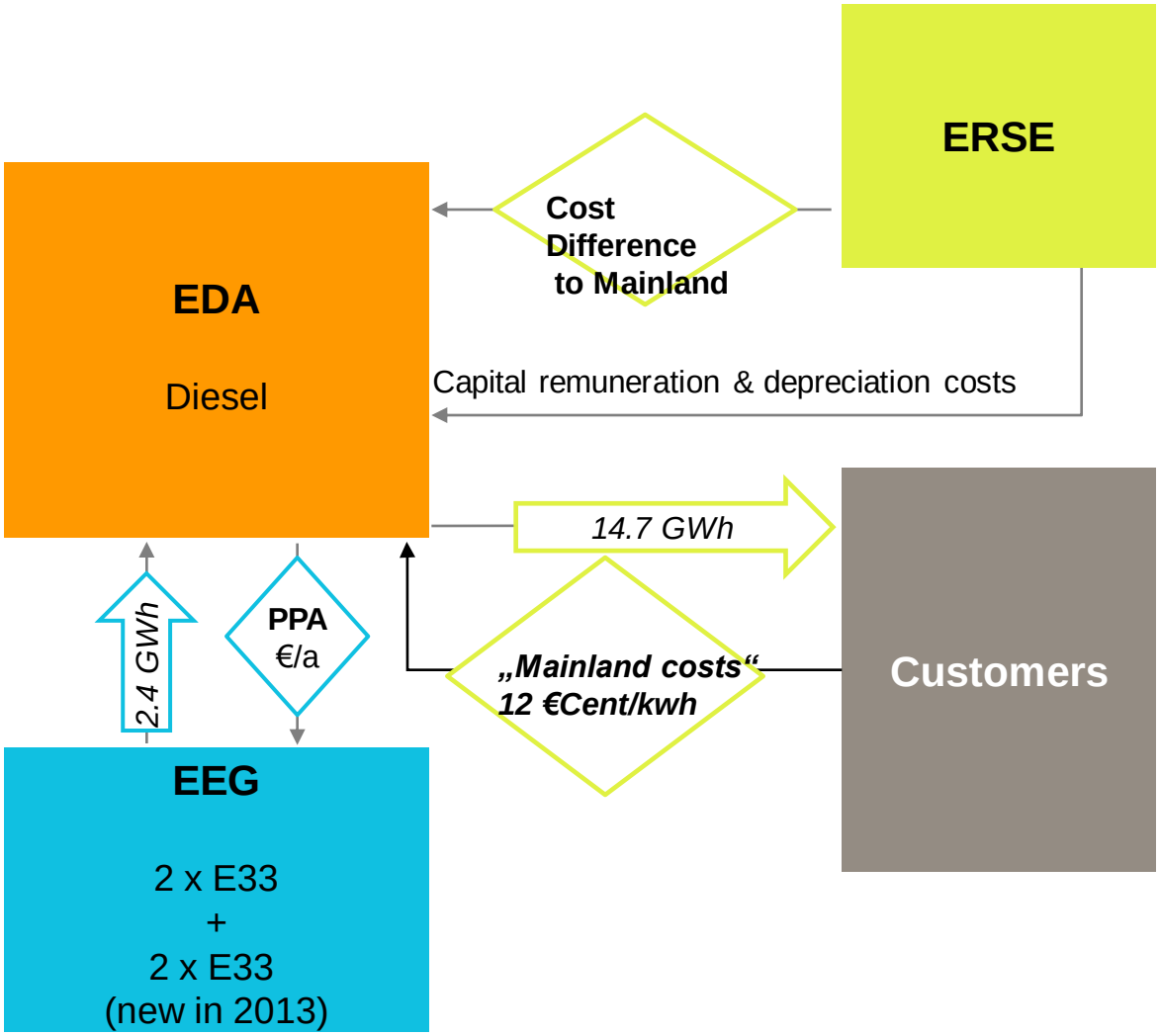
Aktuelles Layout der Energieversorgung



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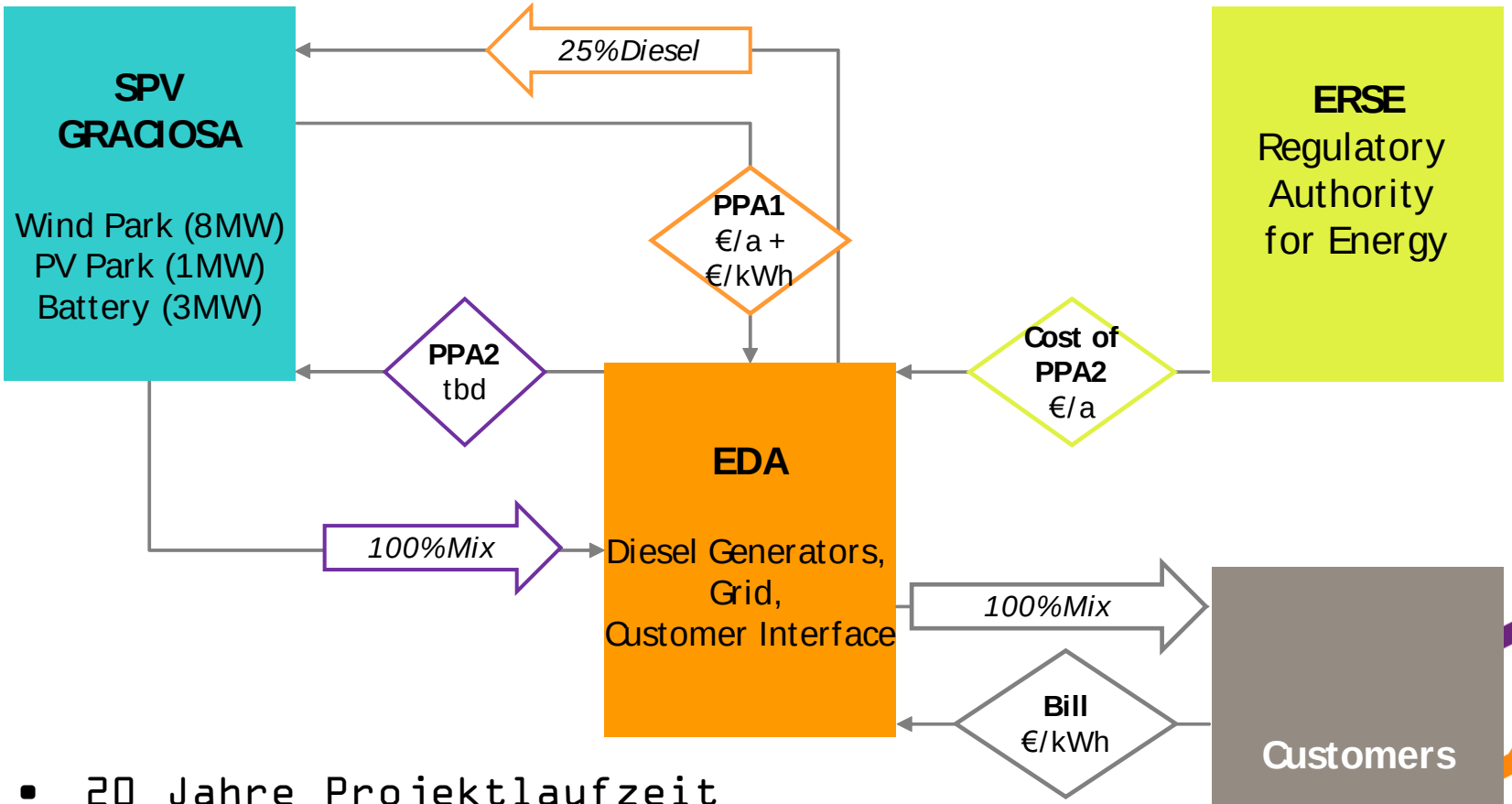
Indikative Projektstruktur



- 20 Jahre Projektlaufzeit
- Projektbeginn (Stromproduktion) in 2013
- Eigenständige Projektgesellschaft

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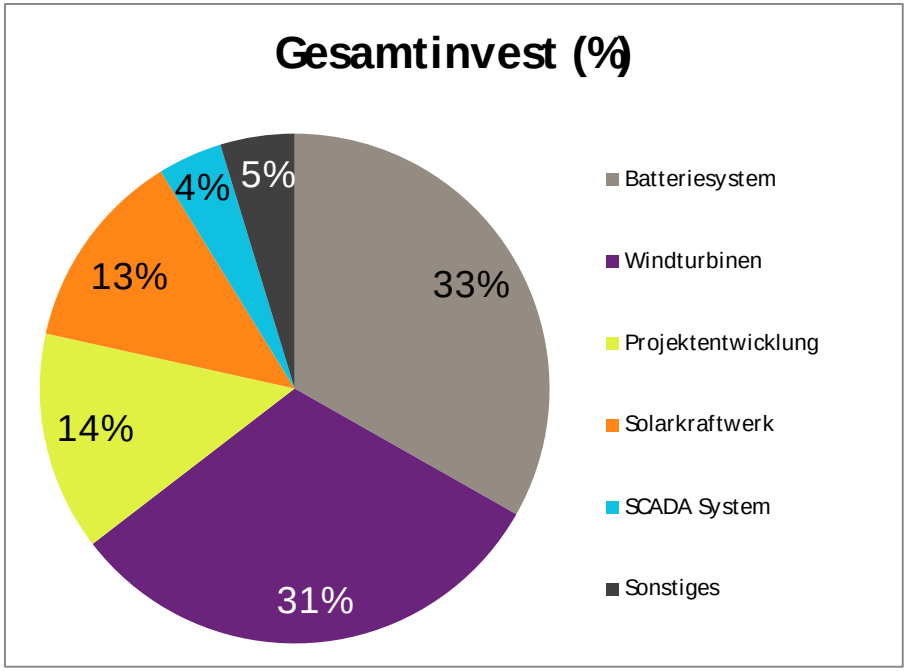
Investitionsbedarf

- Gesamtinvestment: 31,85 Mio. €
- Erweiterungsinvestition nach 5 Jahren Laufzeit: 4,2 Mio. €*
- Sonstige Investitionen (Reserve Accounts)



*bei Annahme stabiler Preise für ein weiteres MW NaS Batterien, um 20 Jahre Betriebslaufzeit des Gesamtsystems zu gewährleisten

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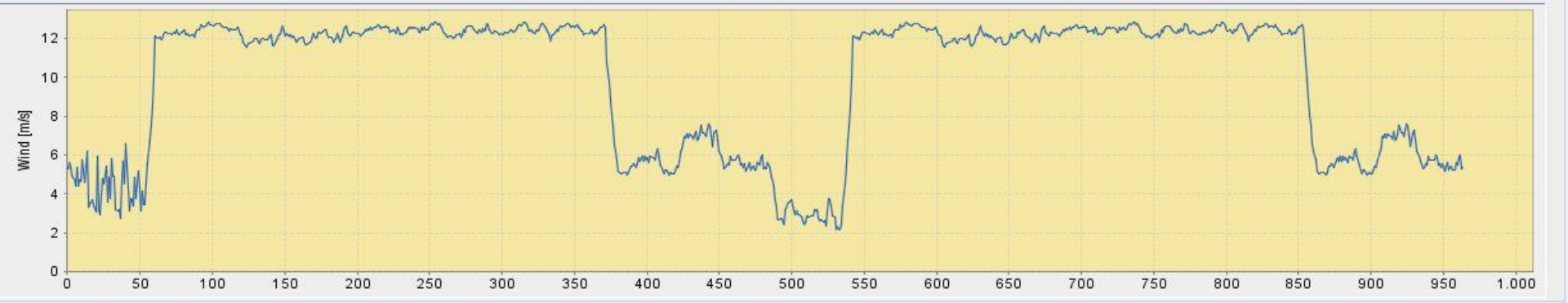
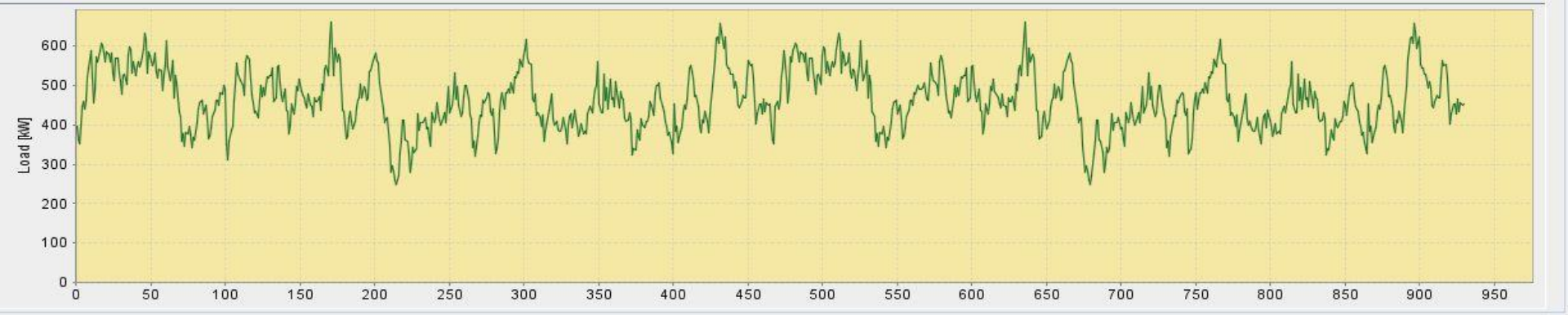
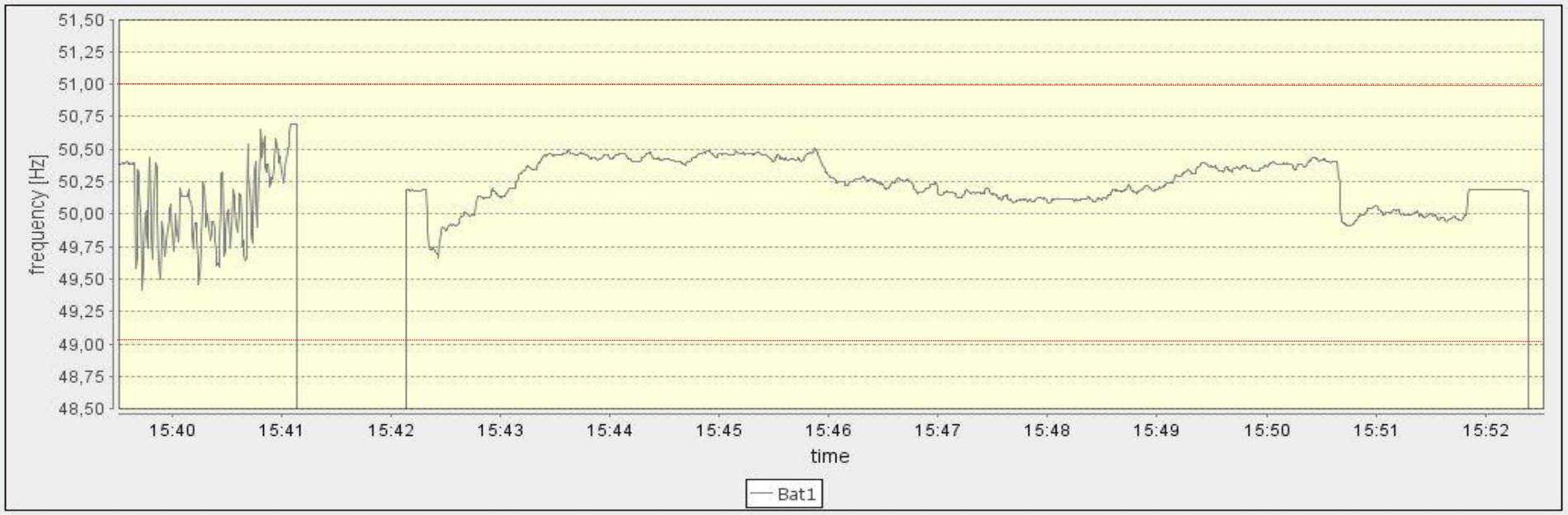
Profiles used for the Demonstration (1s resolution)

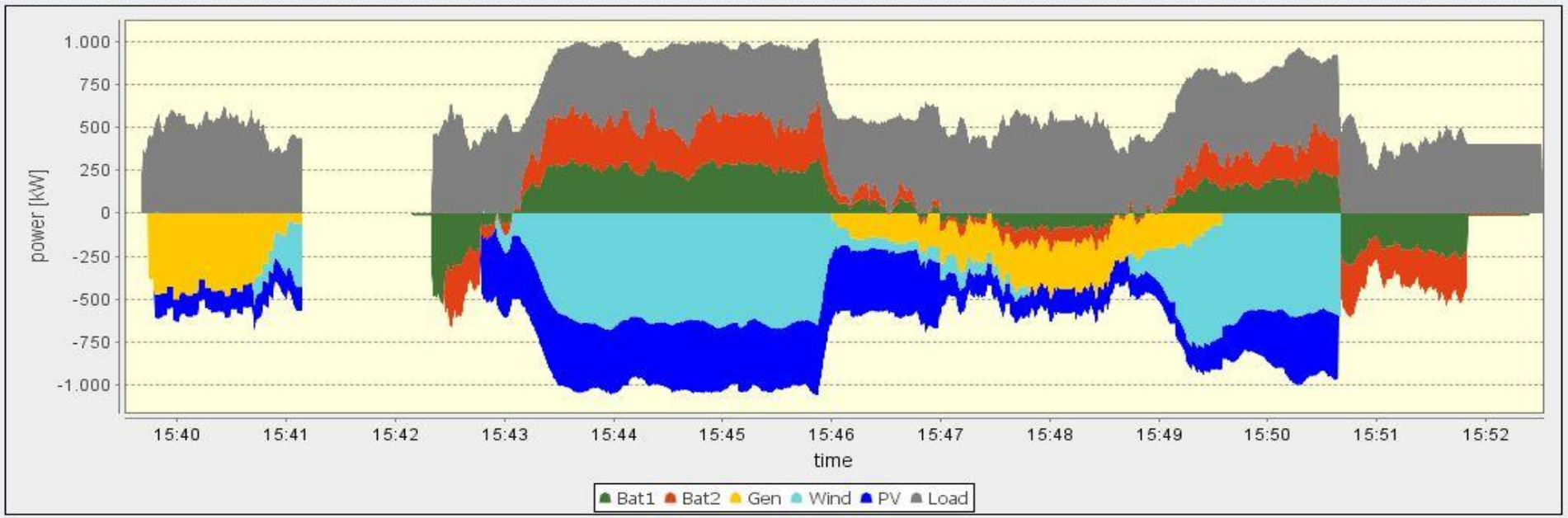




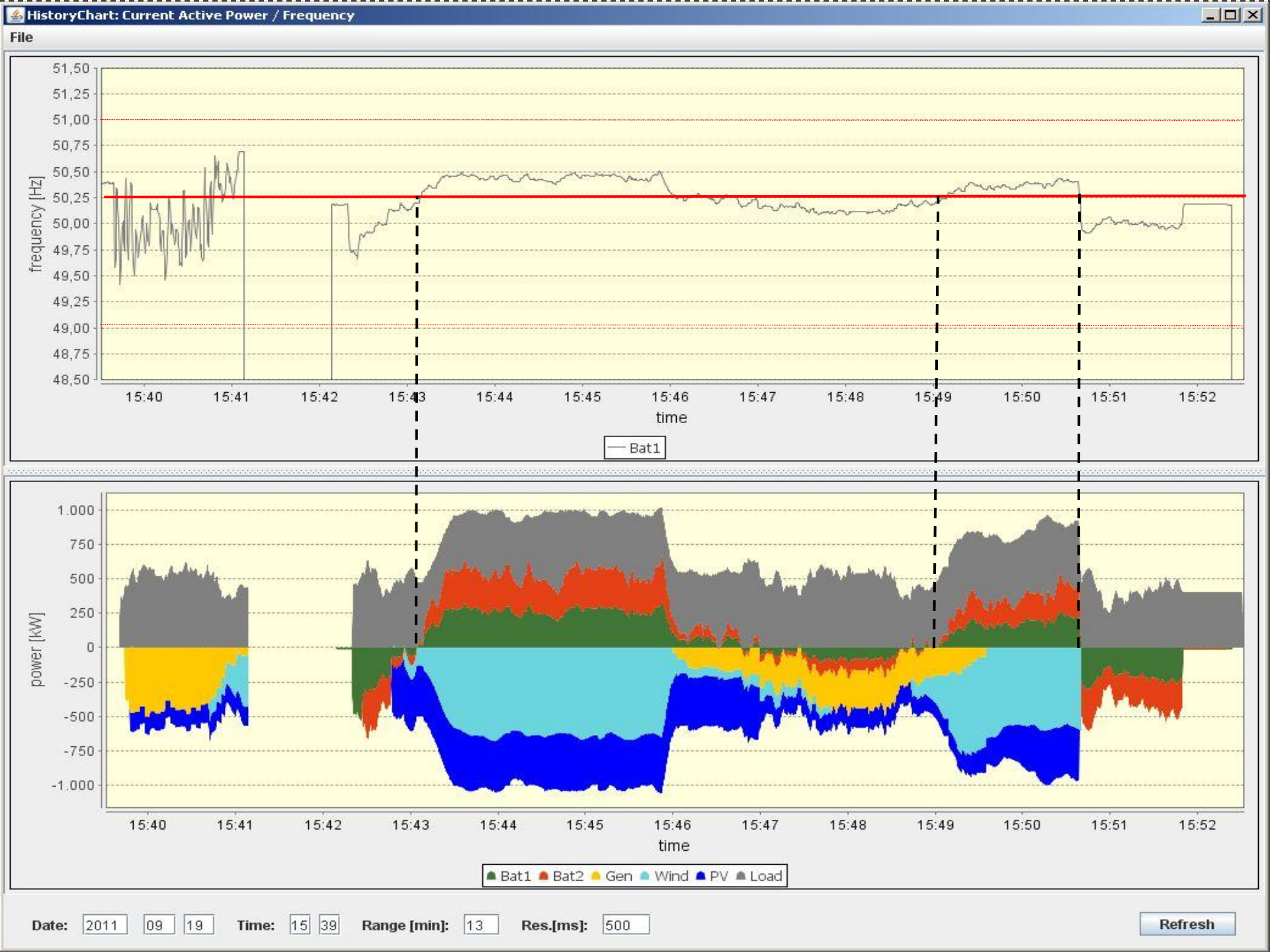
HistoryChart: Current Active Power / Frequency

File

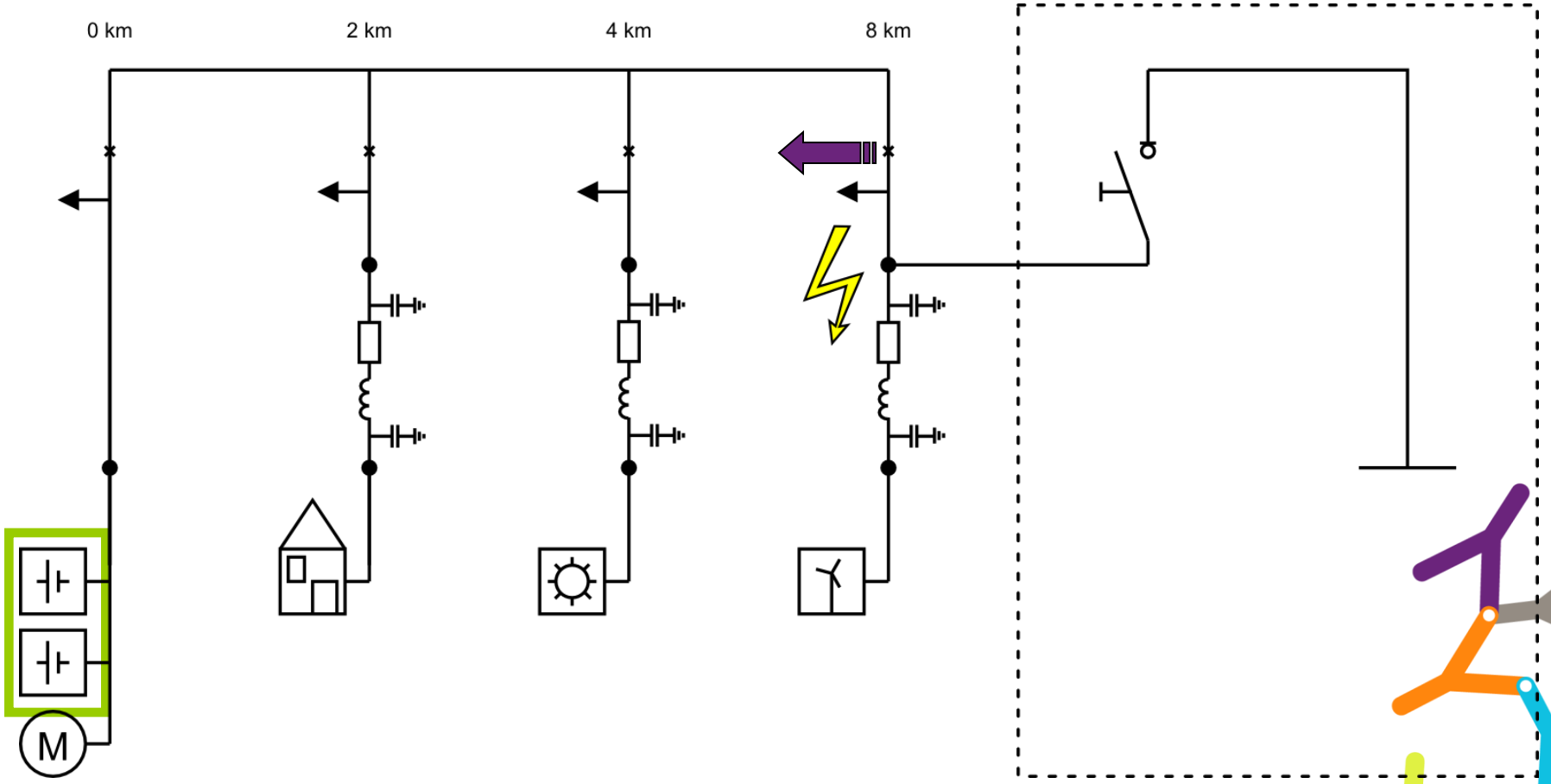




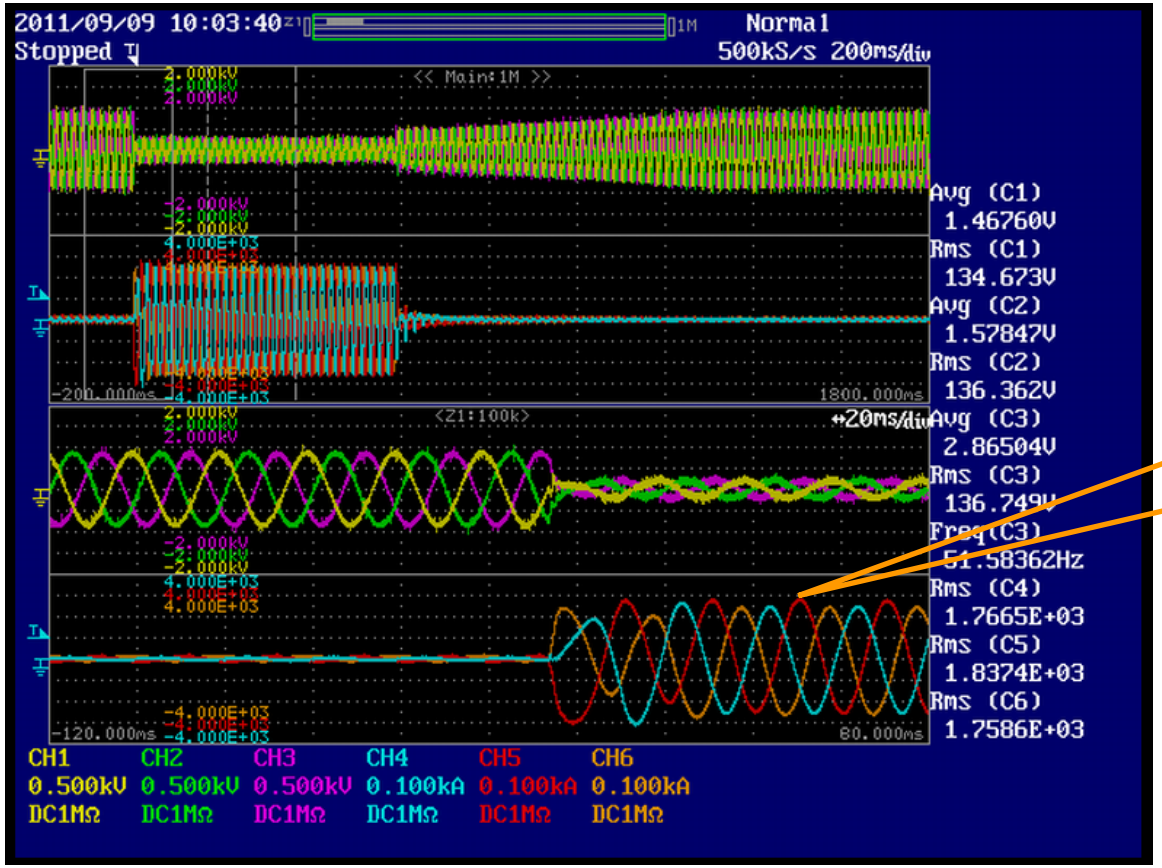
Date: 2011 09 19 Time: 15 39 Range [min]: 13 Res.[ms]: 500 Refresh


HistoryChart: Current Active Power / Frequency
File
frequency [Hz]
51,50
51,25
51,00
50,75
50,50
50,25
50,00
49,75
49,50
49,25
49,00
48,75
48,50
15:40
15:41
15:42
15:43
15:44
15:45
15:46
15:47
15:48
15:49
15:50
15:51
15:52
time
Bat1
power [kW]
1.000
750
500
250
0
-250
-500
-750
-1.000
time
Bat1 Bat2 Gen Wind PV Load
Date: 2011 09 19
Time: 15 39
Range [min]: 13
Res.[ms]: 500
Refresh

Short Circuit at substation



With proper Dimensioning of the Inverters and fast Control, the Batteries are capable of Supplying Enough Short Circuit Power to Substitute the Convenional Generators



3.5 x nominal current

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2010 - LOI with EDA (October 20th 2010)

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Obrigado!