



## Storage Solutions for Renewable Energies integrations in islands

IRENA 10<sup>th</sup> March 2015 – AKUO ENERGY



## Akuo Energy Group

- Who we are
- A worldwide RnW player
- Island Strategy

### 1. Hybride PV+Diesel: the benefit of storage device

- 100% diesel user Islands analysis
- Comparaison of PV+ Diesel VS PV+Storage+Diesel

### 2. Feedback of the French call for tender - 29 MWh

- Technical specifications & experience
- The importance of the performance
- World Tendence in storage applications



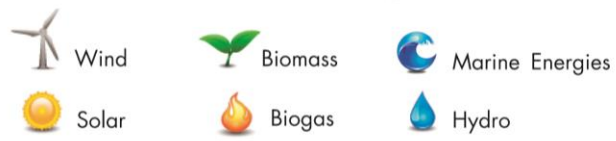
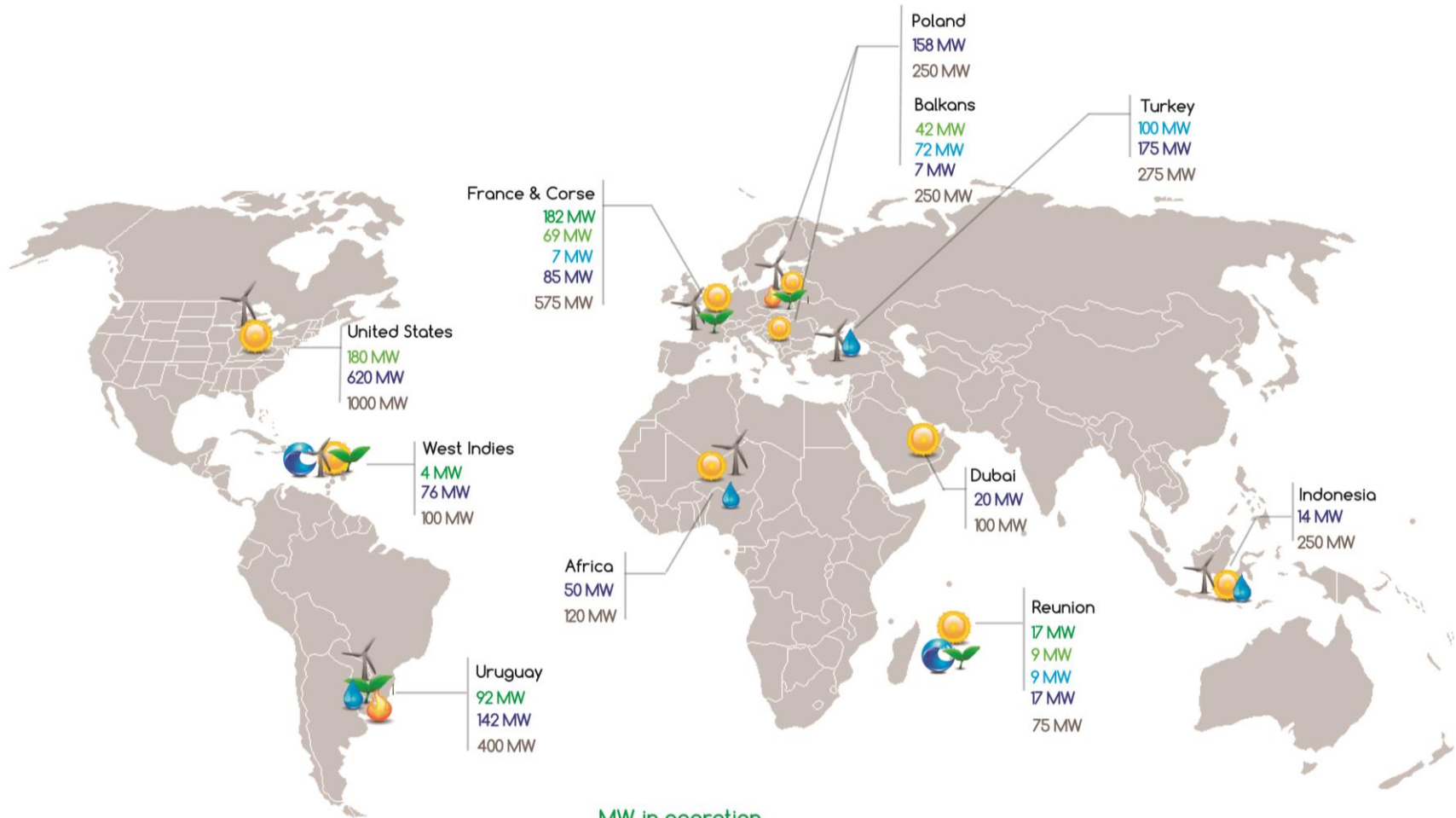
# Akuo Energy, Entrepreneur by Nature



- **Independent Power Producer (IPP - Paris based)**
  - ⦿ 527 MW in operation and under construction
  - ⦿ More than 1,300 MW under development
  - ⦿ 80% owned by its cofounders
  
- **Multi Renewable Energy Pure Player**
  - ⦿ Wind, solar, biomass, biogas, hydro and marine energies
  
- **Integrated Player**
  - ⦿ Development, finance, construction, operation
  - ⦿ 180 employees
  
- **Clear Strategy**
  - ⦿ Long-Term Vision: Keeping the Control of our Assets
  - ⦿ Fast Growth
  - ⦿ Geographic and Technological Diversification



# A Worldwide Renewable Energy Producer



MW in operation  
 MW under construction  
 MW financing underway  
 MW under development  
 MW objectives

A portfolio of more than 1,300 MW secured projects under development - as of end-2013



# Islands Strategy: the Proof of Concept

## ISLANDS: INNOVATING IN REAL-WORLD CONDITIONS

Given their specific constraints, islands provide the best terrain to run and validate new experiments which will be developed at large scales on continents.

### Agrinergie®



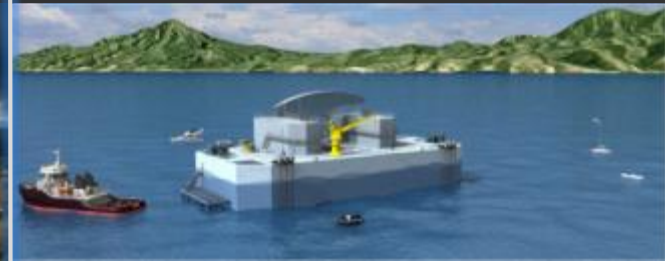
- ▶ Combination of agriculture and solar operation on the same site
- ▶ Turns decreasing agricultural activities into profitable farming
- ▶ Creates new opportunities of development and better integration for community
- ▶ Proof of concept: excellent harvests, hurrican proof

### Solar + storage



- ▶ 29 MWc of PV projects awarded by the French Energy Regulation Agency (2012 call for tenders)
- ▶ Bardzour (9 MWc) and Olmo 1 (4 MWc) are online: perfect match of the real production profile with the simulated ones

### OTEC



- ▶ A disruptive technology that is already highly developed
- ▶ An abundant resource, stable and predictable, a base load energy
- ▶ July 2014: NEMO, Martinique (Fr), 11 MW, is awarded a EUR 72m subsidy within the NER 300 program

Akuo Energy, the leading player on islands



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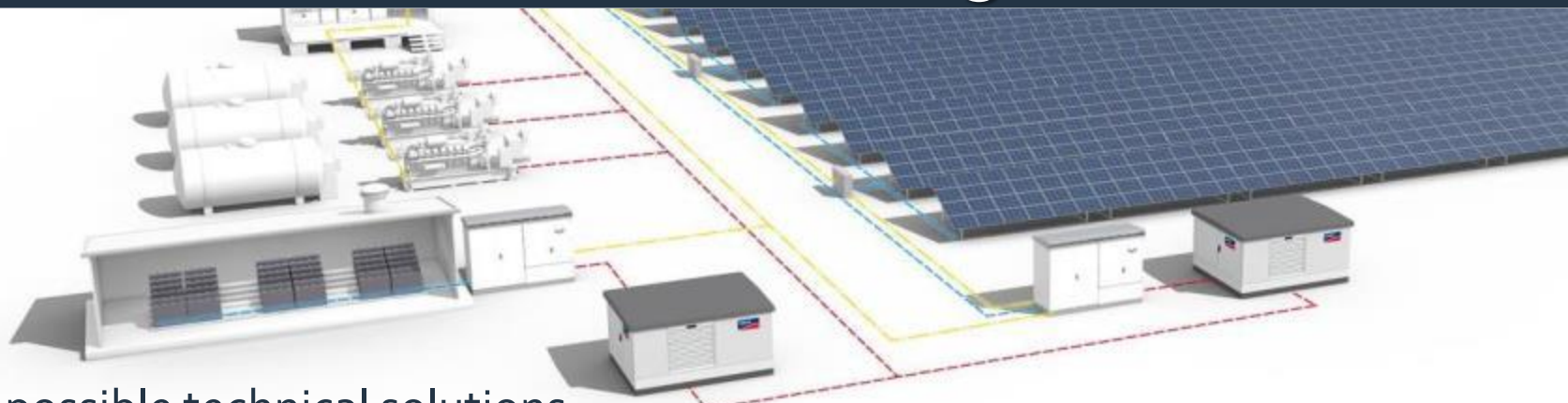


# 1. PV+Diesel: The Benefit of Storage

- > 100% diesel user islands analysis
  - ⌘ Island size and population density
  - ⌘ Latitude
  - ⌘ Climate and microclimates (seasonality, relief)
  - ⌘ Resources available (wind, irradiation, waterfalls, biomass)
  - ⌘ Consumption profile (hourly, daily, monthly, annually)
  - ⌘ Agriculture (land, local acceptance, importation issue)
  - ⌘ Need of Independency (Interconnection to a territory, facility of access to the island)
  - ⌘ Electrical network (Size, capacity, power, voltage, frequency) between 500 kW and 10 MW
  - ⌘ Government will and political stability (feed in tariffs...)



# 1. PV+Diesel: The Benefit of Storage



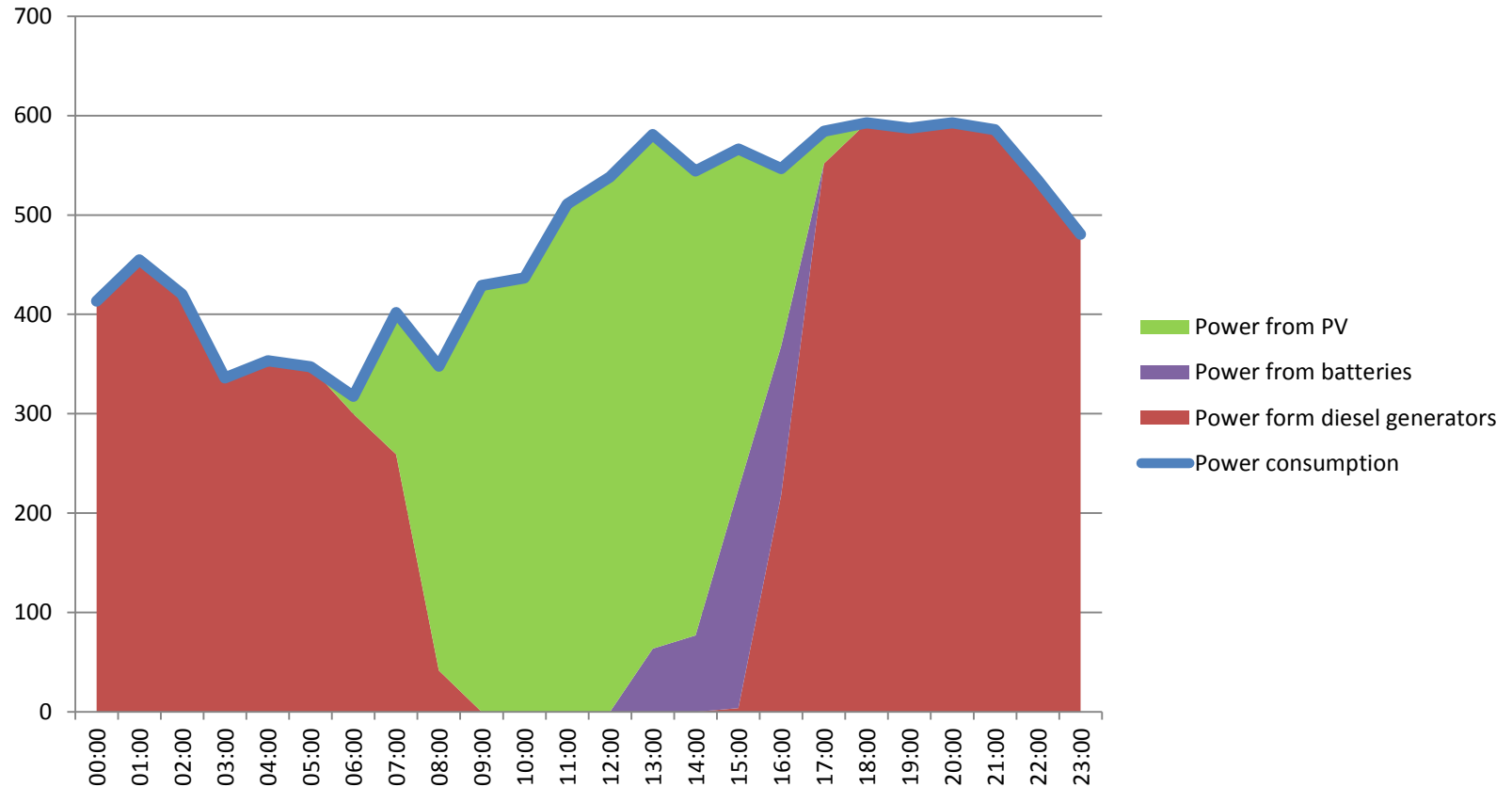
- Two possible technical solutions
  - ◆ PV plant without batteries
  - ◆ PV plant with Li-Ion batteries
- PV integration is limited without batteries
  - ◆ Based on manufacturers of hybrid PV/diesel systems, PV integration rate should be limited to 60% for optimal operation of both PV and diesel generators
    - Technical limitation based on minimum load on the diesel generator
      - Diesel generators need to run at all time in case of decrease of PV generation (clouds...)
      - Minimum recommended load on diesel generators of 30-40%
  - ◆ With the addition of a storage system (batteries), this technical limitations does not apply anymore
    - Increased PV installed capacity
    - On most days, diesel generators can be switched off during part of the day time. Batteries would be able to supply enough energy the time to switch on the genset when needed
    - More fuel savings, lower carbon emissions





# 1. PV+Diesel: The Benefit of Storage

➤ Exemple: a resort energy needs



*Decomposed power production meeting consumption needs*

*\*based on informations available in the Energy Report from Team Sustain, April 2013*



# 1. PV+Diesel: The Benefit of Storage

- Comparison between the 2 options
- 800 kWp without batteries VS 1 MWp with batteries

	800 kWp, no batteries	1 MWp, 500 kWh batteries
AC Power	700 kW	900 kW
Penetration rate	60%	78 %
Energy produced per year	1200 MWh	1600 MWh
Fuel savings	343 000 l/year	445 000 l/year

The second solution improve fuel savings (+30%)

➤ Still economic comparison to do: depending on fuel price



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## 2. Feedback of the French call for tender

- Increasing renewable energy in french islands at competitive price
  - Intermittent energies penetration in island

Puissance installée en éolien et photovoltaïque	Corse	Guadeloupe	Martinique	Réunion	Guyane
Insallations éoliennes à fin 2013	18	26	1	15	0
Installations PV à fin 2013	90	67	63	155	34
Somme des installations éoliennes et PV à fin 2013	108	93	64	170	34
Production avec un coefficient de 0.6	64,8	55,8	38,4	102	20,4
Puissance minimale appelée à midi sur le réseau (dimanche et jours fériés)	165	160	150	263	82
Estimation du taux maximum de pénétration des ENR	39%	35%	26%	39%	25%

### *Penetration rate of Solar + Wind energies in french Islands – End 2013*

- Already high penetration of intermittent energies in French island >30%
- Storage is a solution to increase the penetration rate of intermittent energies into the grid

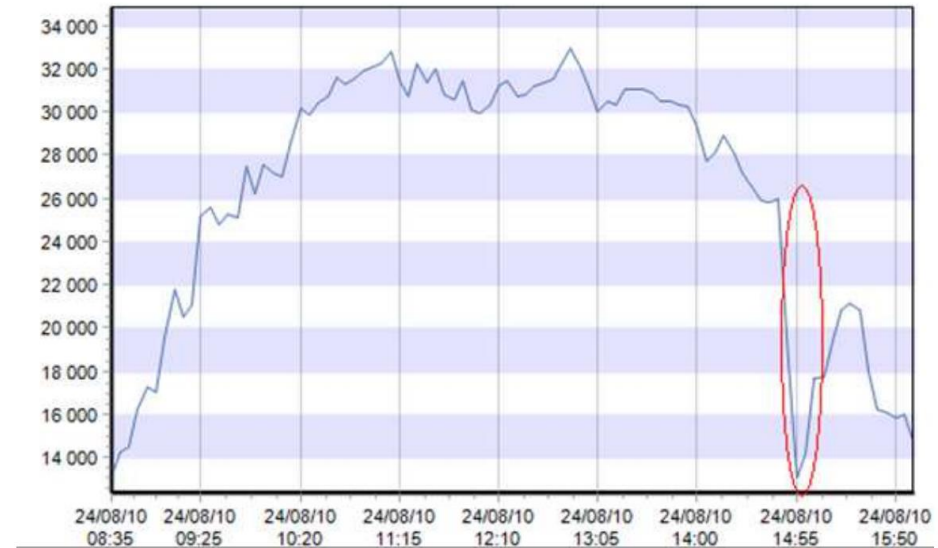
Source: EDF SEI : Estimation-taux-ENR-intermittentes\_fin-2013.pdf



## 2. Feedback of the French call for tender

### ➤ Increasing renewable energy in french islands at competitive price

- As an illustration, La Reunion island has already registered 60% photovoltaic production decrease in 15mn, Mayotte 70% in 10mn.
- Thus, intermittent renewable energies absolutely have to contribute to the system stability by supporting the grid in order to increase their penetration rate.



*With quicker occurrences, the solar generation in Reunion island has already fallen from 26MW to 12MW in a second.*

- Storage is one of the solutions:
  - It allows to build up a primary reserve to limit the dips of frequency, the grid's disruption, to curtail the consumption peaks, to smooth production peaks and to stabilize current quality.
  - It is therefore a management mode at the origin of intermittency and gives the possibility of increasing the integration threshold.



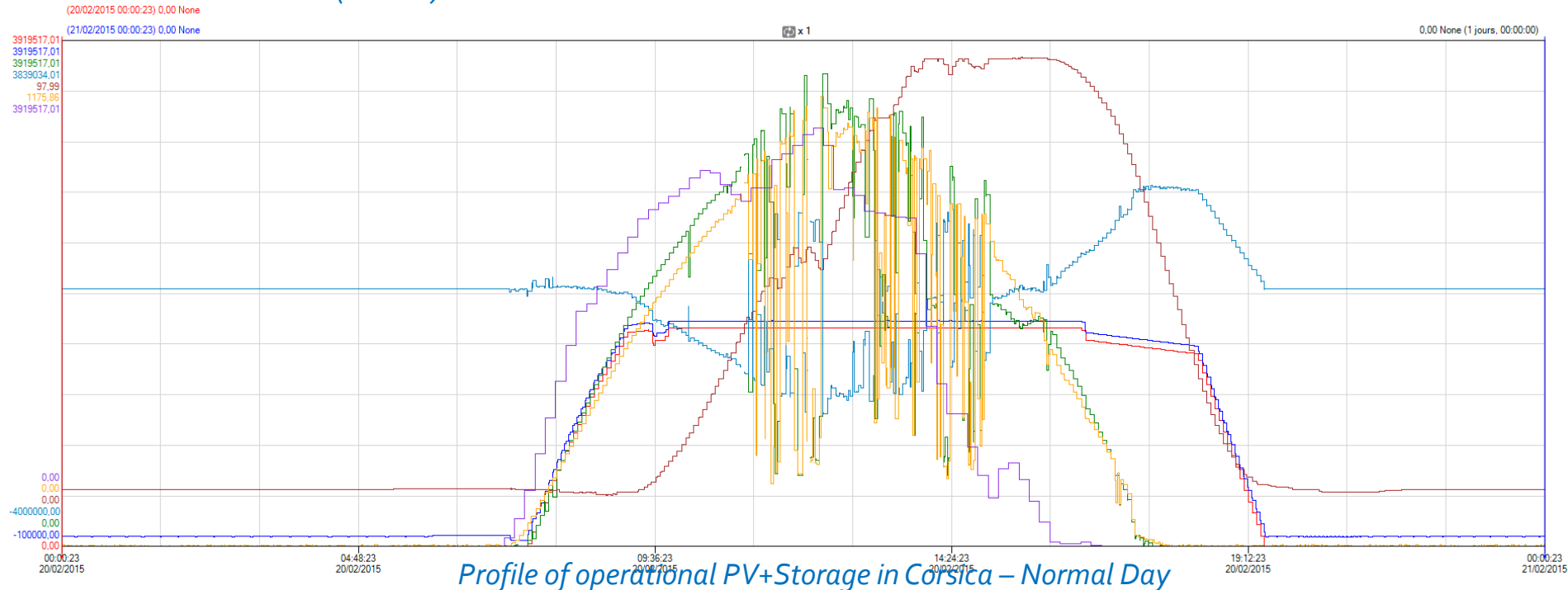
# 2. Feedback of the French call for tender

## ➤ Technical specifications and experience



Akuo Award: La Réunion 18 MWh,  
Corsica 11MWh (Ratio 1)

- The profile of the power injected must meet climb gradient, a stationary phase and a glide slope.
- Prediction ( $T_1$ ,  $T_2$ , Pref) has to be communicated to grid operator the day before
- Active and Reactive power to the grid based on the state of the frequency and outage.



Profile of operational PV+Storage in Corsica – Normal Day



## 2. Feedback of the French call for tender

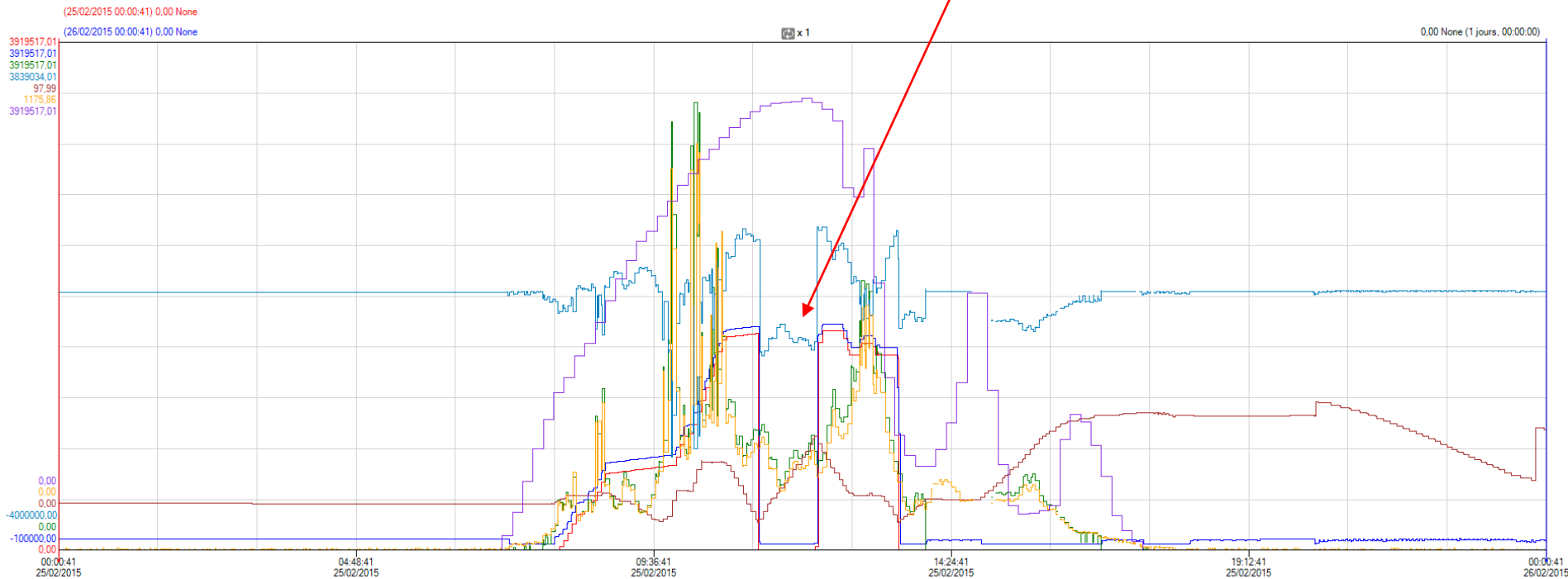
- Performance importance
  - The model for financing is based on a final **Performance Ratio**. These parameters are included:
    - **Electrical losses** due to architecture and converting elements
    - **Chemical losses** due to charges and discharges of the batteries
    - **Penalties** applied by disrespect of the constraints imposed by the grid manager in the degraded situations
    - **Curtailement**, situation appearing when batteries are full and the solar plant production is over the injection limit level
    - **The impact of forecast errors** carried out by the study results
  - Results tend to a solar performing ratio (P<sub>90</sub>) around 80% (classical solar PR), coupled with a second storage conversion ratio about 75%.

- **Performance Ratio (PR) is the first parameter of rentability,**
- **Sizing (ratio Battery capacity / Solar) is a second parameter.**
- **A total stable phase and a predictable "T<sub>1</sub>/T<sub>2</sub>/Pref" is not what grid dispatchors need: don't mistake about storage applications need**



# 2. Feedback of the French call for tender

- The forecast imprecision with microclimates in islands, and this stable phase constraints and penalties **degrades** :
  - **and the performance ratio,**
  - **and the quality of the signal to optimize this PR**
  - **The optimization of the size of the battery**
- The consequence: the Tariff is higher than the one needed.



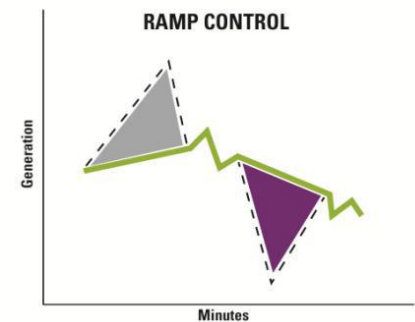
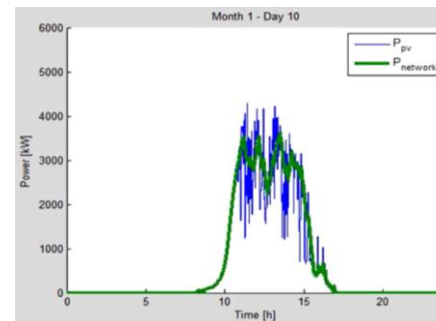
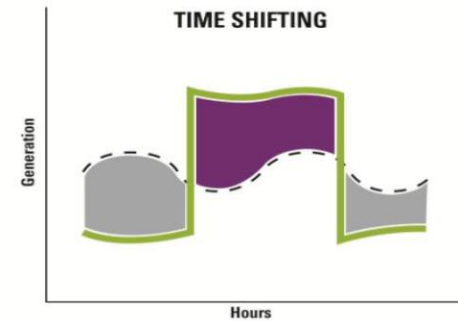
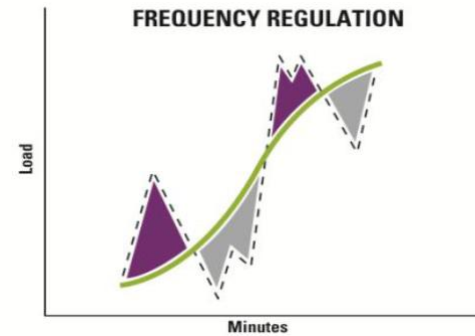
*Profile of operational PV+Storage in Corsica – « Bad » Day and « bad forecast »*





# 2. Feedback of the French call for tender

- Tendance of the Main services of Energy Storage in the world
  - Frequency Regulation (33%)
    - The demand always have to be equal to the production
  - Electric Energy Time Shift (12%)
    - Storing energy during low price times, and discharging during high price times
  - Renewable Capacity Firming and ramp control (11%)
    - specifically related to the uncontrollable nature of renewable generation



Source: <http://www.energystorageexchange.org/> - Energy storage database

