UNION EUROPÉENNE

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RÉPUBLIQUE FRANÇAISE

UNIVERSITÉ DE LA RÉUNION

MAFATE MICRO GRID PROJECT

ERDF Project 2019-2022 – Reunion Island

HEPMAD 2019

piment
Physique et Ingénierie Mathématique pour l'Énergie et l'environnemeNT

SIDELEC RÉUNION

TECHNOPOLE ZINNIA
OLIARA

LABORATOIRE ONDES et MILIEUX COMPLEXES

SUMMARY

I – Reunion Island

II – Project members

III – Mafate Micro Grid

1. Production & Storage
2. Weather station & data
3. Consumptions
4. Physical & mathematical models

IV – Expectations

I – REUNION ISLAND – LOCATION

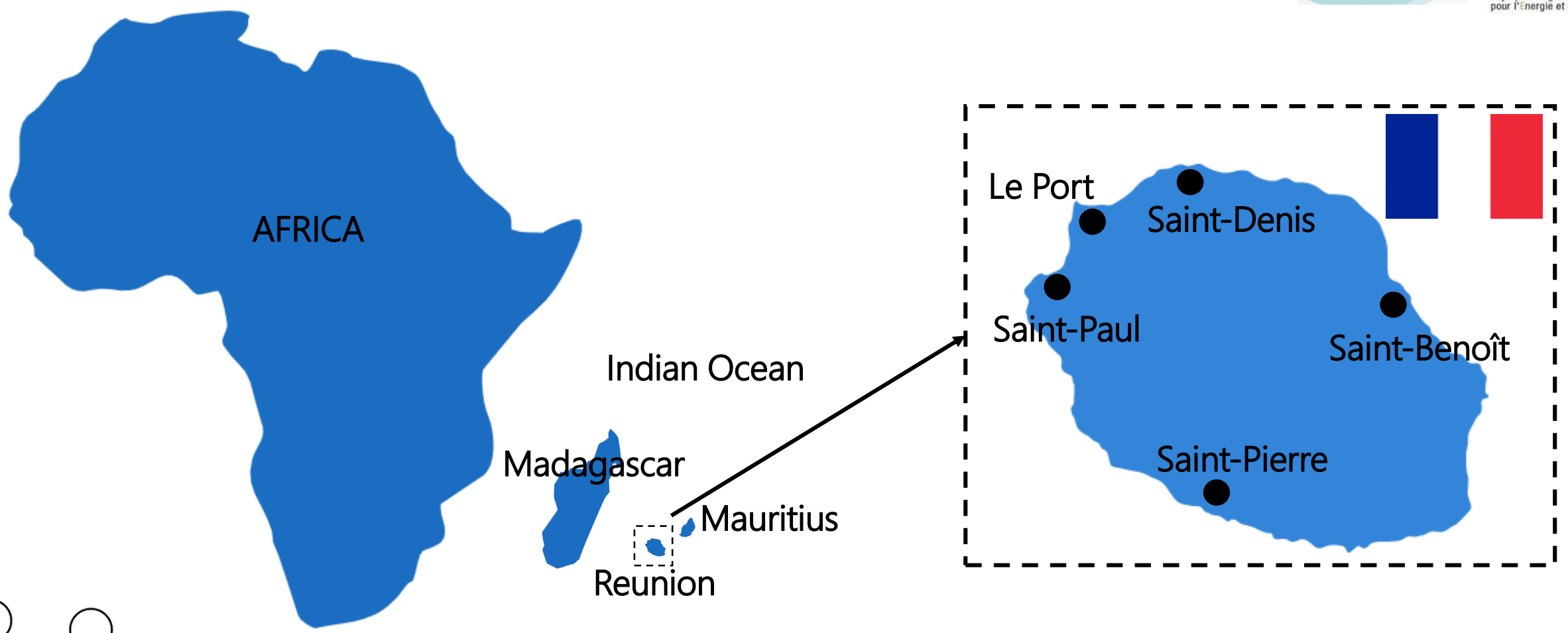


Figure 1 – Reunion Island location

I – REUNION ISLAND – INFORMATION

- Population of 866,506 inhabitants (Jan 2019)
- Area 2,500 km² (x200 = Madagascar area)
- Population concentrated on the coast
- Hot season average 28 to 31°C / Cool season 17 to 20°C (coast area)
- 2700 hours of sunshine per year (coastal areas)

Figure 2 – 3D view map

I – REUNION ISLAND – REMARKABLE PLACES

Sunrise from the Piton des Neiges

Eruption of the Piton de la Fournaise

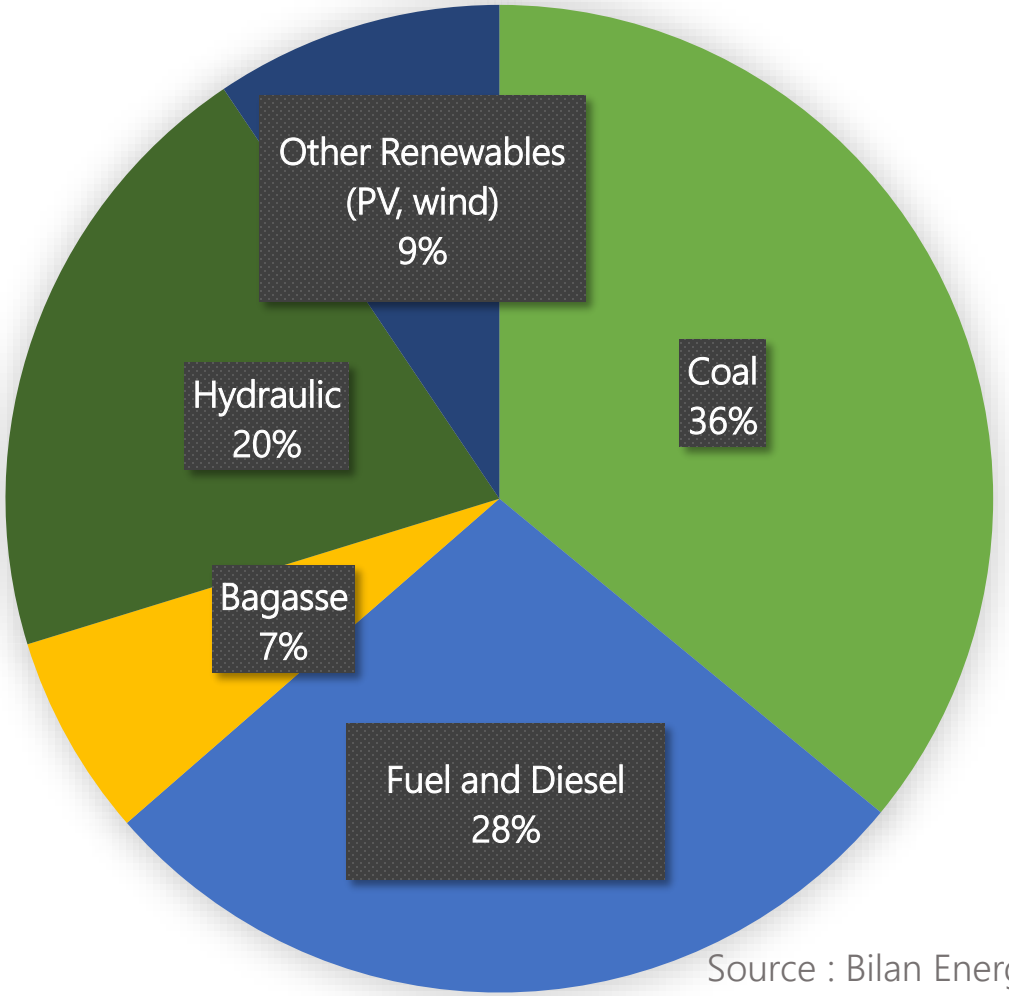
New water front road

Mafate circus

Figure 3 – Some of the remarkable places in Reunion

- **Piton des Neiges:** One of the highest peaks in the Indian Ocean (alt.3071 m)
- **Piton de la Fournaise:** One of the most active volcanoes in the World (3 eruptions this year)
- **Water front road:** One of the most expansive constructions in the World (2B€)
- **Mafate Circus:** Natural circus, accessible on foot or by helicopter. UNESCO World Heritage.

I.1 – REUNION ISLAND – ENERGY CONTEXT



Source : Bilan Energétique de La Réunion édition 2019

- Insular context:
  - depends on goods importations
  - local electricity production
- Electricity production 3,000 GWh/year (2018)
- Electrical power installed 890 MW
- Photovoltaic power connected to the main grid : 190 MW (21%)

Figure 4 – Electrical production from different primary sources in Reunion

I.2 – ENERGY CONTEXT IN MAFATE

- No car access
- Supplying goods by helicopter or on foot
- "Traditional" power supply:

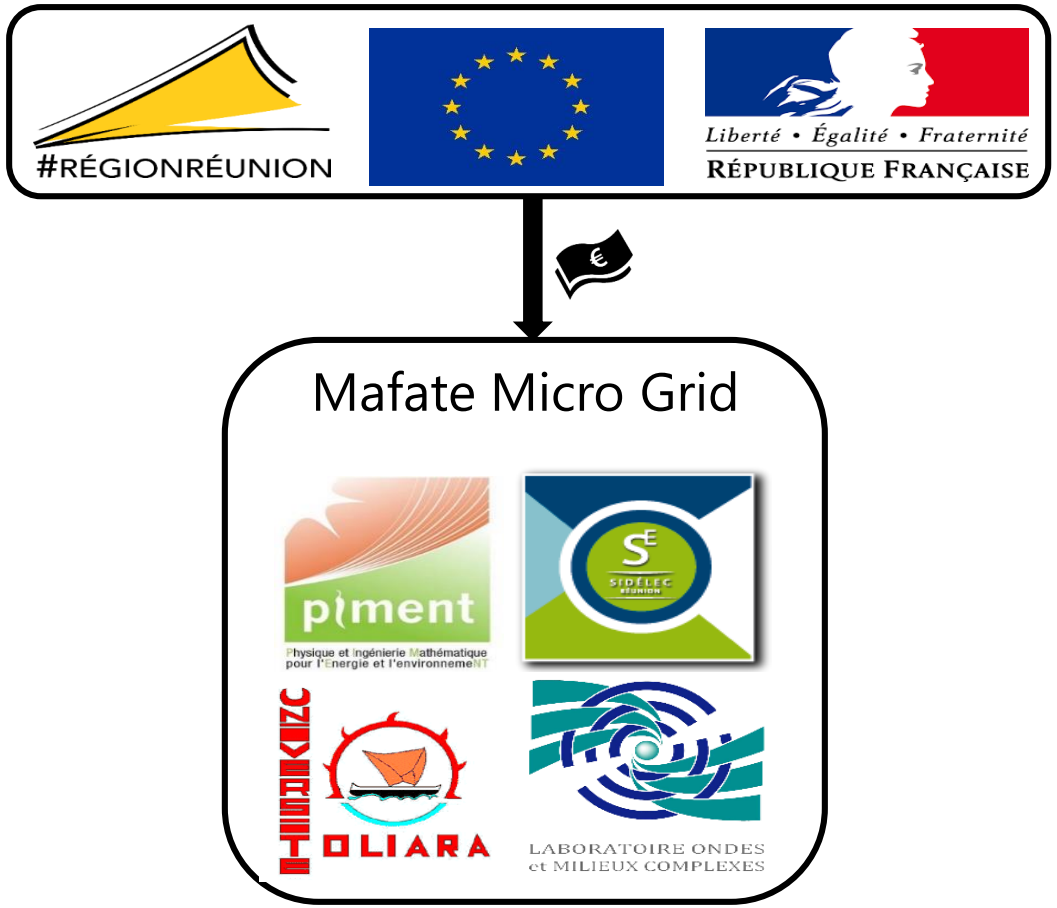
  -Old solar installations
  -Fuel power generators

- Electrical devices used by Mafate people:

  TV, Freezer, Refrigerator, Washing machine,
  Radio stations, Light bulbs, Cell chargers …

Figure 4 – House in Mafate

II – PROJECT MEMBERS AND FUNDERS



- European Regional Development Fund - ERDF
- Reunion Council
- French Government

- SIDELEC (Union for the distribution of electricity in Reunion Island)
- University of Toliara:
  - Tovondahiniriko FANJIRINDRATOVO
  - Olga RAMIARINJANAHARY
- LOMC (Laboratory waves and complex environments)
  - Innocent MUTABAZI

Figure 5 – Project members and funders

II – PROJECT MEMBERS – PIMENT LAB

- Physics, engineering, mathematics for energy and environment

- Domains:

  - Building
  - Energy efficiency
  - Solar energy
  - Conversion and storage of energy

- Members of the team “Mafate Micro Grid” project within PIMENT Lab:

  - Didier CALOGINE
  - Oanh CHAU
  - Philippe LAURET
  - Jean CASTAING-LASVIGNOTTES
  - Mathieu DAVID
  - Johann FRANCOU
  - Paulisimone RASOAVONJY

Link: https://piment.univ-reunion.fr/

III – MAFATE MICRO GRID

Microgrid definition:

Network composed of a localized electricity plant (renewables or not) supplying few (micro compared to a macro) buildings (residential or not) around.

Objective: Develop smart and small grids in Reunion Island

Resources we have:

- Real solar powered microgrid (7 kWp)
- Living lab in Mafate: Experimentation on 3 inhabited houses
- Consumption diagnostics to understand how the inhabitants consume
- Weather station to understand the climate in-situ

Figure 6 – Satellite picture of the solar powered microgrid

III.1 – PRODUCTION AND STORAGE

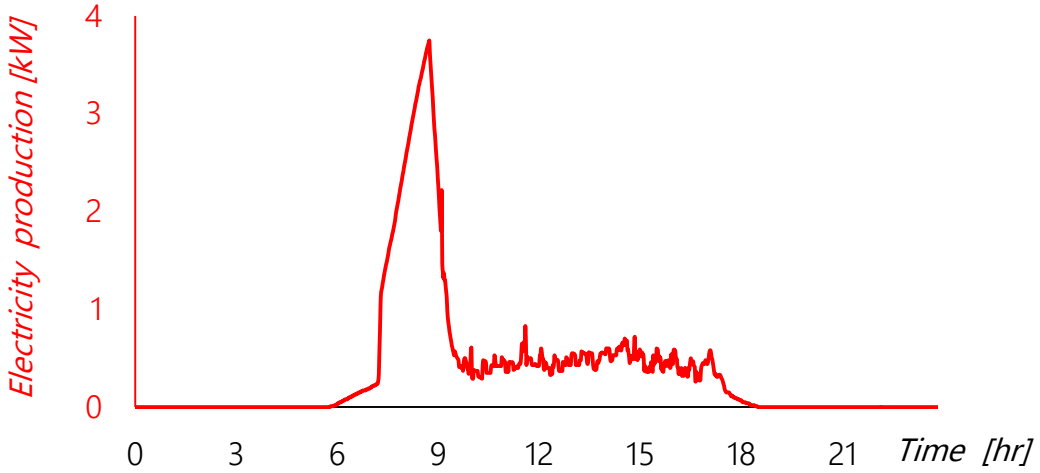


Figure 7 – Electrical production for a typical winter day

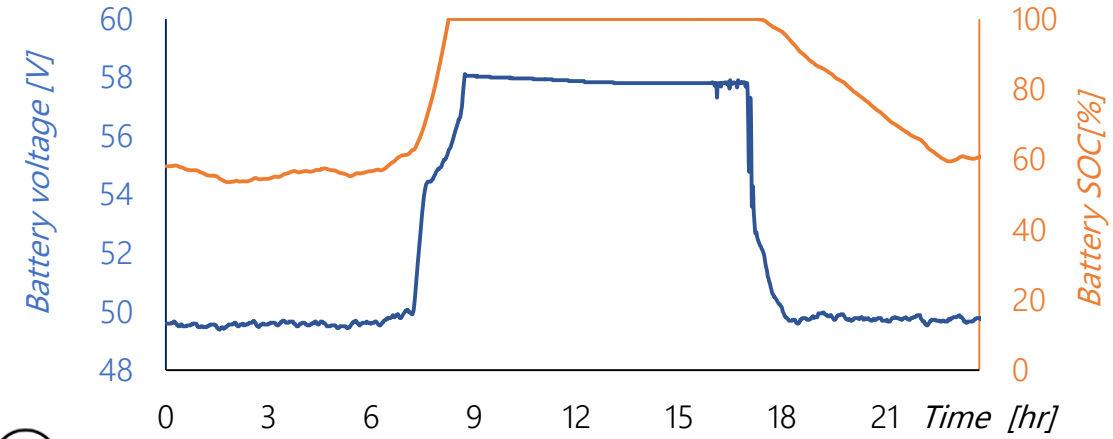


Figure 8 – Battery state of charge for a typical winter day

- 7 kWp solar plant
- Designed and maintained by SIDELEC
- Wet lead acid batteries
- Oversized installation to meet a potential increasing demand over the years

Figure 9 – Microgrid solar plant

III.2.a – WEATHER STATION

- Pyranometers: Global irradiations
- Hygrometer: Relative Humidity
- Thermometer: Ambient temperature
- Surface thermometer: Solar panels surface temperature
- Rain Gauge

Figure 10 – Weather station

III.2.b – WEATHER DATA

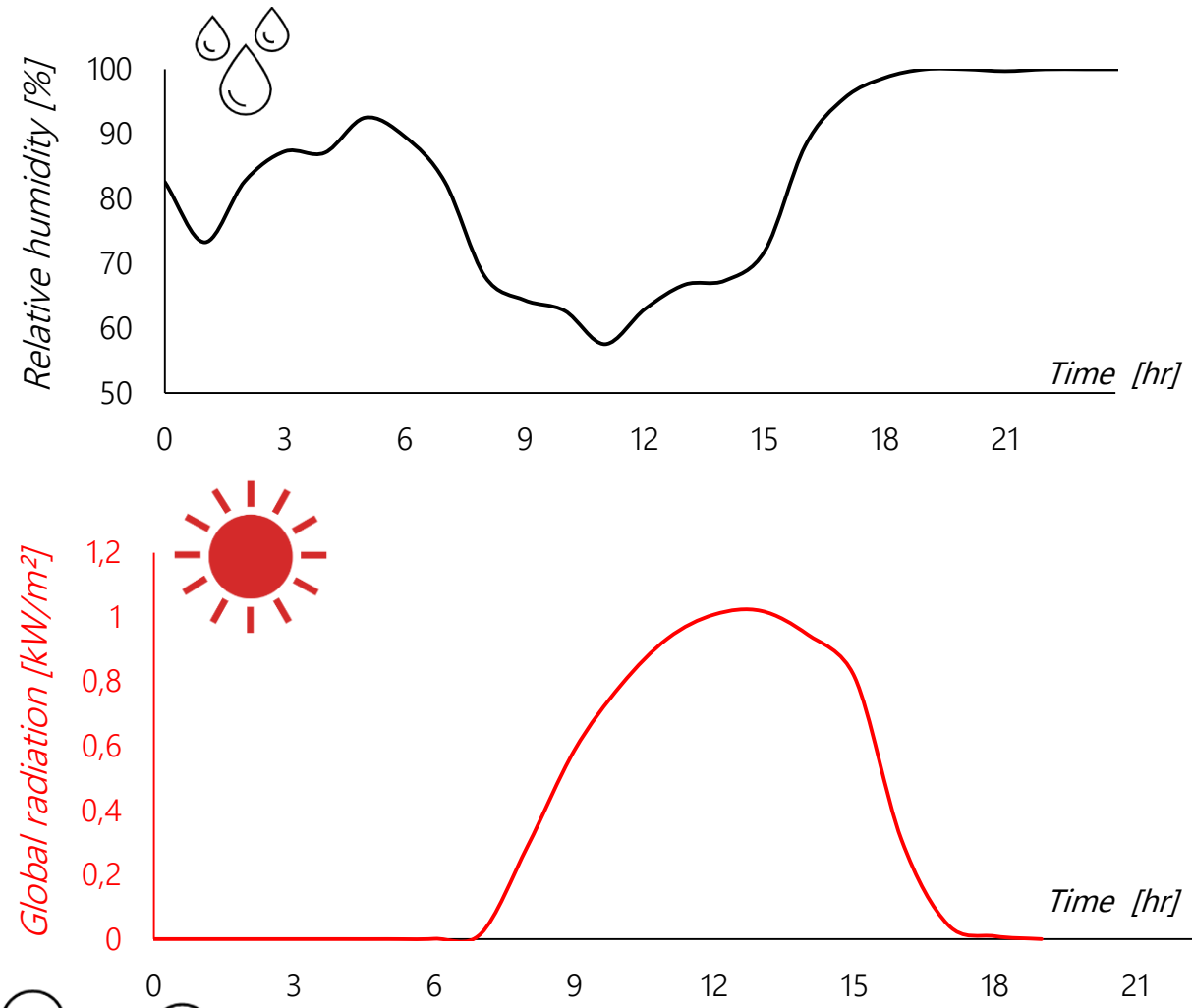


Figure 12 – Global radiation on a horizontal surface

WEATHER DATA IN MAFATE FOR A WINTER DAY:

- Humid climate
- Global radiation max ≈ 1,0kW/m²

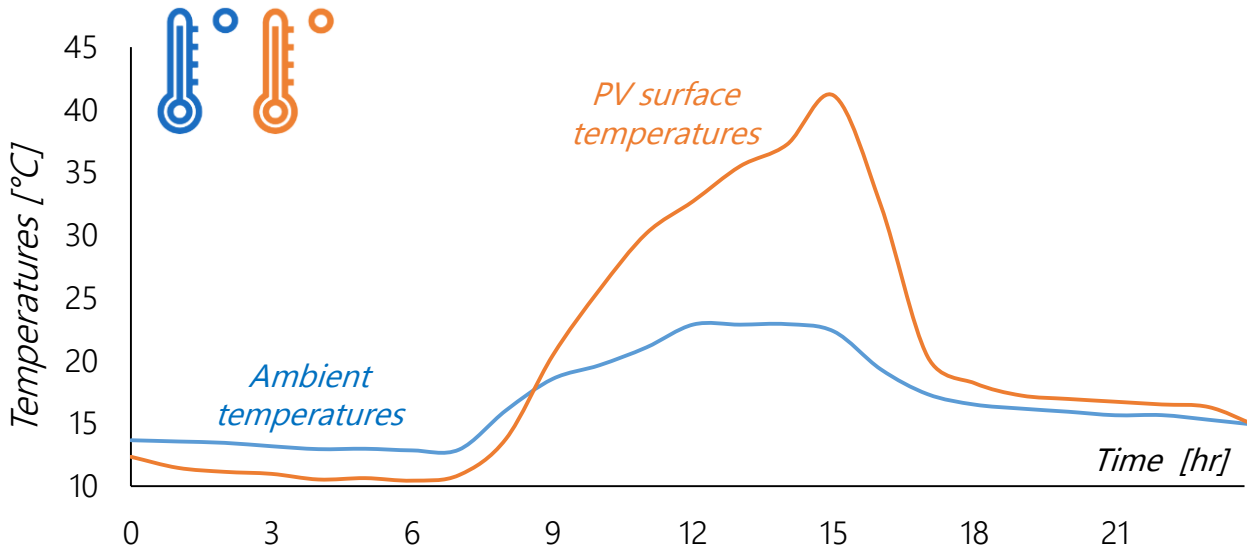


Figure 13 – Ambient temperature and surface temperature on the PV panels

III.3.a – CONSUMPTIONS STUDIES

- Global consumption measured
- Consumption measured for each house
- Consumption measured for each electronical device

  -SQUID allows to measure the current used by an equipment
  -SQUID communicates via the LoRaWan protocol
  -Ideal for long-range transmission (max 1.5 km)

- **Objective:** Set up a consumption diagnostic

Figure 14 – SQUID sensor from EWATTCH

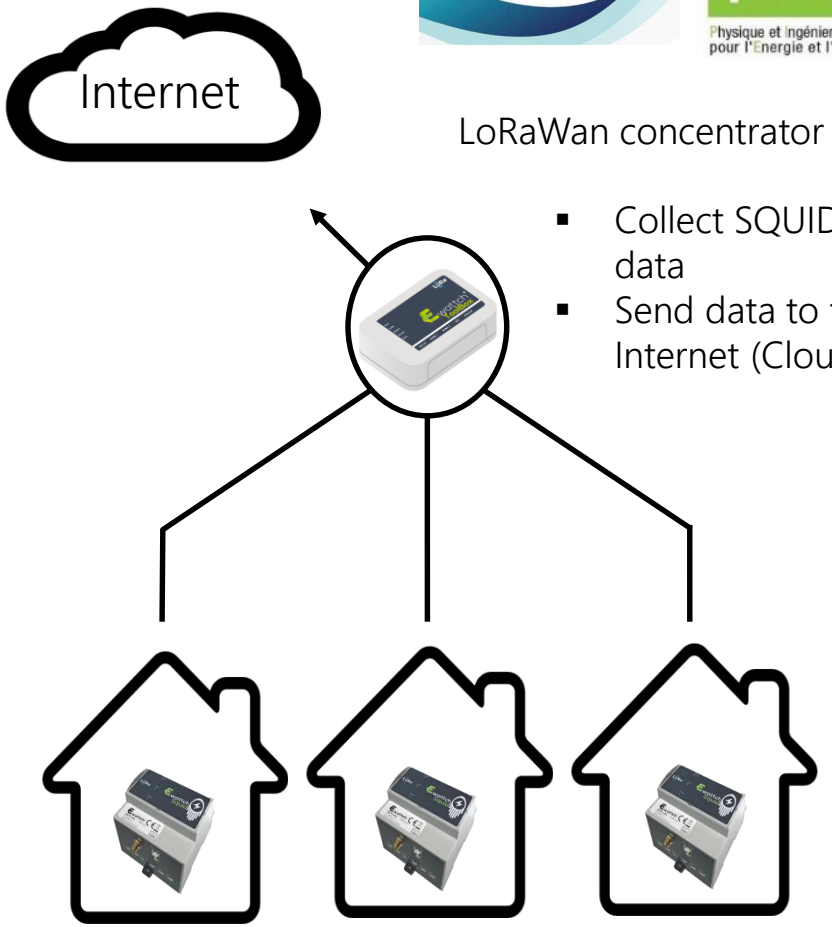
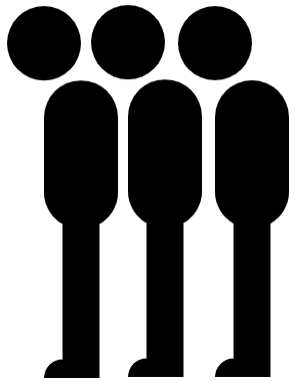


Figure 15 – Network structure for the use of the LoRaWan SQUIDS for the microgrid

III.3.b – CONSUMPTION BEHAVIOURS

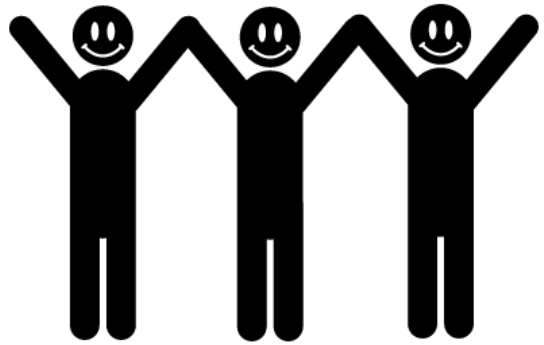
Old solar installations
Fuel power generator



Insecure production
Limited consumption

BEFORE THE MICROGRID

Over-sized solar microgrid



Higher consumptions?
Ideal sizing of the microgrid?

WITH THE MICROGRID

III.4 – PHYSICAL & MATHEMATICAL MODELS

- Development of an Energy Management System (EMS)
  - Consumption tracking
  - Human/Machine interface (Android)
  - Consumption optimization

- Storage dynamic simulations
  - Lead Battery
  - LiFePo Battery
    Experimental set-up
  - Compressed Air Energy Storage (CAES)
    Jean CASTAING-LASVIGNOTTES
    Sidiki SIMPORE

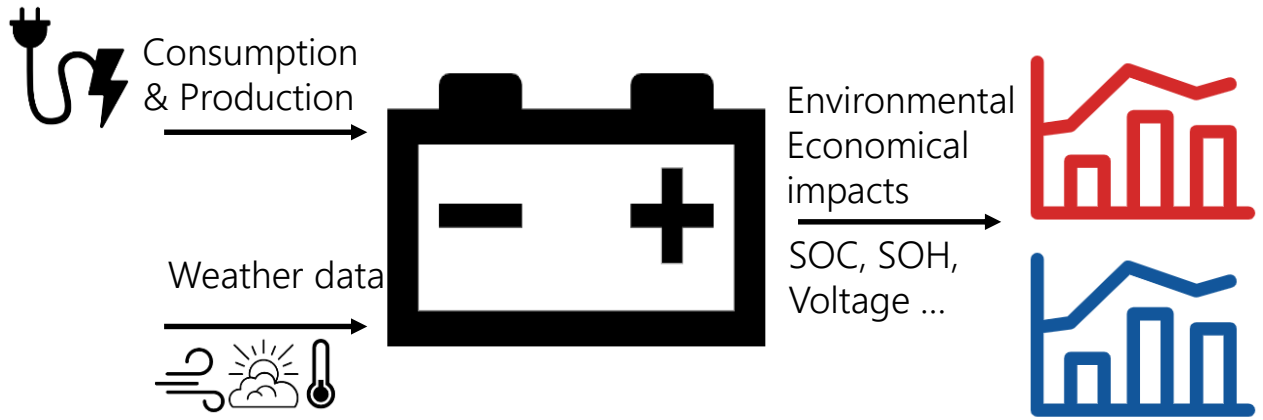


Figure 16 – Storage simulations principle

III.4 – PHYSICAL & MATHEMATICAL MODELS

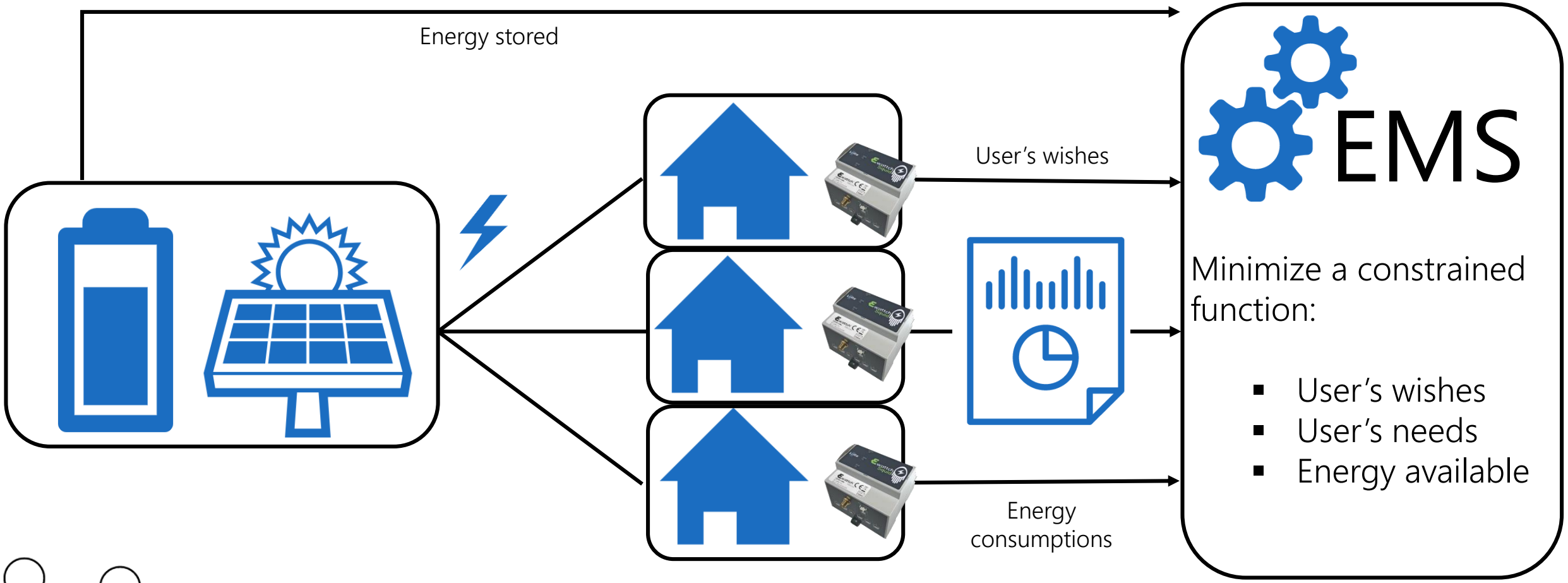


Figure 17 – Smart grid management EMS inputs

III.4 – PHYSICAL & MATHEMATICAL MODELS

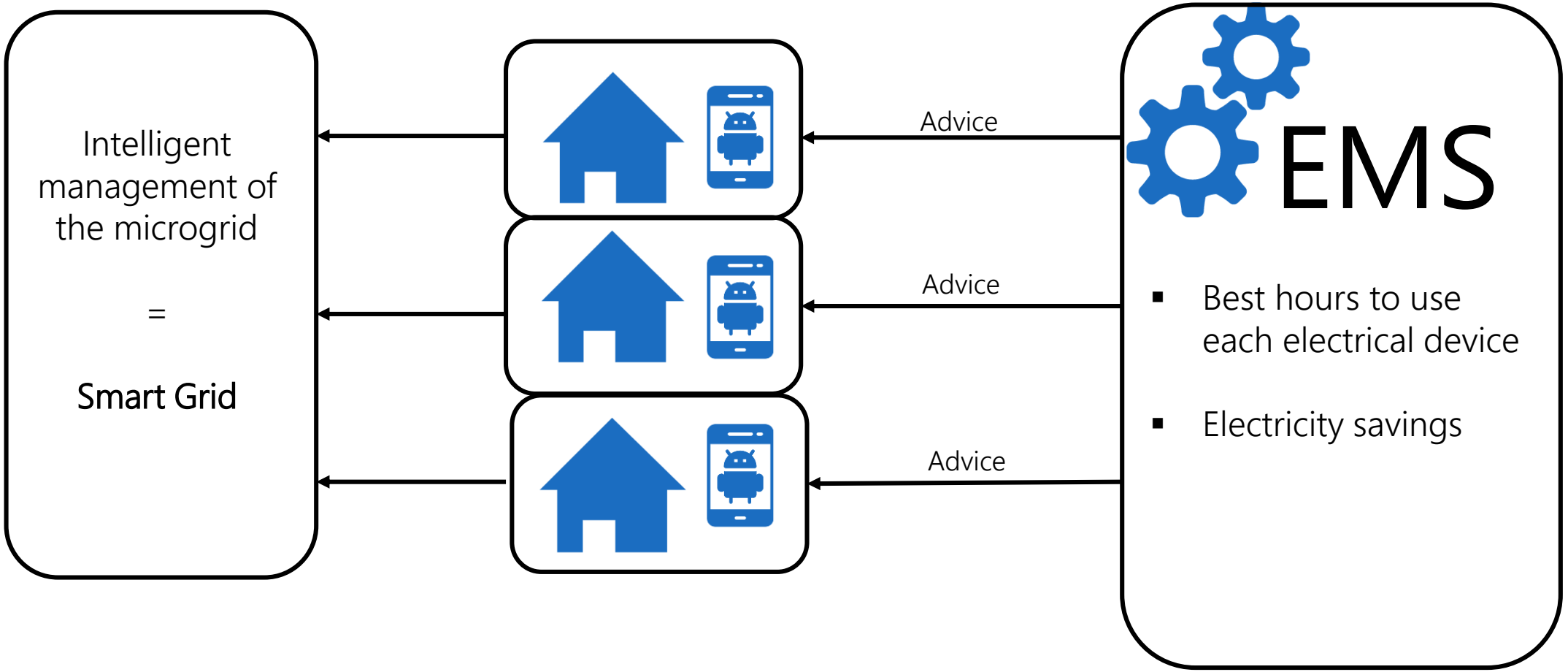


Figure 18 – Smart grid management EMS outputs

IV – EXPECTATIONS

- Develop the concept of smart and small grids in Reunion Island
- Sort out electricity insecurities in the isolated areas
- Develop methods for microgrids design
- Develop methods and techniques for microgrids management
- Economy on microgrids designing
- Encourage the use of solar

THANK YOU

- Funders:

- Suppliers and service providers:

- Collaborators: