

# Energy Building



Ce projet a été cofinancé par l'Union européenne.  
L'Europe s'engage en Midi-Pyrénées avec le Fonds européen de développement régional.



Université Fédérale  
Toulouse Midi-Pyrénées



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- **Context & objectives**
- **Funding & resources**
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- **Research examples**
- **Proposed services**



# Context & Objectives

## > Objectives of the platform

- Instrumented experimental building for the implementation and testing of energy management technologies (hardware and software) within a context of renewable energies and storage technologies deployment.

## > Scientific and technical challenges

- Providing innovative solutions to energy transition issues:
  - Test of new technologies in real conditions: *PV panels, power converters, algorithms, storage elements, etc*
  - Massive introduction of renewable energies : *intermittency management*
  - Smart energy management: *optimization between production, consumption and storage*
  - Living lab of 1700m<sup>2</sup> including researchers' offices (73 persons)

# Platform funding & resources

> Funding within the framework of (2007-2012) State-Region Contract Project: **ADREAM** scientific project



> Storage equipment funding



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> Total funding: 7.37 M€

- Building: 5.2 M€
- Equipment : 2.17 M€

> Technical support

- 4 engineers + 2 technicians

## State-Region Contract Project 2007-2012

### Ambient Intelligence, Internet of Things, Autonomy



- Open & Pervasive Embedded Systems
- Human & Robot Interactions
- Resilience
- Security & Privacy
- Optimization
- Smart Grids
- Energy Conversion & Management

#### Cyber-Physical Systems:

- *Investigate & Propose Theories, Methods & Tools for Architecting, Experimenting & Assessing*
- *Exploit & Develop Synergies & Interdisciplinary Studies*



*\*Architectures Dynamiques Reconfigurables de systèmes Embarqués Autonomes Mobiles*

# *SYNERGY Energy Building: Instrumented building with photovoltaic production, geothermics and energy optimization*



©CNRS Photothèque – FRESILLON Cyril

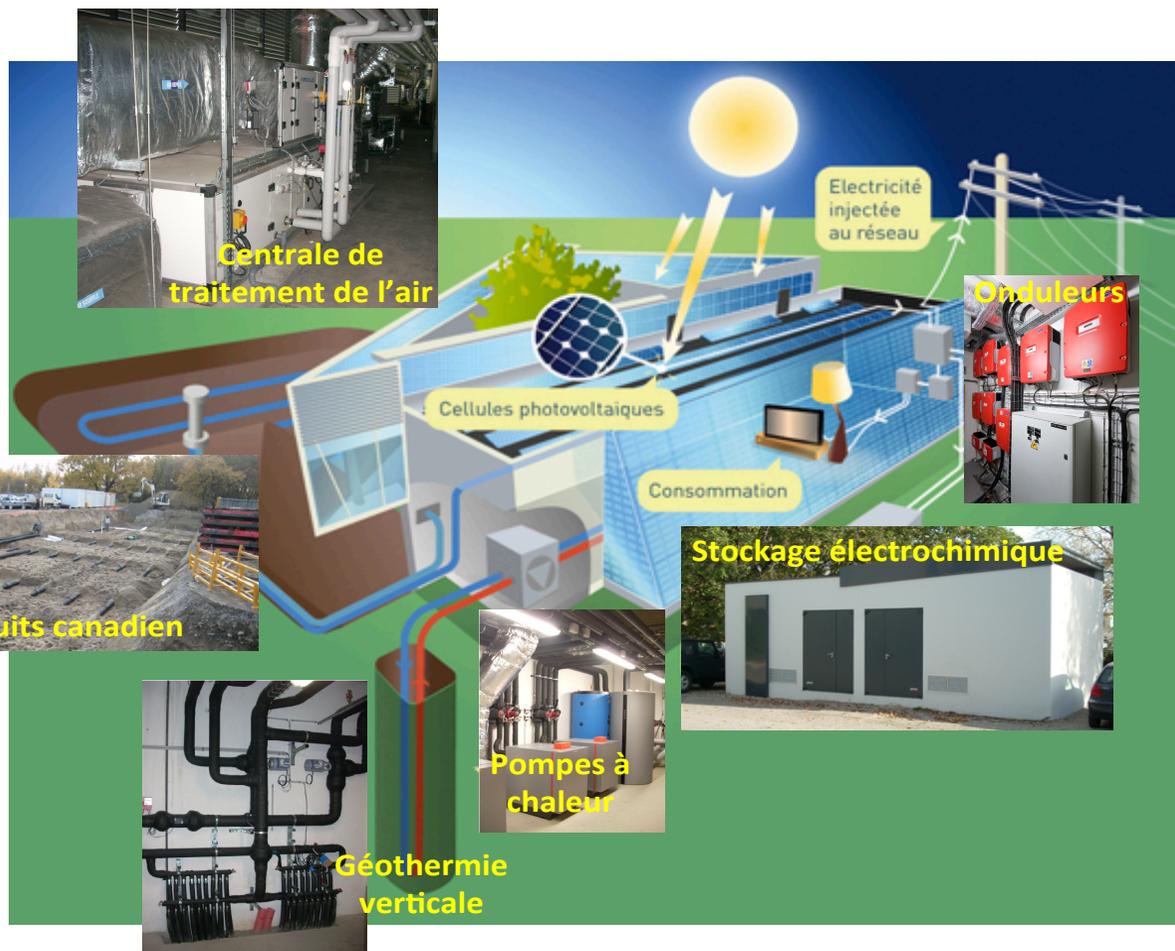
# Energy production sources



# SYNERGY Energy building



- **100kWp photovoltaics**
- **Geothermics:**
  - Canadian well
  - Vertical geothermics
  - 3 heat pumps
- **Storage:**
  - Lead batteries (900 kWh)
  - Li-ion batteries (60 kWh)
  - Supercapacitors (286Wh)
- **Three supervision systems:**
  - Lighting, Ambient temperature control, Energy production/ consumption



# Three Supervision System

- > *Heating, Ventilation, Air Conditioning*
  - 650 points of measurement and regulation
- > *Lighting*: 3700 measurement points
  - Movement detection and illumination sensors
  - Power adjusted according to ambient light level
  - Setting of time slots / operation by zone
- > *Electricity*: 500 data collected
  - Detailed power consumption (zone, usage...)
  - Energy production (photovoltaic, geothermics)
  - Correlation to environmental/ambient measurement

## Three heat pumps of 50kW connected to 18 geothermics probes (150m)

### > Heating Mode:

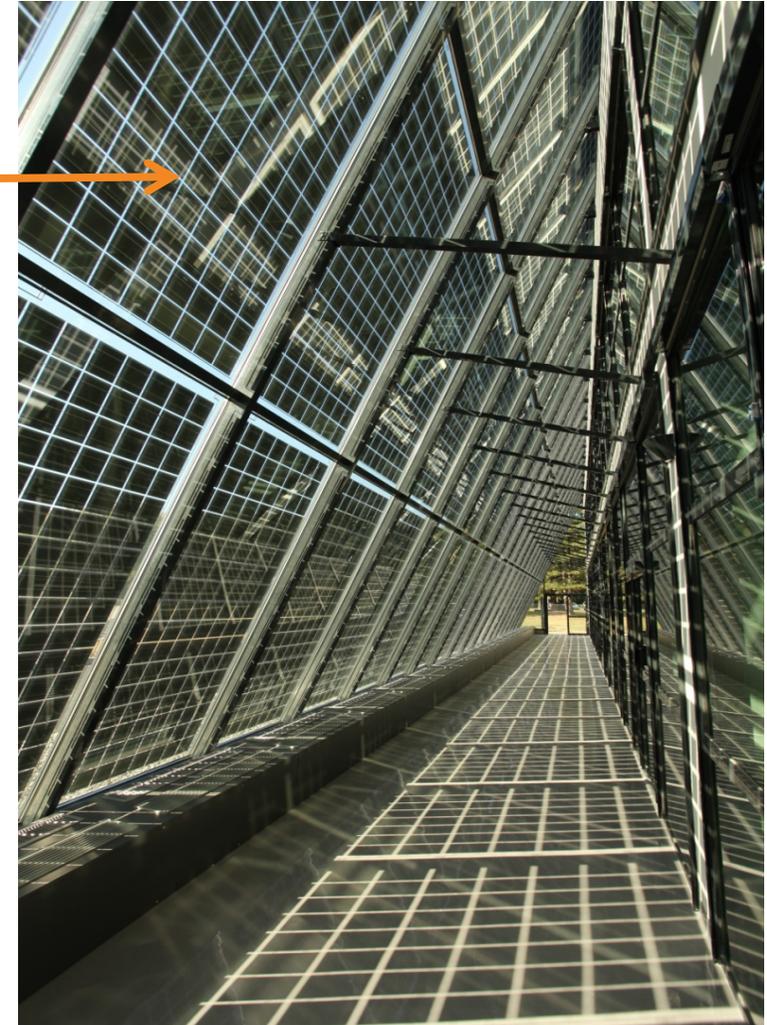
- 2 heat pumps for estimated needs of 75kW max.
- Buffer tank of 1000 liters to limit starting of the production equipment
- Three different circuits of distribution

### > Cooling Mode :

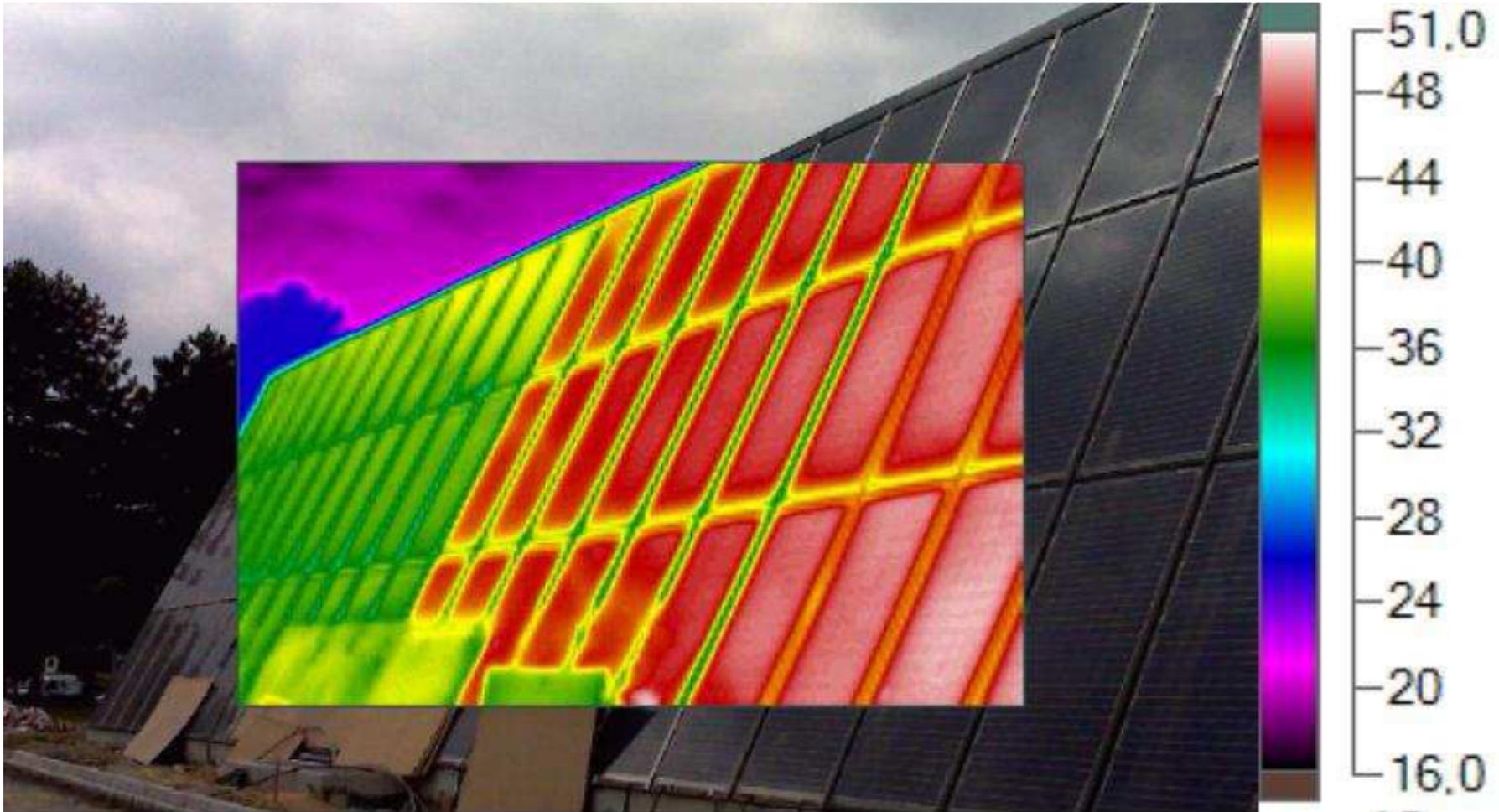
- 3 heat pumps for estimated needs of 135kW max.
- Buffer tank of 1000 liters to limit starting of the production equipment
- 2 circuits of distribution



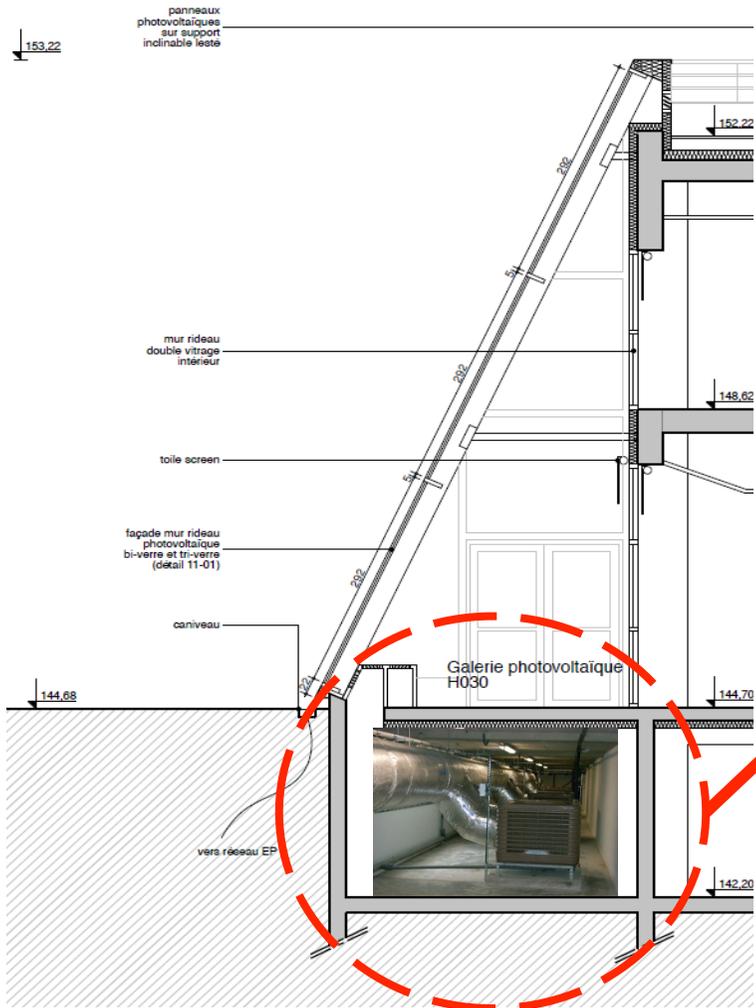
- > **Three distinct zones:**
  - Photovoltaic semi-transparent wall (36kWp): *double & triple glass*
  - Roof level 1, variable panel tilt, (35kWp)
  - Roof level 2, 10° tilt, (29kWp)
- > Two different types of inverters (2 to 6 kW)
- > **Electrical storage:**
  - Li-ion batteries
  - Lead batteries
  - Supercapacitors



# Impact on energy production efficiency



# Free-cooling system to improve energy efficiency



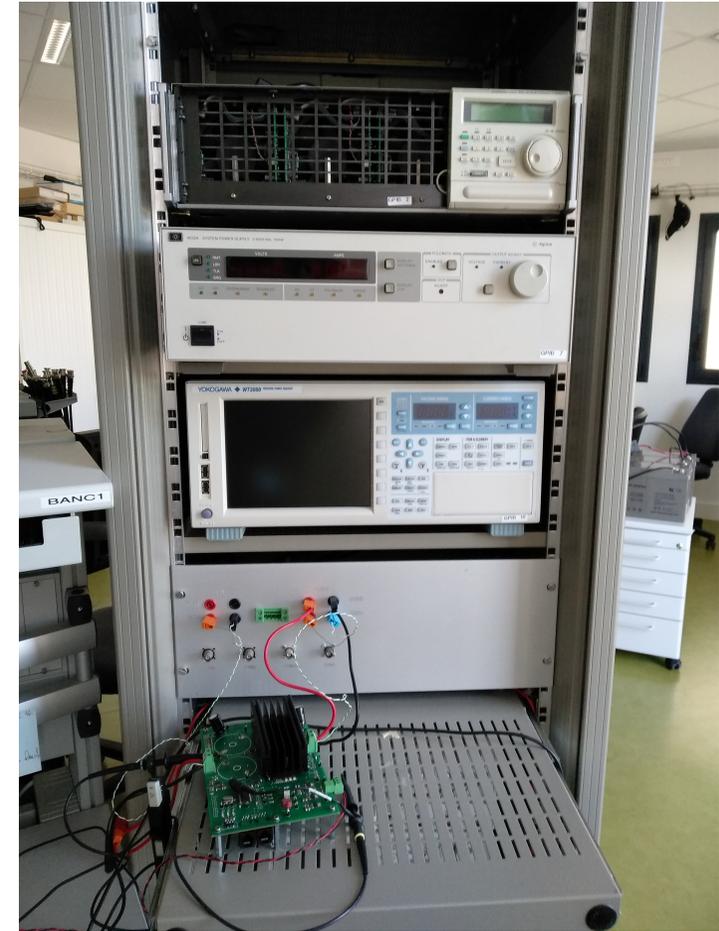
- > **Objective ① : PV panels cooling**
  - Energy efficiency improvement
  - Homogeneization of energy production whatever the type of panel
  
- > **Objective ② : heating of gallery**

# Experimental PV platform

- > **PV Platform R+1: 19.2 kWp Tenesol**
  - Solar panel mounting system with adjustable inclination (0 → 90°)
  - Modules glass-tedlar in cristalline silicon
  - Power/element: 250Wp
  - Modular terrace
- > **Facade triple-glass: 2.1 kWc Scheuten**
  - 144 cells per panel ( 17cm \* 8cm)
  - Power/element: 529Wc
- > **PV cladding glass-Tedlar: 13.4 kWc**
  - Fixed mounting system at 90°
  - Modules glass-tedlar in cristalline silicon
  - Power/element: 250Wp
- > **PV Platform R+2: 25 kWp Tenesol**
  - Mounting system with fixed inclination at 10°
  - Modules glass-tedlar in cristalline silicon
  - Power/element: 250Wp



# Dedicated characterization platform

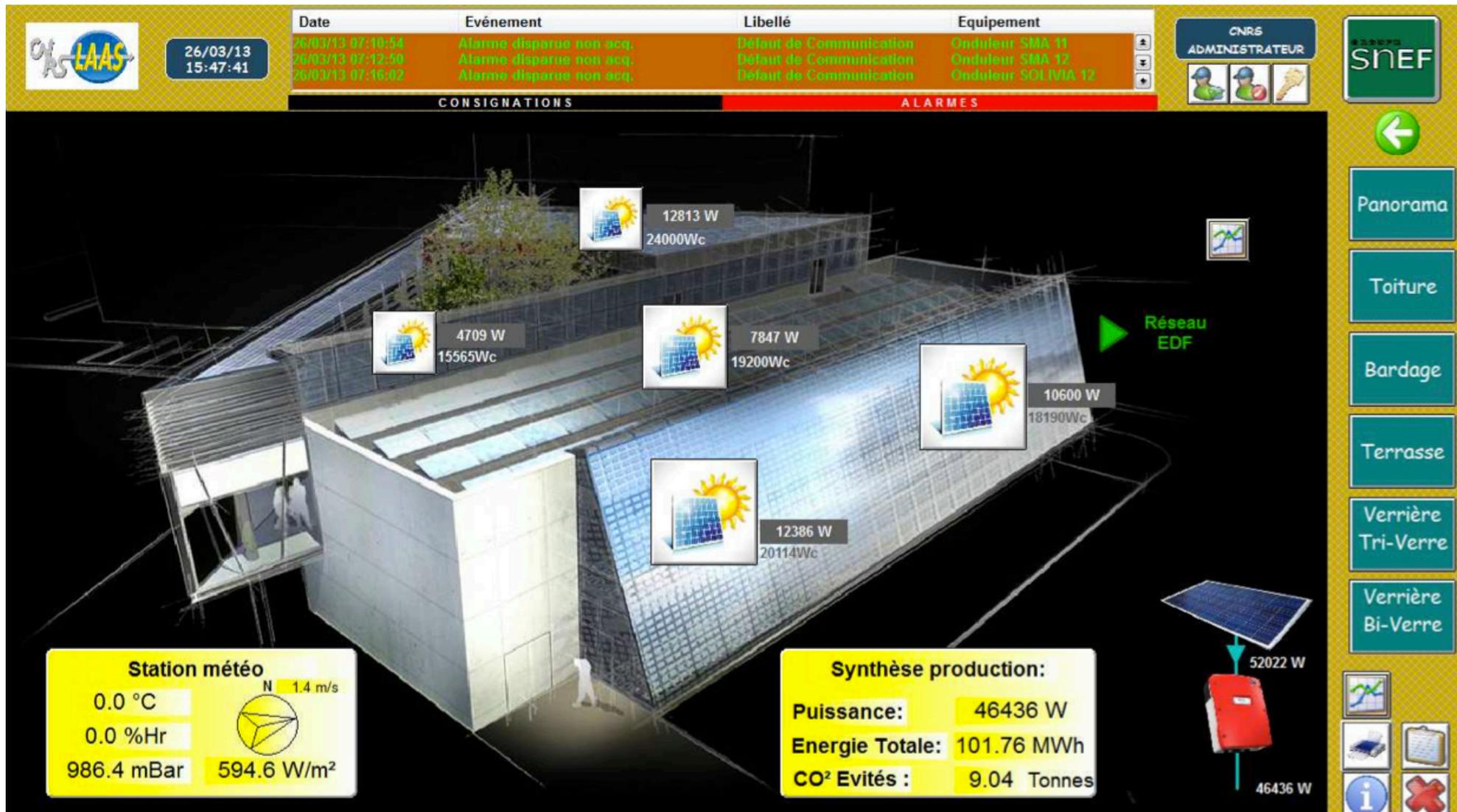


## > Database:

- Building operation parameter setting :  $T^\circ$ , time slots, PV production, power consumption, etc
- Building supervision: lighting,  $T^\circ$  control, equipment
- Data collection every 1 to 5 min of **6000** inputs coming from various sensors: **500 000 data/day**

## > Open supervision system

- PCVUE software
- Coupling to a database
- Data command/control



# Open Data Syndream Platform

<https://syndream.laas.fr/>

## OPA Project

Open Platform for ADREAM

Please, login to get privilege access



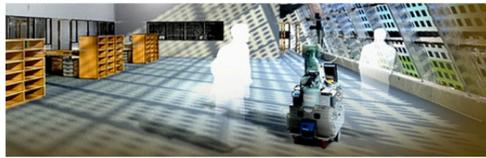
### Latest news

**OPA project website online** Sept. 27, 2016  
 The Open data & Open services apps are now available. Create your account or authenticate using your... [More](#)

### Project

Networking massive objects and intelligent agents.  
 Get privilege access to the Open Data and the Open Services.

OPA
ADREAM
OM2M



### Open Data

Open data is the idea that some data should be freely available to everyone to use and republish as they wish, without restrictions from copyright, patents or other mechanisms of control. Get sensors data.

Note: Since you are not logged in, the list of datasets will be limited.

GET DATA


### Open Services

Eclipse OM2M project provides a horizontal M2M service platform for developing services independently of the underlying network, to facilitate the deployment of vertical applications and heterogeneous devices.

Note: Please login to access to the Open Services app (only for Partners or LAAS employees).

INTERACT


# Open Data Syndream Platform

<https://syndream.laas.fr/>

OPA Project  
Open Platform for ADREAM

Open Data

LAAS and CNRS have inaugurated the experimental building Adream in 2012. Unique in Europe, this building hosts research projects dedicated to ambient intelligence, that is to say communicating objects of tomorrow.

The building is equipped with a multitude of sensors to assess to the condition of the building and the connected devices inside. These range from energy efficiency to comfort requirements.

The data from most of these sensors are available.



Search data

253 datasets in total

E.g., photovoltaic, day, laas

Advanced search

Help page

Popular Domains & Tags:

Electrical

CVC

Photovoltaic

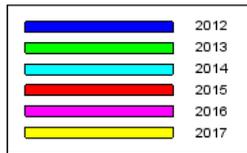
Meteorological

**Note:**

Since you are not logged in, the list of datasets will be limited.

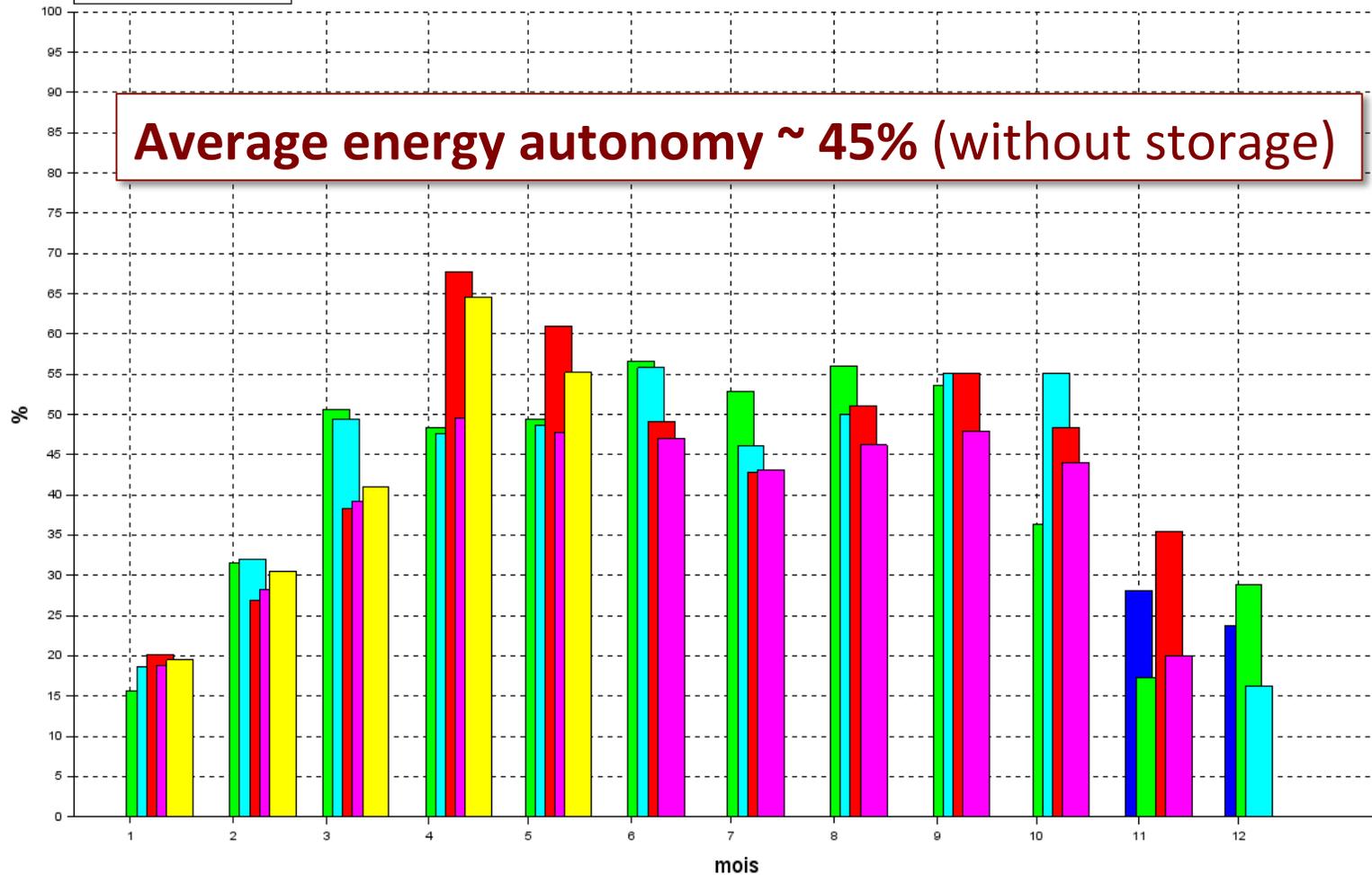
Registration is free and no personal information will be published or used for anything.

# Energy Production Data



Ratio production PV / consommation du bâtiment par mois: 2012 à 2017

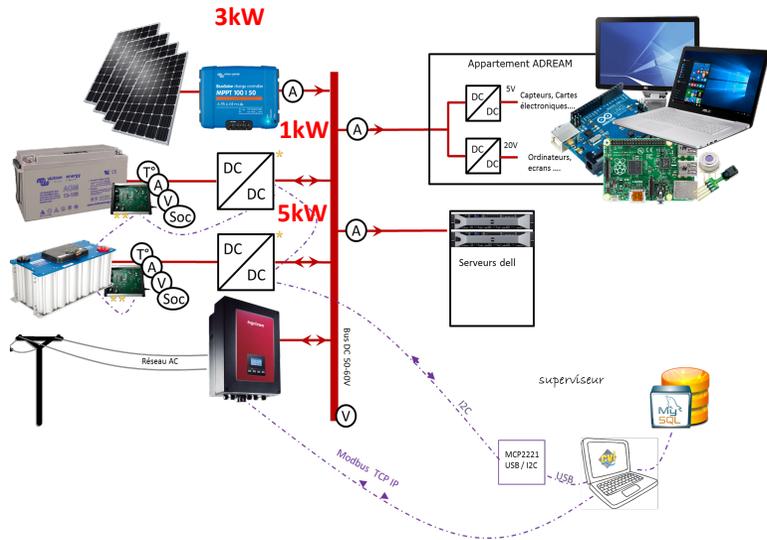
**Average energy autonomy ~ 45% (without storage)**



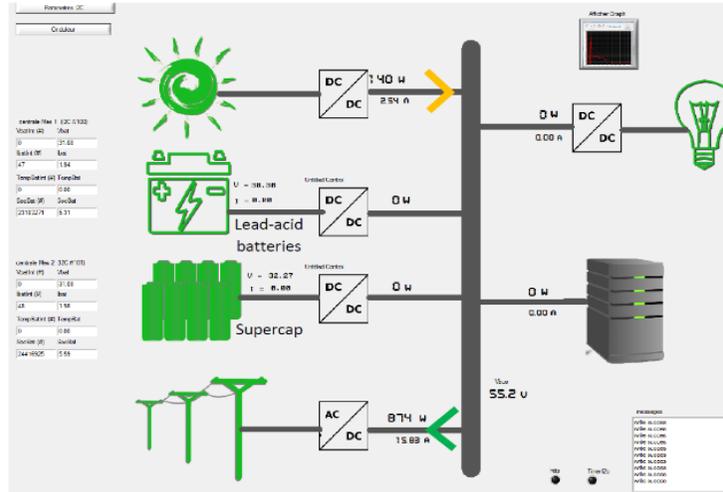
# Building Modularity & Research



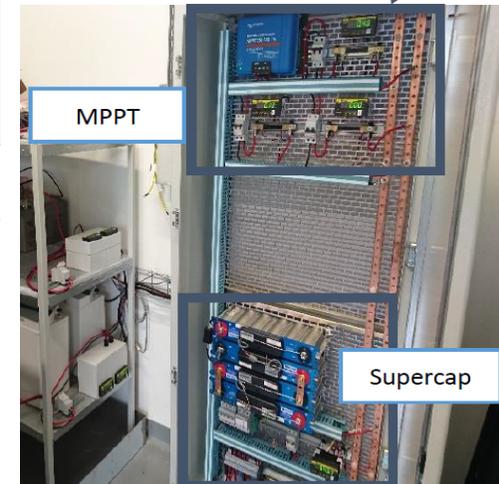
## Hybrid micro-grid architecture



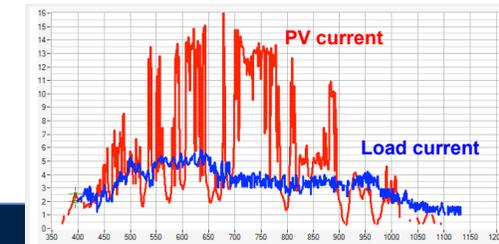
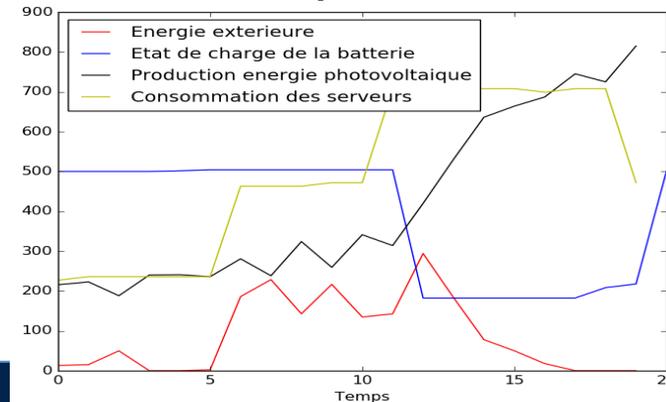
## User interface of hybrid micro-grid (low-level supervision)



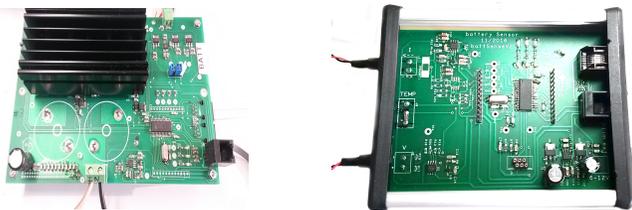
## Storage units



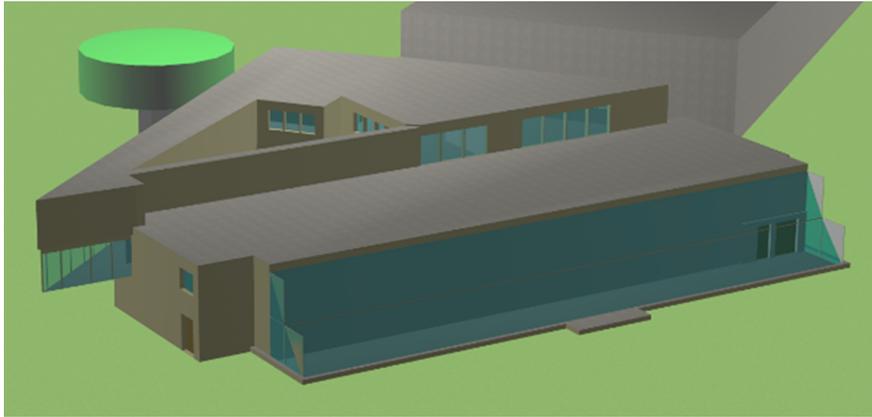
## High-level supervision: combinatorial optimization methods



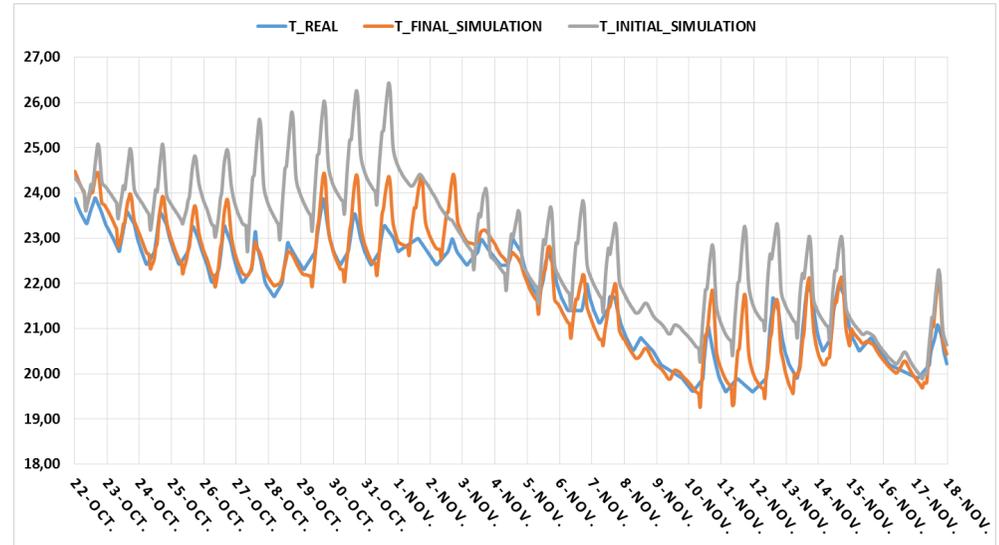
Specifically developed bidirectional 1kW DC-DC converters and associated command



# Dynamic Thermal Simulation



3D Model of the ADREAM Building in the Alcyone environment of the Pleiades + Comfie Software



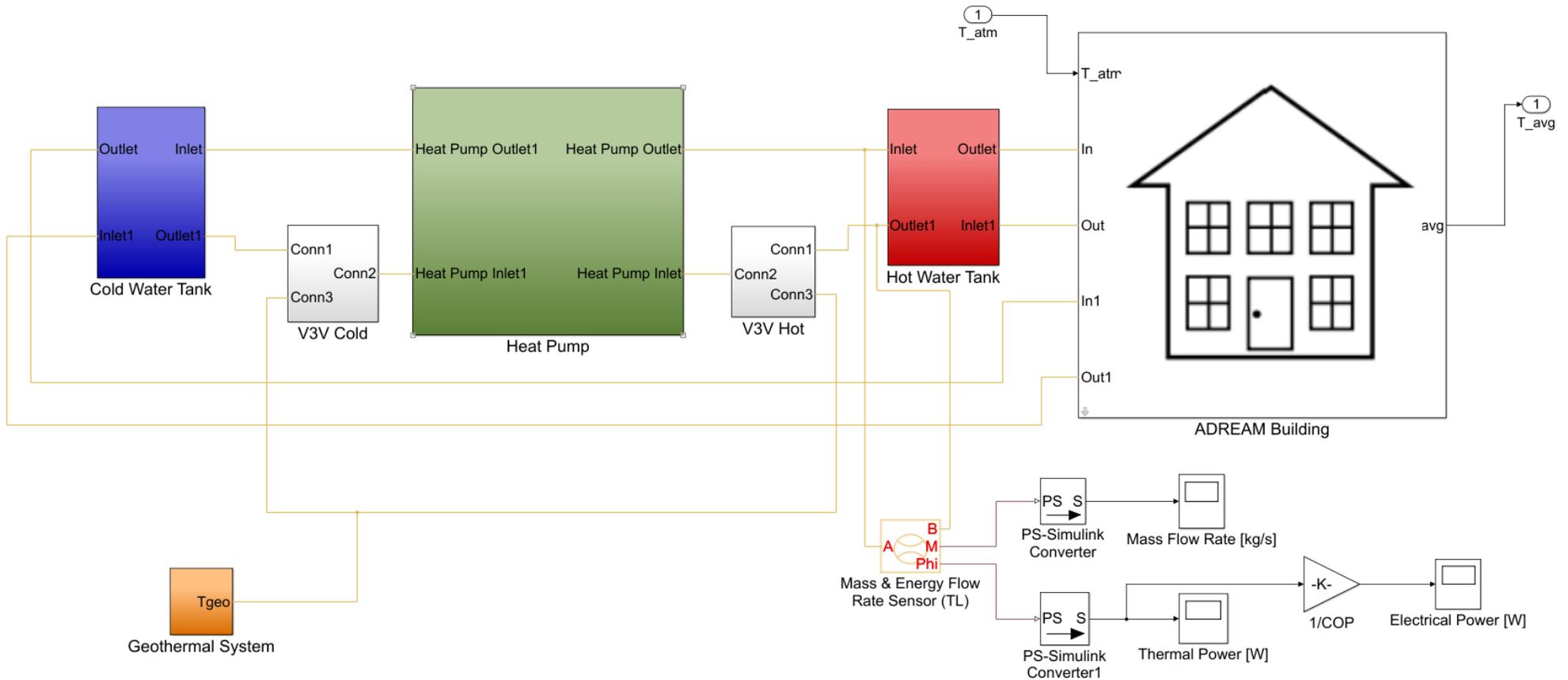
Calibration between real and simulated temperature for a thermal zone (RRMSE = 2,84%)

Consumption Source	Real Consumptions [MWh/an]		Simulated Consumptions [MWh/an]	Relative Error [%]
Heat Pump 1	9,03	35,41	36,49	3,05
Heat Pump 2	16,71			
Heat Pump 3	9,67			
Air Handling Unit	17,79		17,55	1,35
Distribution Pumps	69,64		63,63	8,63
Electronic Equipment	65,77		63,43	3,56
Lighting	12,03		11,89	1,16
<b>TOTAL</b>	<b>200,64</b>		<b>192,88</b>	<b>3,82</b>

Simulated Energy Gain following parametric variation : ~20% by changing the distribution pumps

I. Papas, B. Estibals, C. Ecrepont, Emmanuel Vialan, C. Alonso, Dynamic Thermal Simulation of the ADREAM Smart Building: First results of an Energy Optimization approach, *Journal of Building Engineering*. (accepted with minor revisions)

## Global Model in Simulink Environment



# Our Dream

## 100% Renewable-energies (RE) Workday

*Smart management of 100%-RE, secure and resilient microgrid*

**Today, LAAS energy consumption  $\approx$  6 GWh/yr**  
82% related to the clean room

### LAAS Energy Autonomy

**Energy autonomy  
Building-mobility coupling**

**Energy autonomy of  
ADREAM building**



Short term

Middle term

Long term

## > Open platform

- Access to the dedicated characterization platform, to associated technical support and experimental equipment (solar cells, batteries, inverters, software, etc.) for the testing of new technologies in real conditions.
- Access to the database issued from the 6000 sensors: SYNDREAM open data platform (<https://syndream.laas.fr/>).
- Hosting and training of visiting researchers.

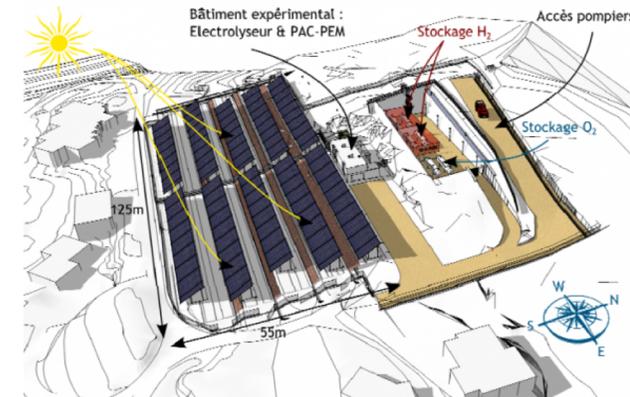
## > Who?

- Academic partners
- SMEs
- Large industrial companies
- Nationally and internationally

- > **Dates:** 01/09/18-31/08/19
- > **Objectifs:** collaboration avec l'Université de Corse sur le développement de travaux communs de modélisation et de simulation des micro-réseaux.
  - **Dimensionnement d'une pile à combustible** appropriée en termes de production de puissance et d'énergie pour le BIPV ADREAM sur la base de l'expérience acquise sur la plateforme MYRTE.
  - **Couplage virtuel des plateformes MYRTE et ADREAM** à travers la modélisation commune. Verrous: grande échelle, modèles complexes pluridisciplinaires, échelles de résolution et de temps de réaction de chaque élément différents.
  - Préparation du **couplage avec la plateforme du G2Elab** apportant une autre complémentarité.
  - **Modèles de prédiction de la ressource solaire.**



**Plateforme expérimentale MYRTE,  
Ajaccio**



*“When we are dreaming alone it is only a dream. When we are dreaming with others, it is the beginning of reality.”*

Hélder Câmara

