

ADEME's Invitation to tender:
« *CLIMATISATION DU FUTUR* »

PV-COOLING



Philippe ESPARCIEUX, Ph.D

ZI de TOULON EST – BP145

83088 – TOULON CEDEX 9

tel.: +33 (0) 494 482 563

e-mail : p.esparcieux@atisys.fr

web : www.atisys-concept.com

PV-COOLING



The New Generation Solar Cooling and Heating Systems
Workshop IEA SHC Task 53–MADRID–April 11-13, 2016

Task 53

What is at stake ?

One cannot get rid of producing cold :

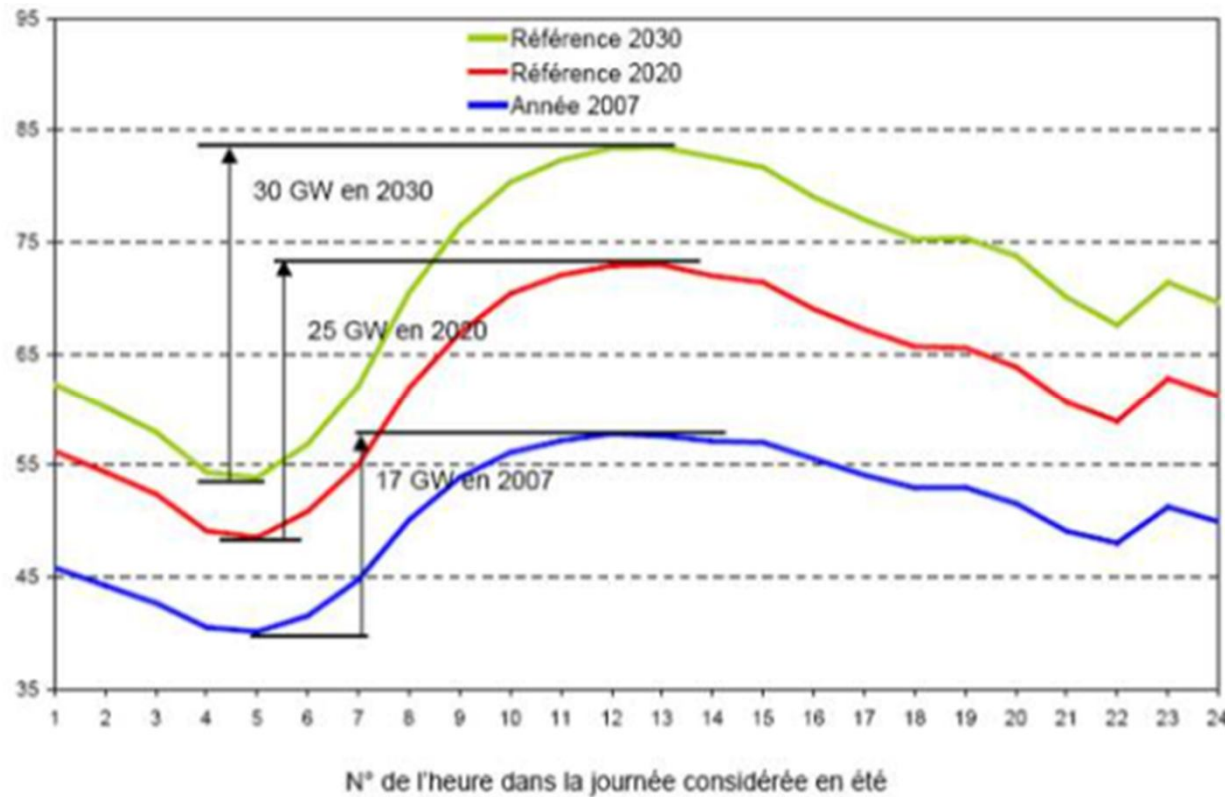
- Summer comfort
- Fragile populations (elderlies, ...)
- Food preservation
- Other industrial use

Effect on energy consumption :

- Availability of power
- Environmental incidences of energy production

What is at stake ?

■ Summer power consumption in France



Typical summer day power need (2007/2020/2030 forecast)

■ Fragility of PDN (Public Distribution Network)

PV-COOLING

What is at stake ?

Environmental problems due to :

- ways of producing energy
- chiller fluid leakage

Energy efficiency improvement :

- thermodynamic chiller feeding
- heat transfer fluid regime

PV-COOLING response

Use **low GWP fluid** in thermodynamic system

Use **renewable energy** for powering chiller

Adapt heat transfer fluid **temperature regime** and **heat exchangers dimensioning** for optimal efficiency

Goal of the project

Produce cooling effect using low GWP* thermodynamic system (propane C_3H_8) coupled to **PhotoVoltaic (PV)** plant for driving, monitoring and supervision.

*GWP: global warming potential

Technical justification

Energy efficiency :

- matching of need and renewable resource
- investigate innovative regimes of temperature and energy storage

Environmental efficiency :

- use low GWP fluid
- peak shaving by solar PV self-consumption

Economical justification

geographic areas

- French oversea territories (DOM/TOM)
- Maghreb, Middle East
- Southern Europe
- Australia, USA
- Southern France (Riviera, Corsica...)

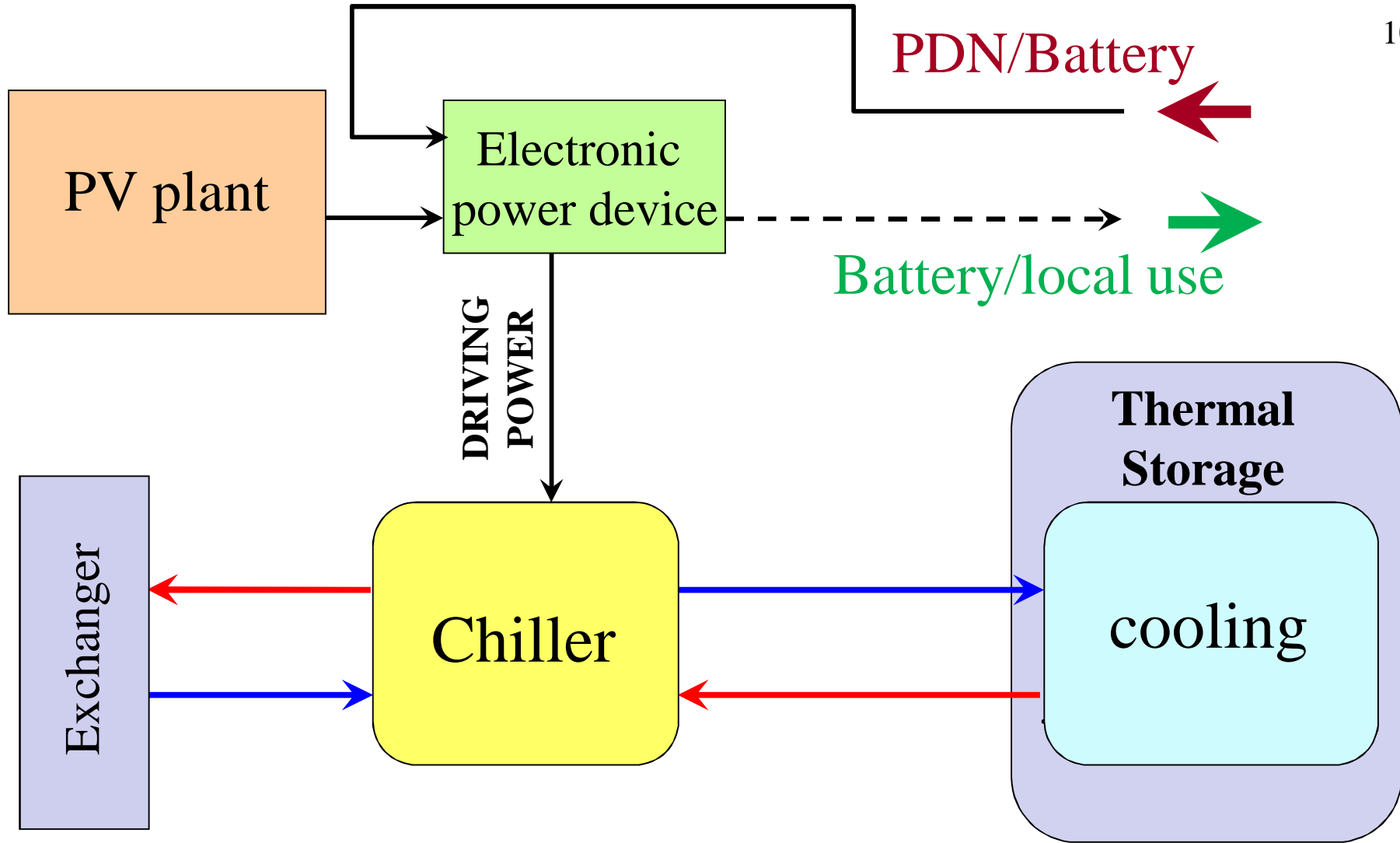
Electric problem

9

Compressor power supply needs being secured by external reliable complement (PDN, battery storage, ...)

- Possible **power complement** provided by external supply (PDN, battery)
- PV **power excedent** is used for thermal energy storage or local inner use
- **power excedent** not injected to PDN because perturbations

PV-COOLING



PV-COOLING

The thermal problem

11

- Define acceptable COP **chiller compressor working domain** (adjustable power)
- Analysis of **heat transfer fluid** regime for optimizing performances
- Storage and distribution **management**
- **Dimensioning** whole system

Role of partners :



12

35 years expertise dedicated to Solar Energy and International
Expert on the topic of Solar Cooling (EU, AIE)

Role of **TECSOL** within the project :

- Market survey of **PV-COOLING** approach
- Practical feedback and know-how on cooling and PV engineering from French oversea territories (Antilles, Réunion)
- overall system architecture designer (self-consumption)
- PV plant designer
- Participate to test rig performance analysis
- Scientific communication on **PV-COOLING**

PV-COOLING

Role of partners :

13

More than 30 years expertise dedicated to heat exchangers technology & design, heat transfer and cooling system

Role of **NeoTHERM** within the project :

- Thermal architecture and conception of the system
- **Thermal & Energetic Simulation**
- Heat Exchanger **Technology choice** (low fluid load, high performance)
- Heat Exchangers **design** and **integration** of test rig system
- Participate to test rig **performance analysis**
- **Scientific communication** on PV-COOLING

Role of partners :

14

More than 25 years expertise in designing **special thermodynamic equipments** dedicated to many different areas

Role of **EED** within the project :

- advice on compressor technology and choice
- design and produce chiller
- participates to test rig installation
- participate to test rig performance analysis

Role of partners : ATISYS Concept

www.atisys-concept.com

25 years expertise in designing and implementing **innovative systems**

Role of ATISYS within the project :

- Overall coordination of the project
- Design and produce chiller power feeding unit
- Design and implement management strategies of the system
- Manage experimental set-up installation
- Participate to test rig monitoring and performance analysis
- Participate to scientific communication

PV-COOLING

Diary

16

- To: **kick-off**
- To + 4 months : overall **specification** of test rig system
- To + 8 months : begining of **installing test rig** system
- To + 12 months : begining of **on-site validation**
- To + 18 months : final report on test rig **system performances**

Conclusion

17

- Evidence has been given that **electric coupling of power consuming machine and PV plant** is possible and adaptive coupling has been demonstrated *
- **PV-COOLING actual innovation** mainly consists of setting together a clever way improved components : PV plant, low GWP fluid chiller, optimized exchangers
- Time to experiment with actual thermodynamic system
- Application to realistic set-up is on its way

*see ATISYS presentations:

IEA Solar Heating and Cooling meeting (sept 23 2015, ROMA)

IEA SHC conference (2-4,Dec. 2015, ISTAMBUL)



PV-COOLING



**The New Generation Solar Cooling and Heating Systems
Workshop IEA SHC Task 53–MADRID–April 11-13, 2016**





Task 53 

SPARE SLIDES

Preliminary tests

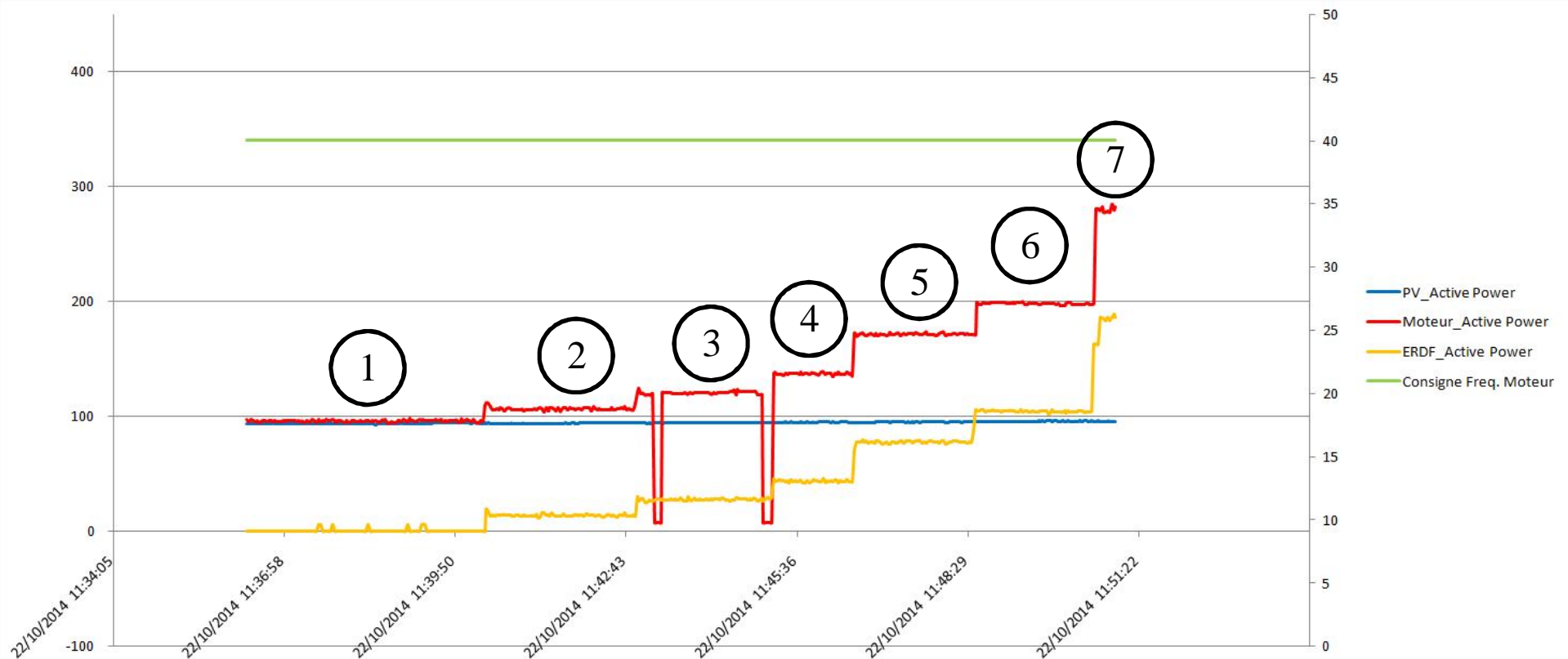
20

For understanding next graphes:

-  PV power (W)
-  Motor active power (W)
-  PDN active power (W)
-  motor speed (rpm)

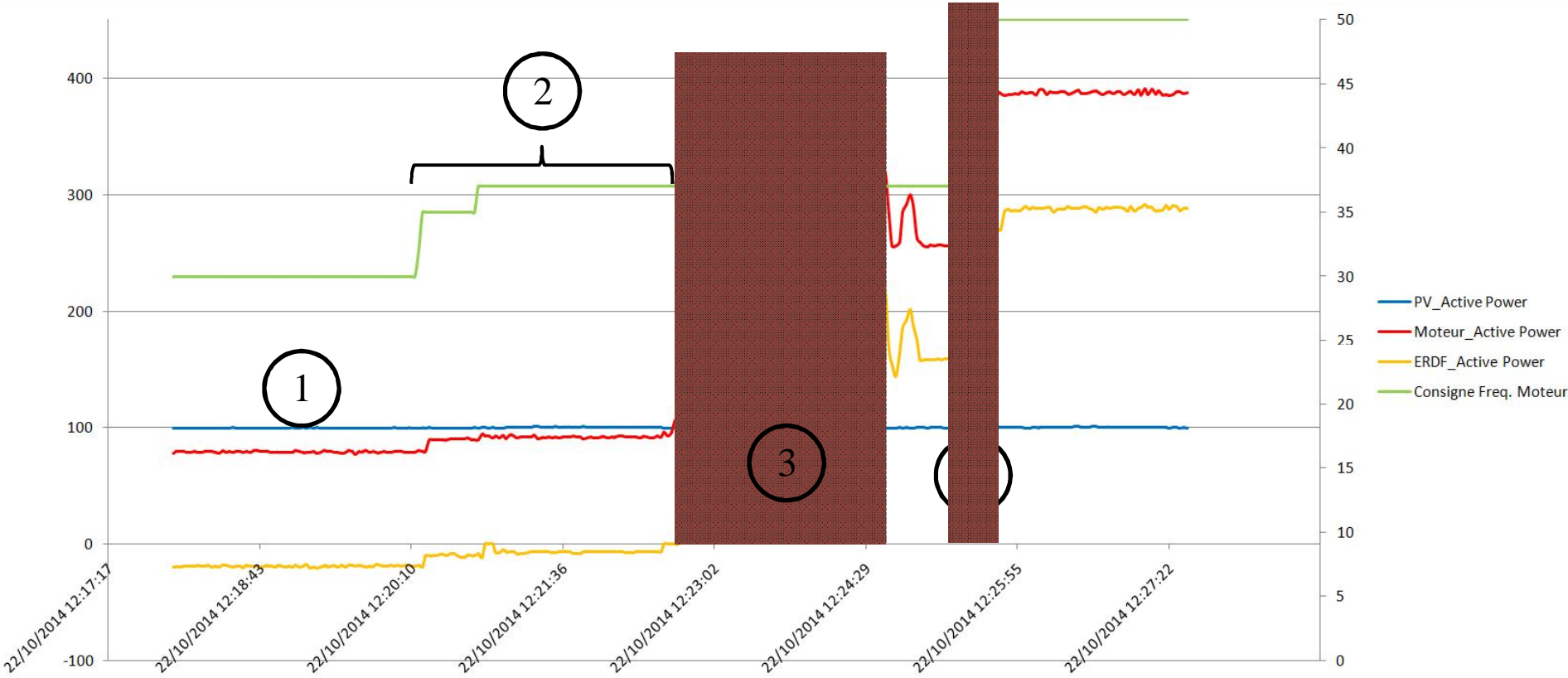
Constant speed (rpm), variable load

21



PV-COOLING

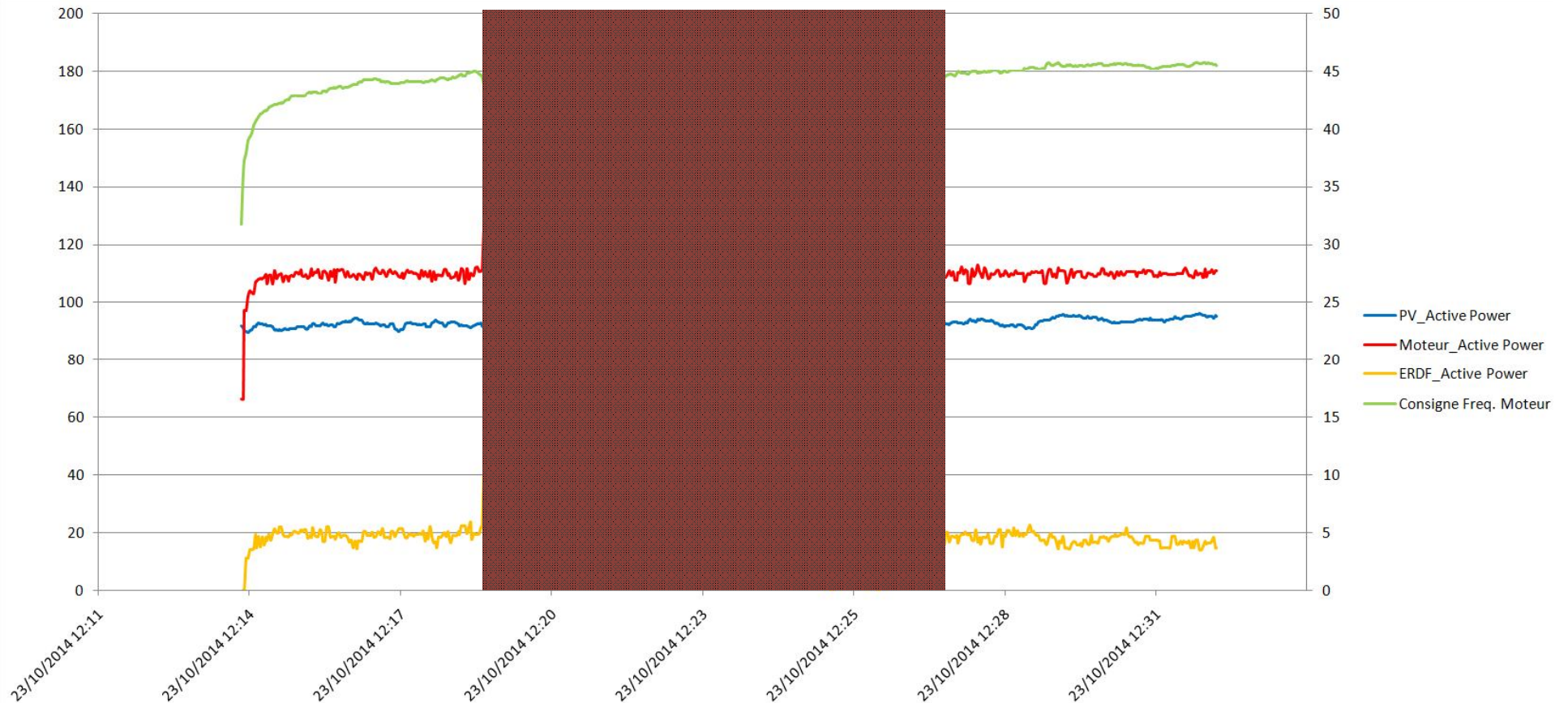
Constant speed (step by step) variable load



PV-COOLING

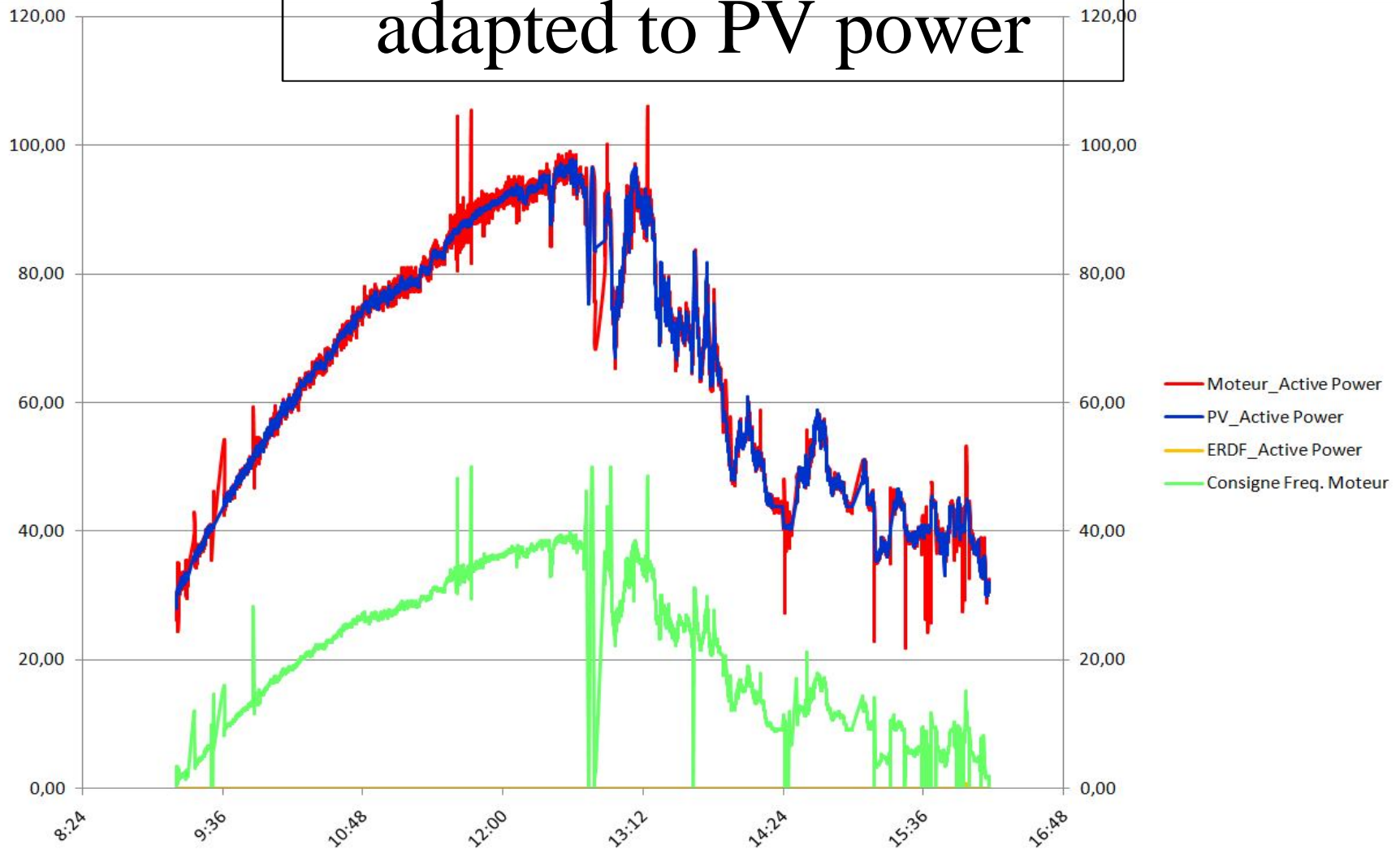
Constant motor power variable load

23



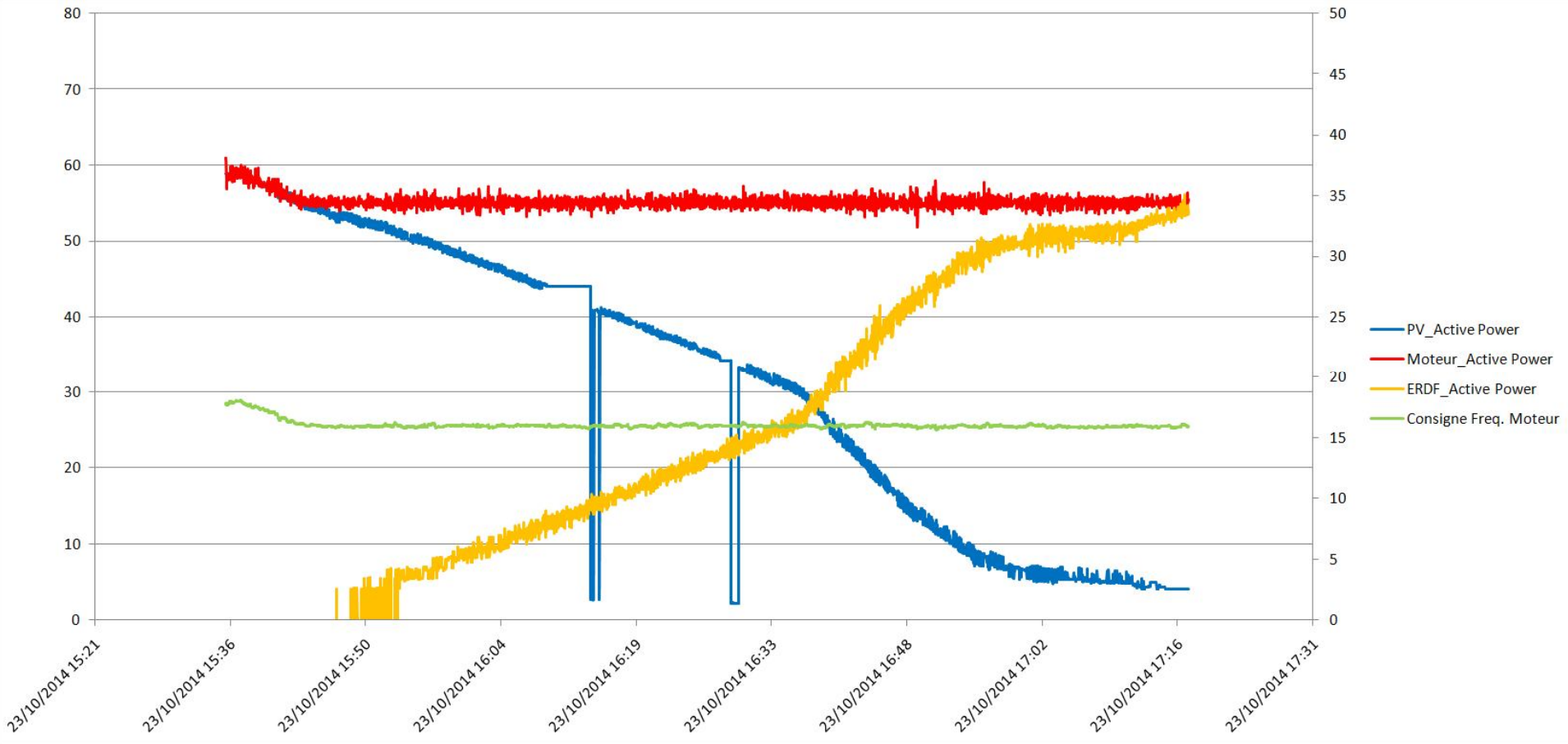
PV-COOLING

Motor speed adapted to PV power



PV-COOLING

solar extinction Constant power request



PV-COOLING

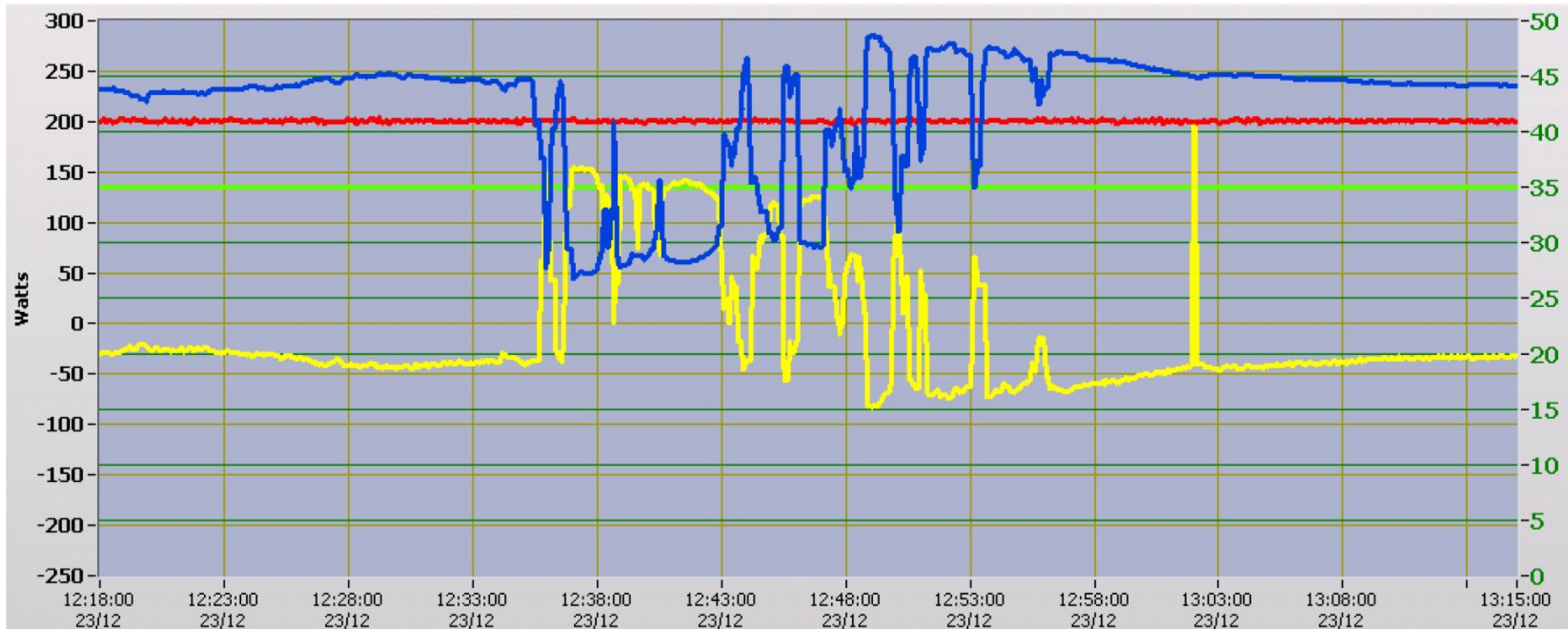


The New Generation Solar Cooling and Heating Systems
Workshop IEA SHC Task 53–MADRID–April 11-13, 2016



Automatic regulation (cloud obstruction)

26



puissance PV

puissance active moteur

puissance active réseau (<0 : injectée ; >0 : consommée)

vitesse moteur (Hz) échelle de droite

-COOLING

Conclusion of preliminary tests

27

- Evidence has been given that electric coupling of power consuming machine and PV plant is possible
- Adaptive coupling has been demonstrated
- No reason for not working with thermodynamic system
- Application to realistic set-up is on its way