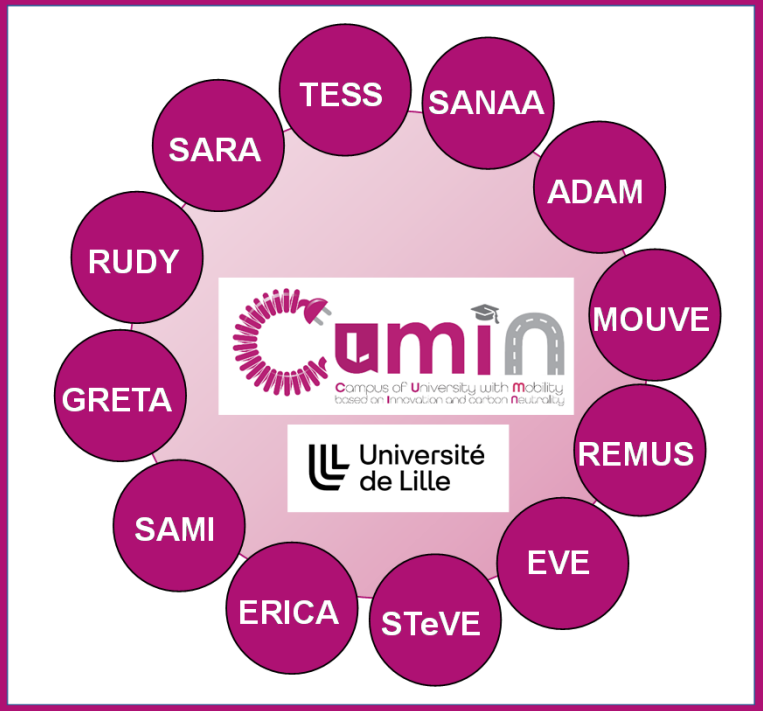
https://cumin.univ-lille.fr/



CUMIN - SAMI

Charging stations of electrified vehicles using PV panels

Salma Fadili (ULille, L2EP)
Alain Bouscayrol (ULille, L2EP)
Philipe Delarue (ULille, L2EP)
Nicolas Ferlay (ULille, LOA)

Outline

1. SAMI project
2. Sizing
3. Final Prototype
4. LOA activities

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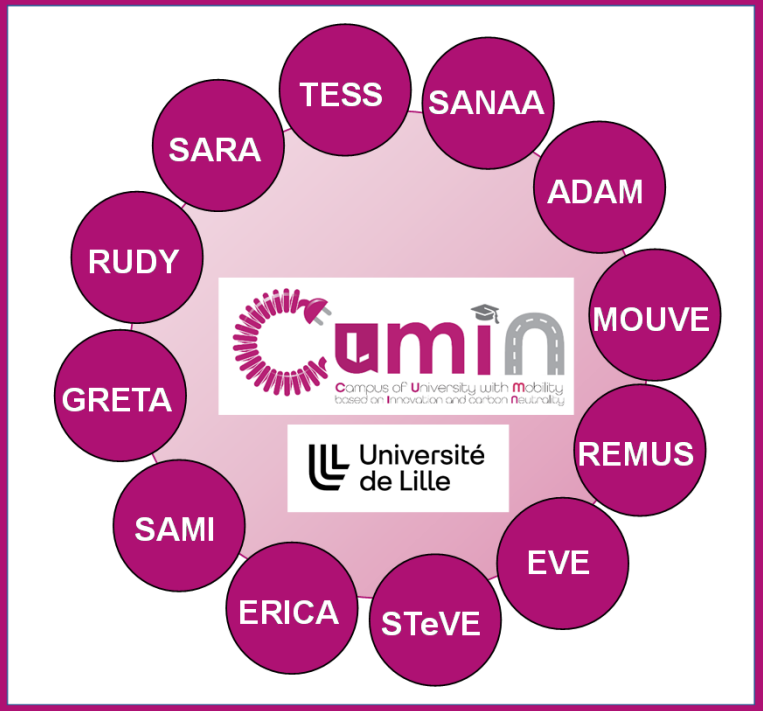
CUMIN - SAMI

Study of Autonomous charging stations of light e-Mobility for low environmental Impact (SAMI).



Specifications

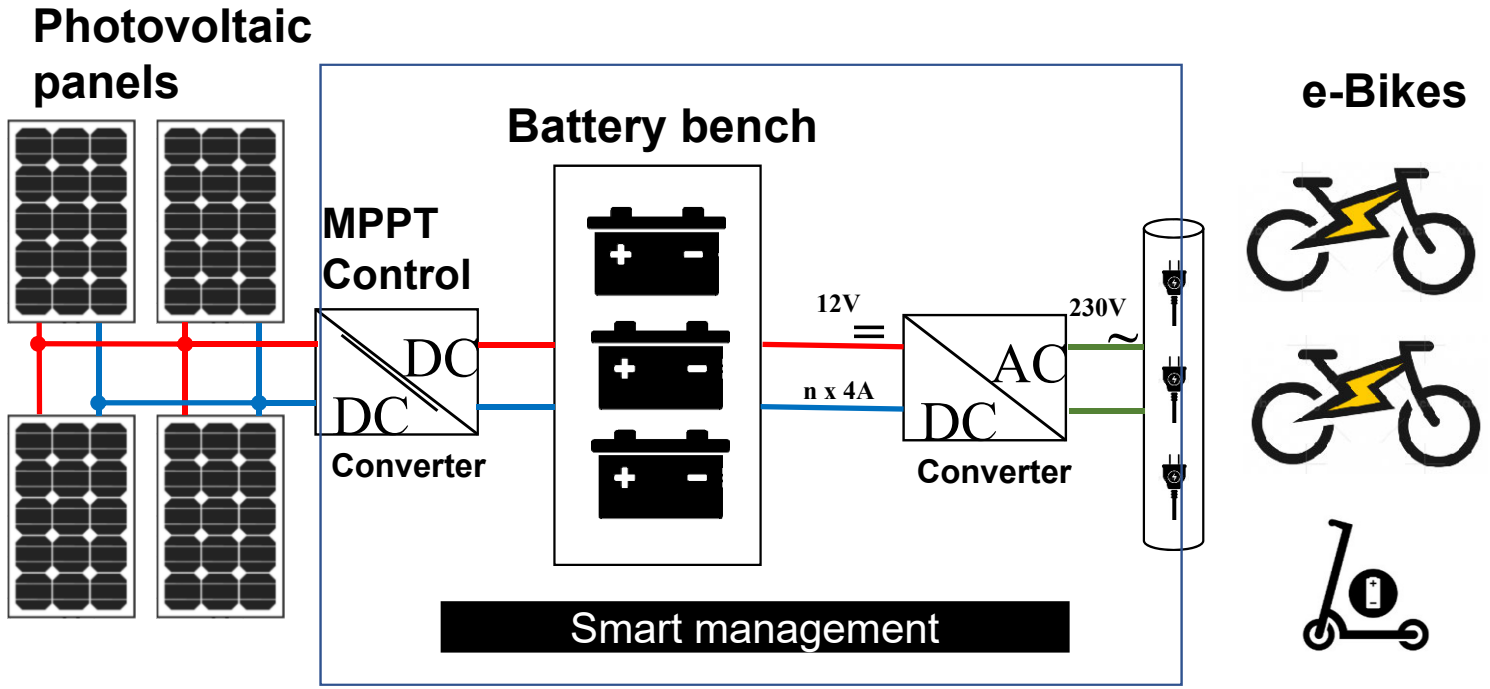
➡ Build a demonstrator of an autonomous charging station for light electric vehicles, based on renewable energy.

Demand

- The demonstrator would be placed at « cité scientifique » Campus.
- The charging station is completely off-grid.
- The energy needed is provided solely by photovolatic panels.
- Docking for 3 e-bikes or equivalent.
- Room for 2 m² of PV panels.

Synoptic of the demonstrator

The demonstrator is flexible in terms of sizing, usage and placement and can be extended to fulfill different objectives for different projects.



Flexible surface | Adapted storage | Multiusage system

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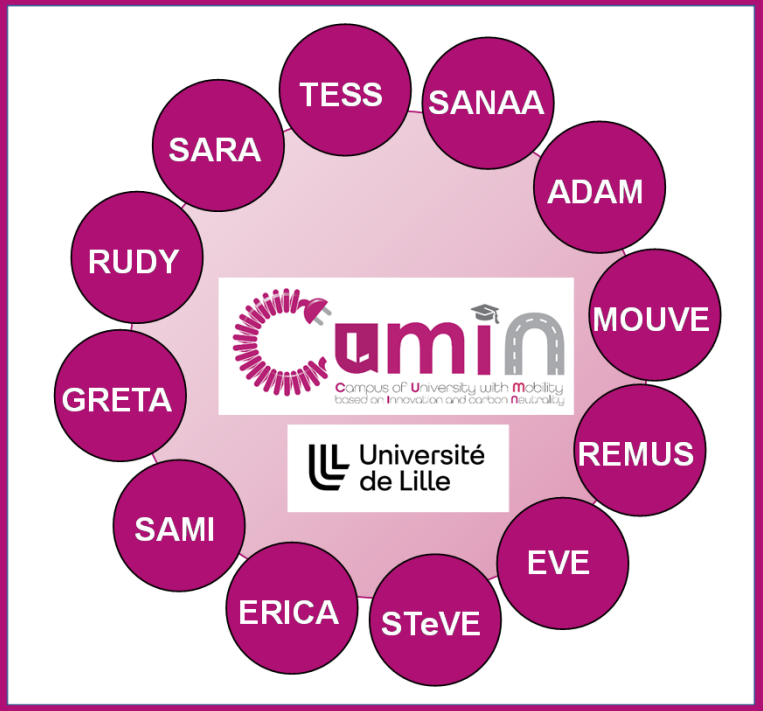
CUMIN - SAMI

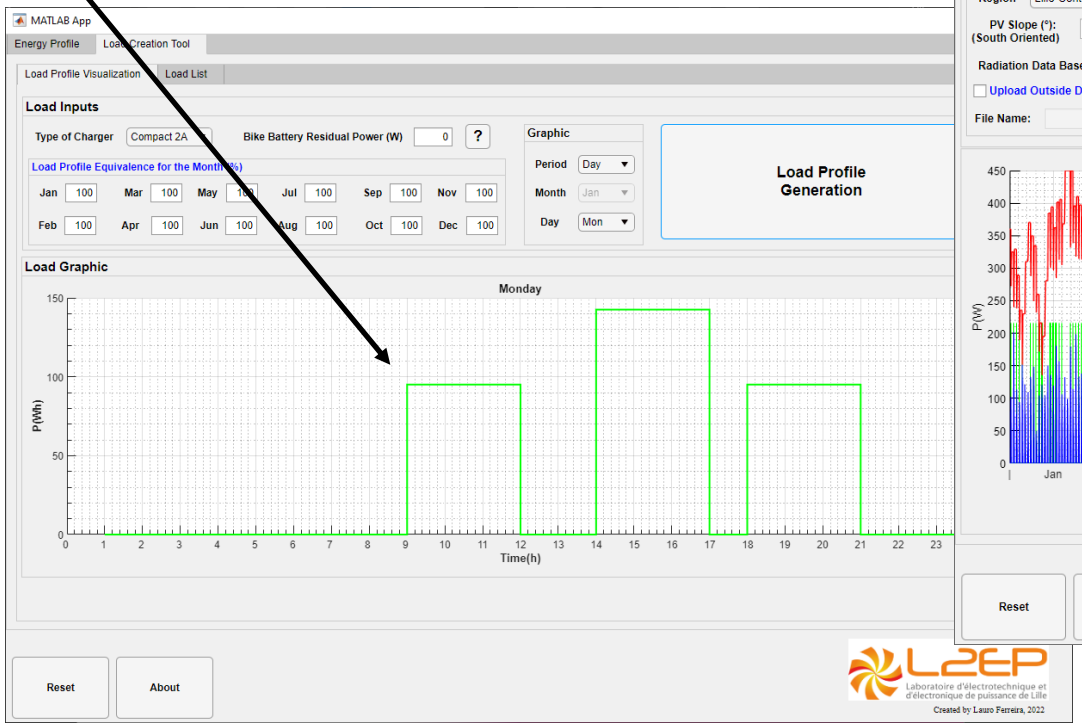


Sizing

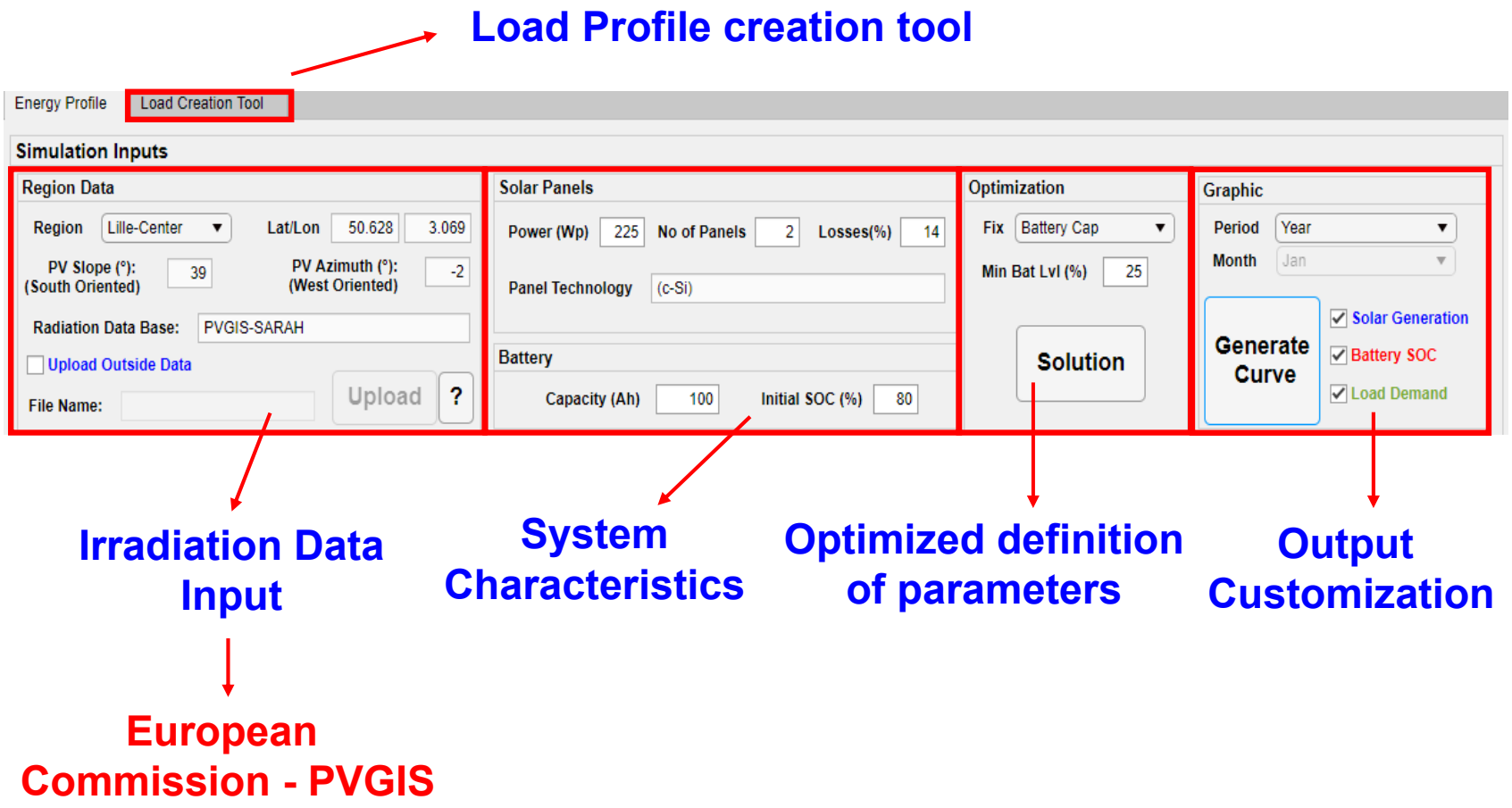
System sizing

- Interface tool developed with MATLAB GUI (Graphical User Interface)
- Based on the PVGIS satellite database

Daily charging profile

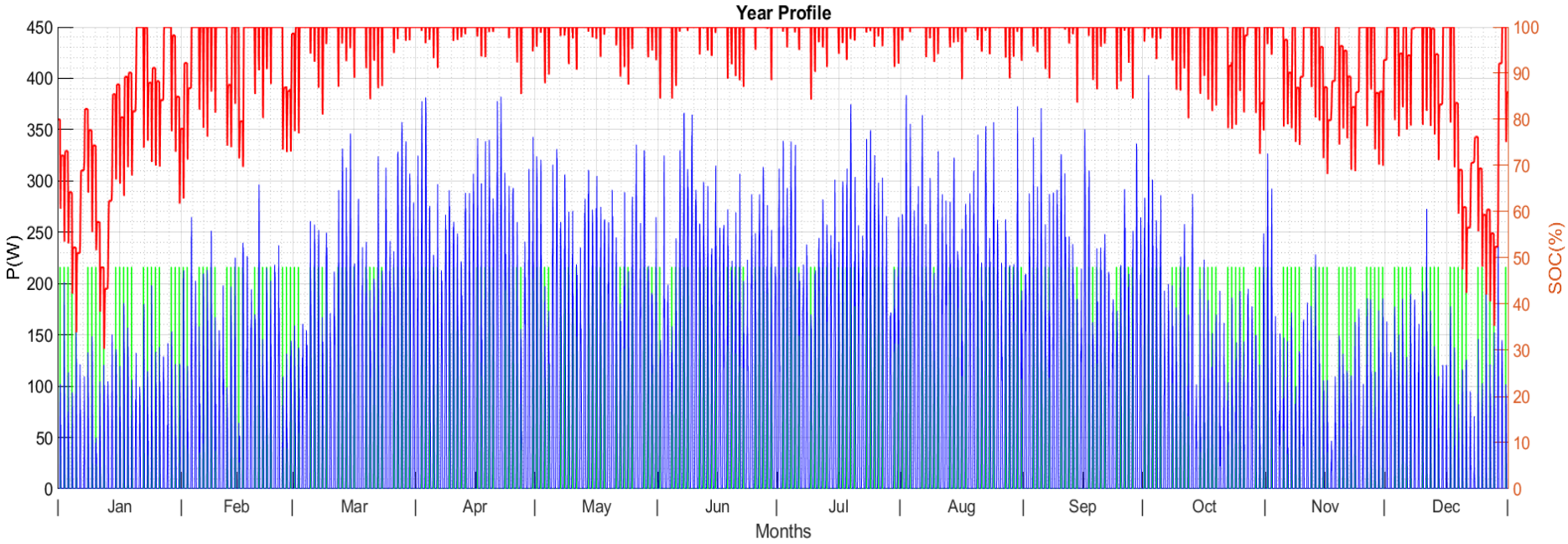


Interface usage



Simulation results

- Location - University of Lille, **Cité Scientifique**
- Battery Capacity - **100Ah, 12V** \\ PV Panel Power **- 2 x 225W**
- Load Profile (Workday) **- 3 bikes** charging from **9 am to 6 pm** with **66%** of SOC



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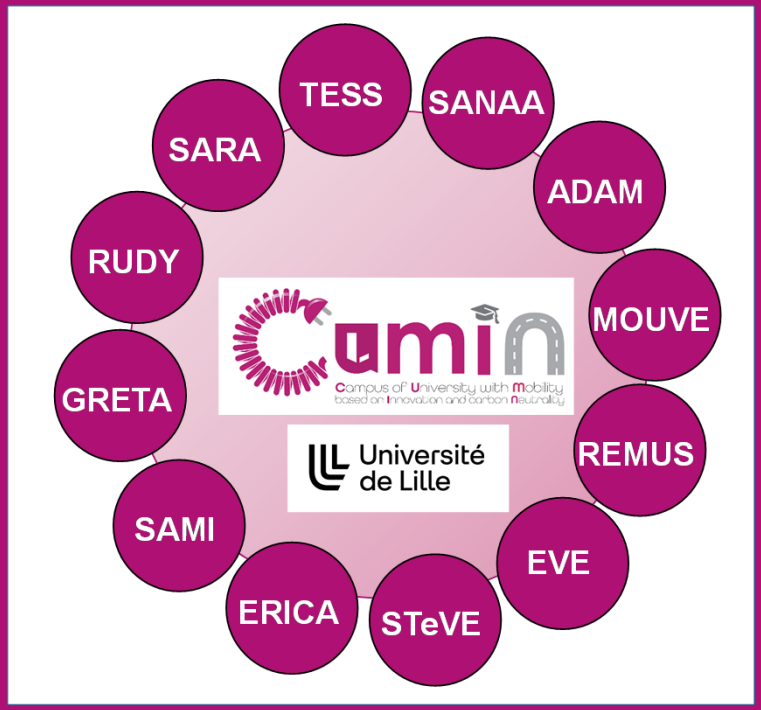
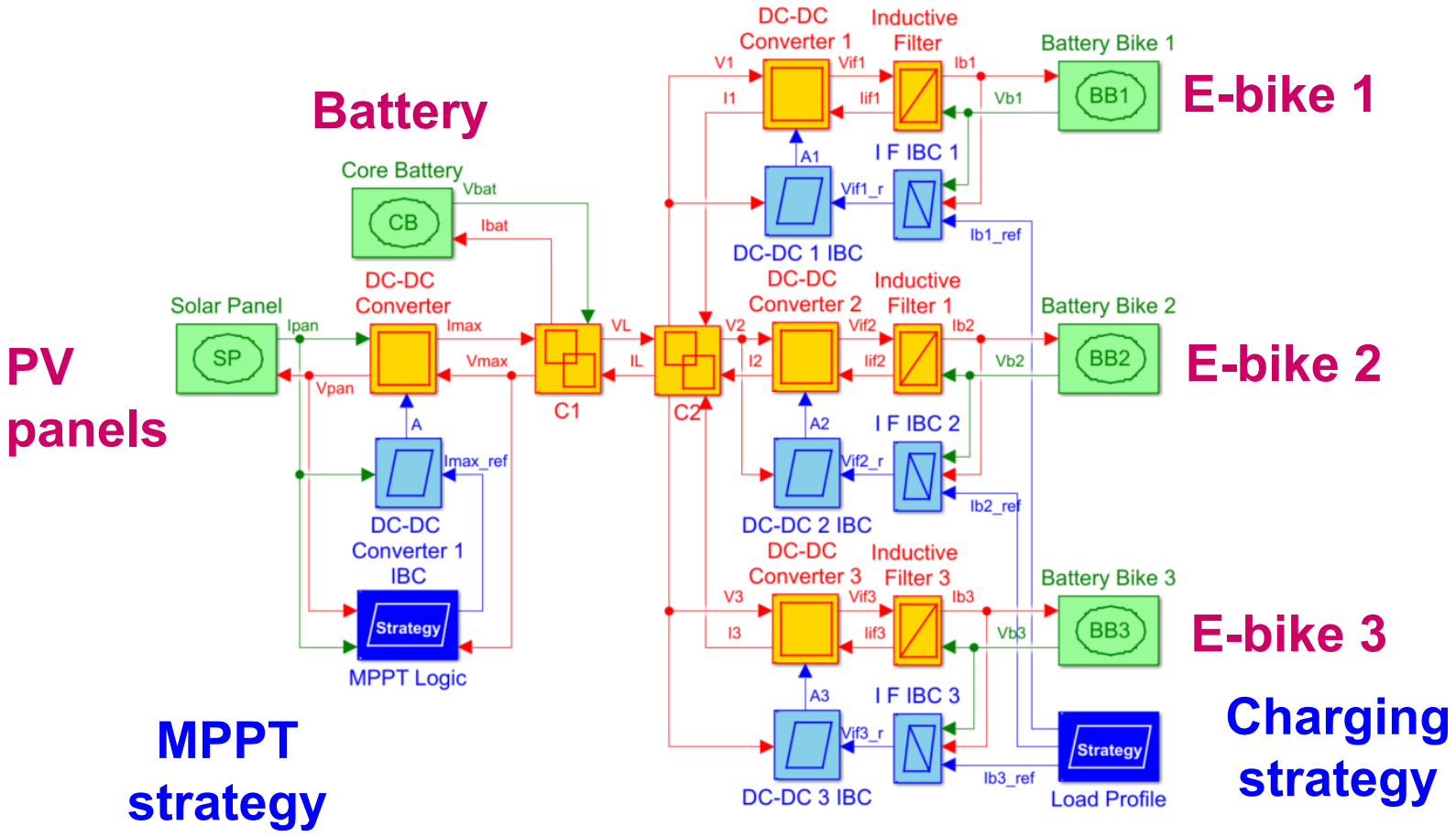


CUMIN - SAMI

Final prototype

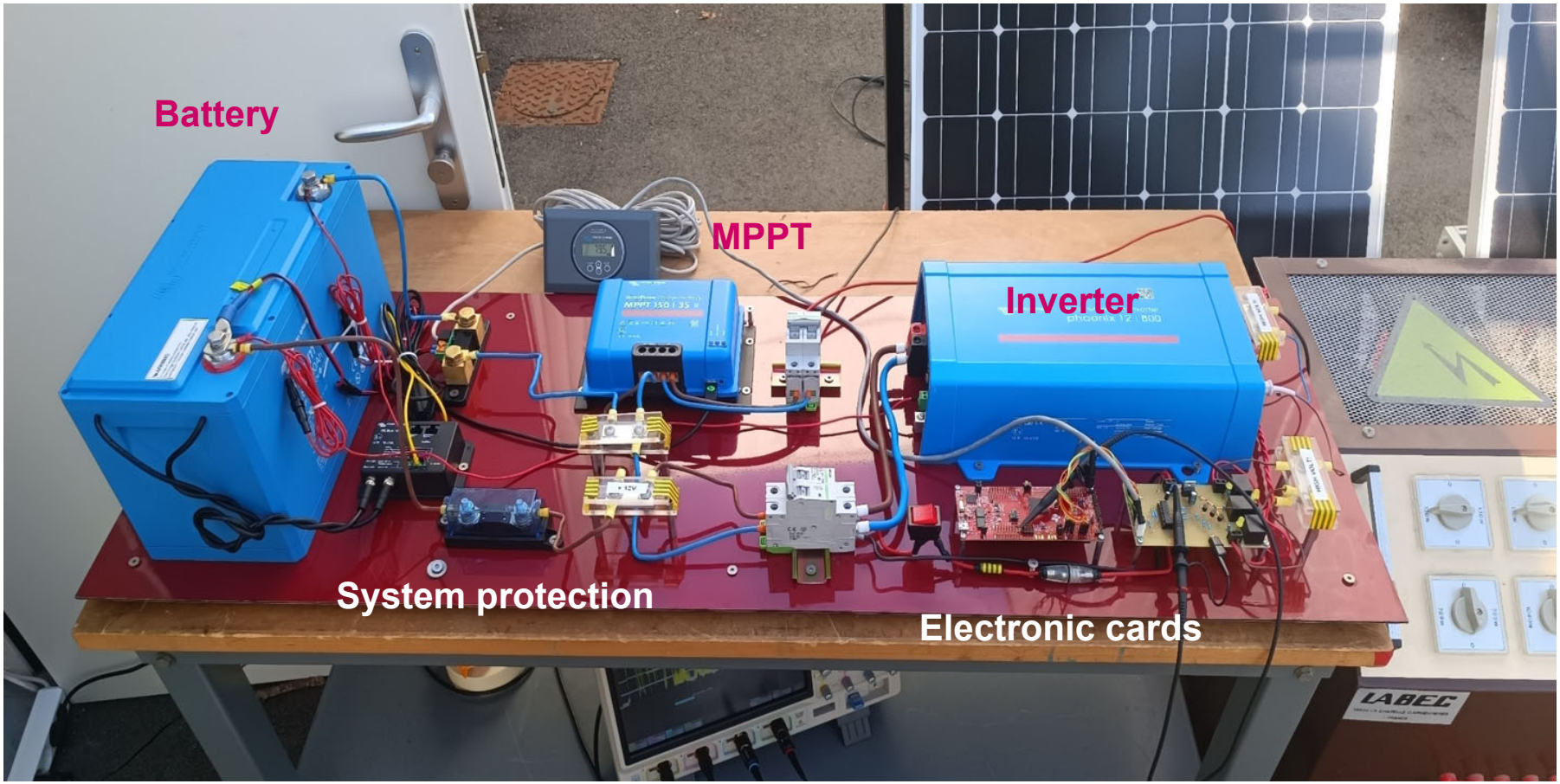
Simulation of energy flow

- Energetic Macroscopic Representation (EMR)
- Simulation on Matlab-Simulink ©



Energy conversion system

The prototype of the energy conversion system



Final prototype

Solar panels

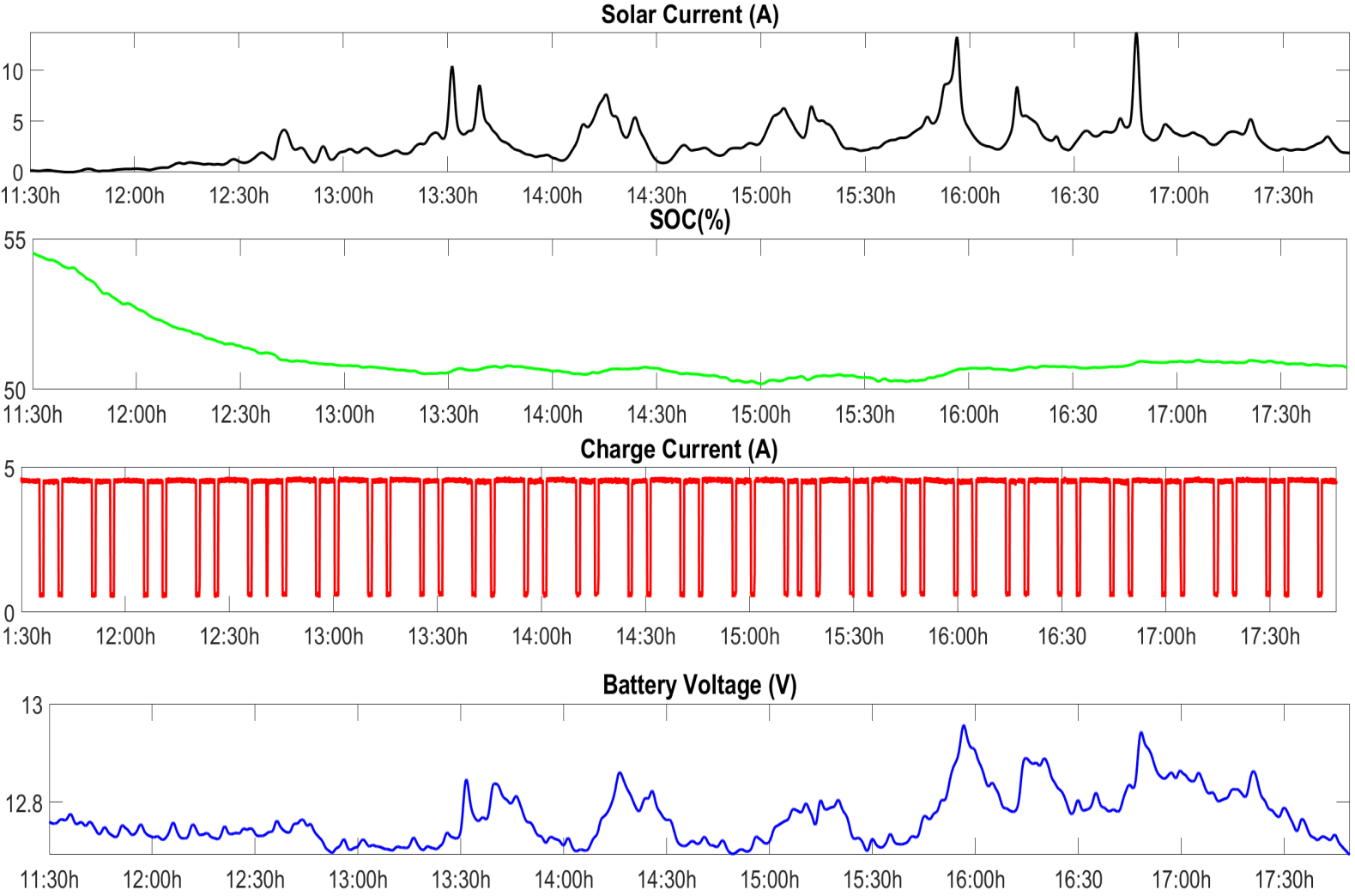
Energy conversion system

Electric scooter

Electric bike 1

Electric bike 2

Example : measurements of july 21st 2022 (cloudy sky)



- Peaks of sunlight during the day
- The SoC stays between 55-50% thanks to the strategy used
- The SoC is lower than 60% → one vehicle charging at a time
- The voltage is related to the state of charge

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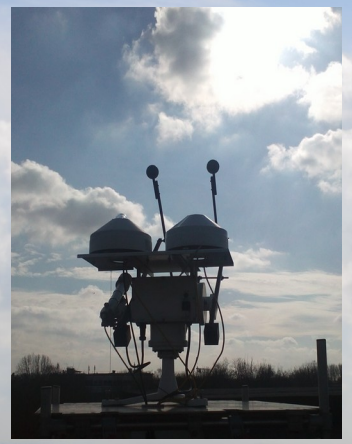
CUMIN - SAMI

LOA activities

Research activities toward a better characterization and exploitation of the solar resource, particularly with photovoltaic systems:

ground-based measurement facility, exploitation of atmospheric modellings, and some perspectives at the LOA laboratory, in connection with the CUMIN project



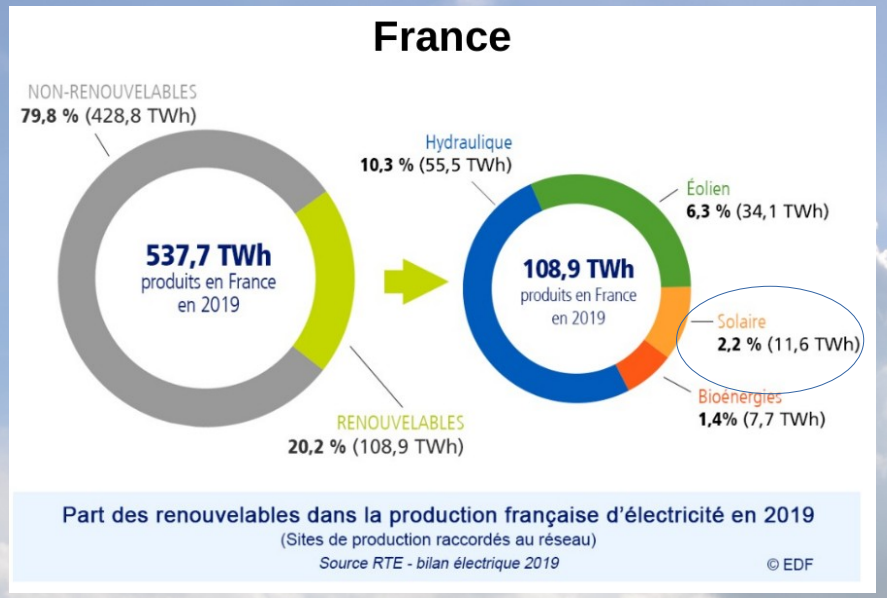
Nicolas Ferlay
Associate professor

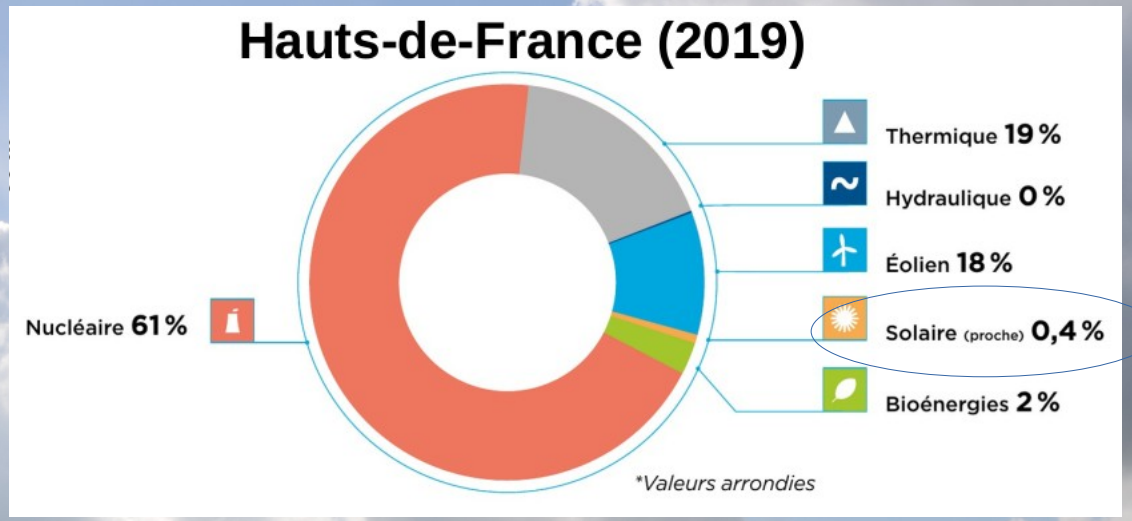
Laboratoire d'Optique Atmosphérique (LOA)
Physics Department
Batiment P5, Cité Scientifique,
Villeneuve d'Ascq

Université de Lille

CONTEXT & MOTIVATIONS

Much less installed photovoltaic capacities in Hauts-de-France as compared to other regions and countries (Belgium and Germany)





rate of PV production in 2020

France: 3%

Belgium: 4% E.U. : 5%

Germany: 8%

CONTEXT & MOTIVATIONS

Much less installed photovoltaic capacities in Hauts-de-France as compared to other regions and countries (Belgium and Germany)

despite :

a regional dynamism

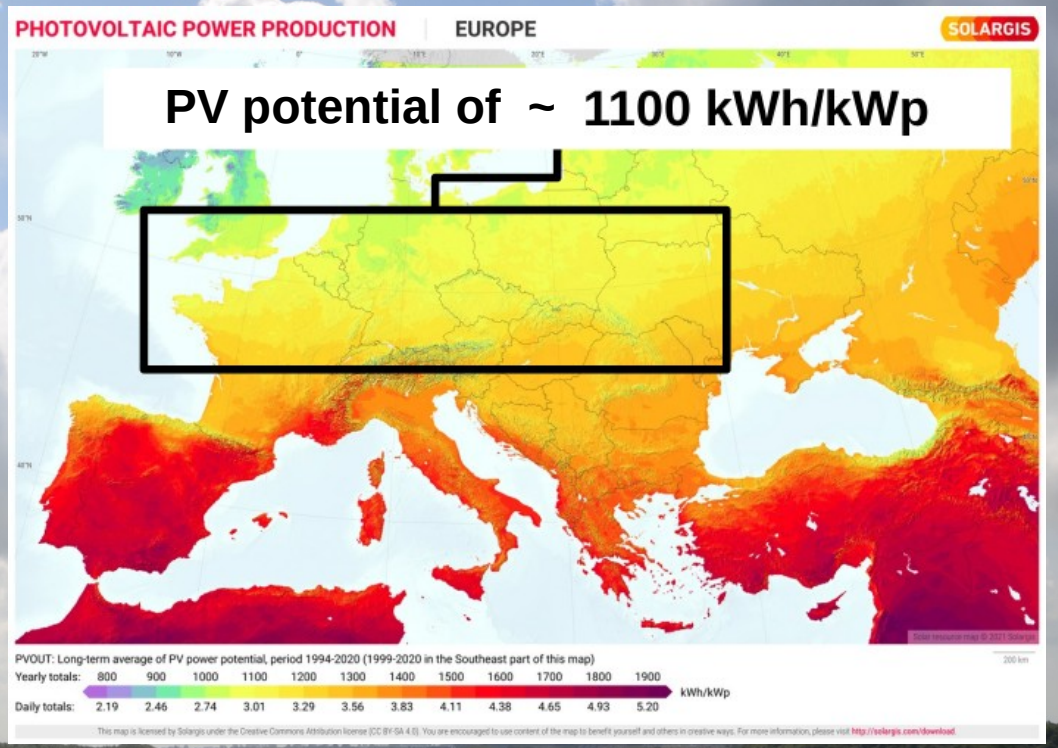
CORÉSOL
Le collectif régional de l'énergie solaire

reu3

CD2e
ACCÉLÉRATEUR
DE L'ÉCO-TRANSITION

… For sure, there is a challenge, a need to optimize the exploitation of the solar resource in HdF ...

a not so weak solar potential



MOTIVATIONS & QUESTIONS

- Climatology of the solar resource, understanding of intra- and inter-annual variabilities, its spatio-temporal variability
- Partition of solar energy between clear sun and cloudy moments, direct and diffuse radiation fields
- Sensitivity of solar energy to the atmospheric content
- Quantify the Direct Radiative Effect (DRE) of aerosols and clouds

- Accuracy of satellite based products (atm. content, surface solar irradiance)

- Estimation of the solar irradiance on tilted surfaces

- Solar and atmospheric environment in the future?

- Efficiency or load factor of photovoltaic systems under real working conditions: actual values (compared with reference), dependence?
- Forecast of surface solar irradiance and PV power

MOTIVATIONS & QUESTIONS

- Climatology of the solar resource, understanding of intra- and inter-annual variabilities, its spatio-temporal variability ***XX***
- Partition of solar energy between clear sun and cloudy moments, direct and diffuse radiation fields ***XX***
- Sensitivity of solar energy to the atmospheric content ***XX***
- Quantify the Direct Radiative Effect (DRE) of aerosols and clouds ***X***

- Accuracy of satellite based products (atm. content, surface solar irradiance) ***X***
- Estimation of the solar irradiance on tilted surfaces ***X***

PhD thesis of G. Chesnoiu (2020-2023)

- Solar and atmospheric environment in the future? ***Work in progress***

- Efficiency or load factor of photovoltaic systems under real working conditions: actual values (compared with reference), dependence? ***Short term perspective***
- Forecast of surface solar irradiance and PV power ***Long term perspective***

RESEARCH ACTIVITIES AT LOA

- Study of atmospheric components and their interactions with solar and terrestrial radiation fields
- Expertise in radiative transfer modelling and simulation
- Expertise in airborne and spaceborne remote sensing
- Expertise in ground based measurement and remote sensing (photometry, lidar, radiometer, spectrometer) to characterize aerosols, water vapor, clouds

SOME OF IT FOCUSE ON SOLAR RADIATION

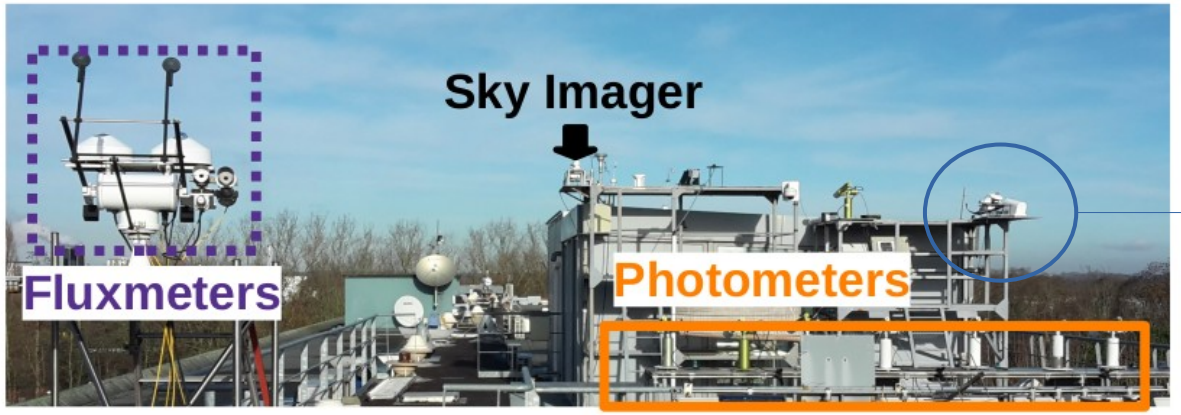
- Ground based measurements of surface solar irradiance since 2009
- Developments since 2015 :
  - 3 L3, 1 M1, 3 M2 internships
  - A phD thesis (3rd year) financed by Region HdF and ADEME
  - Some accompanying grants (LEFE/INSU), CPER Climibio
  - Acquisition of new instruments ((spectro)radiometer, sky imager) and development of modelling tools
  - Collaboration with HYGEOS (Lille, Euratech), CNRM, with CUMIN (2022)

ATOLL platform

+ Solar flux on tilted surface
+ spectroradiometer EKO MS711

ATOLL measurements

Use of a unique data set for the Hauts-de-France region of coincident aerosol and radiation measurements from the ATOLL platform in Lille over the period 2010-2020.



View of the instrumental platform ATOLL (Atmospheric Observations in Lille) located on the roof of the P5 building of the University of Lille, Villeneuve d'Ascq, campus Cité scientifique.

Additional measurements:

- Sky imager since 2009
- Surface concentrations (PM_{10} et $PM_{2.5}$, ATMO-HdF) and chimical composition of NR-PM_1 by an ACSM (SO4, NO3, NH4, Org) and aethalometer (BC)

AEROSOLS

Photometer CIMEL AERONET/PHOTONS

- Aerosol Optical Depth (AOD) and Angström Exponent (AE) in Clear-sun conditions
- Inversions of the size distribution and absorption properties of aerosols

SOLAR ENVIRONMENT

Kipp & Zonen fluxmeters (since 2009) – 1-min resolution

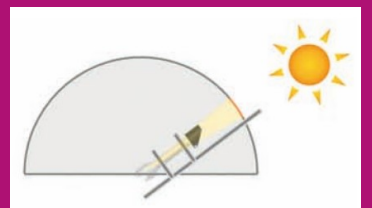
Pyrheliometer (CH1)
Direct incident radiation, DNI

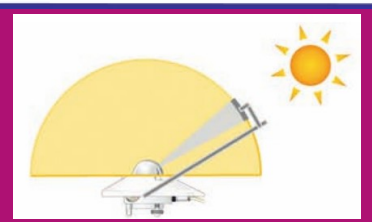
Pyranometer (CMP 22)
Diffuse irradiance, DHI

↓

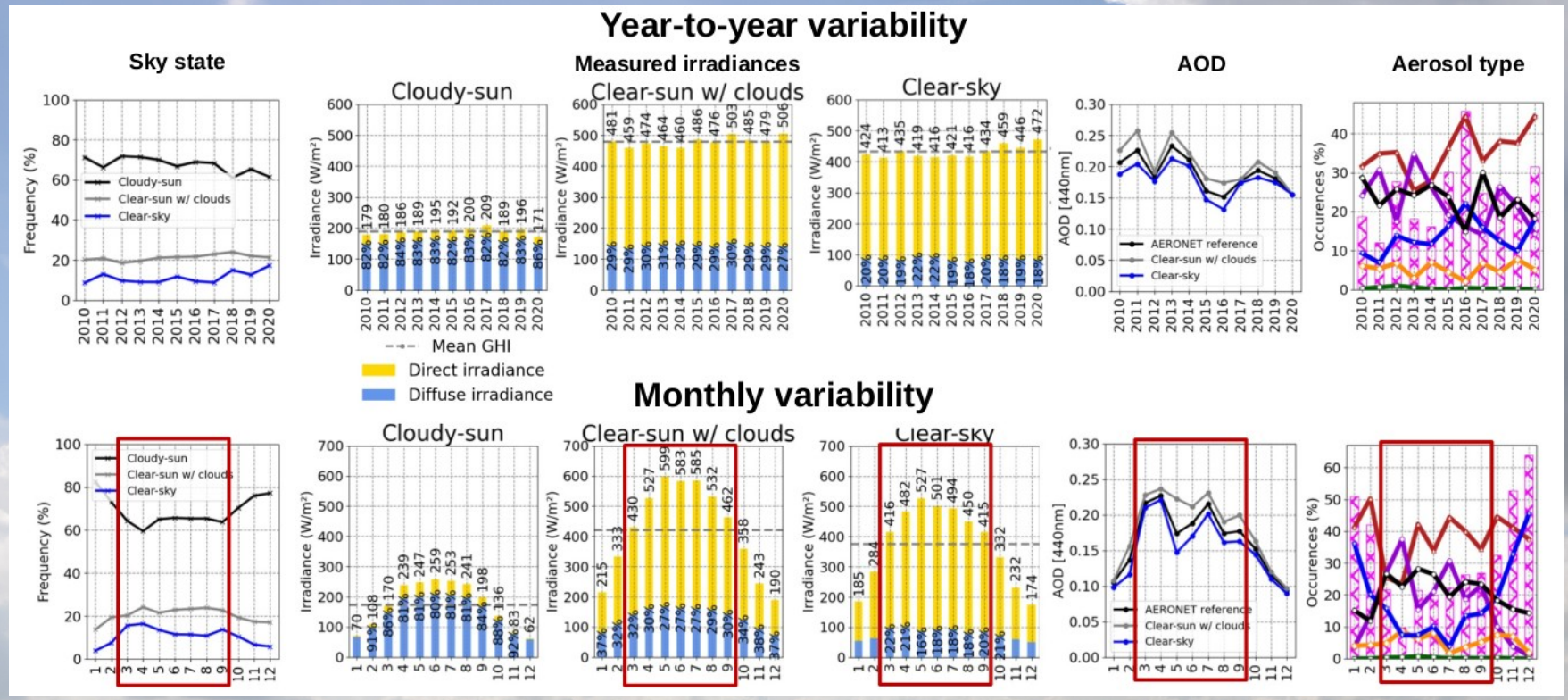
Beam horizontal irradiance
(BHI) = cos(Θs)*DNI

→ Global irradiance, GHI = BHI + DHI





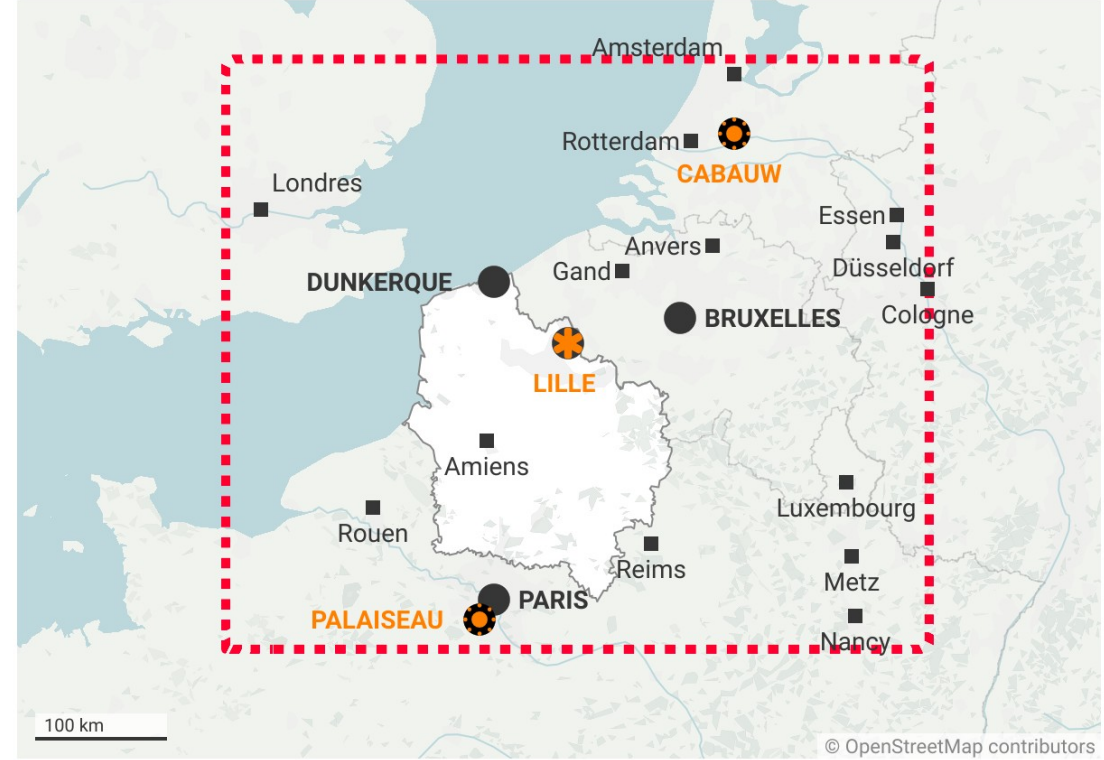
- Climatology of the solar resource, understanding of intra- and inter-annual variabilities, its spatio-temporal variability
- Partition of solar energy, occurence of clear/cloudy situations



- Clear-sun detection using Battles et al. (2000) :
  → **33% of situations** on average although they produce **54% of the total energy** received in a year and **84% of the direct energy**
- Clear-sky detection using a revised algorithm from Garcia et al. (2014) :
  → **11% of situations** on average over 2010-2020

- Climatology of the solar resource, understanding of intra- and inter-annual variabilities, its spatio-temporal variability

Study area



Use of the atmospheric model **ALADIN-climat** from and in collaboration with CNRM (Centre National de la Recherche Météorologie,Toulouse) (12km, 1 hour)

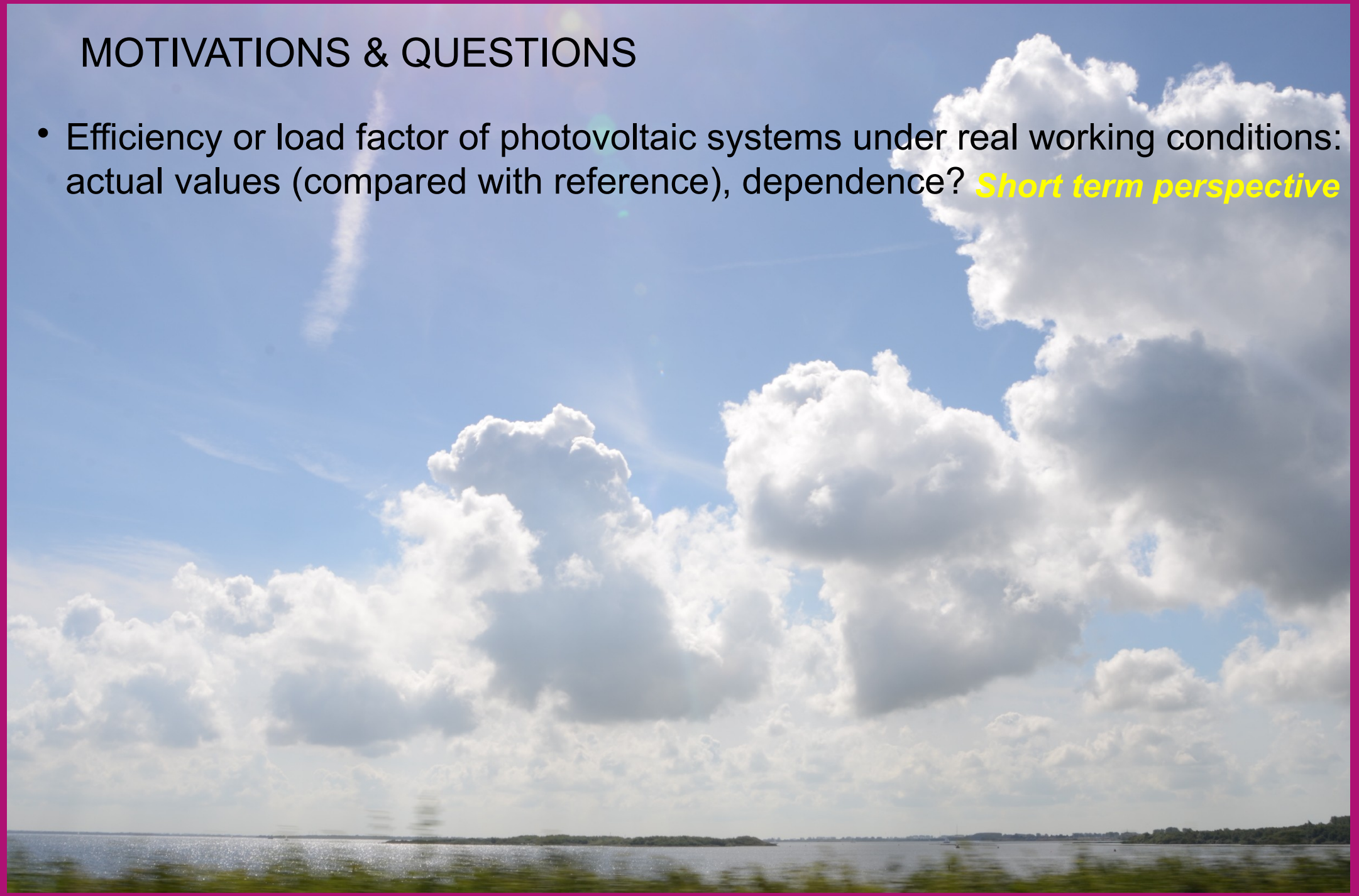
As a regional model
As a climate model (horizon : 2100)

(radiation, clouds, particle pollution)

PhD thesis of G. Chesnoiu (2020-2023)

MOTIVATIONS & QUESTIONS

- Efficiency or load factor of photovoltaic systems under real working conditions: actual values (compared with reference), dependence? ***Short term perspective***



MOTIVATIONS & QUESTIONS

- Efficiency or load factor of photovoltaic systems under real working conditions: actual values (compared with reference), dependence? ***Short term perspective***

  - Measurements of outdoor PV (I, U) characteristic curve
    - Collaboration with L2EP :
      - (I,U) measurement instrument : ongoing
      - Acquisition of PV modules : done
        to be incorporated in the ATOLL platform : to come
  - Measurements of SSI and its spectral content

  +

  - Cross analysis
  - Simulation tool : Simulation of the solar irradiance
    +
    Spectral response of the PV module
    +
    Simulation of the PV electric response


THANK YOU FOR YOUR ATTENTION !
QUESTIONS ?

MOTIVATIONS & QUESTIONS

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  actual values (compared with reference), depe

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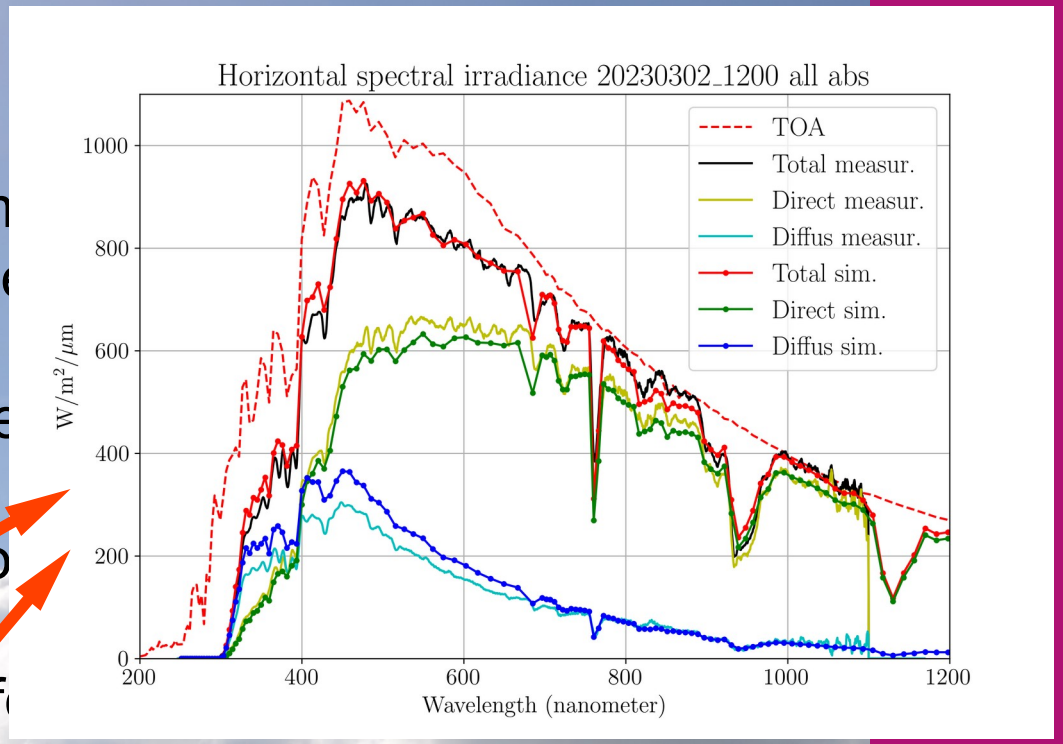
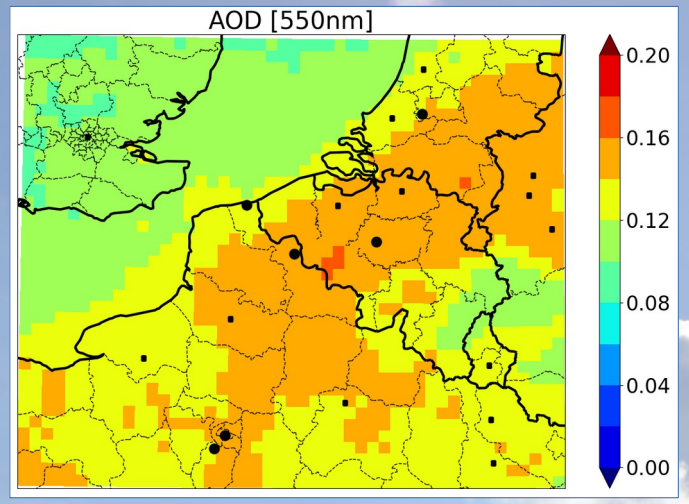
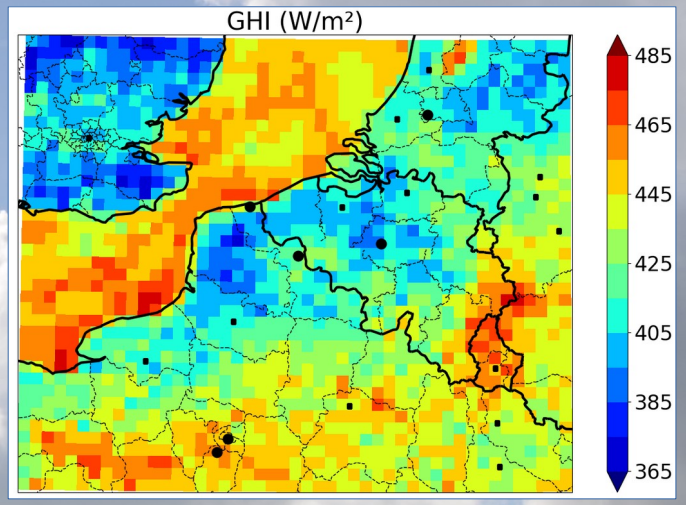


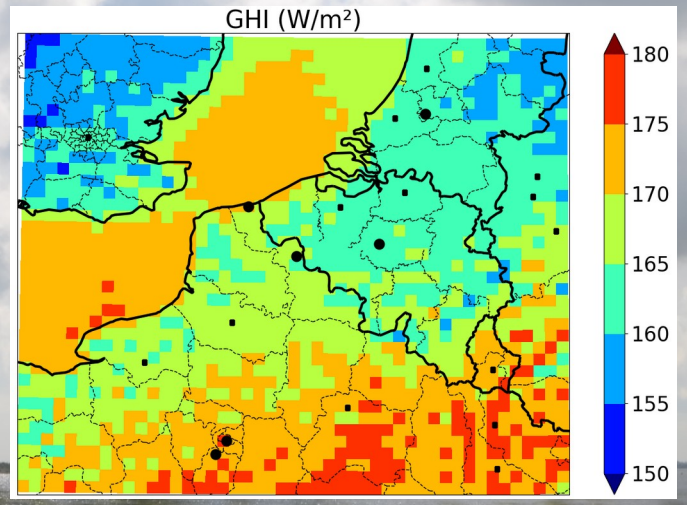
- Climatology of the solar resource, its spatio-temporal variability

Aerosol AOD over 2010-2020 in Spring



Global Horizontal irradiance over 2010-2020 in Spring – Clear Sky





Global Horizontal irradiance over 2010-2020 in Spring – All Sky