« Assessment of Off-Grid Solar Charging System for E-Bikes »

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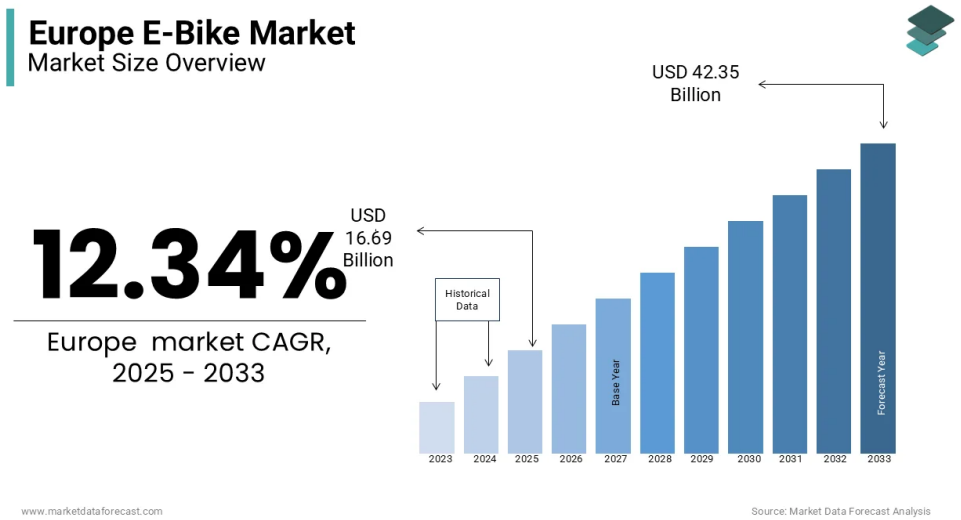
- Outline -

1. Off-Grid solar charging system and its EMR
2. Data base generation
3. EMR and Backward Modelling
4. Simulation Analysis and Discussions

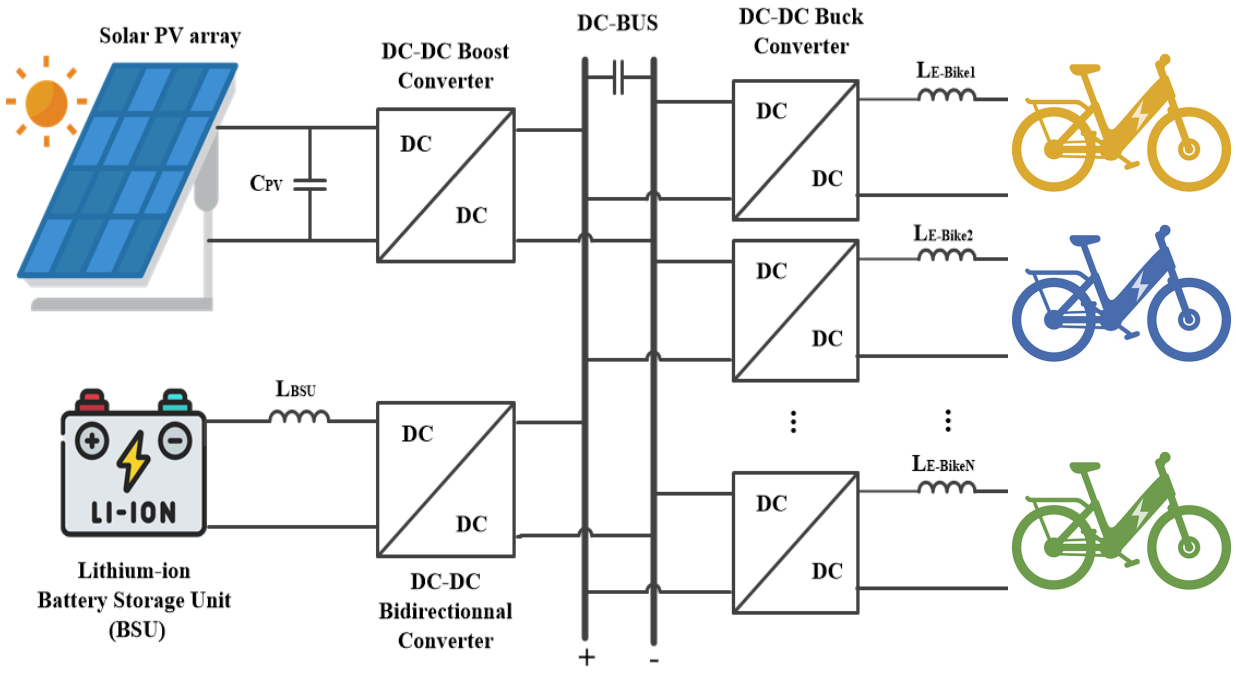
« Off-Grid Charging System and its EMR »

Global E-Bike's growth



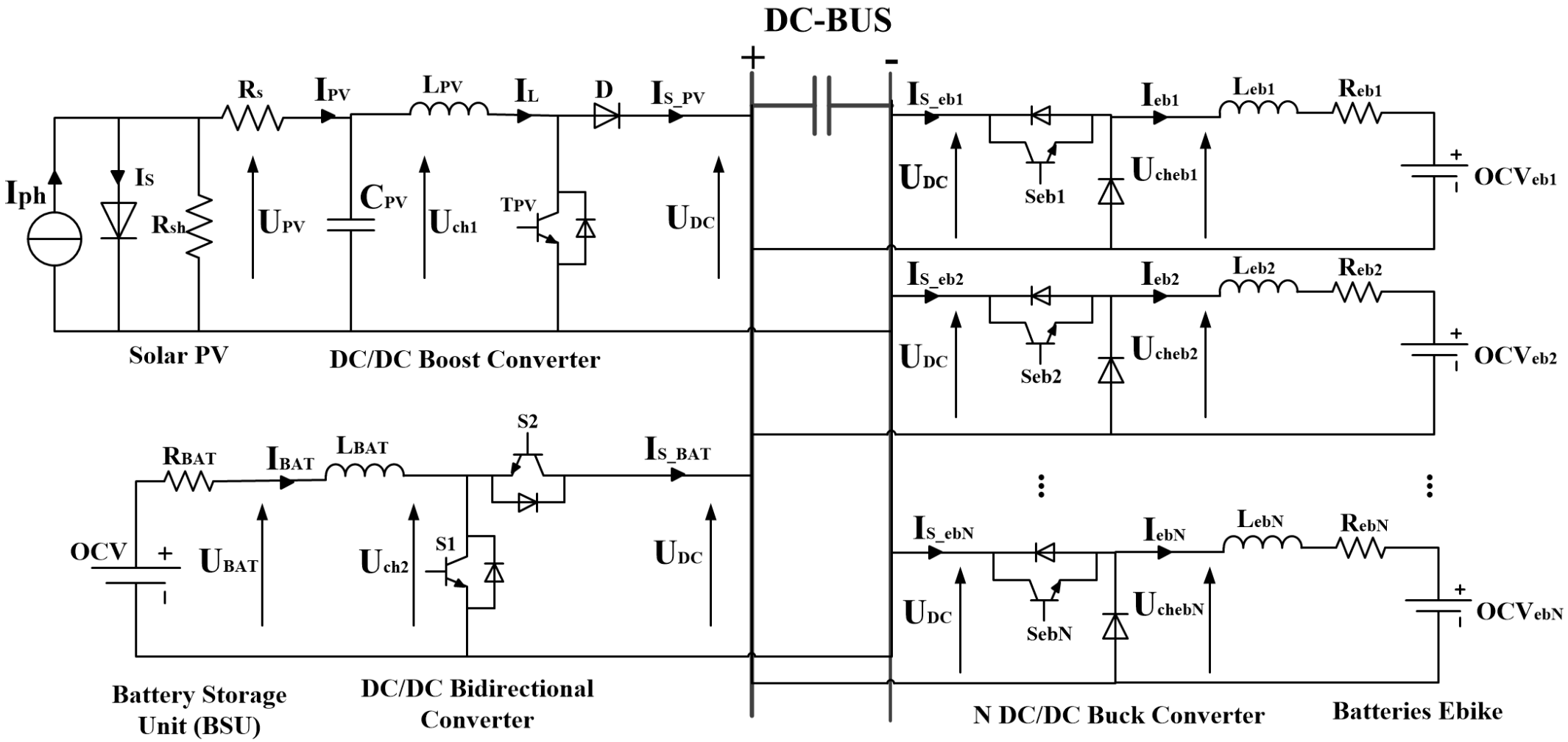
Why Off-Grid Charging?

- Reduce pressure on grid infrastructure
- Enable charging access in rural/remote areas
- Promote green urban mobility
- Support smart cities and energy autonomy



Off-grid Solar Charging E-Bikes's system under study

- Structural scheme of the E-Bikes's charging system -



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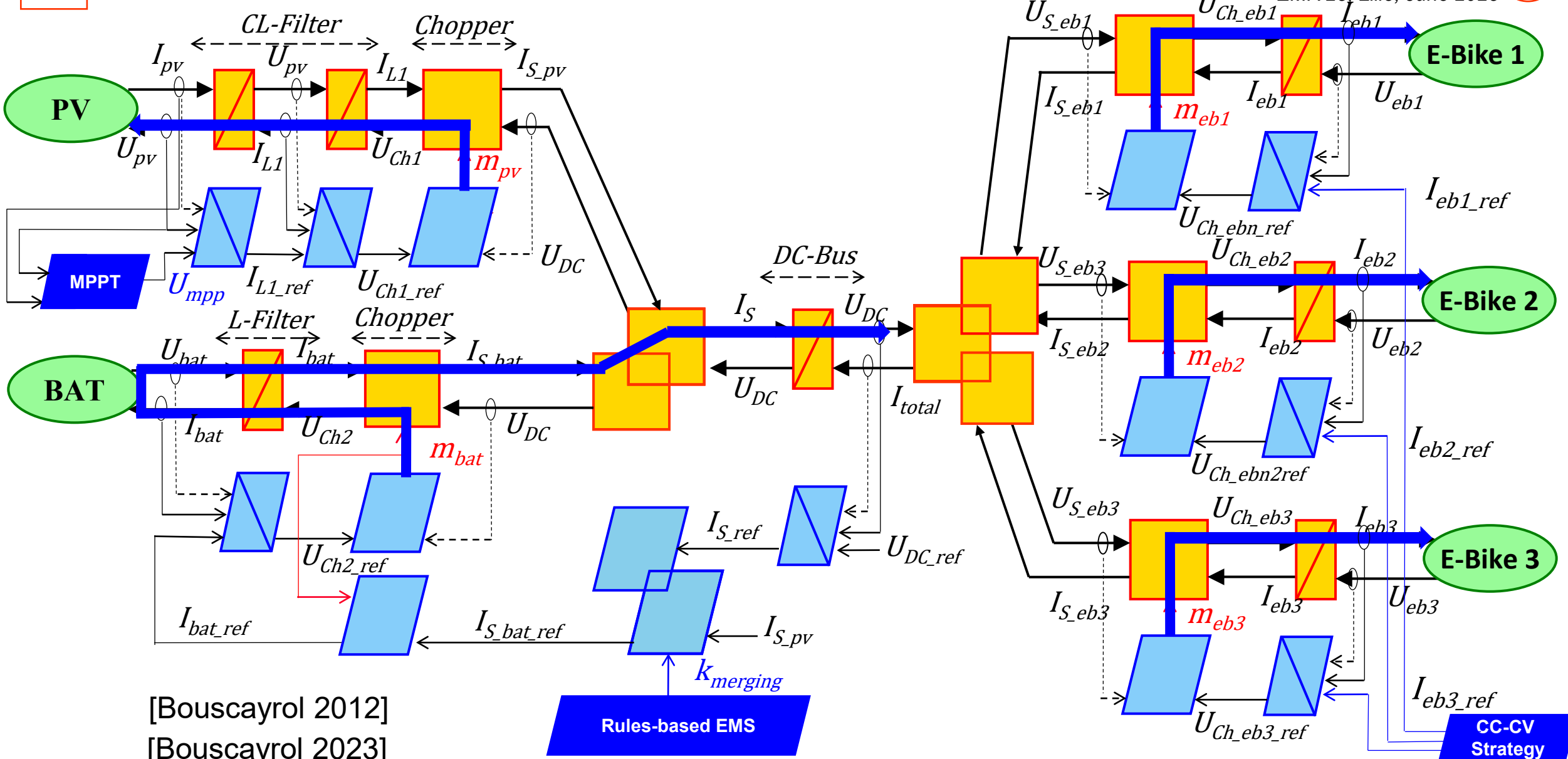
- EMR and MCS of off-grid charging E-Bikes system -



[Bouscayrol 2012]
[Bouscayrol 2023]

1) Problem statement after studies

- Solar energy (weather variability, variable yield)
- Temperature (overheating or under-performance)
- Stationary battery (ageing, thermal management, cycling)
- System autonomy (storage management vs. user demand)
- Variable recharging demand over time

Solar energy (weather variability, variable yield)

Stationary battery (ageing, thermal management, cycling)

System autonomy (storage management vs. user demand)

Variable recharging demand over time

Oversizing issues of the solar PV array and battery storage unit

2) Objectives

- **Sizing methodology to promote the viability and feasibility of setting up off-grid charging system**

« Data Base Generation »

- Solar potential based GHI data-

2 sensible points: Global Horizon Irradiation (GHI) and Charging demand profile over the time

Weather server API

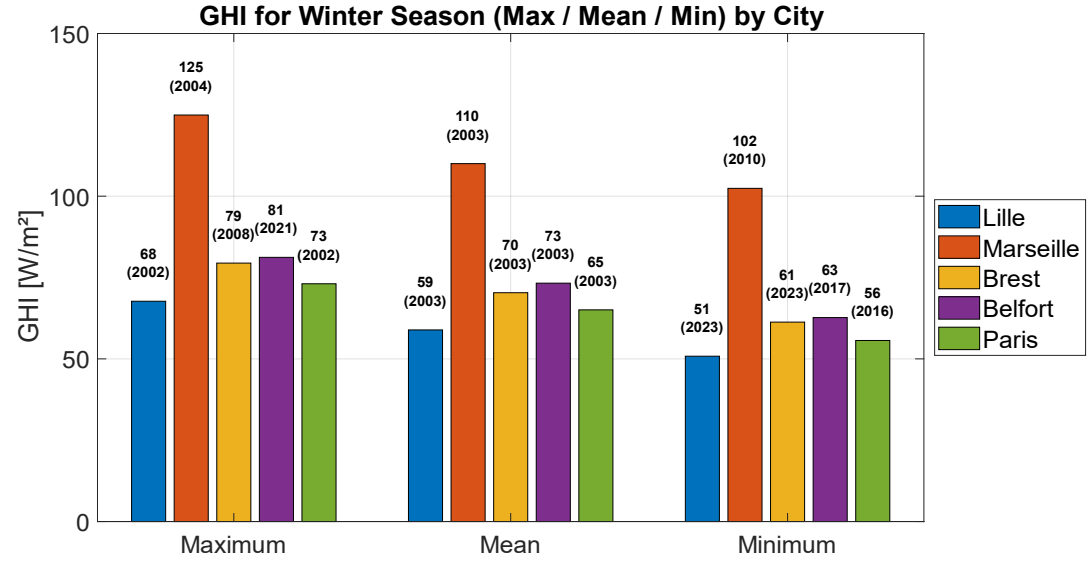
python API

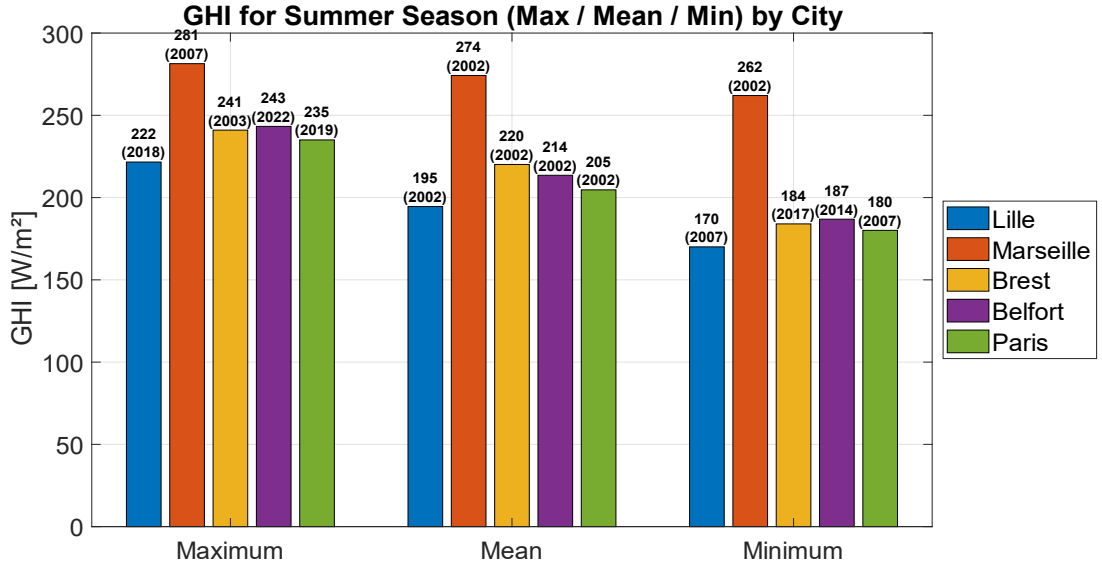
GHI → Belfort, Marseille, Paris, Brest, Lille

2000 to 2024

python

Data base of Solar radiance





2 sensible points: Global Horizon Irradiation (GHI) and Charging demande profil over the time

Ebike server API (velib – Paris)

RÉPUBLIQUE FRANÇAISE recherche.data.gouv.fr

python API

Data base → Paris, Elsewhere } ≃ 1500 station

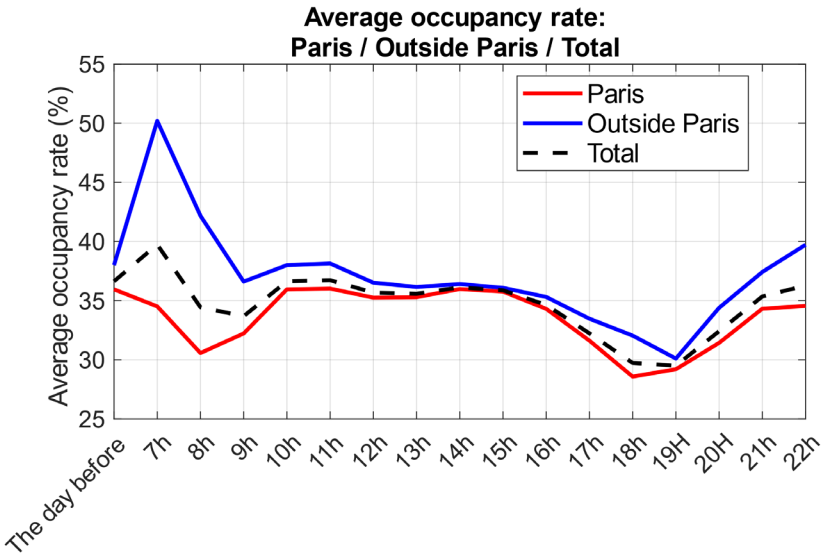
52 000 combinaisons

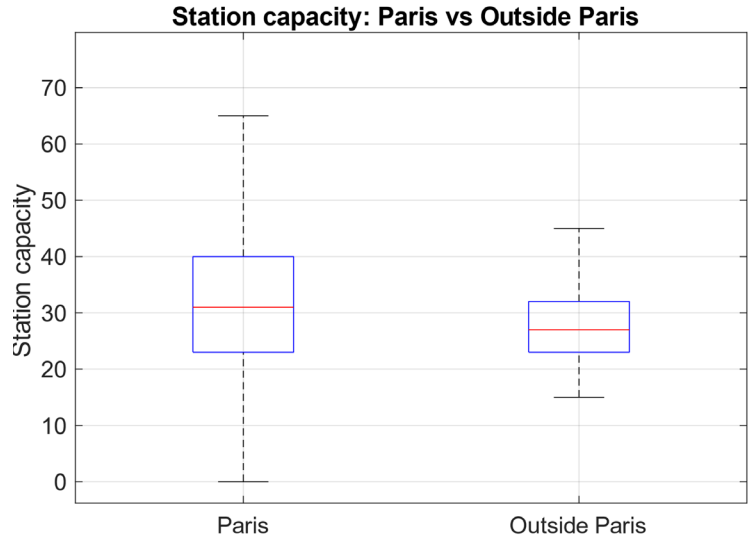
python

International Energy Agency
Electric Vehicle Charging and Grid Integration Tool

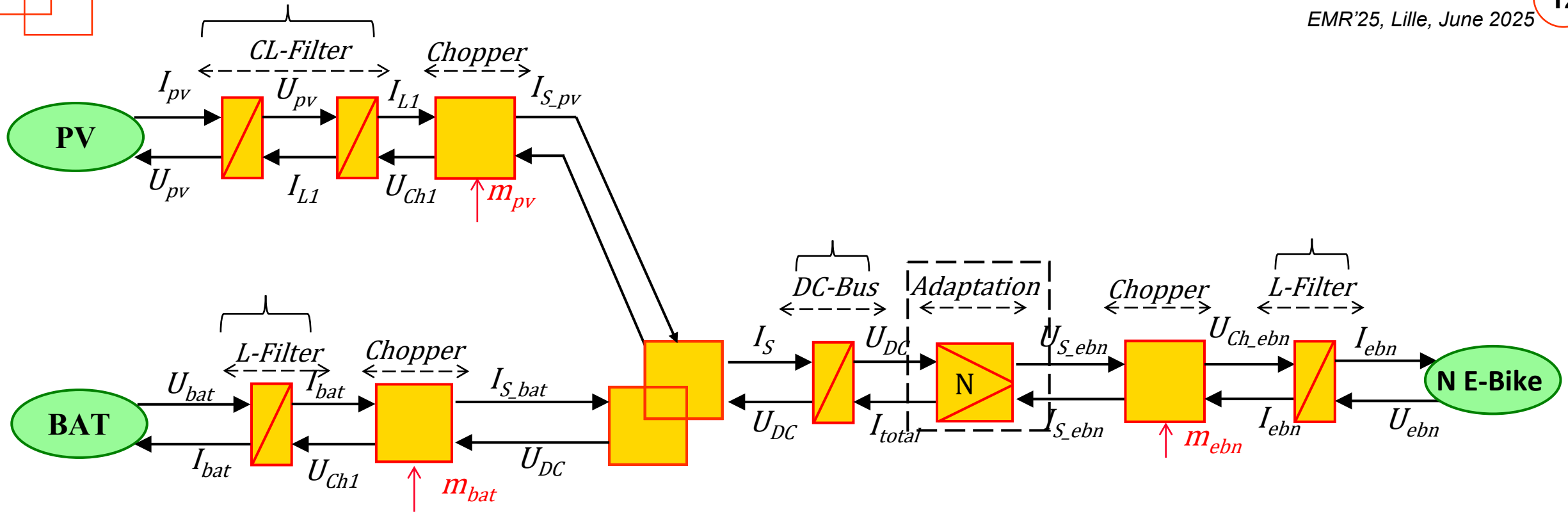
GEF-7 Global Program to Support Countries in the Shift to Electric Mobility

Data base of charging profile based on statics of Velib





« EMR and Backward Modelling »

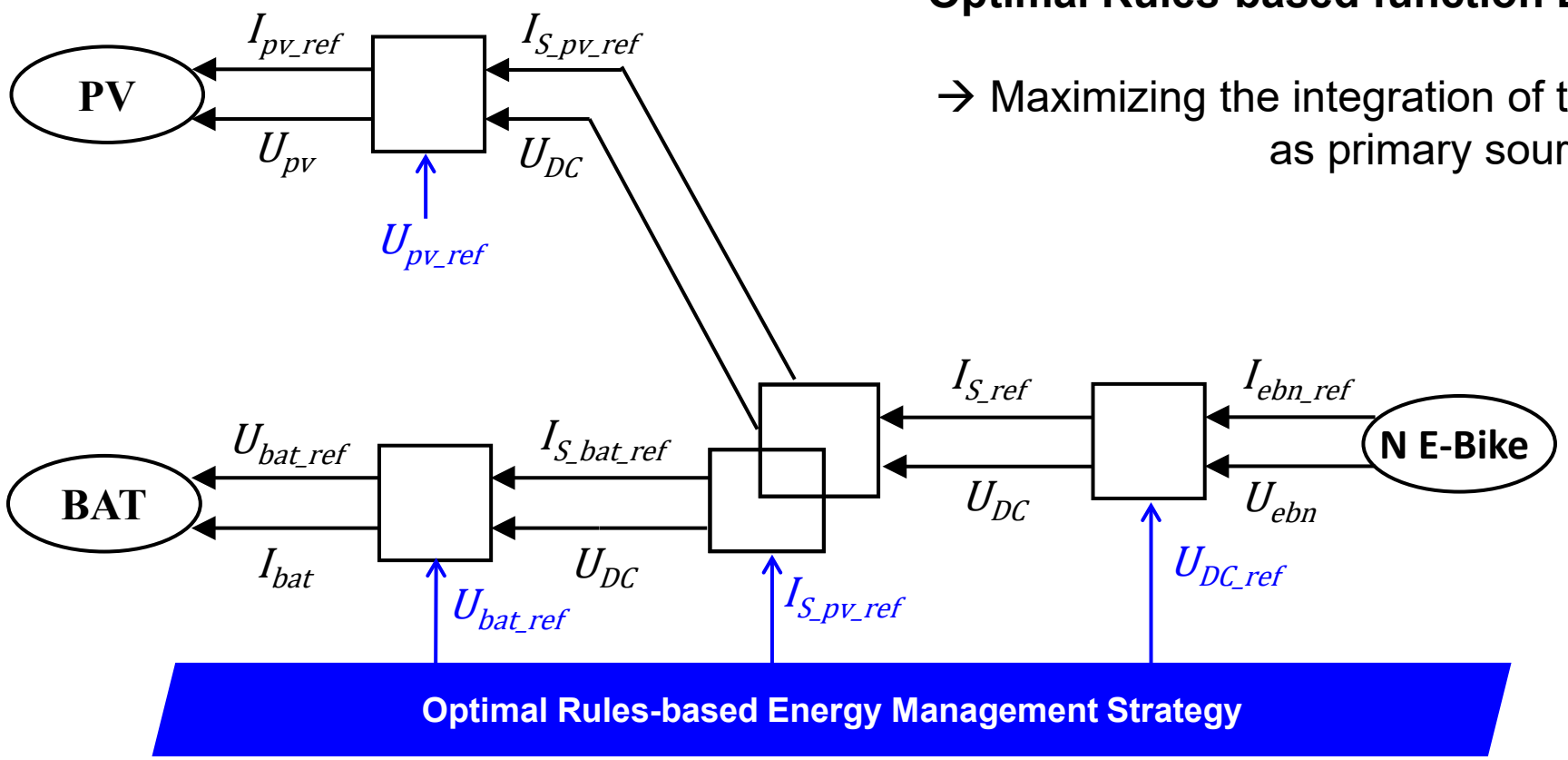


Assumptions:

- System's dynamic is neglected.
- Efficiency of the power converters are considered
- Control considered as ideal
- Total energy demand for N E-Bikes is considered as consumption of all demand profiles [Horrein 2018]

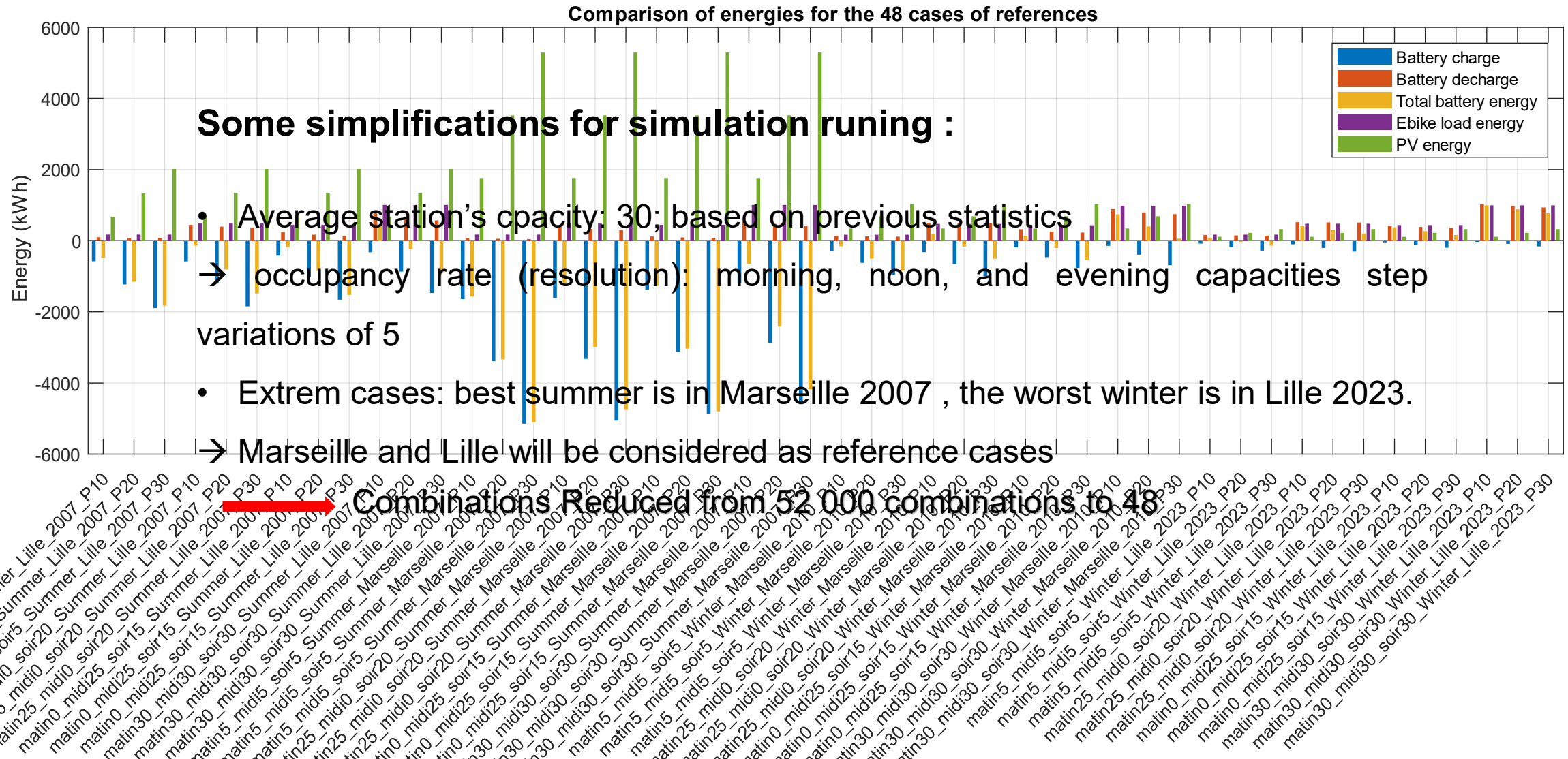
Optimal Rules-based function EMS:

→ Maximizing the integration of the solar PV energy; as primary source



Static model based Backward of off-grid charging E-Bikes's system

« Simulation Analysis and Discussions »



Some simplifications for simulation runing :

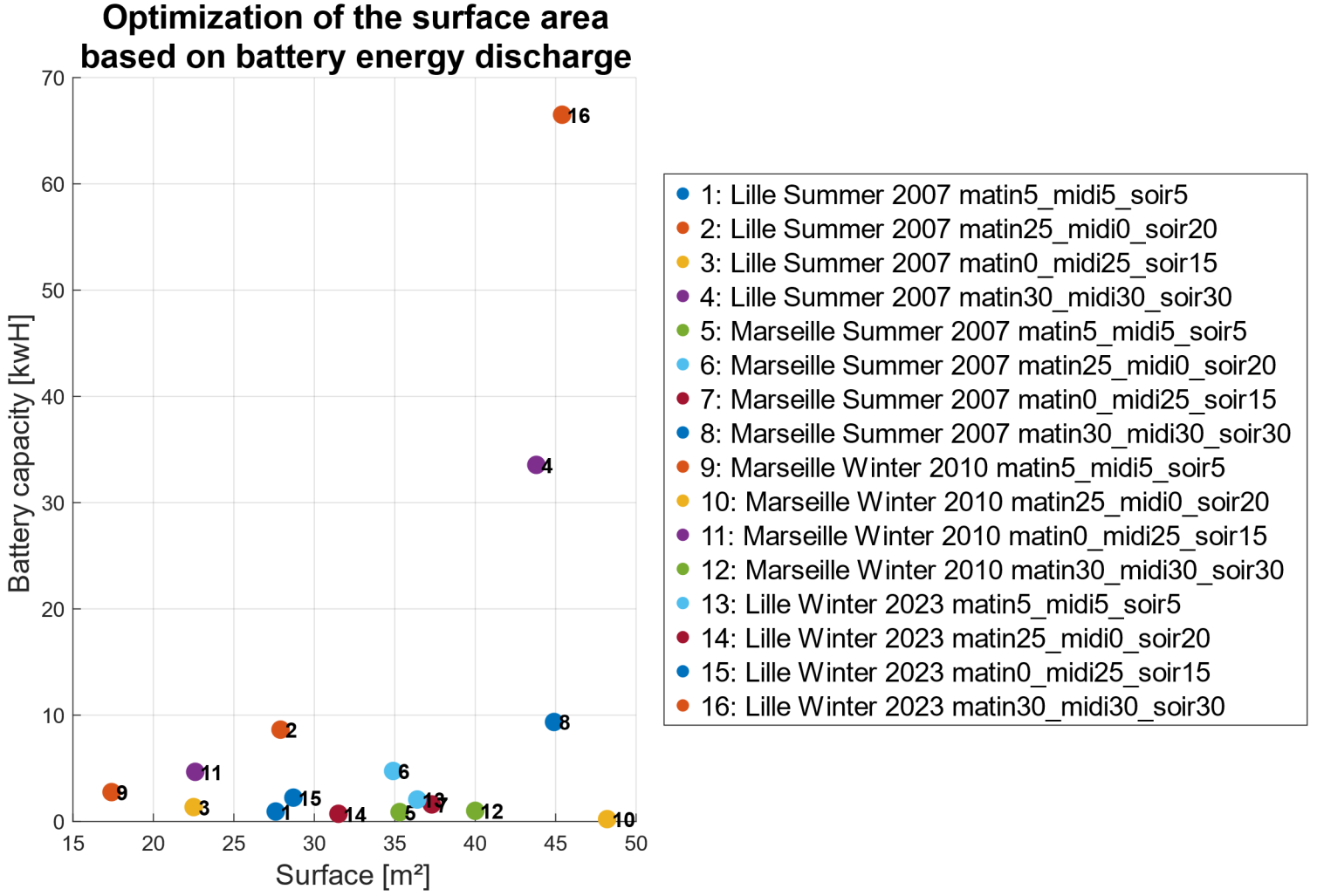
- Average station's cpacity: 30; based on previous statistics

→ occupancy rate (resolution): morning, noon, and evening capacities step variations of 5

- Extrem cases: best summer is in Marseille 2007 , the worst winter is in Lille 2023.

→ Marseille and Lille will be considered as reference cases

→ Combinations Reduced from 52 000 combinations to 48



No simple rules or trends for the solution about sizing process.

System have strong dependences at :

- Solar Irradiance
- Load profile over the time
- Battery capacity to assume charge
- Same oversizing PV or Battery is not coccineous

« Conclusion and Perspectives»

Key points:

- Off-grid E-bike charging is feasible with correct system sizing
- **EMR** and backward modelling offer solid tools for system sizing and validation
- Trade-offs between cost, performance, and reliability must be balanced

➢ **Challenges for developping a generic methodology for sizing**

➢ **Modular and scalable sizing adapted per case study**

Perspectives:

- **EMR** and **MSC** for validation of **sizing** results and constraints
- Investigate **hybrid systems** (solar + grid or wind) for EV's charging
- Expand to real-time deployment and **Life Cycle Analysis (LCA)**
- Explore scaling the model for **fleet-level systems**

« Biographies and references »

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Thank you for your attention !