ÉNERGIE ÉLECTRIQUE 4.0

MEDEE
Maîtrise Energétique des Entraînements Electriques

COMITE DE SUIVI EE4.0-MEDEE

Presentation of R.E.CO.N.S.I.D.E.R.

10 April 2026

Project data

Name of the Project : R.E.CO.N.S.I.D.E.R. Rethink Energy COmmuNitieS' Integration and Design of Electricity stRategies

Name of the PhD candidate : Mohammed QASEM

Supervisors: Stephane BRISSET (L2EP), Sesil KOUTRA (UMONS)

Co-supervisors: Arnaud DAVIGNY (L2EP), Benoit DURILLON (IMT Atlantique)

Partners involved : Université de Mons

Electrical engineering labs : L2EP

Labs outside electrical engineering : Science, Construction, Materials and Energy Department

Other partners :

Grant : Université de Mons & Région Haut-de-France

Context

Renewable Energy Communities (RECs)

Citizen-led groups that generate, share, and manage renewable energy at the local level.

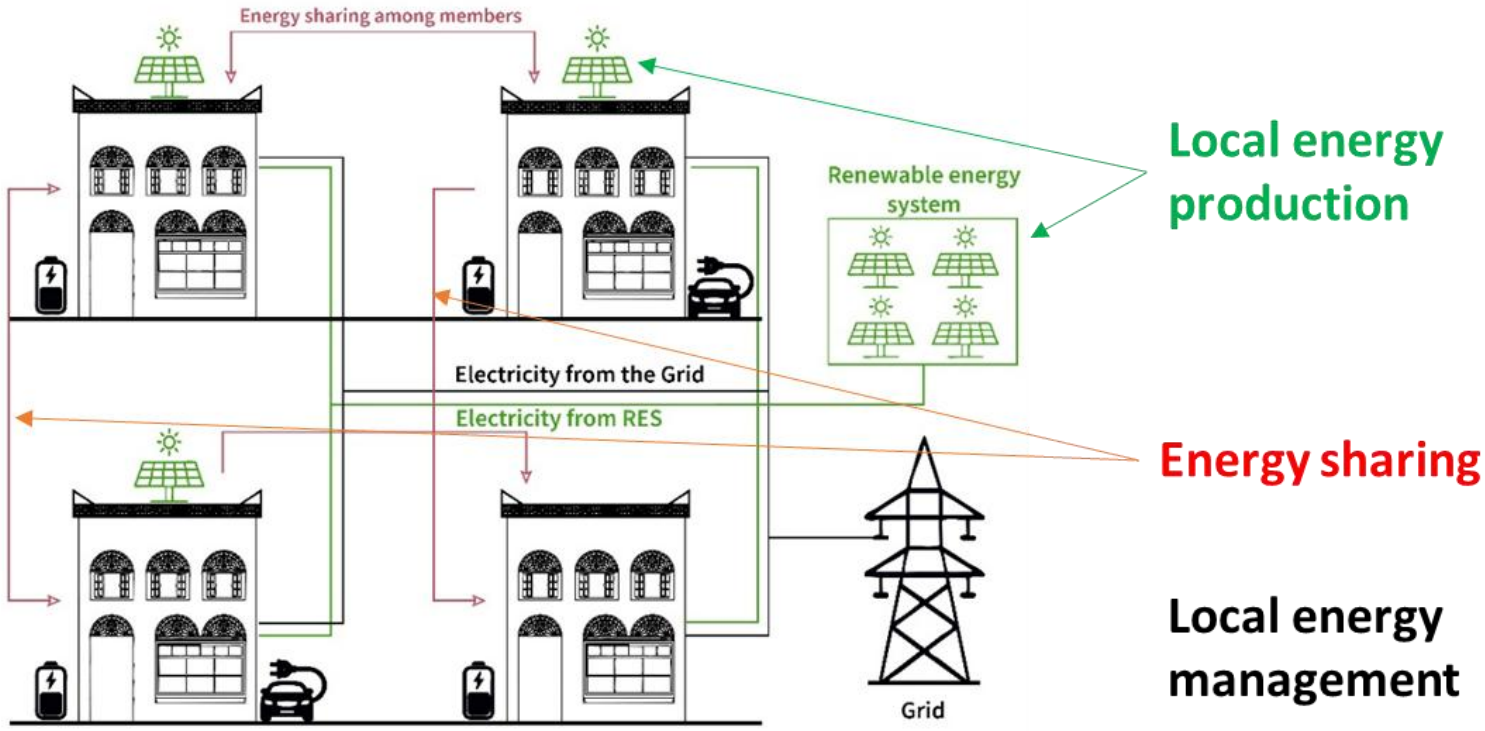
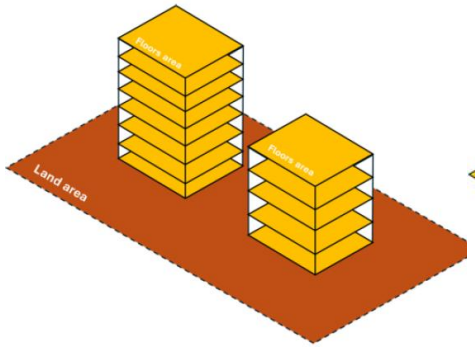


Figure 2. General structure of a REC (Renewable Energy Directive II, 2018/2001/EU)

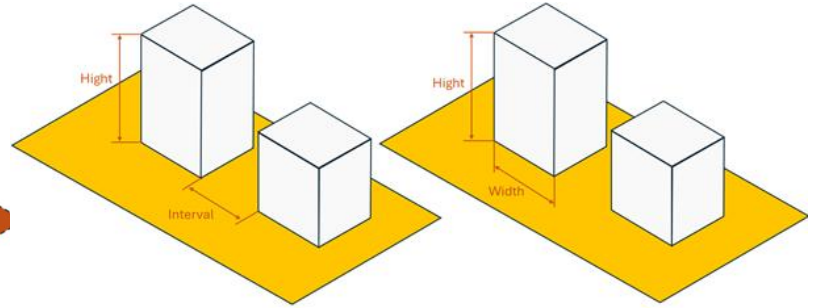
Context

Built and Non-Built Environment is expressed through urban form.

Building form

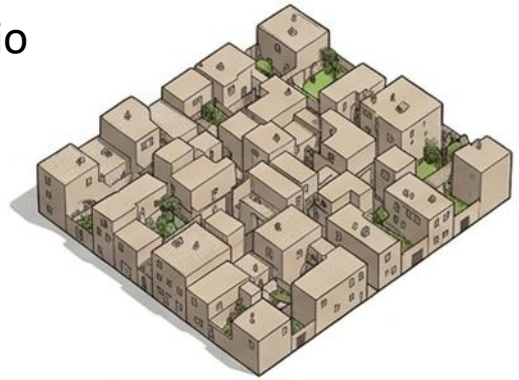


Building height



Aspect ratio

Urban form



Buildings density

Green space distributions

(AI generated)

Related Work in our labs

L2EP Research Focus:

Enhancing local autonomy through optimized REC self-consumption (Matthieu Stephant, 2021).

Applying cooperative game theory for energy management within ECs (Adrien Bossu, 2024).

UMONS Research Focus:

Research Excellence for Solutions and Implementation of net Zero Energy Districts" (RESIZED, Project ID: 621408).*

*ILES (Integrated Energy Local Systems, FEDER-Fonds de Transition Juste, Priority 6) (Ongoing Portfolio)**.*

* https://cordis.europa.eu/project/id/621408/results (Accessed: 03/04/2026)

** https://web.umons.ac.be/energie/fr/le-portefeuille-de-projets-integrated-local-energy-systems-iles--2021-2027 (Accessed: 03/04/2026)

Research Gap & Objectives

Research gap

- *Limited understanding of how building and urban forms affects the energy production and consumption of RECs.*

Research Objectives

To model the impact of building form on electricity demand and generation in RECs.

To explore the economic trade-off between investment in renewable energy systems and building envelope improvements.

To identify building form and urban configurations that minimize electricity demand and maximize energy generation in RECs.

Case Study

Description

- *Building at the early stage.*
- *Community of 12 households.*
- *All members connected to the same low-voltage network.*
- *Different family's compositions.*

Assumptions

- *Building construction elements, except the insulation layer and windows, are constant.*
- *Time-varying grid price, identical for all households.*
- *No revenue from grid export.*

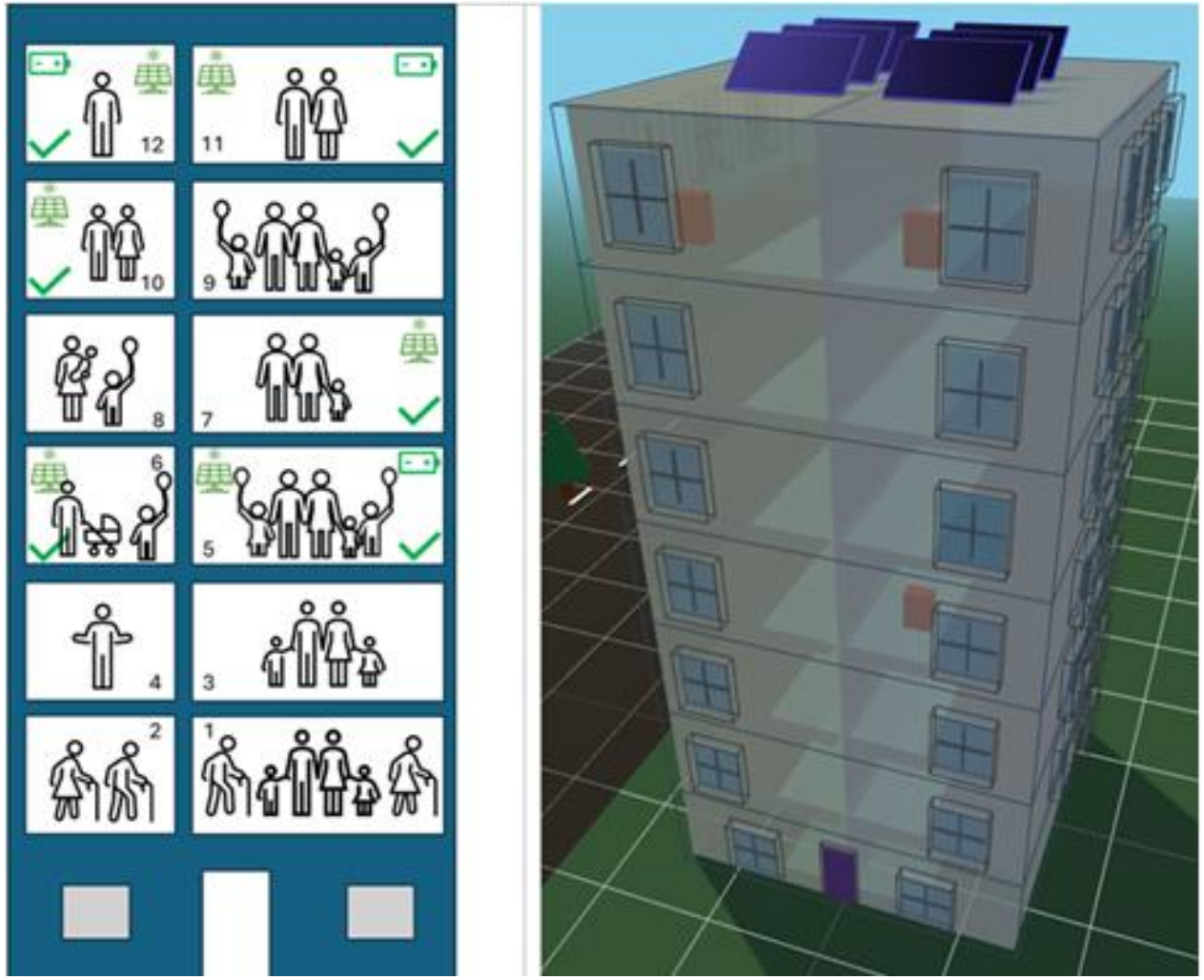
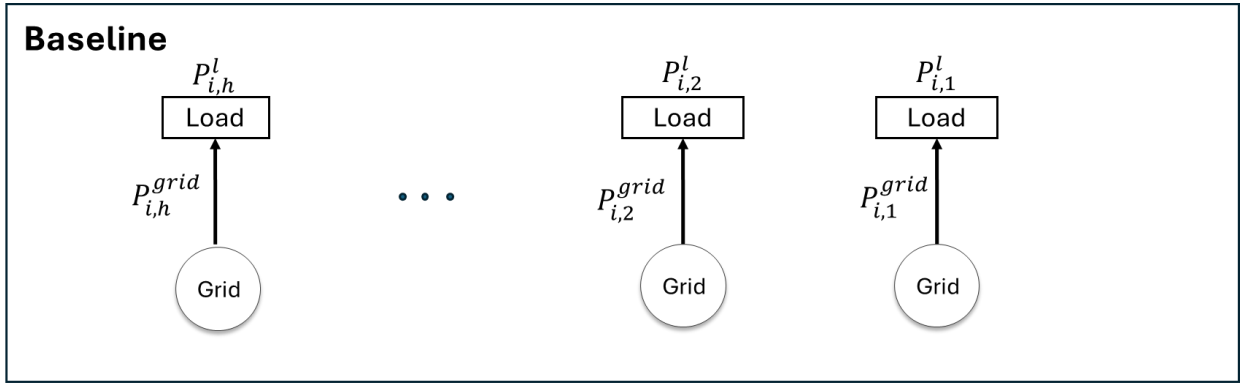
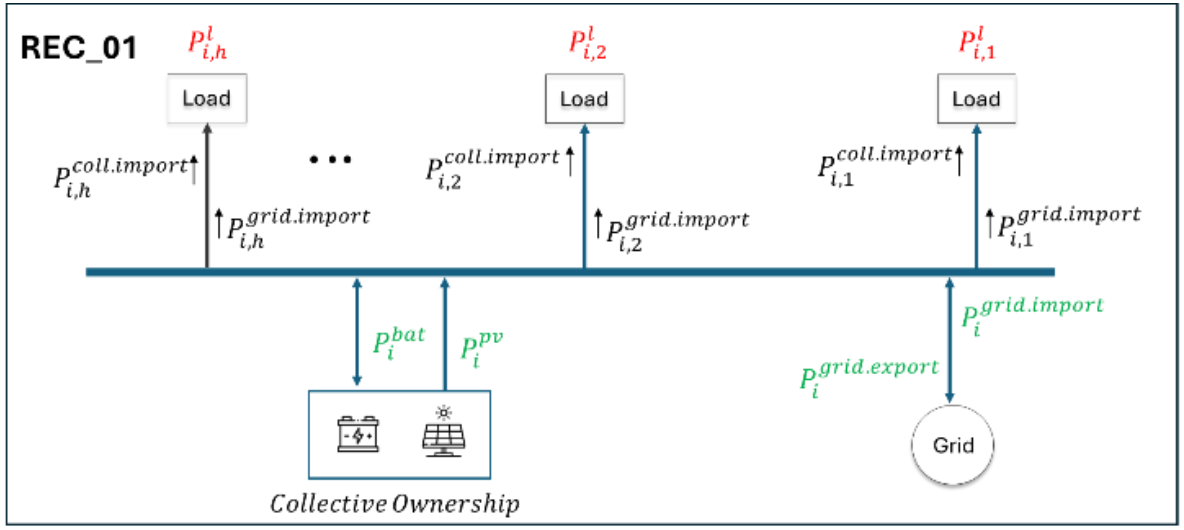


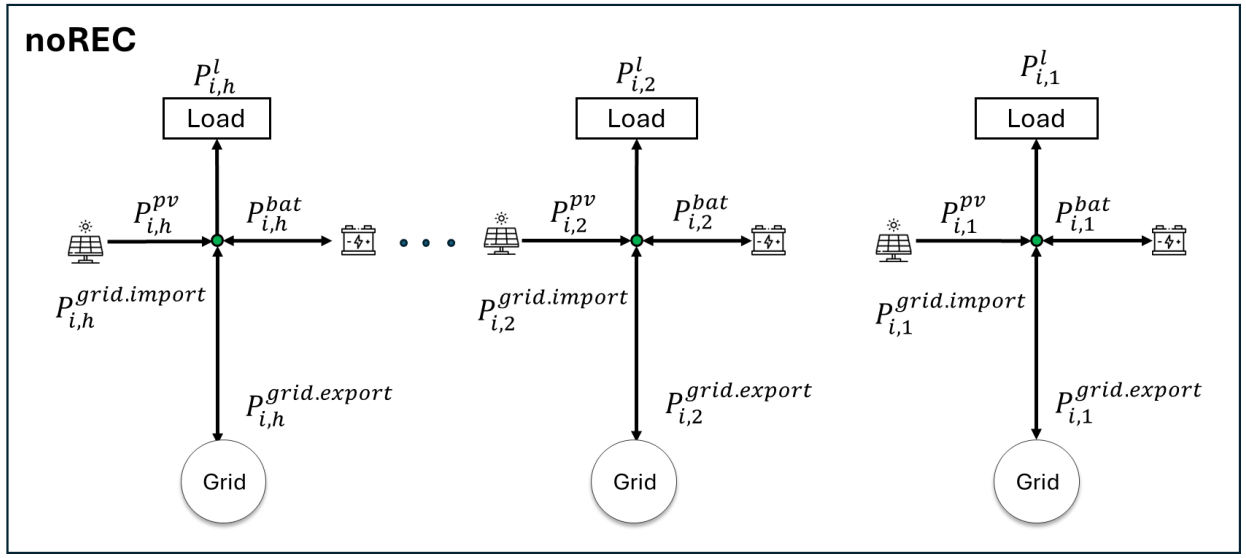
Figure 4. Residential building for the proposed REC

Case study

How is the energy shared in the energy community ?







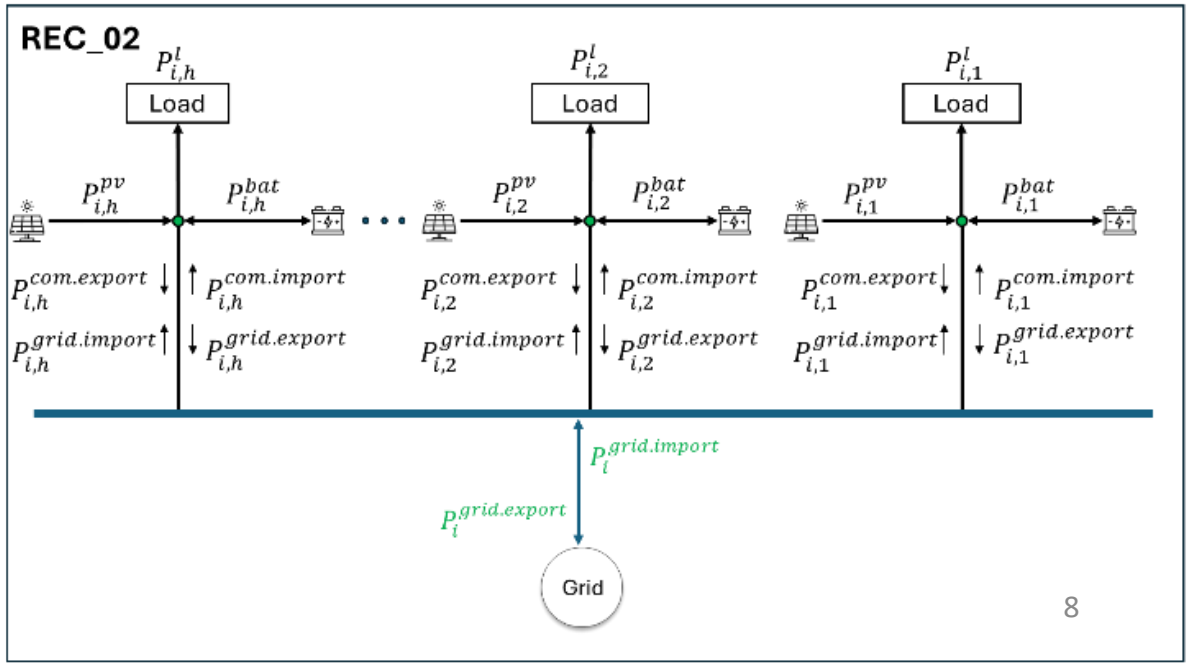


Figure 5. Power flow in REC with different ownership frameworks (REC_01, REC_02),no energy sharing framework (noREC) and Baseline

Methodology

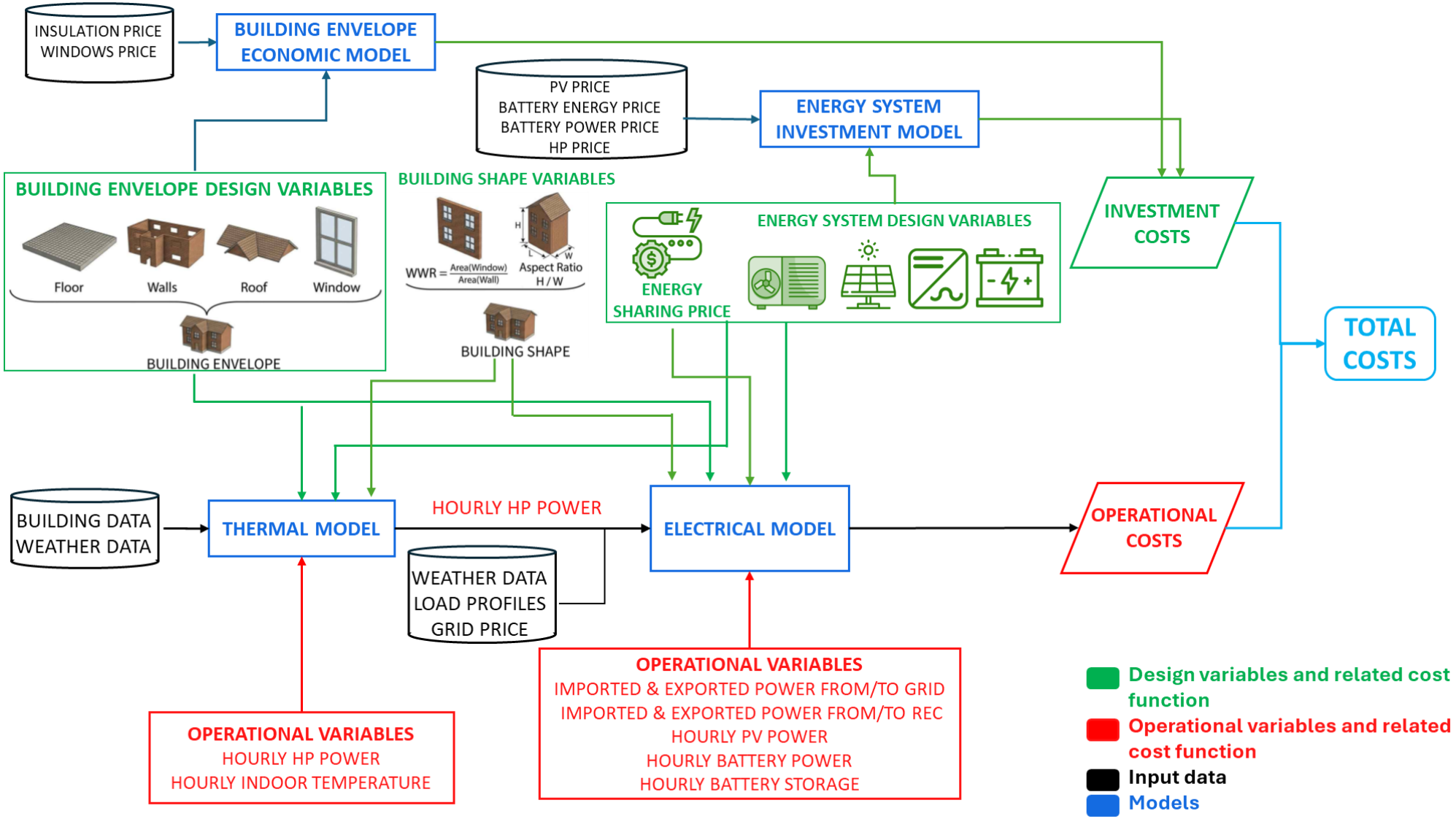


Figure 6. The Developed Multi-Disciplinary Model

Methodology

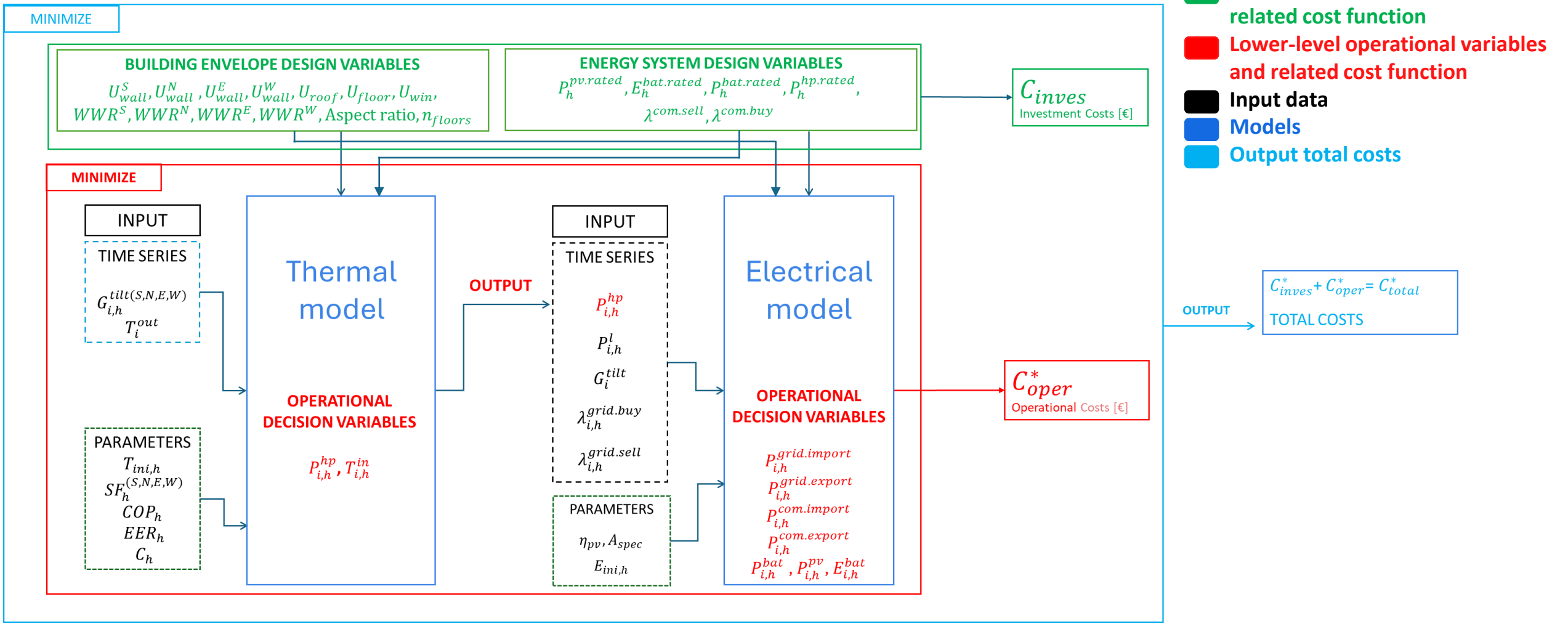


Figure 7. Bi-level optimization problem detailed structure

Methodology

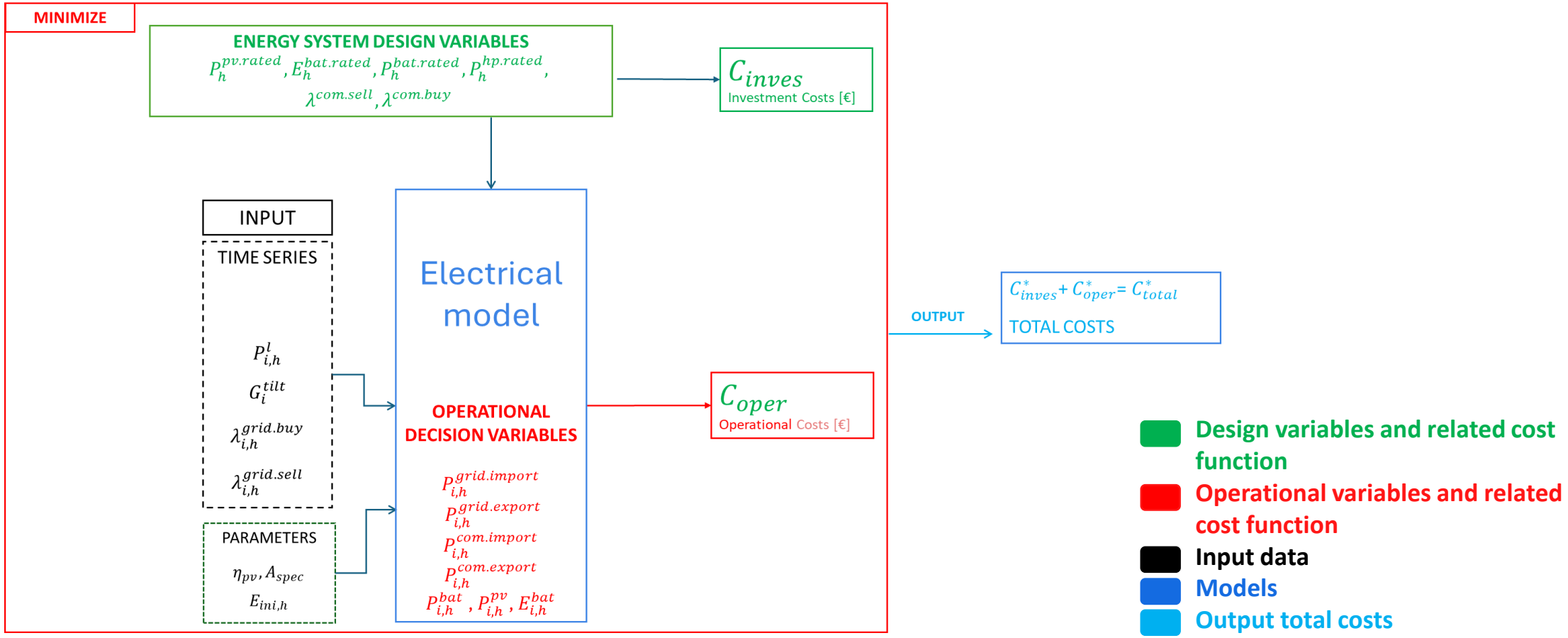


Figure 8. Lower-level optimization problem detailed structure

Work carried out

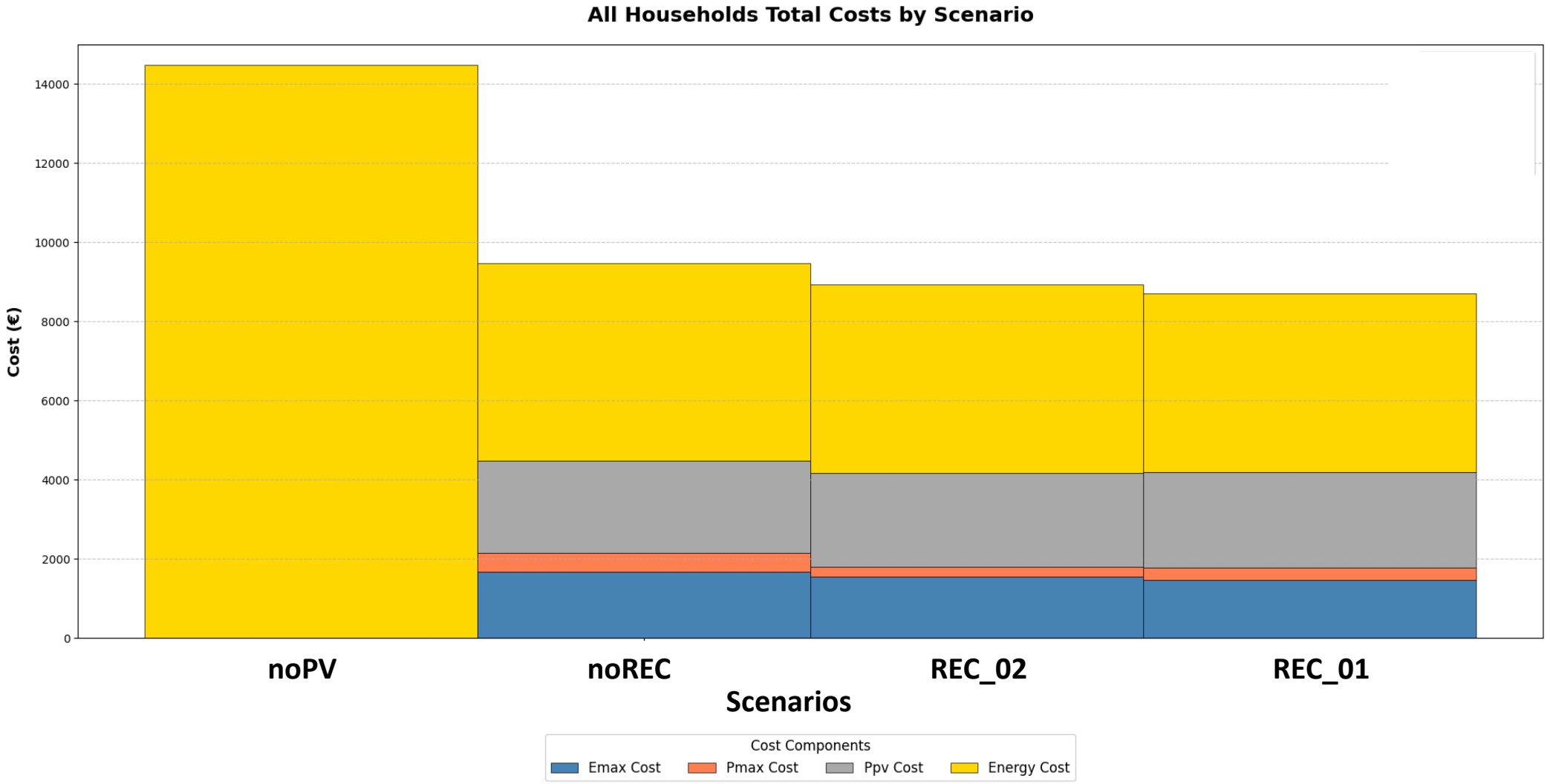


Figure 9. The total costs of each household under different scenarios

Work carried out

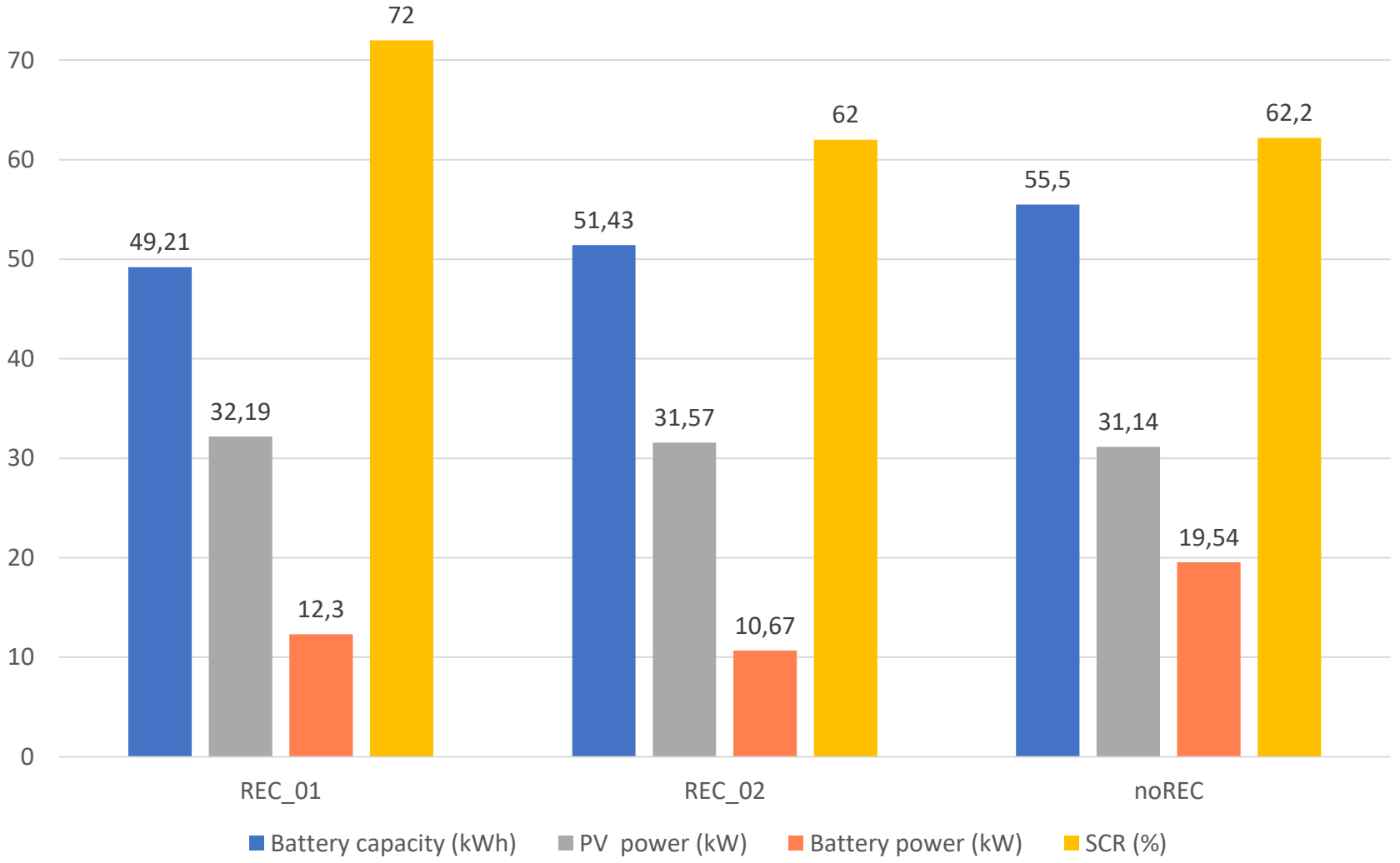


Figure 10. Comparison of installed system capacities and self-consumption rate under different REC configurations

Summary of the work carried out

Collective self-consumption framework (REC_01) deliver the lowest total cost by:

- *enabling larger-scale PV deployment.*
- *increasing the self-consumption rate*
- *reducing investment in battery.*
- *lowering reliance on grid electricity.*

Internal pricing mechanisms play an important role in shaping economic performance of RECs investment frameworks.

Limitations:

- *Investment costs and energy allocation in REC_01 are distributed proportionally to each household's annual demand.*
- *More investigations on the economic model of REC_02 is needed.*

PhD work progress

- *Developed the multi-disciplinary model used for studying the link between the building form and energy production and consumption of a building-scale REC.*
- *Obtained the first results for the energy sharing frameworks within RECs.*

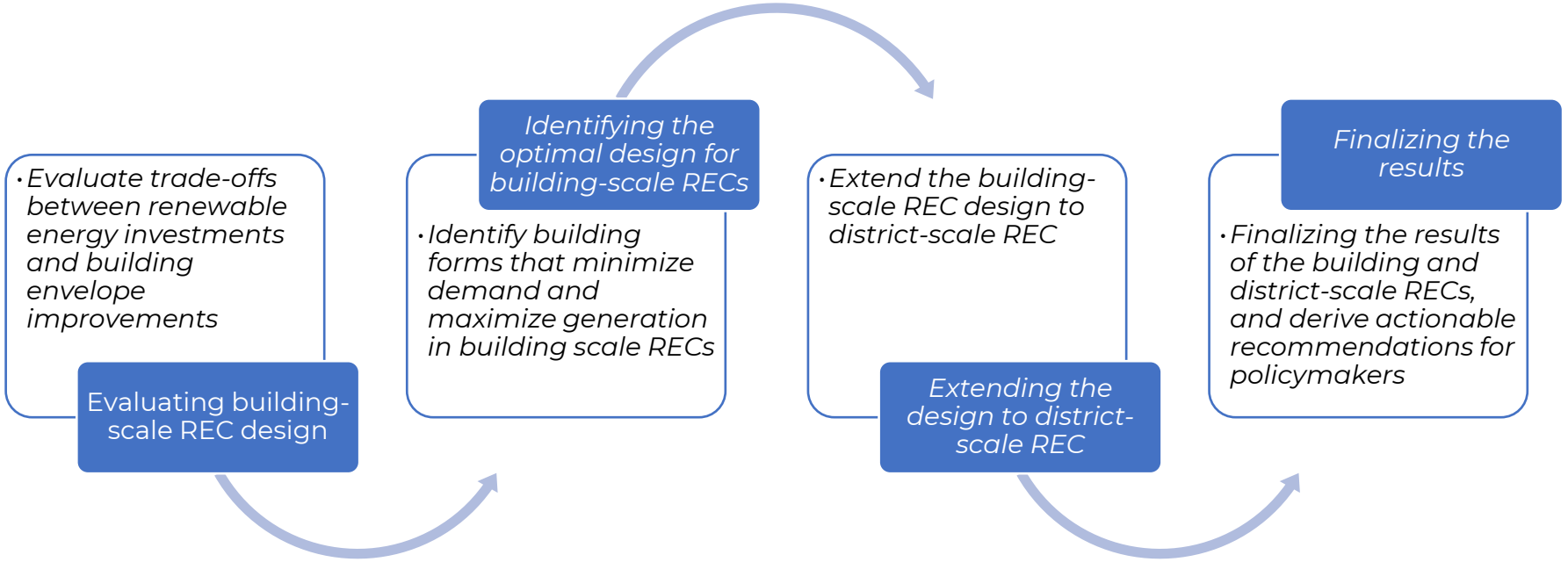


Figure 10. Next Steps

Conferences and events

- *M. Qasem, BRISSET Stéphane, DAVIGNY Arnaud, Benoit DURILLON, and S. Koutra. "Open-Source Datasets, Models, and Tools for Renewable Energy Community Design." Paper presented at Conférence SYMPOSIUM DE GENIE ELECTRIQUE (SGE 2025), Toulouse, France, July 2025.*

- *M. Qasem, BRISSET Stéphane, DAVIGNY Arnaud, Benoit DURILLON, and S. Koutra. "Unveiling the correlations of Renewable Energy Communities and Urban Form." Paper presented at the 5th Latin American SDEWES conference, Cartagena de Indias, Colombia, January 2026.*

- *Mahfoud, C., SAPIENZA, G., GUGLIELMINO, R., Qasem, M. Q. M. S., TERES-ZUBIAGA, J., & Koutra, S. (24 March 2025). "Belgian Energy Communities: Key Challenges and Opportunities"[Paper presentation]. SMARTGREENS 2025, Porto, Portugal.*

- *A research stay on agent-based modeling for RECs (University of Deusto, Bilbao, Spain).*

Thank you for your attention

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