

This presentation was selected by the Sc. Committee of the EU PVSEC 2025 for submission of a full paper to one of the EU PVSEC's collaborating peer-reviewed journals.

## **SOCIAL HOUSING AND ENERGY COMMUNITIES: BALANCING AFFORDABILITY AND PROFITABILITY IN MULTI-APARTMENT BUILDINGS.**

Elina Bosch<sup>1</sup>, Caroline Plaza<sup>2</sup>, Melodie De L'Epine<sup>2</sup>, Gaëtan Masson<sup>1</sup>  
1 Becquerel Institute, Brussels, Belgium;  
2 Becquerel Institute France, Lyon, France

**ABSTRACT:** Energy poverty remains a major challenge in the European Union, disproportionately affecting residents of social housing. At the same time, declining photovoltaic (PV) costs and new EU legislation on renewable energy communities create opportunities for energy sharing schemes that can reduce bills and improve access to clean energy. Yet, translating this potential into practice is particularly complex in multi-apartment social housing. This paper identifies and categorises the barriers to PV-based energy sharing in this context, drawing on a literature review and empirical evidence from three demonstration sites of the ProLight project in Spain, Portugal, and Italy. The analysis highlights the central role of fair benefit allocation and scope definition, the constraints of limited roof space, and the challenges of high tenant turnover, arrears risk, and low administrative literacy. In addition, fragmented decision rights, split incentives, and procurement and state-aid rules create further institutional hurdles. The findings underline that energy sharing can only succeed when accompanied by tailored business models, trusted intermediaries, and supportive regulatory frameworks. Coupling energy sharing with refurbishment strategies, subsidies, and co-creation processes can enhance both fairness and feasibility, positioning social housing as a critical driver of an inclusive energy transition.  
Keywords: solar photovoltaics, energy sharing, business models, social housing, energy poverty

### 1 INTRODUCTION

Energy poverty remains a persistent challenge across the European Union (EU). Estimates from the Joint Research Centre (JRC) suggest that between 8% and 16% of the EU population can be classified as energy poor, with the precise figure depending on the methodology used [1]. The issue is complex and multi-dimensional: it can manifest as low absolute energy expenditure, a disproportionately high share of household income spent on energy, inability to maintain adequate indoor warmth, or arrears on utility bills. While only a small fraction of EU citizens meet all these conditions simultaneously, almost 40% of households are energy poor according to at least one indicator.

At the same time, photovoltaic (PV) technology has become increasingly affordable, creating new opportunities to expand access to clean energy [2]. The EU has also introduced a supportive regulatory framework through the Clean Energy for All Europeans package, which includes Article 2 of the Electricity Directive (EU) 2019/944 and Article 22 of the Renewable Energy Directive (RED II). These legislative measures laid the foundation for and promote the establishment of joint self-consumption schemes, citizen energy communities (CECs) and renewable energy communities (RECs), allowing households, businesses, and public organisations to share locally generated electricity. Importantly, the RED II explicitly requires Member States to ensure that participation in renewable energy communities is open to all consumers, including low-income and vulnerable households [3].

The integration of PV within energy-sharing schemes is therefore increasingly recognised as a promising strategy to alleviate energy poverty. Evidence suggests that households are willing to engage: for example, one recent study reported that 91.3% of respondents (in two Italian social housing neighbourhoods) would be willing to invest in or request shared PV systems from their landlords [4]. Such initiatives can improve access to affordable, sustainable electricity, reducing both costs and vulnerability for disadvantaged groups.

However, translating this potential into practice is far from straightforward. Multiple barriers—technical, social, regulatory, administrative, governance, and financial—

continue to hinder the development and scaling of energy sharing initiatives. Against this backdrop, this study explores social housing and energy communities, focusing on how to balance affordability and profitability in multi-apartment buildings, with the aim of identifying viable pathways to address energy poverty while ensuring long-term sustainability.

### 2 METHODS

#### 2.1 Approach to barrier identification and categorization

Our analysis aims at developing a clearer understanding of the barriers specific to social housing in the context of energy sharing schemes.

To this end, we conduct a literature review of academic papers and policy reports that explicitly address this topic, as well as publications presenting relevant case studies.

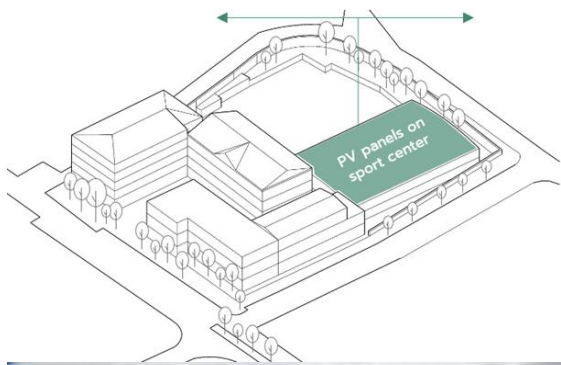
In parallel, we draw on empirical insights from the demonstration districts of the ProLight project, which provide practical evidence on how energy-sharing schemes are being implemented in multi-apartment social housing.

Identified barriers are contextualised in relation to the specific features of social housing, including the socio-economic profile of residents, governance and ownership structures, and the prevalence of energy poverty. For each barrier, it is further indicated whether it is most relevant during the setup phase, the operational phase, or across both stages of implementation.

#### 2.2 ProLight demonstration sites

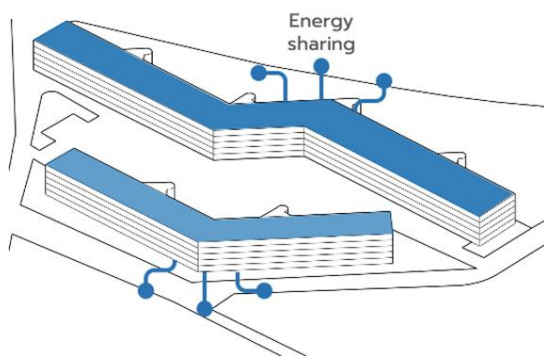
In the frame of the ProLight project, there are three demonstration sites which are related to social housing and energy sharing schemes. These demonstration sites are at different stage of energy-sharing scheme implementation (running phase, setting-up phase, feasibility assessment phase).

First, the Guernica TEK demonstration site in Spain which is a running energy community based on 200 solar panels located on the local San Fidel school. Electricity is shared with 150 homes, shops and public buildings.



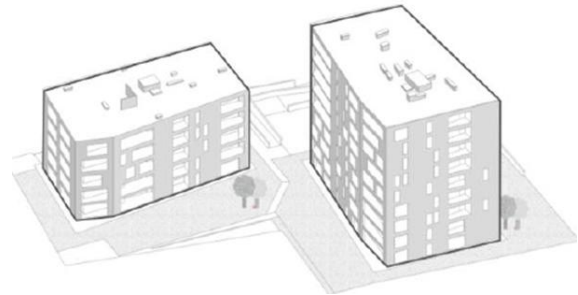
**Figure 1:** Gernika-San Fidel TEK (ProLight Spanish demonstration site)

Second, the Matosinhos demonstration site in Portugal where an energy sharing scheme is being set up in a recently refurbished social housing multi-apartment building. The energy sharing scheme will be based on a 200 kWp solar photovoltaic system located on the roof. Electricity will be shared with the residents as well as with a few local shops located on the ground floor of the building.



**Figure 2:** Matosinhos (ProLight Portuguese demonstration site)

Third, the Urbana New Living demonstration site in Italy. The establishment of an energy community is being considered in this recently refurbished social housing multi-apartment building. The building currently has a rooftop PV installation but which only covers the common electricity loads (corridors, elevators, ...).



**Figure 3:** Urbana New Living (ProLight Italian demonstration site)

## 2.2 Recommendations for model definition

For the different identified challenges, recommendations with regards to model definition are provided. In particular, model definition recommendations resonate with Business Model Canvas components such as cost structure, ownership, benefit and revenue distribution, .... The Business Model Canvas was selected because it is a widely used and flexible tool that facilitates the structured analysis of value creation, stakeholder roles, and financial flows, making it particularly suitable for innovations at the intersection of technology, governance, and social objectives.

## 3 BARRIERS AND RECOMMENDATIONS WITH REGARDS TO MODEL DEFINITION

### 3.1 Barriers related to (PV-based) energy sharing scheme

**Benefit allocation design** (most relevant in setup phase): Establishing fair distribution keys is a central issue. While this applies broadly, the need for equitable allocation mechanisms is heightened in social housing, where affordability constraints mean that even small imbalances can have strong distributional consequences [4]. As seen in the examples of demonstration sites in ProLight, a certain diversity of socio-economic profiles as well as energy consumption profiles can be observed in a social housing building. In the Italian demonstration site, the social housing includes around half of ‘affordable rents’, around 15% of “social rent”, the rest being sold units. In the Portuguese demonstration sites, the ground-

floor of the social housing building, includes a few shops which can contribute positively to the overall energy sharing scheme profitability through the presence of complementary consumption patterns, but needs to be an attention point to avoid concentrating the energy saving benefits on a few profiles only.

**Energy-sharing scope selection** (most relevant in setup phase): Whether on-site produced electricity should cover only the common load (corridors, elevators, ...) or also extend to the individual housing units' consumption directly shapes both fairness and feasibility. Indeed cost minimization and self-consumption maximization goals may conflict. For example, with a common load scope, the savings for each self-consumed kWh will typically be higher with savings on most electricity price components including taxes and network fees. On the contrary, if the scope extends to individual unit's load, each self-consumed kWh will allow savings on the commodity component of electricity price and in some case partially on network fees with taxes still being applicable.

**Allocation and billing complexity** (relevant in both setup and operational phase): Complex metering arrangements and the use of algorithms to manage sharing keys create higher onboarding and follow-up needs in social housing compared to private dwellings [4] [5] [6]. The example of the energy community demonstration site in Spain in ProLight has shown how the presence of an external private utility can play a key role in facilitating administrative, legal and financial procedures.

### 3.2 Barriers related to multi-apartment setting

**Physical constraints** (most relevant in setup phase): The limited roof surface relative to the number of dwellings restricts the scale of PV that can be installed. This is a general challenge in multi-apartment buildings, but in social housing the higher dwelling density exacerbates the limitation [6].

### 3.3 Barriers related to socio-economic setting

**CAPEX and access to finance** (most relevant in setup phase): Access to upfront investment is often more difficult in social housing, where both providers and tenants face tighter financial constraints and limited borrowing capacity [9] [10].

**Tenant rotation and arrears risk** (most relevant in operational phase): High participant turnover and the risk of non-payment are more salient in social housing than in private housing, directly affecting revenue stability and long-term viability [13]. This is particularly relevant for private social housing units, where the economic benefit of implementing an energy sharing scheme may not be immediately obvious to the owner. However, by lowering tenants' energy bills, such schemes can reduce the risk of rent arrears and thereby improve payment stability.

**Awareness, trust, and administrative literacy** (relevant in both setup and operational phase): Language barriers and low energy literacy levels increase onboarding and communication challenges in social housing, requiring additional support measures throughout the lifecycle of the project [1] [2] [3]. The example of the Italian demonstration site in ProLight project has shown that the presence of a local intermediary (i.e. a local social manager) is essential to build trust and enhances outreach activities towards local citizens. In general, across all demonstration site in ProLight, the implementation of energy sharing schemes (or other energy saving measures) are systematically accompanied with end-user information

sharing, engagement and co-creation activities which can take various forms of communication and dissemination action such as workshops, door-to-door communication, ...

### 3.4 Barriers related to social housing setting.

**Fragmented decision rights** (most relevant in setup phase): Multiple actors—housing companies, facility managers, tenant committees—hold decision-making power. This fragmentation often delays or complicates project development [7] [8].

**Split-incentive / landlord-tenant dilemma** (most relevant in setup phase): This barrier is especially acute in social housing because the social housing sector remains fundamentally tenant-based [11]. While mass giveaways (UK, Ireland, Romania, ...) did significantly shift housing into owner-occupancy, those practices have been mostly phased out. Moreover, regulated rent regimes typically prevent the recovery of capital expenditures through tenants' energy bills, decoupling investment incentives from user benefits [8].

**Procurement and state-aid constraints** (most relevant in setup phase): In publicly owned or managed housing, strict procurement rules and state-aid considerations create additional delays and limit flexibility. These rules are designed to ensure transparency and fairness, but in practice they can create lengthy administrative processes and restrict the ability to experiment with innovative financing models. In particular, they can make it more difficult to mobilise alternative sources of support, such as sponsorships or donations, which could otherwise help reduce upfront investment needs [7].

### 3.5 Barriers related to energy poverty context

**Reliance on pre-existing energy efficiency measures** (most relevant in setup phase): Energy sharing typically becomes viable only after refurbishment or retrofitting, as inefficient building envelopes undermine both the economic case and comfort outcomes. This dependency is especially relevant in social housing, where building stock is often older and poorly insulated [14] [15].

**Challenges in benefit quantification** (most relevant in operational phase): If analysis focuses only on monetary savings, the true social benefits are underestimated. In social housing, affordability constraints often lead to energy under-consumption (e.g. not heating), meaning that savings appear low despite major improvements in comfort and well-being [1].

## 4 CONCLUSIONS

This study has shown that while photovoltaic-based energy sharing holds significant potential to alleviate energy poverty in social housing, its implementation faces a complex set of interrelated barriers. These range from technical and physical constraints, such as limited roof space and metering complexity, to socio-economic and institutional challenges, including limited investment capacity, tenant turnover, arrears risk, and fragmented decision rights. Importantly, the social housing context amplifies these challenges: affordability constraints heighten the distributional consequences of benefit allocation, administrative literacy gaps demand stronger engagement and support measures, and strict procurement and state-aid rules limit flexibility in financing.

Despite these obstacles, the analysis of the ProLight demonstration sites illustrates that energy sharing in social housing can be made viable when barriers are explicitly addressed in the design of business models. Careful definition of benefit allocation keys and scope, transparent billing arrangements, and the involvement of trusted intermediaries are essential for building trust and ensuring equity. Likewise, coupling energy sharing with refurbishment strategies, mobilising targeted subsidies and grants, and fostering cooperative governance arrangements can enhance both feasibility and long-term sustainability.

A better understanding of the barriers is also critical for shaping replication strategies, ensuring that lessons from the ProLight demonstration sites can be transferred to other contexts. Already at this stage, many insights have been gained regarding both technical and social aspects, while within a year, by the end of the project, more quantitative evidence will become available. These forthcoming results will further inform business model orientations, supporting the definition of viable pathways to scale up PV-based energy sharing in social housing.

Overall, PV-based energy sharing should not be viewed as a stand-alone solution but rather as part of a broader strategy to reduce energy poverty in multi-apartment buildings. By embedding such schemes within supportive regulatory frameworks and ensuring that social and economic safeguards are prioritised, they can deliver not only economic savings but also improved comfort, well-being, and social cohesion. In this way, social housing can become a key driver of an inclusive and just energy transition in Europe.

## 5 REFERENCES

- [1] S. a. D. I. MAIER, «Who is "energy poor" in the EU,» 2024.
- [2] IEA PVPS Task 1, «Trends in PV Applications 2024,» 2024.
- [3] European Parliament and the Council , «Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources,» 2024.
- [4] L. Marchi, L. Felicioni, F. Sabatini et L. Errante, «Exploring Energy Literacy in Italian Social Housing: A Survey of Inhabitants Preparing the Ground for Climate Transition,» Sustainability , 2023.
- [5] M. R. P. S. M. A. A. L. B. F. M. Federico Gianaroli, «Development of dynamic sharing keys: Algorithms supporting management of renewable energy community and collective self consumption,» Energy and Buildings, vol. 311, 2024.
- [6] I. a. E. E. A. D.-G. f. E. F. B. L.-E. K. M. C. e. a. European Climate, «Report on energy sharing,» Publications Office of the European Union, 2025.
- [7] V. M. G. P. M. M. D. Casalicchio, «Renewable Energy Communities: Business Models of Multi-family Housing Buildings,» Smart and Sustainable Planning for Cities and Regions, p. 261–276, 23 March 2021.
- [8] M. K. E. N. F. S. R. M. Fritz Braeuer, «Optimal system design for energy communities in multi-family buildings: the case of the German Tenant Electricity Law,» Applied Energy, vol. 305, 2022.
- [9] J. a. D. Q. Arnould, «Energy communities in the EU: Opportunities and barriers to financing,» Amsterdam, 2022.

- [10] J. a. D. Q. Arnould, « Energy Communities in the EU: Fulfilling consumer rights and protections,» Amsterdam, 2022.
- [11] G. S. H. P. D. F. F. C. A. D. V. N. C. C. M.-B. I. a. U. A. Koukoufikis, «Energy Communities and Energy Poverty,» Publications Office of the European Union, Luxembourg, 2023.
- [12] Housing Europe, «Alleviating energy poverty in social and privately-owned homes from 2020 until today,» [En ligne]. Available: <https://www.housingeurope.eu/alleviating-energy-poverty-in-social-and-privately-owned-homes-from-2020-until-today/>. [Accès le September 2025].
- [13] F. G. R. Hanke, «The struggle of energy communities to enhance energy justice: insights from 113 German cases,» Energ Sustain Soc, vol. 13, n° %116, 2023.
- [14] L. Marchi, L. Felicioni, F. Sabatini et L. Errante, «Exploring Energy Literacy in Italian Social Housing: A Survey of Inhabitants Preparing the Ground for Climate Transition,» Sustainability , vol. 15, 2023.
- [15] E. F. I. S. T. D. A. Y. J. B. G. A. L. R. B. O.-S. S. P. B. M. A. B. Directorate-General for Energy, «Study on mapping of regulatory frameworks and barriers for individual and collective renewables self-consumption in EU Member States,» Publications Office of the European Union, 2024.
- [16] B. R. A. R. Aravind Poshnath, «Adoption of Renewable Energy Systems in common properties of multi-owned buildings: Introduction of 'Energy Entitlement',» Energy Policy, vol. 174, 2023.
- [17] OECD, «Social Housing: A Key Part of Past and Future Housing Policy,» 2020.
- [18] L. B. P. E. M. Castellazzi, «Overcoming the split incentive barrier in the building sectors: unlocking the energy efficiency potential in the rental & multifamily sectors,» Publications Office of the European Union, Luxembourg, 2017.
- [19] P. McManamon, «Toward Building Energy Reduction Through Solar Energy Systems Retrofit Options: An Equest Model,» Journal of Applied Engineering Sciences, 2018.
- [20] U. Madushika, T. Ramachandra, G. Karunasena et Udakara, «Energy Retrofitting Technologies of Buildings: A Review-Based Assessment,» Energies, 2023.

## 6 ACKNOWLEDGMENT AND FUNDING



The work described has received funding as part of the PROLIGHT project from the European Union's Horizon Europe research and innovation program under grant agreement N° 101079902.