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Overcoming Barriers to Photovoltaic Adoption: The Role of Regulation for Plug-In Solar from the Viewpoint of Tenants and Apartment Owner-Occupiers

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Residential photovoltaic (PV) adoption has increased substantially over the past couple of decades in many developed economies (e.g., REN21, 2024). However, not all population groups have benefited equally from this expansion. A key disparity lies in homeownership: until recently, PV adoption has been predominantly limited to homeowners. Tenants and residents of multi-unit buildings –despite showing interest –have had limited opportunities to access photovoltaics (Best, 2022; Gerber et al., 2025; Zander, 2020). This meant that large sections of the population were excluded from direct use of PV technologies. In the European Union, for instance, 46 percent of the population lives in apartments rather than houses, and 30 percent lives in rented accommodation. Even in countries with high homeownership rates, the growing prevalence of multi-unit dwellings due to ongoing urbanization continues to constrain access to photovoltaics (Charters and Heffernan, 2021; Poshnath et al., 2023).

This study was motivated by the political debates in Germany during 2023 and 2024 surrounding the regulation of plug-in solar devices. These discussions led to several legislative changes and a rapid increase in plug-in solar adoption. The new regulations addressed not only the technical requirements for these systems but also reporting obligations to relevant authorities and the need for approval from landlords and homeowner associations (HOA). At the same time, the number of installations rose sharply –from 11,653 in 2021 to 77,251 in 2022, 265,556 in 2023, and 429,248 in 2024. These developments raised the question of whether all (proposed) regulatory changes are equally important in promoting access to PV adoption among tenants and apartment owner-occupiers, or whether some are considerably more influential than others. To explore this, we first analyzed online documents to trace how these regulatory changes evolved. Building on these insights, we designed a stated choice experiment to assess the relative importance of individual policy measures for the purchasing intentions of tenants and apartment owner-occupiers. Specifically, we address two main research questions:

- Which policy measures preceded the breakthrough of plug-in solar in Germany?
- How relevant are these measures in shaping the purchase intentions for plug-in solar devices?

The literature has examined the underlying causes of restricted PV access for tenants and apartment owner-occupiers. In many jurisdictions, tenants are legally prohibited from making structural modifications to rented properties without landlord approval (Dodd and Nelson, 2022). As a result, the installation of PV systems typically requires explicit landlord permission (Dodd and Nelson, 2022). Moreover, uncertainties related to tenancy duration can undermine the economic viability of such investments (Dodd and Nelson, 2022; Roberts et al., 2019). High upfront installation costs further compound these barriers (Best, 2022; McCarthy, 2024). Landlords, in turn, often lack motivation to invest in PV due to the split-incentive problem: while they bear the investment costs, it is the tenants who benefit from reduced electricity bills (Hammerle et al., 2023; Roberts et al., 2019). Apartment owner-occupiers face similar legal and structural constraints. In most countries, residential property law governs the rights and responsibilities of owners in multi-unit buildings. While individuals may hold private ownership of specific units, the building's structure, facade, roof, and shared spaces are typically under collective ownership (Poshnath et al., 2023; Roberts et al., 2019). Consequently, any alterations – such as installing PV systems –require formal approval by the HOA. Although approval thresholds vary across jurisdictions (e.g., unanimous, two-thirds, or simple majority), the collective decision-making process frequently constitutes a barrier to action (Poshnath et al., 2023). Diverging interests among different types

of owners –such as resident versus investor owners, or original versus subsequent purchasers –further complicate consensus-building. Low meeting participation, interpersonal conflicts, and general mistrust among neighbors can also hinder agreement (Charters and Heffernan, 2021; Zander, 2020). Even when consensus is reached, coordination challenges often persist due to differing perceptions of responsibility, time constraints, or lack of engagement (Charters and Heffernan, 2021; Poshnath et al., 2023).

Following recent stated choice experiment literature, we use mixed logit models, which are more flexible than previously used conditional logit models (Hensher and Greene, 2003). We consider pooled and split sample models, as well as models where we interact individual-specific characteristics of tenants and apartment owner-occupiers with the attributes.

We find that apartment owner-occupiers and tenants differ in their group-specific preferences for regulations regarding balcony solar PV systems. Owner-occupiers show stronger preferences for the amount of yearly remuneration that a balcony solar PV system would create, whereas tenants are more likely to opt out of the decision and choose no balcony solar PV system under any circumstances.

Furthermore, we find that preferences are shaped by beliefs about solar PV in general, for both owner-occupiers and tenants. E.g., Owner-occupiers see PV aesthetics as a deciding factor whereas tenants do not.

To our knowledge, this study is the first to analyze preferences for balcony solar PV system regulations. However, we see a need for further research into how engaged tenants and apartment owner-occupiers are with plug-in solar systems. Even though it is evident that the share of the total installed capacity will remain small, balcony solar systems might contribute to high levels of public support for the energy transition (Mildenberger et al., 2019).

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