How to make building renovation work for low-income renters: Preferences for distributional principles and procedural options in Austria

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Abstract

Widespread thermal refurbishment of existing buildings is essential for mitigating carbon emissions and energy poverty. Retrofitting for better energy efficiency in low-income rental housing comes up against the tenant-landlord dilemma, however; for renovation to be accepted by residents, rules for cost sharing and fair implementation are required. The present study employs structural equation modelling to analyse distributional and procedural preferences in a survey sample of 942 low-income renters in Austria. The distributional principles of polluter-pays and energy bill neutrality are preferred for allocating renovation costs. Equal-pay, ability-to-pay, and paying extra instalments to finance the renovation are only accepted for buildings in high need of renovation. Low-income renters welcome a wide range of procedural options, in particular, providing transparent and comprehensive information on the planned renovation and mitigating inconvenience during the construction phase. Psychological and relational capabilities play into these preferences: households holding pro-environmental attitudes favour polluter-pays to prevent free-riders. A frugal mindset, trust in the landlord and renter concerns make low-income renters endorse ability-to-pay to avoid being displaced to lower-grade dwellings on a discriminating housing market. The results suggest that distributional principles need not stand alone but could be combined. For instance, allocating the majority of renovation costs by polluter-pays, but a smaller share by ability-to-pay, may cushion disproportionate impacts on less affluent residents. Energy counselling could empower low-income renters to manage personal energy and renovation costs, and to build literacy about renovation benefits and legal claims to encourage their landlord to renovate.

Highlights

- General justice terms spelt out to those who may be most affected by injustices.
- Survey operationalisation of distributional principles and procedural options.
- Acknowledges heterogeneous capabilities of vulnerable groups.
- Shows interrelations and common drivers of distributional and procedural justice.

Keywords

energy justice, fuel poverty, energy vulnerability, energy insecurity, split incentives, burden sharing

1. Introduction

Widespread renovation of existing buildings for better thermal performance is considered essential for mitigating both carbon emissions and energy poverty (IEA 2014). Building renovation is a central pillar in European energy and climate policy, most recently with the announcement of the Renovation Wave (European Commission 2020), and similarly, at the national level in the governmental programme for Austria, the study region of the present paper (Federal Chancellery Austria 2020). Poor-quality and energy-inefficient homes are associated with income poverty and energy poverty (Boardman 1991, Gillard et al. 2017, Bartiaux et al. 2018). Low-income households often live in poorly maintained dwellings with long-term disinvestment in energy efficiency (Hernandez & Phillips 2015), and these households often have least resources or opportunity to invest in retrofits (Walker & Day 2012). Thus, improving access to energy services through renovation may lessen the deprivation of energy-poor households (Sovacool 2015, Jenkins et al. 2016, Wrigley & Crawford 2017).

Low-income households in Austria are predominantly renters (Statistik Austria 2019). In Austria, therefore, as well as in other countries with a similar housing market, financing renovation comes up against the tenant-landlord dilemma: tenants are only charged for operating costs and therefore accrue the efficiency gain of a renovation via their lower energy bill, but landlords have to fund the entire renovation and may only compensate for or even profit from this investment if they raise rents. Vice versa, if landlords refrain from refurbishing, tenants carry the full burden of this omission in excessive energy bills. Consequently, subsidies or low-interest loans to mitigate the financial pressure of upfront investment costs are the most prominent policy suggestions for promoting renovation in housing inhabited by low-income households (Charlier 2015, Castellazzi et al. 2017, Brown et al. 2019). Unless the renovation costs are fully borne by the state or the building owner, however, renters need to repay a share of the renovation costs over time. Repayment can be done by withholding cost savings from the energy bill, so that tenants pay the same amount as they did before the renovation (termed 'energy bill neutrality' in the present study), or by increasing rent over a given period (termed 'green lease' in the present study; Bird & Hernandez 2012, Astmarsson et al. 2013, Brown et al. 2019). Renovation in low-income housing is highly contested: low-income households typically live in bad housing, so they would benefit from renovation, but making low-income renters carry a part of the renovation costs may displace them to lower-grade housing segments, resulting in gentrification and segregation (Femenias et al. 2018, Sovacool et al. 2019a).

Making renovation work for low-income renters is thus a matter of sharing the costs and implementing the renovation process in a fair manner. Distributional and procedural aspects are core elements in the energy justice debate (Walker & Day 2012, Jenkins et al. 2016)[1]. Distributional justice refers to the source of inequity, i.e. the allocation of direct and indirect costs and benefits (Simpson & Clifton 2016, Gillard et al. 2017, Becker et al. 2019). Procedural justice refers to strategies for remediating inequity, foremost impartial, inclusive and unbiased decision-making. Procedural aspects include disclosing critical information, providing access to legal and technical basics, or treating those affected with respect (McCauley et al. 2019, Mundaca et al. 2018). Procedural and distributional justice are inherently connected, as procedural processes produce or counteract unfair distributional outcomes (Walker & Day 2012, Bartiaux et al. 2018, Sovacool et al. 2019b).

The aim of the present paper is to contribute a bottom-up perspective of low-income renters to the debate on implementing distributional and procedural justice in building renovation. Drawing on

[1] Besides distributional and procedural justice, recognition of those who are affected but ignored or misrepresented is the third tenet of energy justice (Jenkins et al. 2016). While undoubtedly essential, recognition justice is not addressed in the present study, because the survey sample exclusively consists of low-income beneficiaries of welfare support who are already acknowledged as vulnerable and marginalised.

survey data of 942 low-income renter households in the city of Graz, Austria, the study shows which distributional principles and procedural options are preferred over others and why. In contrast to previous studies which surveyed distributional and procedural justice in general terms (e.g. Evensen et al. 2018) or using qualitative methods (e.g. Willand & Horne 2018), the present study offers a detailed operationalisation by breaking down to specific principles and options. By exploring the drivers behind distributional and procedural preferences, the study acknowledges that low-income households are not a homogeneous group but differ in their capabilities and needs (Blomsterberg & Pedersen 2015). Illustrating how capabilities drive distributional and procedural preferences allows for policy recommendations for combining and promoting distributional principles and procedural options in renovation projects.

The remainder of the paper proceeds as follows: the theoretical background section presents the equal-pay, polluter-pays and ability-to-pay distributional principles, the procedural options available during the renovation process, and material, psychological and relational capabilities as drivers behind these principles and options. The method section specifies survey sample, measures of principles, options and drivers, and analytical approach. In the results section, descriptive results of the endorsement of the respective principles and options are reported; principles and options are intercorrelated to illustrate synergies and trade-offs, and preferences for specific principles and options are explained using structural equation modelling. The paper concludes with a discussion of policy recommendations, methodological caveats and directions for future research.

2. Theoretical background

2.1 Distributional principles

Distributional justice refers to the assignment of responsibility or costs to involved parties. Citizens evaluate their own burden against the prospects of others, such as landlords when paying for energy efficiency improvements (Hernandez & Phillips 2015, Collins & Curtis 2018), other renters when sharing the costs of a joint heating system (Charlier 2015) or energy companies when paying for transition to a low-carbon society (Evensen et al. 2018, Becker et al. 2019). Distributional justice need not mean perfect equality; winners are accepted if the losers are not worse off than before or if community benefits are provided for all (Mundaca et al. 2018). Thus, distributional justice requires rules for assigning costs to parties.

Approaching a just distribution may follow three distributional principles (Brooks & Davoudi 2014, Groh & Ziegler 2018): *equal-pay*, meaning that each party pays the same amount; *polluter-pays*, each party pays according to their consumption; or *ability-to-pay*, each party pays according to their capabilities and needs. These principles appear in various existing energy policies: adding a uniform renewable energy surcharge to all energy tariffs, regardless of customer type, is an example of the equal-pay principle (Simpson & Clifton 2016). Polluter-pays is common in allocating heating costs in multi-apartment buildings by dividing the total costs by floor area (Charlier 2015). Examples of ability-to-pay are progressive income tax imposing lower tax rates on the less affluent, or the provision of higher grants to low-income and vulnerable residents as in the British Warm Front renovation scheme (Brooks & Davoudi 2014). Generally, households prefer polluter-pays over the other distributional principles (Groh & Ziegler 2018).

Few studies have analysed distributional preferences regarding energy policies in standardised surveys. For financing the German energy transition, polluter-pays is preferred over ability-to-pay, which is preferred over equal-pay (Groh & Ziegler 2018). Groh and Ziegler report that equal-pay is widely rejected as being indiscriminate; polluter-pays is more accepted by people with pro-

environmental values but rejected by people with high energy expenditures; ability-to-pay is preferred by households with lower income. British citizens expect energy companies and the government to pay for transition to a low-carbon society because they have the financial means from making substantial profits (similar to ability-to-pay, Becker et al. 2019). This notion of not granting any additional benefits to a party that already turns a good profit also appears in Irish tenants rejecting renovation because they do not want to concede more revenues to their landlord (Collins & Curtis 2018). In another British study (Evensen et al. 2018), agreeing that deprived households should pay less for energy (similar to ability-to-pay) is associated with higher personal acceptance of costs for transition to a low-carbon society. However, this study finds personal income to be unrelated to the preferred allocation of costs between oneself and other energy system actors. Regarding public funding for private solar installations in Australia, Simpson & Clifton (2016) find unclear preferences for whether all customers should contribute equally by a tariff surcharge (similar to equal-pay) or poor applicants should be prioritised in receiving funding (similar to ability-to-pay), pointing to diverging opinions dependent on personal characteristics such as age or income. Taken together, these studies confirm that citizens do reflect on distributional principles in their personal context, and indicate income, expenditures and pro-environmental values as factors behind their preferences.

2.2 Procedural options

Procedural justice refers to how decision-making processes are designed and implemented. Procedural justice spans giving a voice or institutional representation to residents (Gillard et al. 2017, McCauley et al. 2019, Mundaca et al. 2018), providing accurate and sufficient information (Jenkins et al. 2016, Becker et al. 2019), ensuring transparency and accountability in energy contracts (Willand & Horne 2018), and establishing respectful and honest relationships between all parties (Evensen et al. 2018).

Procedural options are associated with a multitude of positive outcomes: deliberative engagement of the public can improve legitimacy and acceptance of energy projects (Devine-Wright 2008, Mundaca et al. 2018, Becker et al. 2019) and is a means to overcome power structures of hierarchy and control (de Feijter et al. 2021). In building renovation in particular, procedural options may promote mutual accounting for the respective needs of tenants and landlords (Bird & Hernandez 2012), may cushion tenant-landlord conflicts over the renovation (Femenias et al. 2018), and may help to ensure that unjust tactics do not pressure or mislead people into agreeing with a renovation (Sovacool et al. 2019b).

Procedural options may be implemented throughout the renovation process: in the *planning phase*, by providing information at renter assemblies, online, or in personal meetings with the architect; by conducting independent pre-renovation audits; by visiting demo buildings which have been successfully retrofitted; or by giving residents a saying in the renovation decision (Astmarsson et al. 2013, de Feijter et al. 2021). Early participation of residents is paramount, whereas post-decision consultation may trigger protest (Mundaca et al. 2018). During the *construction phase*, in particular if residents stay in their homes during renovation works, by adhering to a prearranged schedule; by integrating the renovation with other building modifications; by maintaining privacy and quality of living despite the disruption by noise, dust and presence of craftspeople; or by allowing the opening of windows and use of balconies during the fitting of wall insulation (Blomsterberg & Pedersen 2015, de Feijter et al. 2021). In the *post-retrofit repayment phase*, by detailing the tariff structure of energy bills; by enabling occupants to monitor their energy consumption; or by offering support for new energy-saving domestic practices (Astmarsson et al. 2013, Becker et al. 2019, de Feijter et al. 2021). Regarding renovation payback and renter security, by guaranteeing minimum energy savings after the renovation; by suspending rent increases or termination of rental contracts until the renovation investment has been repaid; or by restricting renovation efforts to short-term leases where each unit

is renovated after its rental contract has expired (Middlemiss & Gillard 2015, Castellazzi et al. 2017, Trotta et al. 2018). Conducting stepwise partial renovation instead of all-at-once deep renovation may stretch the cost burden over a longer period and may allow readjustment of planning to emerging needs, concerns or technological advancements (Femenias et al. 2018).

2.3 Drivers of distributional and procedural preferences

Disadvantaged households are not uniform, but differ in their sensitivity to the factors incurring energy poverty (Middlemiss & Gillard 2015, Willand & Horne 2018) and are exposed differently to distributional and procedural injustices (Chard & Walker 2016, Gillard et al. 2017). The present study draws on the material, psychological and relational capabilities of vulnerable households to explore their distributional and procedural preferences (Bartiaux et al. 2018).

Material capabilities refer to income poverty and energy poverty, which in turn are associated with housing conditions. *Income poverty* and *energy poverty* should not be confounded but they are closely related: energy poverty definitions compare energy expenditures with income (Boardman 1991); energy poverty interventions struggle to have lasting impacts if income does not keep up with rising energy prices (Sovacool 2015); systemic material undersupply increases the likelihood of becoming energy-poor (Chard & Walker 2016, Gillard et al. 2017). In income poverty and energy poverty, economic deprivation intersects with health, emotional well-being and the overall possibility of living a good life (Bartiaux et al. 2018). Low income is associated with higher preference for the ability-to-pay principle (see Section 2.1). Regarding renovation, a stable income guarantees regular payment of rent and renovation payback instalments (Middlemiss & Gillard 2015) and makes it more likely that residents will have savings or access to capital for upfront investment costs (Bird & Hernandez 2012, Hernandez & Phillips 2015, Willand & Horne 2018).

Psychological capabilities refer to personal views on protecting the environment and on living frugally. *Environmental concern* increases the acceptance of renewable energy technologies (Devine-Wright 2008). Describing oneself as engaging in pro-environmental behaviours increases willingness-to-pay for building renovation (Collins & Curtis 2018). Caring for the environment is not a privilege of the well-off; the less-affluent living in social housing also hold pro-environmental attitudes towards domestic practices (Jansson-Boyd et al. 2017), are more willing to invest in home efficiency modifications if they are concerned about climate change (Scott et al. 2014), and state pro-environmental besides economic reasons for energy saving (Walker et al. 2014). Some low-income households consider it common sense to save costs by pursuing an economical lifestyle (Middlemiss & Gillard 2015, Sovacool 2015). This *frugality* mindset refers to self-imposed, voluntary austerity; thus, frugality differs from forced thriftiness that manifests in undercutting heating needs below healthy or comfortable levels or even facing a heat-or-eat dilemma (Anderson et al. 2012, Chard & Walker 2016, Willand & Horne 2018).

Relational capabilities refer to *trust and tenancy relations with the landlord*. Low-income households depend on secure tenancy because they would face financial and contractual barriers and a limited range of alternative homes if their rental contract were terminated unexpectedly (Middlemiss & Gillard 2015, Gillard et al. 2017, Willand & Horne 2018). Precarious tenant-landlord relations may render a renovation less likely in many ways: renters fearing eviction may underexpress their demand for retrofitting; mistrust may instigate misinformation about the property's thermal performance; landlords may sacrifice tenant comfort over costs, for instance by turning down heating boilers or by postponing energy efficiency upgrades (Hernandez & Phillips 2015, Wrigley & Crawford 2017, Willand & Horne 2018). After completing renovation, a trustful relationship remains critical: tenants may worry about rent increases; if a tenant defaults on his rent, the landlord has to step in for the renovation payback instalment in addition to his loss in rent revenue; households may perceive renovation as

unfair if they do not experience a visible improvement in their own dwelling (Bird & Hernandez 2012, Blomsterberg & Pedersen 2015). On the wider topic of transition to a low-carbon society, relational capabilities intersect with distributional considerations, such as citizens accepting more responsibility if they trust energy companies and the government, and with procedural justice criteria, such as transparency about how costs are allocated and profits are spent by the respective energy system actors (Evensen et al. 2018, Becker et al. 2019).

3. Method

3.1 Case study of low-income renters in Graz, Austria

The present study was conducted in the city of Graz, Austria. Graz has ca. 300,000 inhabitants who predominantly live in rented properties (62%; Statistik Austria 2019). In Austria, as is common elsewhere, most energy-poor households are tenants (Bouzarovski et al. 2012; Llera-Sastresa et al. 2017; Seebauer et al. 2019). Austrian renters are very familiar with the polluter-pays principle because rental law requires distribution of heating costs in multi-apartment buildings by floor areas and radiator meters. Legal rules on the allocation of costs for energy efficiency renovations between tenants and landlords are mostly lacking (Seebauer et al. 2019). Raising rents temporarily to fund pressing housing renovations, which may also include thermal improvements, is eligible only in selected housing segments and requires approval by regional authorities.

Retrofitting 3% per annum of the existing building stock for improved energy efficiency is a policy target in European and Austrian climate strategies (European Commission 2018, Federal Chancellery Austria 2020). Although promoted by more than a decade of subsidy programmes, the annual retrofitting rate in Austria averaged just 0.7% in 2008-2018 and still falls short of policy expectations (Environment Agency Austria 2020). There is, as yet, no binding regulation that obligates property owners to renovate. Current policy efforts focus on advancing renovation in limited-profit and communal housing; however, private rental, as the biggest share of the housing market, remains unaddressed (Amann & Mundt 2019, Seebauer et al. 2019). Thus, there is a clear policy need for approaches to make renovation work for low-income residents who live in private rental.

3.2 Data

Standardised self-completion questionnaires were distributed by post in the summer of 2020 to all current 9,815 beneficiaries in the SozialCard program[2] of the social welfare office in Graz. Households received a direct, personally addressed mailing with the office's header. Responses could be returned by post using a prepaid return envelope or entered in an identical online survey. A lottery of gift vouchers (10 x 30 Euro) incentivised survey participation. Individual support in completing the questionnaire was offered by welfare staff and the study team, either in person or via phone.

With 96 misspelt or out-of-date addresses and 1,062 valid responses, the response rate amounts to 10.9%. The present analysis uses a subsample of 942 households who live in rented housing. These households predominantly live in multi-storey apartment buildings (95.1% of the sample) and have an income in the lowest quartile of the Austrian income distribution (96.5% have a monthly net income of less than 1,900 Euro); 20.5% are households with children; 33.6% are pensioner households; 59.7%

[2] The SozialCard entitles low-income households to discounts for public services and to benefit payments for winter fuel or school supplies. See https://www.graz.at/cms/beitrag/10200148/7761791/SozialCard.html (accessed: 11 Feb 2021)

of the respondents are female. Written comments in the returned questionnaires indicate that the respondents are deeply concerned about their housing situation and costs as an essential part of their livelihood; however, many are barely proficient with the technicalities and financing of building renovation. This should be kept in mind when interpreting the results.

3.3 Measures

The questionnaire was extensively pre-tested with social workers and external experts for simple German to facilitate access for people with learning difficulties, language barriers or semi-literacy. A short introduction specified renovation as thermal improvements of the building envelope, such as wall insulation or double-glazed windows. In order to avoid unjustified expectations or concerns, the introduction clarified that the survey was to be answered for a potential future renovation and that no actual renovation was planned at the respondent's building. Full item wordings, response scales and descriptive statistics are given in Tables 1 and 2 for distributional principles and procedural options, and in Table A.1 for all other items (all tables in the Appendix are indicated by the prefix A).

Distributional principles. With respect to sharing renovation costs between the residents of a building, presented as single statements: (i) equal-pay, all pay the same amount, and (ii) polluter-pays, costs are assigned according to heating consumption (Evensen et al. 2018, Groh & Ziegler 2018). Ability-to-pay was differentiated into (iii) ability-to-pay-income, those with lower income pay less, and (iv) ability-to-pay-situation, those living in a deprived situation pay less. With respect to repaying renovation costs over time, also presented as single statements: (a) energy bill neutrality, continuing to pay the same energy bill as before until costs are recouped from energy savings, and (b) green lease, paying additional rates in order to pay back the investment faster. For the sake of comprehensibility, these distributional statements did not stipulate exact burden shares, payback timeframes, size of payback rates, or whether timeframes and rates might be adjusted if energy prices were to shift (Brooks & Davoudi 2014). Thus, household responses to these statements should be interpreted as preferences, not as policy acceptance.

Procedural options. In total, 17 procedural options were presented, spanning the planning, construction and repayment phases of a building renovation. By means of factor analysis, these options were aggregated to four factors (see Table A.2): (1) information, communicating and describing benefits, drawbacks and technical options; (2) participation, involving residents in decision-making; (3) construction, adhering to schedules and minimising noise, dust and privacy discomfort; and (4) renter protection, freezing rent and energy costs or suspending termination of rental contracts for several years. As above, procedural options were described in general terms and should be understood as preferences towards different forms of resident involvement.

Need for renovation. Respondents rated the perceived necessity for renovating their building regarding windows, heating system and insulation of outer walls. If a particular building had already been (partially) renovated, respondents were expected to express a correspondingly lower need for (additional) renovation, unless they were dissatisfied with the quality or extent of the renovation work.

Income poverty. As an objective indicator, available monthly household income was measured in six income categories corresponding to selected deciles and quartiles of the Austrian income distribution. Income responses were converted into a metric scale using the respective category midpoints and transposed to equivalised household income to control for household size (EU SILC 2019). As a subjective indicator, households stated how well they make ends meet with their income (adopted from the Generation and Gender Programme; Bartiaux et al. 2018). Measuring an objective and a subjective indicator allows checking whether manifest or perceived deprivation is more important for distributional and procedural preferences. Household income was measured as the absolute amount

in euro; thus, this indicator captured variability within a survey sample that is overall much less affluent than the general Austrian population.

Energy poverty. As an objective indicator, the share of the household income spent on housing expenditures, in other words, rent, heating and other energy services, was assessed. As a subjective indicator, households stated whether they can afford to keep the home adequately warm (adopted from the European Survey on Income and Living Conditions; Eurostat 2020). The same considerations apply as in income poverty regarding manifest and perceived deprivation as well as variability.

Personal norms. Three items expressed pro-environmental self-identity, as well as feelings of responsibility and obligation to use space heating in an environmentally sound way (Bamberg et al. 2007, Seebauer 2018).

Frugality. Two items captured self-restraint and voluntary moderation in the consumption of everyday goods (Goldsmith et al. 2014, Seebauer 2018).

Trust in the landlord. Three items measured whether the landlord is seen as honest, trustworthy and fair (Evensen et al. 2018). This factor reflects a belief that the landlord would not take advantage of their tenants and therefore both parties might enter informal arrangements instead of codified distributional or procedural rules.

Renter concerns. Three items addressed concerns about premature termination of the rental contract, being pushed to lower-quality housing, and rent increases (Middlemiss & Gillard 2015). This factor reflects marginalisation experienced on the private rental market.

3.4 Analytical approach

The analysis proceeds in three steps: first, mean comparisons show how strongly low-income households agree with the various distributional principles and procedural options (Sections 4.1 and 4.2). Second, intercorrelations show how principles and options may preclude or complement each other (Section 4.3). Third, the same set of material (need for renovation, income poverty, energy poverty), psychological (personal norms, frugality) and relational (trust in the landlord, renter concerns) capabilities is applied to explain the endorsement of distributional principles and procedural options in order to compare differing motivations (Section 4.4 and 4.5). Results are tested against a $p<.05$ significance level.

In the third step, structural equation modelling is applied to analyse causal relationships between latent factors (Byrne 2010). The drivers need for renovation, personal norms, frugality, trust in the landlord and renter concerns enter the analysis as latent factors, each based on multiple items, since this enables better correction for measurement error than factor indices. The quality of the assignment of items to factors is reflected in the general model fit; therefore, results from separate confirmatory factor analyses are omitted. Factor loadings are satisfactory throughout (mostly >.70; see Table A.1). By contrast, the drivers income poverty (income, make ends meet) and energy poverty (housing expenditures, keep home warm) enter the models as single items, pursuant to the use of single indicators in energy poverty research (Karpinska & Smiech 2020). Endorsement of each distributional principle and procedural option is analysed in a separate model. Jointly entering all drivers as explanatory factors allows the unique, stand-alone influence of each driver to be shown while controlling for the influences of all other drivers. The models include correlations between selected factors (e.g. between objective and subjective poverty indicators) in order to cater to conceptual relatedness and to improve model fit.

All models are calculated with raw data, applying Full Information Maximum Likelihood (FIML) estimation to account for missing values. Model fit indices indicate how well the observed data are represented by the model structure. Model fit is considered good with a comparative fit index (CFI) and normed fit index (NFI) larger than .90, a root mean square error of approximation (RMSEA) lower than .08, and a ratio of Chi^2 to degrees of freedom (df) lower than 5 (Schumacker & Lomax 2004).

4. Results and discussion

4.1 Endorsement of distributional principles

Polluter-pays is the favoured distributional principle; the mean of 3.94 clearly lies in the positive range of the five-step response scale (Table 1). By contrast, equal-pay is mostly rejected. Presumably, polluter-pays is preferred because households are familiar with this principle as the current rule for allocating heating costs in apartment buildings. The average agreement with ability-to-pay is slightly above the mid-point of the response scale, however, indicating a certain willingness to take personal capacities into account. This ranking of distributional principles conforms with the Groh & Ziegler (2018) study on the German energy transition where polluter-pays has much higher acceptance (80%) than ability-to-pay (46%) and equal-pay (16%).

Regarding the repayment of renovation costs, energy bill neutrality (i.e. paying the same energy bill as before and withholding cost savings) is clearly preferred over green lease (i.e. paying additional rates; Table 1). However, variance is fairly high in all distributional principles (SD>1.2), pointing to differences between households that may be explained by their respective material, psychological and relational capabilities in Section 4.4.

Table 1. Descriptive statistics on distributional principles.

Distributional principle	N	Mean	SD
Equal-pay All residents pay the same amount, regardless of income, energy consumption or situation.	833	2.23	1.35
Polluter-pays Each resident pays as much as he consumes in energy for heating.	870	3.94	1.23
Ability-to-pay-income Each resident pays as much as he can afford, depending on income.	868	3.46	1.35
Ability-to-pay-situation Each resident pays as much as he can manage, depending on his living situation. For example, residents with many children, those chronically ill or those with special needs pay less.	843	3.49	1.31
Energy bill neutrality Each resident keeps paying the same costs for heating as before the renovation. Repayment goes slowly.	856	3.56	1.26
Green lease Each resident pays a bit more for heating than before the renovation. Repayment goes faster.	838	2.79	1.28

Items translated from German; five-step response scale from 1=very bad to 5=very good to the question 'How do you find these options for sharing renovation costs?'
Mean comparison between equal-pay, polluter-pays, ability-to-pay-income and ability-to-pay-situation: n=805; repeated measures ANOVA, greenhouse-geisser adjusted; F=281.6; df=2.4, 1931.1; p<.001; bonferroni-adjusted post-hoc analysis shows significant differences between all principles, except ability-to-pay-income and ability-to-pay-situation.
Mean comparison between energy bill neutrality and green lease: n=803; repeated measures t-test; t=12.8, df=802, p<.001.

4.2 Endorsement of procedural options

Most procedural options are rated with a mean in the range from 3.7 to 4.2 on the five-step response scale, showing high interest of low-income households in having a say in how renovation would be implemented in their home (Table 2). Among this general call for being included in renovation decisions, information on costs and construction details stand out as most important. Households are less interested in site visits to already renovated buildings and in stepwise partial renovation over a longer period, which runs counter to the recommendation by Femenias et al. (2018) for extending refurbishments over time and therefore making them more adaptable to changing needs. Options for participation in decision-making tend to be rated as less important than the other procedural options. Possibly, households not only see the benefit, but also the potential drawback of inclusive decision-making, if a few objecting residents block a consensus vote and stall renovation (Charlier 2015, Castellazzi et al. 2017).

As with the endorsement of distributional principles, the high variance in all procedural options (SD>1.1) suggests looking into differences between households regarding their material, psychological and relational capabilities. In order to keep the number of models in Section 4.5 manageable, twelve of the seventeen procedural options are aggregated to the four factors information, participation, construction and renter protection (for factor analysis results see Table A.2).

Table 2. Descriptive statistics on procedural options.

Procedural options	N	Mean	SD
Providing information on the starting date of the renovation [i]	876	4.17	1.24
Providing information on benefits, drawbacks and costs [i]	871	4.34	1.13
Choosing between several variants of the renovation [i]	853	3.93	1.23
Providing independent information [i]	838	3.96	1.20
Offering site visits to already renovated buildings [p]	836	2.84	1.37
Co-deciding on exterior building appearance [p]	851	3.19	1.40
Including all residents in decision-making [p]	872	3.67	1.39
Starting and completing construction works on schedule [c]	843	4.15	1.14
Minimising noise and dust during construction [c]	849	4.02	1.16
Ensuring privacy during construction [c]	850	4.21	1.10
Carrying out the renovation together with other remodelling works	843	3.72	1.28
Carrying out the renovation in small steps over a longer period	811	2.53	1.35
Improving heating control	836	4.09	1.17
Providing personal energy counselling	839	3.76	1.26
Freezing rent and energy costs for several years [r]	853	4.27	1.08
Suspending termination of rental contracts for several years [r]	838	4.16	1.22
Detailing the total costs of the renovation	868	4.37	1.07

Items translated from German; five-step response scale from 1=unnecessary to 5=absolutely necessary to the question 'How much would you need these options if your house were renovated?'; i, p, c, r item assigned to factor information, participation, construction, or renter protection (see Table A.2).
Mean comparison between seventeen procedural options: n=742; repeated measures ANOVA, greenhouse-geisser adjusted; F=177.8; df=10.8, 8008.5; p<.001; bonferroni-adjusted post-hoc analysis confirms significant differences between most options – in particular, that offering site visits, co-deciding on appearance, including all residents, carrying out in small steps, and detailing total costs differ from the other options.

4.3 Interrelations between the endorsement of distributional principles and procedural options

Distributional principles need not be mutually exclusive, but can (and should) be combined. For instance, since a strict polluter-pays allocation of heating costs disadvantages those who live in badly insulated attics, a share of the overall costs could be allocated according to ability-to-pay considering the thermal performance of different parts of the building. The same complementary logic applies to procedural options. For instance, involving residents in renovation decisions might go hand in hand with establishing a common knowledge basis by providing transparent and comprehensive information. Moreover, distributional and procedural aspects are interlinked; distributional outcomes may be remediated or negotiated by procedural concessions. For instance, additional personal costs

are accepted if, in turn, the authorities commit to long-term policy changes (Simpson & Clifton 2016); however, in the present study, interrelations only emerge clearly within procedural options.

Distributional principles correlate weakly to moderately with each other (r<.25, except ability-to-pay; upper left quadrant in Table 3). This indicates that households discriminate between the principles and do not consider them as facets of the same overarching distributional justice factor. This indication of discriminant validity justifies the separate explanatory models for each principle in the following Section 4.4. It comes as no surprise that the two ability-to-pay principles are more closely related (r=.64) than the other distributional principles, as having a low income often also means living in a deprived situation. Equal-pay correlates negatively with polluter-pays and ability-to-pay (r=-.08 to r=-.16), since equal treatment for all precludes differentiation by consumption, income or situation. Energy bill neutrality and green lease are virtually uncorrelated (r=.05); thus, it seems that these two approaches for renovation repayment are neither perceived as supplementary nor as trading off against each other. Interestingly, accepting the additional rates of green lease is associated with the notion of sharing burden equally (r=.25) or by individual consumption (r=.12).

Intercorrelations between procedural options range from r=.38 to r=.67 (lower right quadrant in Table 3). Presumably, the options build on each other; in particular, information shows the highest correlations with the other options, which underscores the role of information as a necessary precondition for subsequent procedural activities. Still, procedural options are also confirmed as sufficiently distinct concepts, which justifies modelling each option separately in Section 4.5.

Distributional principles and procedural options correlate fairly weakly (r<.17; upper right quadrant in Table 3), even though they could be expected to be more closely related because of their common roots in the energy justice debate (see Section 1). Similar background factors seem to link distributional and procedural considerations: equal-pay correlates negatively with most procedural options (r=-.10 to r=-.14), possibly because uniform contributions by all render any efforts to reconcile diverging interests unnecessary. In turn, polluter-pays and ability-to-pay correlate positively with procedural options (r=.05 to r=.17), presumably because the rules defining pollution and ability need to be negotiated. Energy bill neutrality is positively associated (r=.11), but green lease is negatively associated (r=-.12) with procedural options for renter protection. Both correlations may represent two sides of the same coin: either seeking to minimise erosion of one's personal situation by safeguarding current energy costs as well as renter security; or valuing the opportunity of renovation by being less dependent on renter security and better able to carry additional energy costs.

Some intercorrelations between distributional principles and procedural options may come from the same underlying driver; for instance, polluter-pays and construction are both influenced by personal norms, or ability-to-pay-income and renter protection are both influenced by renter concerns.

Table 3. Intercorrelations between distributional principles and procedural options.

	Equal-pay	Polluter-pays	Ability-to-pay-income	Ability-to-pay-situation	Energy bill neutrality	Green lease	Information	Participation	Construction	Renter protection
Equal-pay	1	-.08 (p=.019)	-.16 (p<.001)	-.09 (p=.011)	.16 (p<.001)	.25 (p<.001)	-.10 (p=.007)	.05 (p=.214)	-.14 (p<.001)	-.14 (p=.001)
Polluter-pays		1	.20 (p<.001)	.20 (p<.001)	.14 (p<.001)	.12 (p=.001)	.12 (p=.001)	.05 (p=.213)	.11 (p=.004	.14 (p<.001)
Ability-to-pay-income			1	.64 (p<.001)	.18 (p<.001)	.04 (p=.269)	.08 (p=.024)	.13 (p=.001)	.11 (p=.003)	.17 (p<.001)
Ability-to-pay-situation				1	.15 (p<.001)	.01 (p=.859)	.09 (p=.014)	.12 (p=.004)	.11 (p=.007)	.17 (p<.001)
Energy bill neutrality					1	.05 (p=.155)	.09 (p=.018)	.08 (p=.047)	-.01 (p=.840)	.11 (p=.011)
Green lease						1	-.02 (p=.624)	.01 (p=.771)	-.03 (p=.445)	-.12 (p=.005)
Information							1	.67 (p<.001)	.63 (p<.001)	.57 (p<.001)
Participation								1	.49 (p<.001)	.38 (p<.001)
Construction									1	.65 (p<.001)
Renter protection										1

Correlation coefficients including procedural options refer to correlations between latent factors in a confirmatory factor analysis.

4.4 Drivers of the endorsement of distributional principles

Next, a set of drivers reflecting material, psychological and relational capabilities is employed to explain why low-income renters endorse various distributional principles. Each column in Table 4 lists a separate model for each distributional principle. Model fit is satisfactory throughout (e.g. CFI>.92, RMSEA<.056); however, the explained variance R^2<10% cautions taking these results only as an explorative step towards understanding distributional preferences. Low explanatory power is most apparent in the model on energy bill neutrality where not one driver reaches a p-value below the <.05 significance level.

Considering the building to be in need of renovation increases agreement with equal-pay (β=.10) and ability-to-pay (β=.10, β=.11); possibly, living in a run-down and energy-inefficient building introduces a sense of urgency and makes households endorse principles which render it more likely that other residents, even those who are deprived, follow suit. A higher need for renovation also increases support for green lease (β=.13), as this principle might make the raising of sufficient funding for a renovation more likely. By contrast, a stronger need for renovation decreases agreement with polluter-pays (β=-.09), possibly because this principle would put too much financial burden on those living in bad housing conditions.

Economic drivers only influence selected distributional principles: households with higher income are more likely to endorse polluter-pays (β=.11); the better households manage within their financial means, the more they prefer equal-pay (β=.10). This reflects Groh & Ziegler's (2018) observations of economic self-interest in perceptions about distributive justice; the more affluent expect to do better if everybody is charged by individual consumption or is charged the same amount. However, neither income nor housing expenditures as objective economic indicators are consistently relevant, contrary to previous studies on, for example, sharing the cost burden of transition to a low-carbon society (see Section 2.1). This may trace back to the present study's sample consisting almost exclusively of low-income households; such a floor effect may obscure the influence of objective economic indicators. Being able to make ends meet also increases confidence in being able to tackle the additional costs from green lease (β=.14).

Personal norms for environmentally conscious heating strengthen the preference for polluter-pays (β=.21). This may point to a desire to be rewarded for personal energy-saving efforts, and not to be held accountable for free-riders who are indifferent towards environmental protection. A frugal mindset concurs with higher endorsement of ability-to-pay (β=.20 and β=.21), possibly because a lifestyle of austerity and thriftiness need not be entirely voluntary.

Relational capabilities seem to come into play when fair rules are relevant. Higher trust in the landlord makes households endorse ability-to-pay (β=.09 each) and green lease (β=.11), presumably because they are confident that their interests will be heard when ability criteria and payment schemes are defined. Having renter concerns is associated with preferring ability-to-pay-income (β=.08), as this distributional principle may prevent being pushed into a discriminating housing market.

All models on distributional principles include correlations between conceptually related drivers (see footnote to Table 4). A higher need for renovation is associated with difficulty in keeping the home warm (r=-.33), confirming that energy inefficient housing coincides with energy poverty. Unsurprisingly, higher income is reflected in less subjective material deprivation (being better able to make ends meet, r=.12) and lower relative spending for energy expenditures (r=.-68). Correspondent values of personal norms and frugality point to an underlying lifestyle of sufficiency (r=.74). A trustful relation with the landlord seems to buffer renter concerns about housing market forces (r=-.22). The

coefficients of all these correlations are identical across all models and equally apply to the models on procedural options.

Table 4. Drivers of preferences for distributional principles.

Predictors	Equal-pay	Polluter-pays	Ability-to-pay-income	Ability-to-pay-situation	Energy bill neutrality	Green lease
Need for renovation	.10 (p=.028)	-.09 (p=.033)	.11 (p=.008)	.10 (p=.022)	-.01 (p=.797)	.13 (p=.003)
Income	-.05 (p=.350)	.11 (p=.037)	.03 (p=.627)	.03 (p=.555)	.05 (p=.372)	.01 (p=.856)
Make ends meet	.10 (p=.003)	.06 (p=.063)	.02 (p=.513)	.01 (p=.758)	.04 (p=.197)	.14 (p<.001)
Housing expenditures	-.01 (p=.821)	.01 (p=.993)	-.02 (p=.659)	.02 (p=.690)	.07 (p=.198)	-.09 (p=.119)
Keep home warm	.06 (p=.088)	-.06 (p=.075)	-.03 (p=.452)	-.03 (p=.468)	.07 (p=.055)	.05 (p=.215)
Personal norms	-.13 (p=.104)	.21 (p=.007)	-.02 (p=.760)	-.02 (p=.836)	-.03 (p=.723)	-.03 (p=.694)
Frugality	.06 (p=.522)	.06 (p=.478)	.21 (p=.017)	.20 (p=.030)	.17 (p=.066)	.16 (p=.065)
Trust in the landlord	.03 (p=.408)	.01 (p=.971)	.09 (p=.008)	.09 (p=.019)	.04 (p=.288)	.11 (p=.002)
Renter concerns	-.01 (p=.806)	-.05 (p=.241)	.08 (p=.049)	.05 (p=.200)	.01 (p=.730)	-.01 (p=.757)
R^2 in distributional principle	3.1%	9.5%	7.0%	5.6%	3.4%	7.9%
Chi^2(df)	561 (143) (p<.001)	541 (143) (p<.001)	532 (143) (p<.001)	530 (143) (p<.001)	539 (143) (p<.001)	535 (143) (p<.001)
CFI	.92	.93	.93	.93	.93	.93
NFI	.90	.91	.91	.91	.90	.91
RMSEA (10%-CI)	.056 (.051-.061)	.054 (.050-.059)	.054 (.049-.059)	.054 (.049-.059)	.054 (.049-.059)	.054 (.049-.059)

Standardised path coefficients; CI=confidence interval. Models include factor correlations: need for renovation – keep home warm, r=-.33 (p<.001); income – make ends meet, r=.12 (p<.001); income – housing expenditures, r=-.68 (p<.001); personal norms – frugality, r=.74 (p<.001); trust in the landlord – renter concerns, r=-.22 (p<.001).

4.5 Drivers of the endorsement of procedural options

Here, the same set of drivers as in the preceding section is employed to explain the endorsement of procedural options. As above, model fit is satisfactory in all models (e.g. CFI>.93, RMSEA<.054; Table 5), but explanatory power as indicated by the explained variance R^2<15% is limited, suggesting interpretation of the results as a starting point for explaining procedural preferences in building renovation.

Need for renovation leads to a stronger call for information and renter protection measures (β=.12 each; Table 5). Possibly, this reflects an add-on effect to renter concerns (β=.13 to β=.29): households living in dismal housing conditions and with a lack of alternatives on the rental market wish to anticipate and avoid being forced to downgrade to even lower-quality housing.

Households with a higher income ask for more involvement regarding information and construction (β=.15 and β=.13). It seems likely that this income effect is a proxy for the social standing of the better-off who might be more literate regarding energy and housing issues, more aware of their interests and rights, and therefore demand a stronger say in implementation. Note that in the present study, 'better-off' refers to a relative advantage over the very poor, since the entire sample consists of low-income households. In a similar vein, income does not influence renter protection, as the better-off need to worry less about displacement to poorer housing. This interpretation of income as a proxy for social standing is supported by the absent effects of making ends meet, housing expenditures and keeping the home warm; if the preference for procedural involvement were a question of material capability, these drivers would have to show significant effects, too. The absence of material drivers could point to the vicious dynamic that, when controlling for outspoken renter concerns, the materially deprived who would profit most from advocating their interests instead self-exclude from deliberative processes because they feel overwhelmed, ashamed or resigned (Willand & Horne 2018).

Personal norms lead to more demand for involvement in participation (β=.25) and construction (β=.29); this might represent how pro-environmental views spill over to getting engaged with one's personal surroundings. Finally, trust in the landlord is found to be unrelated, possibly because most procedural options are concluded within a limited period and need not build on a grown relationship of mutual trust and respect.

Table 5. Drivers of preferences for procedural options.

Predictors	Information	Participation	Construction	Renter protection
Need for renovation	.12 (p=.009)	.06 (p=.179)	.03 (p=.456)	.12 (p=.012)
Income	.15 (p=.006)	.09 (p=.157)	.13 (p=.024)	.05 (p=.421)
Make ends meet	-.04 (p=.253)	-.02 (p=.649)	-.03 (p=.431)	-.02 (p=.563)
Housing expenditures	.03 (p=.609)	.06 (p=.371)	.04 (p=.519)	-.01 (p=.876)
Keep home warm	.01 (p=.931)	.04 (p=.382)	.07 (p=.077)	.01 (p=.936)
Personal norms	.14 (p=.085)	.25 (p=.004)	.29 (p<.001)	.09 (p=.306)
Frugality	.08 (p=.362)	-.08 (p=.426)	-.04 (p=.685)	.13 (p=.192)
Trust in the landlord	.03 (p=.479)	-.05 (p=.193)	.01 (p=.823)	.03 (p=.413)
Renter concerns	.13 (p=.003)	.15 (p=.003)	.14 (p=.003)	.29 (p<.001)
R^2 in procedural option	9.2%	7.6%	10.7%	14.4%
Chi^2(df)	673 (199) (p<.001)	586 (179) (p<.001)	612 (179) (p<.001)	601 (160) (p<.001)
CFI	.94	.94	.93	.93
NFI	.91	.91	.91	.90
RMSEA (10%-CI)	.050 (.046-.054)	.049 (.045-.054)	.051 (.046-.055)	.054 (.050-.059)

Standardised path coefficients; CI=confidence interval. Models include factor correlations: need for renovation – keep home warm, r=-.33 (p<.001); income – make ends meet, r=.12 (p<.001); income – housing expenditures, r=-.68 (p<.001); personal norms – frugality, r=.74 (p<.001); trust in the landlord – renter concerns, r=-.22 (p<.001).

5. Conclusions and policy recommendations

Widespread renovation of poor-quality housing is considered pivotal for mitigating carbon emissions and energy poverty. However, investments to improve the energy efficiency of rental property come up against the tenant-landlord dilemma, which is particularly pronounced in the low-income segment. Thus, tailored distributional and procedural arrangements are needed. The results of the present study outline the conditions low-income renters in Austria would prefer for a renovation of their building: according to which distributional principles costs should be shared, with which procedural options they should be involved in decision-making and implementation, and which material, psychological and relational capabilities underlie their preferences.

Low-income renters prefer polluter-pays and energy bill neutrality for allocating renovation costs. In practice, these distributional principles need not stand alone but could be combined with other principles. Preference for polluter-pays and ability-to-pay goes hand in hand (as indicated by positive correlations); this suggests the allocation of the majority of renovation costs by polluter-pays, but distribution of a smaller share of costs by ability-to-pay in order to cushion disproportionate impacts on less affluent residents. There seems to be leeway in setting the exact criteria for what constitutes ability, because ability-to-pay-income and ability-to-pay-situation yield fairly similar results (regarding level of endorsement, interrelations with other principles and options, and drivers). Likewise, energy bill neutrality could be complemented by a mild green lease asking renters for small renovation payback instalments. Even though green lease is less preferred, it is not rejected outright, and generating additional revenue could facilitate raising sufficient funding for renovation.

Procedural issues rank high on the energy and climate policy agenda, as stipulated, for instance, in the Aarhus Convention or the EU Winter Package (European Commission 2005, 2016). It seems, however, as if these policy strategies have not yet been fully deployed to low-income housing in Austria, because the survey respondents welcome all presented procedural options (as indicated by high levels of endorsement). In particular, low-income renters request provision of transparent and comprehensive information and mitigation of inconvenience during the construction phase. The encompassing agreement with virtually all procedural options resonates with Astmarsson et al.'s (2013) recommendation that package solutions comprising financial incentives, information and participation are the most effective for resolving the tenant-landlord dilemma. From the households' perspective, distributional and procedural justice seem not as closely connected (as indicated by weak correlations) as the energy justice literature suggests. Thus, when implementing renovation projects, distributional and procedural issues could be tackled successively instead of simultaneously, which may stretch the planning and negotiation workload over a longer period and could flatten peak demand for professional manpower in deliberative processes.

The results on material, psychological and relational drivers indicate entry points for promoting specific distributional principles and procedural options. The need for renovation influences most principles and options and therefore may act as trigger and opener for commencing a debate with residents. An urgent need for renovation may even bring the less-preferred principles of equal-pay, ability-to-pay and green lease to the negotiation table. Some low-income renters hold pro-environmental attitudes even though it could be alleged that this group has more pressing personal issues than caring for the environment. Activating these attitudes by pointing out the environmental benefits of building renovation could increase support for polluter-pays. Trust in the landlord increases support for ability-to-pay and green lease; thus, when aiming to adopt these principles, advice can be given to either start trust-building activities before announcing the renovation plans, or to prioritise those buildings where tenants and landlords already trust each other. By contrast, income does not seem a particularly precise attribute for targeting specific groups: in regard to preferences for distributional principles, income plays a marginal role; in regard to procedural options, income appears to be a proxy for social standing.

The present study comes with two major methodological caveats, however, which at the same time point to new avenues for future research. First, the applied drivers amount to small effect sizes with standardised path coefficients around β=.10 to β=.15 and an explanatory power of R^2 around 10%. Yet, all distributional principles and procedural options show high variance; this calls for further exploration of the sources of variability between households. Material capabilities could be operationalised not just as spending power, as in the present study, but also as savings or indebtedness to measure the ability to cover upfront investment costs. Earlier studies found that long-term tenants are more likely to agree to building renovation; consequently, tenancy duration might also guide distributional and

procedural preferences. A longer tenancy makes it more likely that renters profit from an energy efficiency improvement as they still live in the building when the renovation is fully amortised (Charlier 2015, Wrigley & Crawford 2017), especially as payback for deep retrofits often takes more than a decade (Collins & Curtis 2018, Brown et al. 2019). The same rationale applies inversely to short-term, limited contracts which imply less rental security (Middlemiss & Gillard 2015, Willand & Horne 2018). However, tenants may not have clear expectations for how long they will remain in their dwelling, may not have a time horizon beyond the renewal date of their current contract, or may think about moving in the near future; all these considerations may render tenant commitment to paying extra for a renovation vague (Bird & Hernandez 2012, Brown et al. 2019).

As a second caveat and starting point for future research, it should be highlighted that the present study is one of the first attempts to pose survey questions on energy justice to those who may be most affected by injustices. Translating abstract and complex justice issues into standardised questionnaire formats is prone to overburdening respondents who are unfamiliar with these issues. How well respondents are able to articulate distributional and procedural preferences hinges on their understanding of how housing costs are currently allocated between fellow tenants and their respective landlords (Simpson & Clifton 2016), their skills in conscious domestic energy use (Walker et al. 2014), their knowledge of energy tariffs (Becker et al. 2019), or their realistic assessment of the return-on-investment of efficiency retrofits (Collins & Curtis 2018). Low-income renters, in particular, may not be fully literate in the energy, technical and financial intricacies of building renovation, as suggested by anecdotal questionnaire comments received in the present study. This may have induced response bias. An example of potential bias are the practically unrelated preferences for energy bill neutrality and green lease; these principles would be expected to correlate negatively as paying the same energy bill as before runs counter to paying additional rates. By contrast, the surveyed households seem to differentiate well between equal-pay, polluter-pays and ability-to-pay, since the moderate correlations of these principles indicate discriminant validity of measurement. Still, even though the present study undertook extensive efforts to adapt the questionnaire design to the survey population, a certain bias from insufficient renovation literacy may colour the present results. Future studies could be advised to conduct small-scale pilot studies prior to survey fieldwork, and to systematically debrief a subsample of respondents post-survey to verify that all items have indeed been understood as intended in the study design.

Finally, it should be kept in mind that the present study's bottom-up perspective on the distributional and procedural preferences of low-income renters only paints part of the picture of realising energy justice in building renovation. Top-down policies are equally important, such as amending rental law for clear rules on burden-sharing between tenants and landlords, mandating refurbishment of poor-quality housing, or offering higher subsidy rates for buildings inhabited by vulnerable groups. Counselling low-income household in domestic energy saving might be a procedural policy to link bottom-up and top-down perspectives: on the one hand, households could be empowered to reduce their economic pressure from energy costs; on the other hand, they could learn about renovation benefits and legal claims and use these as leverage to encourage their landlord to renovate.

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8. Appendix

Table A.1. Item wordings and descriptive statistics.

Factor	Item wording	Response scale / unit	N	Mean	SD	Factor loading
Need for renovation	Windows	1 = not necessary, 5 = very necessary	814	2.34	1.57	.75
	Heating system		799	2.24	1.50	.69
	Insulation of outer walls		804	2.48	1.57	.73
Income poverty	Equivalised available monthly household income	Euro	764	845.0	300.1	1.00
	Thinking of your household's income, is your household able to make ends meet?	1 = very difficult, 6 = very easy	918	2.85	1.27	1.00
Energy poverty	Equivalised monthly housing expenditures for rent, heating and other energy services	Euro	648	443.0	140.2	1.00
	Can you afford to keep the home adequately warm?	1 = yes, 0 = no	913	0.67	0.47	1.00
Personal norms	I am a person who considers the environment when heating.	1 = fully disagree, 5 = fully agree	902	4.19	0.98	.71
	I feel obliged to protect the environment when heating.		897	4.01	1.03	.75
	I see myself as a person who cares about the environment when heating.		898	3.97	1.04	.80
Frugality	I resist buying things today so I can save for tomorrow.	1 = fully disagree, 5 = fully agree	899	3.44	1.19	.64
	When shopping, I discipline myself not to exceed my financial capabilities.		916	4.18	1.09	.61

Trust in the landlord	Which personal experiences have you made with your landlord? My landlord is honest with me.	1 = fully disagree, 5 = fully agree	893	4.04	1.14	.90
	I trust my landlord.		894	4.02	1.14	.97
	My landlord makes an effort to be fair.		888	3.97	1.14	.88
Renter concerns	I am concerned that my rental contract will be terminated or will not be renewed.	1 = fully disagree, 5 = fully agree	892	2.18	1,34	.49
	I am concerned that I will have to pay higher rent.		915	3.83	1,29	.54
	I am concerned that I will have to move to a flat of lower quality.		910	2.93	1,51	.77

N = number of valid responses; SD = standard deviation. Items translated from German.

Table A.2. Factor analysis of procedural options.

Procedural options	PCA factor 1	PCA factor 2	PCA factor 3	PCA factor 4	CFA factor information	CFA factor participation	CFA factor construction	CFA factor renter protection
Providing information on the starting date of the renovation [i]	.72				.80			
Providing information on benefits, drawbacks and costs [i]	.73				.88			
Choosing between several variants of the renovation [i]	.61		.52		.82			
Providing independent information [i]	.61	.31	.36		.72			
Offering site visits to already renovated buildings [p]			.77			.65		
Co-deciding on exterior building appearance [p]			.73			.77		
Including all residents in decision-making [p]	.32		.66			.78		
Starting and completing construction works on schedule [c]	.43			.64			.71	
Minimising noise and dust during construction [c]				.83			.80	
Ensuring privacy during construction [c]	.32	.33		.74			.86	
Carrying out the renovation together with other remodelling works	.62							
Carrying out the renovation in small steps over a longer period	-.32		.61	.34				
Improving heating control	.34	.63						
Providing personal energy counselling		.60	.37					
Freezing rent and energy costs for several years [r]		.78						.73
Suspending termination of rental contracts for several years [r]		.71						.73
Detailing the total costs of the renovation	.42	.61						

Factor loadings; i, p, c, r item assigned to factor information, participation, construction, or renter protection in CFA. PCA = Principal Component Analysis; CFA = Confirmatory Factor Analysis. PCA: Varimax rotation; Eigenvalues of factors 1 to 4 = 7.00, 1.67, 1.17, 1.00, respectively; explained variance 63.8%; factor loadings <.30 omitted. CFA: $Chi^2(df)=256(48)$, p<.001; CFI=.96; NFI=.95; RMSEA=.068 (10%-CI .060-.076). For factor correlations in CFA, see Table 3.