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The Well-Being Costs of Energy Poverty: The Role of Affective Channels

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Abstract

This paper examines the impact of energy poverty on subjective well-being in Germany using longitudinal data from the German Socio-Economic Panel (SOEP) over the period 2010–2023. Exploiting within-individual variation, we estimate fixed-effects models using objective, subjective, and composite indicators of energy poverty. Energy poverty is associated with a statistically significant and economically meaningful decline in life satisfaction, even after controlling for income, health status, and household characteristics. The negative association persists among households that are not income-poor, indicating that energy poverty constitutes a distinct dimension of material deprivation. Effects are strongest for subjective and multidimensional indicators, highlighting the importance of perceived energy deprivation and lived experience. Causal mediation analysis suggests that these well-being losses operate primarily through psychological and emotional channels. These findings imply that policies targeting energy affordability and housing efficiency may generate substantial welfare gains beyond income-based support.

Keywords: Energy poverty, Subjective well-being, Energy affordability, Multidimensional poverty, Panel data

JEL Classification Numbers: C23, I14, I31, Q48, D63

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1 Introduction

Energy poverty defined as the inability of households to secure adequate and affordable energy services has become an increasingly important policy concern in advanced economies. Rising energy prices, aging housing stock, and uneven income growth have intensified affordability pressures for many households, particularly in the context of ongoing energy system transitions (Bouzarovski, 2014). While energy poverty is often framed primarily as a problem of affordability, its consequences extend beyond financial hardship. Households that struggle to maintain adequate heating and basic energy services may experience broader welfare losses through increased financial stress, reduced living standards, and a decline in overall quality of life. Understanding these wider welfare consequences is therefore essential for assessing the social implications of energy and climate policies.

Germany provides a particularly relevant setting for examining these welfare implications. The country's ambitious commitment to the *Energiewende* – the transition toward a low-carbon and sustainable energy system – has fundamentally reshaped the energy sector. While essential for achieving climate targets, this transition has coincided with persistently high electricity prices and, more recently, sharp increases in energy costs following geopolitical disruptions. These developments have heightened concerns about energy affordability and equitable access to energy services, especially for low-income households and those living in energy-inefficient dwellings. As a result, energy poverty has emerged as an increasingly salient social issue in Germany with potentially far-reaching consequences for households well-being and quality of life.

This paper investigates how energy poverty affects subjective well-being in Germany using longitudinal data from the German Socio-Economic Panel (SOEP) (Goebel et al., 2025) covering the period 2010–2023. Subjective well-being, commonly measured through self-assessed life satisfaction, captures individuals overall evaluation of their quality of life and has become an increasingly prominent outcome variable in economic research and policy analysis. Focusing on subjective well-being allows for a broader assessment of welfare losses associated with energy poverty, encompassing not only material deprivation but also psychological and social dimensions that are often not captured by conventional economic or health indicators.

From a welfare-economic perspective, the relationship between energy poverty and subjective well-being is inherently multifaceted. Energy poverty may directly reduce utility by constraining access to essential energy services, particularly adequate heating and electricity. High energy cost burdens may crowd out expenditure on other welfare-enhancing goods, such as healthcare, nutrition, and leisure, thereby increasing financial strain. Beyond material channels, energy poverty can generate substantial psychological stress and anxiety, arising from persistent affordability concerns, fear of utility disconnection, or the inability to maintain a comfortably warm home. These psychosocial burdens may significantly diminish life satisfaction even in the absence of severe income poverty or observable health deterioration, suggesting that energy poverty constitutes a distinct dimension of deprivation.

A growing empirical literature documents a negative relationship between energy poverty and subjective well-being. Cross-country analyses show that limited energy affordability is associated with lower life satisfaction, with particularly large welfare losses occurring during periods of heightened energy demand or among low-income households (Welsch & Biermann, 2017). Single-country studies provide similar evidence. For Germany, Biermann (2016) reports a sizable negative effect of fuel poverty on life satisfaction even after controlling for income, employment, and housing conditions, suggesting that energy deprivation affects well-being beyond conventional measures of economic hardship. Evidence from Spain likewise indicates that fuel poverty shifts households onto lower welfare frontiers, implying utility losses that cannot be explained solely by income differences (Rodriguez-Alvarez et al., 2019).

More recent work emphasizes the multidimensional nature of energy deprivation and its implications for well-being. Studies employing broader measures of energy poverty consistently find adverse welfare effects associated with inadequate access to modern energy services or persistent energy affordability constraints (Biermann et al., 2022; Druic et al., 2019; Mayer & Smith, 2019). Similar patterns emerge in developing and emerging economies, where households experiencing multiple forms of energy deprivation report significantly lower life satisfaction (Lin & Okyere, 2021; Phoumin & Kimura, 2019; Zhang et al., 2019). In addition, several contributions highlight substantial heterogeneity in these effects, with particularly large well-being losses observed among vulnerable populations such as women, children, and older adults (e.g., Davillas et al., 2022; Nie et al., 2021; Welsch & Biermann, 2014).

Closely related, a substantial empirical literature documents adverse health consequences of energy poverty, including deteriorations in physical and mental health (e.g., Liddell & Guiney, 2015; Liddell & Morris, 2010; Thomson et al., 2017). Recently, Buchner and Rehm (2025) provide evidence for Germany, showing that energy poverty is associated with deteriorations in self-assessed health outcomes. While this work highlights the importance of energy affordability for physical health, comparatively fewer studies examine how energy poverty affects broader welfare outcomes such as subjective well-being or the mechanisms through which these effects arise in high-income countries, like Germany. Health outcomes capture only one dimension of individual welfare and may fail to reflect reductions in life satisfaction driven by psychological stress, financial insecurity, and diminished living conditions. As a result, focusing exclusively on health risks may underestimate the full welfare costs of energy poverty.

This paper examines the relationship between energy poverty and subjective well-being using longitudinal data from the SOEP. By focusing on life satisfaction as a comprehensive measure of individual welfare, and on health satisfaction as a complementary, domain-specific outcome, the analysis provides a broader assessment of the welfare consequences of energy deprivation. Exploiting the panel structure of the SOEP allows us to control for unobserved individual heterogeneity and to identify within-person changes in well-being over time. This framework further enables us to distinguish the effects of energy poverty from those of income poverty, which are often closely intertwined in the existing literature. To provide additional support for the causal interpretation, the analysis combines two-way fixed-effects models with an instrumental-variable strategy exploiting variation in household-specific heating-energy price indices as a complementary identification approach. In addition, the paper employs causal mediation analysis to shed light on the mechanisms through which energy poverty affects subjective well-being.

This paper contributes to the literature in three main ways. First, it provides updated panel evidence on the relationship between energy poverty and subjective well-being in Germany using recent SOEP waves that capture both electricity and heating expenditures. This extends earlier German evidence, such as Biermann (2016), by analyzing a longer and more recent period that encompasses substantial energy policy changes, rising energy prices, and growing concerns about energy affordability.

Second, the paper adopts a multidimensional approach to measuring energy poverty. By employing several complementary indicators – including expenditure-based measures and self-reported difficulty in meeting energy needs – the analysis captures different dimensions of energy deprivation and assesses the robustness of the results across alternative measurement frameworks.

Third, the paper examines the mechanisms through which energy poverty affects subjective well-being by analyzing potential mediation channels linking energy deprivation to life satisfaction. In particular, we distinguish between mental and emotional pathways – such as health-related worries and affective states – and channels related to physical health conditions and health-care utilization. This allows us to provide new evidence on how energy poverty translates into subjective welfare losses.

Our findings show that energy poverty is associated with a statistically significant and economically meaningful reduction in subjective well-being. These effects persist after controlling for income, employment status, health, and a wide range of socio-economic characteristics. Importantly, the negative association remains present among households that are not income-poor, indicating that energy poverty constitutes a distinct source of welfare loss beyond income poverty.

The magnitude of the estimated effects varies across energy poverty measures, with the largest impacts observed for subjective and multidimensional indicators. This pattern highlights the importance of perceived energy deprivation and housing-related constraints, which appear to play a central role in shaping well-being outcomes. Consistent with this interpretation, heterogeneity analysis shows that the well-being costs of energy poverty are more pronounced among tenants and households living in older, less energy-efficient dwellings, suggesting that limited control over energy efficiency and poor housing conditions amplify the impact of energy deprivation.

Mediation analysis further suggests that a substantial share of these well-being losses operates through psychological and emotional channels, including increased health-related worries, higher levels of sadness, and reduced happiness. In contrast, physical health conditions and health-care utilization play a more limited role in magnitude. Complementary analysis using health satisfaction as an additional outcome yields consistent patterns, supporting the plausibility of the underlying mechanisms and aligning with recent health-focused evidence for Germany (Buchner & Rehm, 2025).

By documenting the broader well-being costs of energy poverty in a high-income economy, this paper contributes to and connects the literatures on energy economics, poverty, and subjective well-being by highlighting the multidimensional welfare consequences of energy deprivation. The results have direct implications for the design of energy and climate policies, particularly in the context of rising energy prices and the distributional challenges associated with decarbonization. Policies aimed at improving energy efficiency, stabilizing energy costs, or providing targeted support to vulnerable households may therefore generate substantial welfare gains that extend beyond improvements in material living conditions alone.

Importantly, the findings indicate that a significant share of the well-being effects operates through psychological and emotional channels, implying that reducing energy insecurity can yield benefits not only by easing financial constraints but also by alleviating stress and uncertainty. The heterogeneity analysis further suggests that these welfare gains are unlikely to be evenly distributed. In particular, tenants and households living in older, less energy-efficient dwellings experience larger well-being losses, pointing to the importance of policies that address structural housing constraints alongside affordability concerns. More broadly, the results suggest that energy poverty should not be viewed solely as an affordability issue, but as a multidimensional source of welfare loss that warrants explicit consideration in the evaluation and design of energy and climate policies.

The remainder of the paper is structured as follows. Section 2 describes the data and key variables used for the analysis. Section 3 focuses on the empirical framework and econometric approach. Section 4 presents and discusses the results, and Section 5 concludes.

2 Data and Variables

The empirical analysis is based on data from the SOEP (Goebel et al., 2025) – a large-scale, nationally representative longitudinal household survey for Germany. The SOEP is conducted annually and collects detailed information on individuals socio-economic conditions, demographics, income, housing characteristics, and subjective assessments of well-being. The analysis is based on SOEP v40, which covers the period from 1984 to 2023 and includes private households across all 16 federal states, encompassing both East and West Germany as well as migrants, foreigners, and refugee populations.

A key advantage of the SOEP for this study is its longitudinal structure, which allows individuals to be followed over time and enables the analysis of within-person changes in well-being associated with changes in energy-related conditions. The survey provides detailed information on household energy expenditures, including heating and electricity costs, as well as rich socio-economic covariates that are central to the analysis. The sample period is restricted to 2010-2023, as electricity expenditure information is only available from 2010 onwards. After applying standard sample restrictions and excluding observations with missing information on key variables, the final unbalanced panel consists of approximately 334,000 individual-year observations. Table 1 reports descriptive statistics for all variables used in the analysis.

2.1 Dependent Variable: Overall Life Satisfaction

The primary outcome of interest is individual subjective well-being (SWB), measured by self-assessed life satisfaction. The SOEP elicits this information through the following question:

How satisfied are you currently with your life in general?

Responses are recorded on an 11-point scale ranging from 0 (completely dissatisfied) to 10 (completely satisfied). This measure has been widely used and validated in the economic literature (Awaworyi Churchill et al., 2020; Kubiszewski et al., 2018; Nguyen et al., 2015) as a comprehensive indicator of individual welfare, capturing both material and non-material aspects of quality of life.

As shown in Table 1, average life satisfaction in the sample is approximately 7.3 with standard deviation of 1.74 and substantial variation across individuals and over time. Figure 1a illustrates trends in average life satisfaction by gender. Overall, life satisfaction evolves similarly for males and females over the sample period, with only modest gender differences in selected years.

2.2 Main Explanatory Variable: Energy Poverty Indicators

To assess the impact of energy poverty on subjective well-being, we employ a set of complementary objective and subjective indicators that capture its multidimensional nature. Energy poverty is not a directly observable condition and may manifest through high energy expenditure burdens, insufficient income, or perceived inability to meet basic energy needs. Relying on a single measure may therefore provide an incomplete picture. Following the existing literature, we combine expenditure-based affordability indicators with a consensual measure reflecting individuals lived experiences of energy deprivation (Meyer et al., 2018; Nie & Li, 2023). To further leverage the multidimensionality of energy poverty, we also construct a composite indicator that integrates information from multiple measures.

Table 1: Summary Statistics of Variables

Variables		Definition	Statistics				
			Obs.	Mean	Std.dev.	Min	Max
Well-Being Indicator	Satisfaction with Life	Satisfaction with Life (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied)	334,158	7.320	1.736	0	10
Energy Poverty Indicators	Ten Percent Rule (10%)	Eq. energy expenditure / Eq. income >=10% (yes=1; no=0)	334,158	0.193	0.394	0	1
	2 Median Share (2M)	Energy-poor if energy expenditure > 2x year-specific median (yes=1; no=0)	334,158	0.164	0.370	0	1
	Low Income High Cost (LIHC)	Energy-poor if household has low income and high cost (yes=1; no=0)	334,158	0.082	0.275	0	1
	Consensual	During cold months individuals can heat apartment (no=1, yes=0)	138,139	0.017	0.131	0	1
	Composite	Identified by two or more indicators (no=1, yes=0)	334,158	0.122	0.328	0	1
Income	Monthly income	Total monthly income in Euros.	334,158	3,246.411	5,211.267	1.000	2,000,000.000
	Equivalised monthly income	Monthly Equivalised Income in Euros	334,158	1,838.268	3,389.247	0.400	1,333,333.000
	Peer Income	Income for each individual as the mean income of the three respective reference groups (age, sex, education, and region)	334,158	1,510.525	229.588	891.036	2,472.220
	Income Poverty	Individuals below the poverty line (yes=1; no=0)	334,158	0.185	0.389	0	1
Energy Expenditures	Monthly Energy expenditure	Total energy expenditure (per month)	334,158	169.867	121.882	0.000	18,195.920
	Monthly heating cost	Heating cost in Euro (per month)	334,158	98.936	84.578	0.000	14,265.580
	Monthly electricity cost	Electricity cost in Euros (per month)	334,158	70.931	56.671	0.000	11,754.250
	Eq. monthly energy expenditure	Equivalised energy expenditure (per month)	334,158	98.402	74.134	0.000	12,130.610
	Equivalised heating cost	Equivalised heating expenditure (per month)	334,158	58.106	52.653	0.000	9,510.390
	Equivalised electricity cost	Equivalised electricity expenditure (per month)	334,158	40.296	33.177	0.000	7,836.170
Individual Characteristics	Poor health	Self-assessed health status (scale 1-5: 1=Bad health, 5=Very good health; recoded < 3 is poor health)	315,585	0.172	0.378	0	1
	No Education	Individual has no education	334,158	0.059	0.235	0	1
	Lower/Upper/Post secondary degree	Individual has degree lower than tertiary	334,158	0.681	0.466	0	1
	Tertiary degree	Individual has tertiary education	334,158	0.261	0.439	0	1
	Self-Employed	Individual is self employed	334,158	0.621	0.485	0	1
	Non-working	Individual is not employed	334,158	0.172	0.377	0	1
	Retired	Pensioner	334,158	0.207	0.405	0	1
	Couple without kids	Married couples without children	334,158	0.289	0.453	0	1
	Single parents	Separated/divorced/widowed with children	334,158	0.087	0.281	0	1
	Single Household	Single	334,158	0.159	0.366	0	1
	Couple with kids	Married with children	334,158	0.435	0.496	0	1
	Other households	Any other households other than the above	334,158	0.031	0.172	0	1
	Urban	Individual lives in an urban area (urban=1; rural=0)	334,158	0.657	0.475	0	1
Housing Conditions	Thermal insulation	Household has thermal insulation (yes=1; no=2)	334,158	0.283	0.450	0	1
Demographics	Age	Age of the individual	334,158	48.213	17.134	16	105
	Age squared	Age squared	334,158	2,618.033	1,755.843	256	11,025

Notes: This table provides descriptive statistics for the variables used in the analysis.

2.2.1 Objective: Expenditure-Based Approach

The expenditure-based indicators, which are considered as objective indicators, rely on information on household income and energy costs, specifically monthly expenditures on heating and electricity. As electricity expenditure data is only available in the SOEP from 2010 onwards, the analysis is restricted to the period 2010-2023. To account for differences in household size and composition, both income and energy expenditures are equivalised using the OECD-modified equivalence scale (OECD, 2013). This scale reflects economies of scale in household consumption and allows for meaningful comparisons across households of different sizes.

Under the OECD-modified scale, the first adult in the household is assigned a weight of 1.0, additional adults aged 14 and above receive a weight of 0.5, and children under 14 receive a weight of 0.3. Using these weights, we compute equivalised monthly income and equivalised monthly energy expenditure for each household. This adjustment ensures that the resulting indicators reflect the relative financial burden of energy costs rather than absolute expenditure levels. As a robustness check, we also apply the OECD square-root scale, which yields highly similar regression results.[1]

[1] The square-root scale adjusts household income and expenditure by dividing them by the square root of household size, without distinguishing between adults and children. Results using this equivalence scale are qualitatively similar and do not alter the main conclusions; detailed estimates are available upon request.

Based on these equivalised measures, we construct the following expenditure-based energy poverty indicators:

- **10% Rule**: With this indicator pioneered by Boardman (1991), individuals in a household are identified as energy-poor if a household spends more than 10% of its equivalized income on energy. The variable is coded as 1, indicating that the household is struggling with disproportionately high energy costs relative to its income, and 0 otherwise. The 10% threshold is based on the assumption that spending beyond this level indicates an unsustainable financial burden, as energy costs consume a substantial portion of disposable income that could otherwise be used for other essential needs.

- **Two-Median (2M) Share**: Based on the European Poverty Observatory methodology (Thema & Vondung, 2020), we first compute the national median share of equivalised energy expenditure in equivalised income for each year. Households are classified as energy-poor if their energy expenditure share exceeds twice this median. The indicator equals 1 if the threshold is exceeded and 0 otherwise. This measure captures households whose energy cost burden is substantially higher than that of the typical household and adjusts for year-specific changes in energy prices and income distributions.

- **Low-Income High-Cost (LIHC)**: The LIHC indicator, introduced by Hills (2012), identifies households that simultaneously face low income and high energy costs. Low income is defined as having equivalised disposable income below 60% of the national median. Disposable income is calculated by subtracting energy expenditures from total household income. High energy costs are defined as equivalised energy expenditure at or above the national median. Households meeting both criteria are classified as energy-poor, and the indicator is coded as 1 (0 otherwise). This measure identifies particularly vulnerable households that face both financial constraints and above-average energy costs.

2.2.2 Subjective: Consensual-Based Approach

In addition to expenditure-based measures, we employ a consensual indicator that captures perceived energy deprivation. This indicator is based on respondents answers to two SOEP questions. The first asks whether the household is able to adequately heat the dwelling during cold months:

> *Which of the following applies to your household? During the cold months, the apartment is always warmly heated?*

Respondents who report that the dwelling is not always adequately heated are then asked whether this situation is due to financial reasons. Following Drescher and Janzen (2021) and Awaworyi Churchill and Smyth (2021), we classify households as energy-poor if they report an inability to maintain a sufficiently warm indoor temperature during cold months due to financial constraints. The consensual indicator is coded as 1 for such households and 0 otherwise. This measure captures dimensions of energy poverty related to perceived hardship and lived experience that may not be fully reflected in expenditure data alone. It is important to note that this indicator is only available in the SOEP from 2016 onwards, resulting in a smaller sample size for analyses involving this measure.

2.2.3 Composite Variable

To capture the multidimensional nature of energy poverty more comprehensively, we construct a composite indicator that combines information from both expenditure-based and consensual measures. The composite indicator is defined as a binary variable equal to 1 if an individual is classified as energy-poor by at least two of the available indicators, and 0 otherwise.

By integrating multiple dimensions of energy poverty, this measure acknowledges that households may experience energy deprivation through different channels, including high energy expenditure burdens, insufficient income, or perceived inability to meet basic energy needs. The composite indicator also mitigates the limitations associated with relying on any single measure and provides a more robust classification of households experiencing persistent or multidimensional energy poverty.

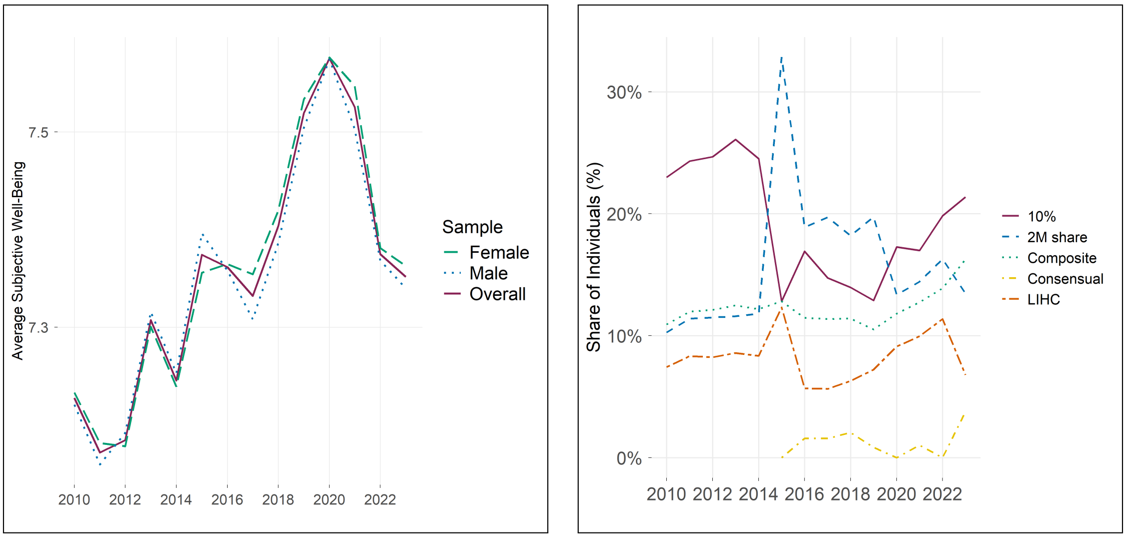
Figure 1b displays the share of individuals classified as energy-poor under each indicator over the study period. The expenditure-based measures – the 10% rule, the 2M share, and the LIHC indicator – exhibit noticeable variation over time, reflecting changes in energy prices, income distributions, and median expenditure benchmarks. In contrast, the consensual indicator identifies a consistently smaller proportion of individuals reporting difficulties in adequately heating their dwelling for financial reasons, which partly reflects its subjective nature and more limited availability in the SOEP.

The composite indicator shows comparatively greater stability over the sample period, with prevalence rates remaining close to 10% in most years. By requiring multiple indicators to be simultaneously triggered, this measure smooths short-term fluctuations observed in individual indicators and captures a subset of households experiencing persistent or multidimensional energy deprivation. Overall, the figure highlights substantial variation across indicators in both levels and temporal patterns, highlighting the relevance of adopting a multidimensional measurement approach in the empirical analysis.

Table 2 reports average monthly equivalised income and energy expenditures by income decile (D1-D10), together with the corresponding shares of individuals classified as energy-poor under each indicator (pooled 2010-2023). Two patterns stand out. First, the energy expenditure burden declines sharply with income. While the lowest-income decile (D1) spends on average about 25% of equivalised income on energy, the top decile (D10) spends roughly 3%, reflecting a markedly lower affordability pressure at the top of

Figure 1: Trends in Overall Life Satisfaction and Energy Poverty Indicators

(a) Overall Life Satisfaction **(b)** Share of Energy-Poor Individuals



the distribution. Second, the incidence of energy poverty is strongly concentrated in the lower deciles across all indicators, though the steepness of the gradient varies by measure. For example, under the 10% rule nearly half of individuals in D1-D2 are classified as energy-poor, whereas this share falls below 1% in D10. The LIHC indicator identifies a smaller group overall, but similarly concentrates in the bottom of the distribution.

Table 2: Average Monthly Equivalized Income, Energy Expenditure, and Share of energy-poor across Income Groups (2010-2023 Pooled Sample)

Averages of Variables	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Subjective Well-Being	6.83	6.88	7.11	7.20	7.30	7.41	7.43	7.57	7.65	7.83
Monthly Equivalised Income	570.00	865.64	1065.71	1262.06	1451.52	1664.36	1917.16	2233.18	2728.78	4659.36
Electricity Cost	25.29	36.63	38.43	39.47	40.02	41.05	42.81	43.40	44.73	51.54
Heating Cost	33.18	48.76	53.59	56.23	57.16	58.73	62.94	63.08	67.64	80.39
Total Cost	58.47	85.39	92.02	95.71	97.18	99.78	105.75	106.48	112.38	131.93
Share of income spent on energy (%)	25.07	9.90	8.66	7.59	6.70	6.00	5.52	4.77	4.13	3.20
Energy Poverty Indicators	Percentage Share of Individuals in the Sample									
10%	49.90	48.03	33.26	22.27	14.56	9.90	7.42	3.72	2.17	0.88
2M Share	43.10	38.43	27.05	19.48	13.60	9.14	6.58	3.75	1.82	0.73
LIHC	32.01	38.93	9.08	2.03	0.33	0.03	0.01	0.01	0.00	0.00
Consensual	3.35	4.86	3.38	1.79	1.48	0.87	0.99	0.78	0.75	0.52
Composite	32.49	37.06	13.57	9.01	7.94	7.37	7.11	4.05	2.56	1.21

An individual is classified as Income poor (income poverty) if their monthly equivalised disposable income, net of equivalised energy expenditure, is less than or equal to the official poverty threshold for that year, where the official poverty threshold is defined as 60% of the national median equivalised income.
Notes: The total number of individuals in our sample is 70,499. For the *Consensual* indicator, the number of individuals is 45,694.

The different indicators also display distinct levels and dispersion across income groups. The consensual measure – based on self-reported inability to keep the dwelling adequately warm for financial reasons – yields substantially lower prevalence rates than the expenditure-based measures, even in the bottom deciles. This contrast suggests that objective affordability thresholds and subjective experiences capture different facets of energy deprivation. The composite indicator, which classifies individuals as energy-poor when at least two measures are simultaneously triggered, identifies a stable subset of households across the income distribution and remains sizable in the bottom deciles (e.g., around one-third in D1-D2). Consistent with the conceptual motivation for a multidimensional approach, the table thus illustrates that no single indicator fully summarises energy poverty, and that combining objective and subjective measures provides a more nuanced description of exposure across the income distribution.

2.2.4 Covariates

The literature on subjective well-being consistently identifies a small set of core determinants – often referred to as the "*big four*": wealth or material conditions, health, social relationships, and individual characteristics (genes) (Bitzer et al., 2024; Clark et al., 2008; Welsch, 2024). Guided by this framework, we include a comprehensive set of covariates capturing socio-economic status, demographic characteristics, housing conditions, and health-related factors that may jointly influence both energy poverty and subjective well-being.

Material Conditions: Material living standards are captured through several complementary income measures. We include the logarithm of equivalised household income to account for marginal income effects on life satisfaction, as well as an indicator for income poverty, defined as having equivalised income at or below 60% of the national median. This specification allows us to distinguish between continuous income variation and the discrete welfare loss associated with falling below a socially defined minimum standard of living. In addition, we control for the logarithm of peer income, defined as the average income of reference groups based on age, gender, education, and region. This variable captures relative income considerations, which play an important role in shaping subjective well-being through social comparison mechanisms (Clark et al., 2008). Together, these measures ensure that the estimated effect of energy poverty is not confounded by either absolute or relative income differences.

Health: Health is a key determinant of subjective well-being and is also potentially correlated with energy poverty. To account for this, we include a binary indicator for poor health, constructed from the self-assessed health status in the SOEP. The indicator equals one if individuals report health below the mid-point of the original five-point scale, and zero otherwise. This transformation focuses on meaningful deteriorations in health status and provides a parsimonious control that is well suited to fixed-effects estimation. Including poor health helps isolate the association between energy poverty and life satisfaction from changes in physical condition that independently affect well-being.

Social relationships and labour market attachment: Social interactions and daily structure are partly captured through labour market status and household composition. We include indicators for being non-working and retired, with employed (including self-employed) individuals serving as the reference group. Employment status may affect subjective well-being through income stability (Nguyen et al., 2015), social participation, and psychological factors, and may also influence household energy use due to differences in time spent at home. Educational attainment is included as an additional socio-economic characteristic, reflecting long-run background, access to information, and coping capacity, including in relation to energy use and efficiency.

Household composition is captured using indicators for couples with and without children, single-parent households, and single-person households. Living arrangements may affect well-being through social support, economies of scale in consumption, and exposure to energy costs. In particular, single-person households may face higher per-capita energy costs and fewer social buffers against economic stress.

Individual characteristics and housing conditions: We control for age and age squared to capture life-cycle patterns in subjective well-being (Bitzer et al., 2024). A dummy variable for urban residence is included to account for systematic differences in housing markets, infrastructure, and living environments between urban and rural areas. Finally, housing conditions are captured through an indicator for thermal insulation. Energy efficiency of the dwelling plays an important role in determining energy demand and exposure to energy poverty and may also affect well-being through indoor comfort and housing quality. Thermal insulation serves as a parsimonious proxy for dwelling energy efficiency and is highly correlated with other building characteristics, such as window quality and heating technology.

3 Empirical Strategy

Our objective is to estimate the within-individual association between energy poverty and SWB, measured as self-assessed overall life satisfaction. Both SWB and energy poverty are potentially correlated with unobserved individual characteristics – such as personality traits, reporting styles, or long-run preferences – as well as with common time shocks, including macroeconomic conditions and energy market developments. We therefore exploit the longitudinal structure of the SOEP and estimate models with individual and year fixed effects. This design compares individuals to themselves over time and absorbs all time-invariant heterogeneity, thereby mitigating concerns about omitted variables that are constant within persons.

Life satisfaction is reported on an ordinal scale. Nevertheless, a large applied literature treats such measures as approximately cardinal and relies on linear fixed-effects estimators as a baseline. This practice is motivated by two considerations. First, as shown by Ferrer-i-Carbonell and Frijters (2004), controlling for interpersonal non-comparability through fixed effects is empirically more important than explicitly modeling ordinal scaling. Second, several studies document that commonly used life-satisfaction scales exhibit approximate linearity in underlying utility, with linear and ordinal estimators yielding very similar conclusions (Kristoffersen, 2017; Liu & Netzer, 2023). Linear fixed-effects models therefore, provide a transparent and interpretable benchmark, allowing effect sizes to be expressed directly in life-satisfaction points and facilitating comparison with the broader SWB literature (Kaiser & Vendrik, 2022).

Accordingly, we adopt a two-way fixed-effects linear model as our baseline specification. To assess robustness to the cardinality assumption, we complement this analysis with fixed-effects ordered logit models that explicitly respect the ordinal structure of the outcome. Consistency of results across both approaches strengthens confidence that the estimated association between energy poverty and subjective well-being is not driven by functional-form assumptions.

3.1 Baseline model: Two-way Fixed-Effects Linear Specification

We estimate the following two-way fixed-effects (TWFE) regression:

$$LS_{it} \; = \; \beta^{(a)} EP_{it}^{(a)} \; + \; \mathbf{X}_{it}' \boldsymbol{\theta} \; + \; \gamma_i \; + \; \gamma_t \; + \; \varepsilon_{it}, \tag{1}$$

where LS_{it} denotes the reported overall life satisfaction of individual i in year t on the 0-10-scale. $EP_{it}^{(a)}$ is an indicator of energy poverty using measure $a \in \{10\%, 2M, LIHC, Consensual, Composite\}$. The coefficient $\beta^{(a)}$ is the parameter of interest and captures the average within-person change in life satisfaction associated with transitioning into (or being in) energy poverty under indicator a, holding constant observed time-varying covariates, time shocks, and all time-invariant individual characteristics.

The vector $\mathbf{X}_{it}$ contains time-varying controls grouped along the core determinants of SWB (material conditions, health, social situation, and individual circumstances). Concretely, $\mathbf{X}_{it}$ includes: (i) material conditions: ln(income), income poverty, and ln(peer income); (ii) health: an indicator for poor health constructed from self-assessed health (binary; equals one if the respondent reports "bad"/"poor" health and zero otherwise); (iii) social and economic situation: labor force status and household type; and (iv) further demographics and housing conditions such as age (and age squared), urban residence, and thermal insulation. Standard errors are clustered at the individual level in all specifications.

3.2 Robustness to Ordinal Scaling: Fixed-Effects Ordered Logit

As a robustness check to the baseline linear specification, we estimate a fixed-effects ordered logit model that explicitly respects the ordinal nature of the life-satisfaction scale. Let LS_{it}^* denote latent life satisfaction for individual i in year t:

$$LS_{it}^* \; = \; \beta^{(a)} EP_{it}^{(a)} \; + \; \mathbf{X}_{it}' \boldsymbol{\theta} \; + \; \gamma_i \; + \; \gamma_t \; + \; u_{it}, \qquad u_{it} \sim \text{Logistic}(0, 1), \tag{2}$$

$$LS_{it} \; = \; j \quad \text{if} \quad \kappa_{j-1} < LS_{it}^* \leq \kappa_j, \qquad j \in \{0, \ldots, 10\}, \tag{3}$$

where κ_j are cut-points mapping the latent index to the observed ordered categories. The parameter of interest, $\beta^{(a)}$, captures the association between energy poverty and latent life satisfaction, conditional on observed covariates, individual, and year fixed effects.

Estimating ordered response models with individual fixed effects gives rise to the incidental parameters problem (Lancaster, 2000). To address this issue, we implement the Blow-Up and Cluster (BUC) estimator proposed by Baetschmann et al. (2015) and further developed by Baetschmann et al. (2020). The BUC estimator exploits multiple dichotomizations of the ordered outcome and stacks (blows up) the resulting datasets, while clustering standard errors at the individual level to account for repeated observations. This approach yields consistent estimates in panel settings with ordered outcomes and has recently been applied to SOEP data in a related work on energy poverty (Buchner & Rehm, 2025).

Ordered logit coefficients are interpreted in terms of changes in the odds ratios. To facilitate economic interpretation and comparability with the linear fixed-effects results, we report average marginal effects (AMEs) for selected outcome ranges, such as the probability of reporting low levels of life satisfaction. For a covariate $x_{kit} \in EP^{(a)}it, \mathbf{X}it$, the marginal effect on the probability of reporting category j is given by:

$$\frac{\partial \Pr(LS_{it} = j)}{\partial x_{kit}} ;=; \theta_k \Big[f(\kappa_{j-1} - \eta_{it}) - f(\kappa_j - \eta_{it}) \Big], \tag{4}$$

where $\eta_{it} = \beta^{(a)} EP^{(a)}it + \mathbf{X}'it\boldsymbol{\theta} + \gamma_i + \gamma_t$ and $f(\cdot)$ denotes the logistic density associated with the logistic cumulative distribution function. We report AMEs averaged over the estimation sample.

3.3 Identification and Instrumental Variable Strategy

Our primary identification relies on within-individual variation in energy poverty status over time, conditional on observed time-varying covariates and common year shocks. By including individual fixed effects, the empirical strategy removes confounding from all time-invariant individual characteristics, such as personality traits, stable preferences, long-run health conditions, and reporting styles. Year fixed effects further absorb macroeconomic developments and nationwide shocks to energy markets that affect all individuals simultaneously.

Despite these controls, two potential sources of endogeneity may remain. First, time-varying unobservables – such as unexpected financial shocks, changes in employment expectations, or household events – may simultaneously influence both energy affordability and subjective well-being. Second, reverse causality cannot be fully ruled out if deteriorations in well-being affect labour market outcomes or household decisions that subsequently influence energy expenditures or the likelihood of falling into energy poverty.

To further address these concerns, we complement the fixed-effects analysis with an instrumental-variable (IV) strategy that exploits exogenous variation in Germany-wide consumer price indices for different heating energy sources (see also Buchner and Rehm (2025)). Specifically, we instrument individual energy poverty status using consumer price indices corresponding to the primary heating energy source used by each household, including gas, oil, electricity, solid fuels, and district heating. These heating-energy-specific price indices capture aggregate fluctuations in household heating costs driven by national and international energy market developments and are plausibly exogenous to individual-level shocks to subjective well-being. The price index data are obtained from the Statistisches Bundesamt (Federal Statistical Office (Destatis), 2026).

Each household is matched to the consumer price index corresponding to its primary heating energy source. The SOEP provides information on the dominant heating source used by households in the 2015 and 2020 survey waves, which allows us to assign heating technologies to households. The assigned heating system is then carried forward and backward across survey waves, provided the household does not report a residential move, under the assumption that the heating technology remains unchanged. Observations for households whose heating source cannot be consistently identified over time are excluded from the IV analysis. Due to data availability, the district heating price index is only available from 2015 onwards.

In line with the reporting structure of energy expenditures in the SOEP, we use one-year lagged values of the relevant heating energy price index as the instrument. This lag structure reflects the fact that reported energy expenditures often correspond to consumption and billing periods from the preceding year, particularly for homeowners who report annual expenditures and renters whose utility bills reflect previously contracted prices. Moreover, because SOEP interviews typically take place during the spring months, energy price developments in the previous year are likely to be most salient when respondents report their energy expenditures.

In addition to the external price-based instrument, we implement the heteroskedasticity-based identification approach proposed by Lewbel (2012). This method generates additional instruments using the covariance between exogenous regressors and heteroskedastic errors in the first-stage equation. In our context, the Lewbel procedure augments the heating-energy price instrument with internally generated instruments constructed from the models residual structure. These additional instruments exploit heteroskedastic variation in the data and provide further moment conditions for identification. The resulting IV specification therefore combines exogenous variation in heating energy prices with heteroskedasticity-based instruments, strengthening identification when the external price instrument alone provides limited identifying variation. Formally, the first-stage equation relates energy poverty status to the lagged heating-energy-specific price index, controlling for the same set of covariates, individual fixed effects, and year fixed effects as in the baseline specification. The second stage then estimates the effect of instrumented energy poverty on life satisfaction.

Identification relies on the assumption that, conditional on individual and year fixed effects, changes in heating energy prices affect subjective well-being only through their impact on household energy affordability rather than through alternative channels. This assumption is plausible because the instrument varies at the level of energy type and time, while individual fixed effects absorb time-invariant household characteristics such as housing quality, energy preferences, and structural differences in energy demand. A potential concern is that energy price fluctuations may influence subjective well-being through broader macroeconomic channels, such as inflation or changes in general living costs. However, year fixed effects absorb common macroeconomic shocks affecting all households simultaneously, so identification stems from differential exposure to heating energy price movements across households using different heating technologies.

4 Results

4.1 Baseline Fixed-Effects Results

Table 3 reports the baseline two-way fixed-effects estimates for the relationship between energy poverty and SWB, measured by overall life satisfaction on a 0-10 scale. The fixed-effects specification identifies the association from within-individual changes over time, net of observed covariates, year effects, and all time-invariant individual characteristics.

Across all specifications, energy poverty is associated with statistically significant and economically meaningful reductions in life satisfaction. The magnitude of the estimated effects varies across indicators, reflecting differences in how energy poverty is conceptualized and measured. Expenditure-based indicators – the 10% rule, the 2M share, and the LIHC measure – are associated with reductions in life satisfaction ranging from approximately 0.02 to 0.04 points. While modest in absolute size, these effects are comparable to other well-documented within-person well-being shocks identified in the subjective well-being literature (Awaworyi Churchill et al., 2020; Davillas et al., 2022; Yang et al., 2025).

The largest effect emerges for the consensual (subjective) energy poverty indicator. Individuals reporting difficulty heating their home due to financial reasons experience a decline in life satisfaction of approximately 0.26 point, which is several times larger than the effect associated with objective expenditure-based measures. This pattern is consistent with findings from prior studies showing that subjective indicators of energy deprivation tend to exhibit stronger associations with well-being than purely objective measures (Awaworyi Churchill & Smyth, 2021; Kahouli, 2020). The result highlights the psychological and emotional dimension of energy poverty: perceived inadequacy of energy services appears to matter more for subjective well-being than budget shares alone.

The composite energy poverty indicator – which captures overlapping deprivation across multiple dimensions – also shows a robust and statistically significant negative

Table 3: Energy Poverty and Subjective well-being – Baseline Estimates

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Life Satisfaction				
	10% Rule	2M Share	LIHC	Consensual	Composite
Energy Poverty	-0.0352***	-0.0198**	-0.0307*	-0.263***	-0.0556***
	(0.00942)	(0.00929)	(0.0163)	(0.0468)	(0.0111)
Income poverty	-0.0798***	-0.0851***	-0.0725***	-0.0716***	-0.0665***
	(0.0129)	(0.0128)	(0.0153)	(0.0242)	(0.0134)
ln(Income)	0.136***	0.139***	0.144***	0.139***	0.142***
	(0.0119)	(0.0119)	(0.0117)	(0.0209)	(0.0117)
ln(Peer income)	-0.325***	-0.329***	-0.332***	-0.582***	-0.324***
	(0.112)	(0.112)	(0.112)	(0.224)	(0.112)
Poor health	-0.776***	-0.776***	-0.776***	-0.761***	-0.776***
	(0.0107)	(0.0107)	(0.0107)	(0.0175)	(0.0107)
Age	-0.0497***	-0.0499***	-0.0499***	-0.0829***	-0.0496***
	(0.00461)	(0.00461)	(0.00461)	(0.0141)	(0.00461)
Age square	0.000398***	0.000400***	0.000399***	0.000729***	0.000398***
	(0.0000326)	(0.0000326)	(0.0000326)	(0.0000782)	(0.0000326)
Education level					
Secondary	Ref	Ref	Ref	Ref	Ref
No degree	0.132***	0.131***	0.131***	0.123*	0.132***
	(0.0322)	(0.0322)	(0.0322)	(0.0686)	(0.0322)
Tertiary degree	-0.0116	-0.0111	-0.0108	0.0258	-0.0119
	(0.0297)	(0.0297)	(0.0296)	(0.0562)	(0.0296)
Employment status					
Employed (self)	Ref	Ref	Ref	Ref	Ref
Non-working	-0.132***	-0.132***	-0.132***	-0.124***	-0.133***
	(0.0120)	(0.0120)	(0.0120)	(0.0223)	(0.0120)
Retired	0.0960***	0.0959***	0.0959***	0.0361	0.0966***
	(0.0185)	(0.0185)	(0.0185)	(0.0314)	(0.0185)
Household types					
Other household	Ref	Ref	Ref	Ref	Ref
Couple without kids	0.169***	0.167***	0.167***	0.194***	0.169***
	(0.0304)	(0.0304)	(0.0304)	(0.0548)	(0.0304)
Single parents	-0.182***	-0.184***	-0.184***	-0.152**	-0.181***
	(0.0343)	(0.0343)	(0.0343)	(0.0620)	(0.0343)
Single Household	-0.0982***	-0.101***	-0.102***	-0.134**	-0.0962***
	(0.0318)	(0.0318)	(0.0318)	(0.0566)	(0.0318)
Couple with kids	0.116***	0.115***	0.116***	0.118**	0.117***
	(0.0297)	(0.0297)	(0.0297)	(0.0541)	(0.0297)
Urban	0.0336	0.0337	0.0338	0.0646	0.0336
	(0.0320)	(0.0320)	(0.0320)	(0.0564)	(0.0319)
Thermal insulation	-0.0140*	-0.0145*	-0.0143*	0.0287**	-0.0150*
	(0.00821)	(0.00821)	(0.00821)	(0.0129)	(0.00821)
Number of Individuals	51,508	51,508	51,508	30,264	51,508
Observations	334,158	334,158	334,158	120,060	334,158
Within R^2	0.0407	0.0407	0.0407	0.0399	0.0408
Year FE	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes

Notes: The data is from SOEP version 40. The dependent variable is Overall life satisfaction (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied). The column labels represents the measure for energy poverty. Each column comes from a unique regression.
Peer income is computed by first calculating the median monthly equivalence household income of reference groups based on age, gender, education level, and region. The mean (equivalised household) income of the four respective reference groups is then computed as an individual's peers' average income.
Clustered standard errors at the individual level are shown in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

association with life satisfaction. Its magnitude lies between those of the objective and subjective measures, suggesting that multidimensional energy poverty captures a broader, persistent burden that is not fully reflected in any single indicator. Taken together, these results indicate that energy poverty is not merely a transient financial inconvenience but a condition with tangible consequences for individuals experienced well-being.

4.2 Energy Poverty vs Income Poverty

A key result emerging from Table 3 is that energy poverty and income poverty exert distinct effects on subjective well-being. Income poverty is consistently associated with reductions in life satisfaction of around 0.07–0.09 points across all specifications. Importantly, the coefficients on energy poverty remain statistically significant even after controlling for income poverty and log income, including in the LIHC specification where low income is embedded in the construction of the energy poverty indicator itself. This finding challenges the common assumption that energy poverty is simply a manifestation of general income poverty. Instead, it indicates that energy poverty captures an additional and distinct dimension of deprivation related to the affordability of essential services, housing conditions, and exposure to energy price risks.

To further assess whether the observed relationship between energy poverty and subjective well-being merely reflects income poverty, we re-estimate the baseline models on a restricted sample of individuals who are not income-poor. Specifically, we exclude all individuals whose equivalised income net of energy expenditure falls below 60% of the national median income. Table 4 reports the results. Across most energy poverty indicators, the negative association with life satisfaction remains statistically significant and economically meaningful. In the fixed-effects specification (Panel A), energy poverty reduces life satisfaction by approximately 0.04 to 0.05 points for the expenditure-based indicators and by nearly 0.19 points for the consensual measure. The composite indicator also yields a sizeable negative effect of around 0.07 points. The LIHC indicator is excluded from this specification because, under the imposed sample restriction, its defining low-income component exhibits no within-individual variation, rendering it collinear with the fixed effects and preventing separate identification.

Taken together, these results provide strong evidence that energy poverty constitutes a distinct dimension of material deprivation that is not reducible to income poverty alone. Even among individuals with sufficient income, constraints related to energy affordability, housing quality, and perceived energy adequacy continue to exert a significant negative influence on subjective well-being. The persistence of these effects in the non-income-poor sample further indicates that the relationship is not driven by variation in energy consumption conditional on income, but instead reflects broader constraints related to affordability, housing conditions, and perceived energy adequacy. This pattern highlights that the welfare effects of energy poverty operate through channels beyond income, including insecurity about meeting basic energy needs and limitations in adjusting energy consumption. This result aligns with conceptual studies emphasizing the multidimensional nature of energy poverty and its distinct welfare implications (Bouzarovski & Petrova, 2015; Meyer et al., 2018). From a policy perspective, it implies that income-based transfers alone may be insufficient to fully mitigate the well-being losses associated with energy poverty, pointing to the importance of targeted energy and housing interventions.

Table 4: Energy Poverty and Subjective Well-Being – Non-Income-Poor Sample

	(1)	(2)	(3)	(4)
	Dependent Variable: Life satisfaction			
	10% Rule	2M Share	Consensual	Composite
	Panel A: TWFE			
Energy Poverty	-0.0482***	-0.0376***	-0.188***	-0.0688***
	(0.0111)	(0.0108)	(0.0578)	(0.0144)
Within R^2	0.0423	0.0423	0.0439	0.0423
Number of Individuals	46,011	46,011	26,438	46,011
Observations	272,244	272,244	98,349	272,244
	Panel B: Ordered Logistics Estimates			
Energy Poverty	0.933***	0.948***	0.770***	0.899***
	(0.0169)	(0.0170)	(0.0639)	(0.0210)
Pseudo R^2	0.036	0.036	0.043	0.036
Number of Individuals	41,128	41,128	23,586	41,128
Observations	265,999	265,999	94,823	265,999
All Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes

Notes: Sample restricted to individuals who are not income-poor, defined as having monthly equivalised income net of equivalised energy expenditure above 60% of the national median equivalised income (year-specific threshold).
Panel A presents estimates derived from a TWFE model, while Panel B reports the odds ratios from an ordered logistic regression applied to the non-income-poor sample. *LIHC* is not reported due to collinearity with the fixed effects in this sample restriction.
The data is from SOEP version 40. The dependent variable is life satisfaction (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied). The column labels represents the measure for energy poverty. Each column comes from a unique regression.
Clustered standard errors at the individual level are shown in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

4.3 Income, Social Comparisons, and Other Determinants

Beyond energy poverty, the results reaffirm several well-established determinants of subjective well-being. Own income enters positively and significantly, indicating that increases in household resources are associated with higher life satisfaction. However, the magnitude of this effect is relatively small compared to the effect of peer income, which enters negatively and with a substantially larger coefficient across all specifications. This finding provides strong evidence for social comparison effects: individuals experience lower life satisfaction when their income lags behind that of their reference group, even if their own income increases. The dominance of relative over absolute income effects echoes a large body of subjective well-being research (Clark et al., 2008; Welsch & Biermann, 2017) and has important implications for the distributional design of climate and energy policies.

Health emerges as one of the strongest predictors of life satisfaction. Individuals reporting poor health experience a reduction in life satisfaction of approximately 0.76 points – an effect that dwarfs the coefficients on income and energy poverty. This emphasizes the central role of health in shaping overall well-being and highlights the potential for energy poverty to indirectly affect well-being through health-related channels, a mechanism which we explore further.

Employment status also matters substantially. Being non-working is associated with a decline in life satisfaction of roughly 0.13 points, even after controlling for income and income poverty (similar effects is found by Welsch and Biermann (2017)). This pattern is consistent with the interpretation that unemployment affects well-being through non-pecuniary channels such as loss of social interaction, purpose, and daily structure (Druic et al., 2019). In contrast, retirement is associated with higher life satisfaction, suggesting that for many individuals the combination of income security and increased leisure outweighs potential health-related declines, a result consistent with previous evidence for high-income countries (Bonsang & Klein, 2012; Eibich, 2015; Gorry et al., 2018; Henning et al., 2023; Merz, 2022).

Household composition further shapes subjective well-being. Individuals living in couples – with or without children – report higher life satisfaction than those in other household arrangements, while single parents and single-person households exhibit significantly lower well-being. These findings are consistent with the role of social support, shared responsibilities, and economies of scale in consumption. Education effects are comparatively muted, with no systematic differences between secondary and tertiary education, and a slightly higher reported life satisfaction among individuals without formal degrees, echoing mixed findings in the broader literature.

Finally, several additional controls display patterns consistent with the broader well-being literature. Age exhibits the well-documented U-shaped relationship with life satisfaction (Bitzer et al., 2024): well-being declines with age at younger stages but increases again later in life, as reflected in the negative coefficient on age and positive coefficient on age squared. This pattern is commonly interpreted as capturing mid-life pressures followed by adaptation and improved emotional regulation in later years. Urban residence is not statistically significant across specifications, suggesting that differences in life satisfaction between urban and non-urban areas are largely captured by other observed characteristics such as income, housing conditions, and employment status.

Thermal insulation shows mixed but generally small effects. In most specifications, better insulation is associated with slightly lower life satisfaction, although the magnitude is modest. One possible explanation is that insulation is correlated with building characteristics or renovation activities that are not fully captured by the model. In contrast, for the consensual measure, insulation enters positively and significantly, indicating that better housing quality may mitigate perceived energy deprivation and improve well-being particularly when energy adequacy is defined in experiential terms.

Overall, these results highlight that subjective well-being is shaped by a combination of economic resources, relative income comparisons, health status, employment conditions, and household structure, alongside housing characteristics. Importantly, the estimated effects of energy poverty remain robust in the presence of this rich set of controls, reinforcing the interpretation that energy deprivation constitutes a distinct and meaningful determinant of well-being.

4.4 Robustness

4.4.1 Ordered Logit Estimates and Marginal Effects

Table 5 reports fixed-effects ordered logit estimates as a robustness check that explicitly accounts for the ordinal nature of the life satisfaction measure. Across all energy poverty indicators, the estimated odds ratios are below one and statistically significant, indicating that energy poverty is associated with lower odds of reporting higher life satisfaction categories. The qualitative pattern closely mirrors the linear fixed-effects results, providing reassurance that the baseline findings are not driven by the cardinality assumption.

To facilitate interpretation, Table 6 presents average marginal effects from the ordered logit models. Energy poverty increases the probability mass in the lower life satisfaction categories (0–5) and reduces the probability of reporting high satisfaction levels (8–10). As in the linear models, the marginal effects are largest for the consensual indicator, confirming that subjectively experienced energy deprivation is particularly detrimental to well-being. These results further indicate that energy poverty primarily affects the lower tail of the well-being distribution, pushing individuals into states of dissatisfaction rather than merely shifting average outcomes.

Overall, the ordered logit results provide consistent evidence across estimators and indicators that energy poverty is a significant and distinct determinant of subjective well-being in Germany. The negative association persists after controlling for income, health, employment, and social factors, and is strongest when energy poverty is measured through individuals lived experiences. These findings reinforce the robustness of the baseline results across alternative estimation approaches.

Importantly, this pattern is not limited to the full sample. The ordered logit estimates in Panel B of Table 4 confirm that the negative association persists even among individuals above the income poverty threshold, with odds ratios below one and statistically significant across all indicators. This further suggests that energy poverty affects subjective well-being through channels that extend beyond income constraints alone.

4.4.2 Endogeneity: IV Estimates

To further address potential endogeneity concerns, we estimate instrumental-variable (IV) models in which the energy poverty indicators are instrumented using exogenous variation in household-specific heating energy prices combined with heteroskedasticity-based internal instruments following Lewbel (2012). The external instrument exploits lagged heating energy price indices, which capture plausibly exogenous fluctuations in household energy costs over time. These price-based instruments are complemented by internally generated instruments derived from the heteroskedasticity of the first-stage residuals. This augmented IV approach allows identification even when the external instrument alone provides limited variation in the presence of extensive fixed

Table 5: Energy Poverty and Subjective well-being – Ordered Logistics Estimates

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Life Satisfaction				
	10% Rule	2M Share	LIHC	Consensual	Composite
Energy Poverty	0.952***	0.974*	0.954**	0.731***	0.921***
	(0.0133)	(0.0135)	(0.0207)	(0.0423)	(0.0146)
Number of Individuals	51,508	51,508	51,508	30,264	51,508
Observations	334,158	334,158	334,158	120,060	334,158
Pseudo R^2	0.034	0.034	0.034	0.039	0.034
All Controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the odd ratios of the ordered logistic regression of Overall life satisfaction. The data is from SOEP version 40. The dependent variable is Overall life satisfaction (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied). The column labels represents the measure for energy poverty. Each column comes from a unique regression.
Peer income is computed by first calculating the median monthly equivalence household income of reference groups based on age, gender, education level, and region. The mean (equivalised household) income of the four respective reference groups is then computed as an individual's peers' average income.
Clustered standard errors at the individual level are shown in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table 6: Energy Poverty and Subjective well-being – Marginal Effects

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Life Satisfaction				
	10% Rule	2M Share	LIHC	Consensual	Composite
Subjective well-being					
0	0.000167***	0.0000878*	0.000161**	0.00118***	0.000277***
	(0.0000472)	(0.0000468)	(0.0000732)	(0.000219)	(0.0000537)
1	0.000179***	0.0000938*	0.000172**	0.00125***	0.000297***
	(0.0000505)	(0.0000500)	(0.0000783)	(0.000231)	(0.0000574)
2	0.000481***	0.000253*	0.000463**	0.00310***	0.000799***
	(0.000136)	(0.000135)	(0.000211)	(0.000572)	(0.000155)
3	0.000946***	0.000497*	0.000910**	0.00591***	0.00157***
	(0.000267)	(0.000265)	(0.000414)	(0.00109)	(0.000304)
4	0.00118***	0.000621*	0.00114**	0.00724***	0.00196***
	(0.000334)	(0.000331)	(0.000518)	(0.00134)	(0.000380)
5	0.00343***	0.00180*	0.00330**	0.0208***	0.00569***
	(0.000968)	(0.000960)	(0.00150)	(0.00385)	(0.00110)
6	0.00271***	0.00142*	0.00261**	0.0172***	0.00450***
	(0.000765)	(0.000759)	(0.00119)	(0.00318)	(0.000871)
7	0.00315***	0.00165*	0.00303**	0.0206***	0.00522***
	(0.000889)	(0.000881)	(0.00138)	(0.00380)	(0.00101)
8	-0.00359***	-0.00189*	-0.00345**	-0.0212***	-0.00596***
	(0.00101)	(0.00101)	(0.00157)	(0.00392)	(0.00115)
9	-0.00555***	-0.00292*	-0.00534**	-0.0355***	-0.00922***
	(0.00157)	(0.00156)	(0.00243)	(0.00656)	(0.00178)
10	-0.00310***	-0.00163*	-0.00298**	-0.0206***	-0.00514***
	(0.000874)	(0.000867)	(0.00136)	(0.00380)	(0.000995)

Notes: This table presents marginal effects of each energy poverty indicator estimated using ordered logistic regression model with fixed effects.
Margins are computed at the sample mean of the dependent variable overall life satisfaction (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied).
Standard errors correspond to the marginal effects evaluated at the sample mean. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

effects. All specifications include individual and year fixed effects as well as the full set of household controls used in the baseline models. To ensure comparability across indicators, the IV analysis is conducted on the sample for which all energy poverty measures are jointly observed.

Table A.1 reports the IV estimates for the five energy poverty indicators. The first-stage results indicate that heating energy prices are strongly associated with most energy poverty measures, particularly the expenditure-based and composite indicators, while the relationship is statistically insignificant for the consensual measure. The Kleibergen–Paap rk LM statistics strongly reject the null of underidentification across all specifications, confirming that the instrument set is relevant. In addition, the Kleibergen–Paap rk Wald F-statistics range from 16.9 to over 204, exceeding the conventional threshold of 10 and alleviating concerns about weak instruments. The first-stage F-statistics are also uniformly large (around 120), further supporting instrument strength.

For the the second-stage results, the IV estimates display a consistent pattern across specifications. All coefficients are negative, indicating that energy poverty is associated with lower life satisfaction. However, the estimates are generally imprecise, and statistical significance is limited to the composite indicator, which remains negative but weakly significant. This pattern suggests that multidimensional measures capturing both objective and subjective aspects of energy deprivation exhibit the most robust association with well-being once endogeneity is addressed.

The diagnostic tests further support the validity of the IV specification. The Hansen J-tests generally fail to reject the null hypothesis of instrument validity at conventional significance levels, indicating that the overidentifying restrictions are broadly consistent with the data. Taken together, the Kleibergen–Paap and Hansen statistics suggest that the instrument set is both relevant and valid in this restricted sample.

An important implication of these results is that the IV strategy primarily captures exogenous variation in objective energy affordability driven by energy prices, while providing limited variation for measures based on perceived deprivation. This is consistent with the insignificant first-stage relationship observed for the consensual indicator and highlights a key limitation of price-based instruments in this context.

Overall, the IV analysis provides complementary evidence supporting the baseline findings. While the IV estimates are less precise than the fixed-effects results, they consistently indicate a negative relationship between energy poverty and subjective well-being. At the same time, the results reinforce the importance of multidimensional measures, suggesting that the well-being effects of energy poverty are most pronounced when both objective constraints and subjective experiences are taken into account. Given the challenges of isolating exogenous variation in energy deprivation in a panel setting with extensive fixed effects, the IV results are best interpreted as a robustness exercise rather than the primary source of causal identification.

4.5 Transmission Channels: Causal Mediation Analysis

To shed light on the mechanisms linking energy poverty to subjective well-being, we examine whether the estimated effects are mediated through physical and mental health-related channels. We implement a causal mediation analysis that decomposes the total effect of energy poverty on life satisfaction into a direct component and indirect components operating through a set of potential mediators.

Our empirical approach follows the causal mediation framework originally proposed by Baron and Kenny (1986) and formalized by Imai et al. (2010), with extensions discussed in Hicks and Tingley (2011), Imai et al. (2011), and Pace et al. (2022). Within this framework, total effects are decomposed into average causal direct effects and average causal mediation (indirect) effects using a linear structural equation model.

We consider a rich set of mediators capturing both physical health and health care utilization – number of doctor visits, sick days, and hospital days – as well as psychological and emotional states, including health worries, happiness, and sadness. Figure 2 illustrates the conceptual structure of the mediation analysis, where the solid arrow represents the direct effect of energy poverty on subjective well-being, and the dashed arrows represent indirect pathways operating through the mediators.

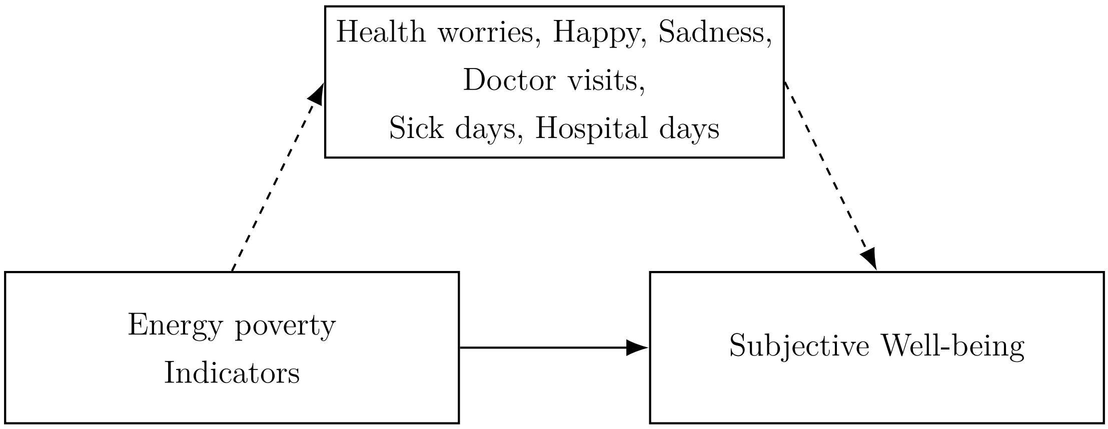


Figure 2: Direct and indirect-mediated effects

Identification of mediation effects relies on the sequential ignorability assumption (Imai et al., 2011). First, conditional on the included covariates and fixed effects, there are no unobserved confounders jointly affecting the mediator and subjective well-being. Second, the mediators are assumed to be exogenous with respect to the outcome, conditional on energy poverty and controls, ruling out reverse causality. While this assumption cannot be tested directly, it is plausible in our setting, particularly for physical health and health care utilization outcomes, where there is limited theoretical or empirical support for contemporaneous feedback from subjective well-being to diagnosed health conditions.

Formally, the mediation analysis is implemented using the following system of equations. First, the mediator is regressed on energy poverty and the same set of time-varying controls used in the baseline specification:

$$Mediator_{it}^{m} = \rho_1^a EP_{it}^{(a)} + \mathbf{X}_{it}'\boldsymbol{\rho} + \gamma_t + \gamma_i + \varepsilon_{it1}. \tag{5}$$

Second, life satisfaction is regressed on energy poverty, the mediator, and the same set of controls:

$$LS_{it} = \psi_1^a EP_{it}^{(a)} + \psi_2 \mathbf{X}_{it}' + \psi_3 Mediator_{it}^{m} + \gamma_t + \gamma_i + \varepsilon_{it2}. \tag{6}$$

Within this framework, the total effect of energy poverty on life satisfaction, $\hat{\beta}_1^a$ from Equation (1), can be decomposed into a direct effect and an indirect (mediation) effect. The direct effect, $\hat{\psi}_1^a$, captures the effect of energy poverty on subjective well-being conditional on the mediator. The indirect effect is given by $\hat{\rho}_1^a \times \hat{\psi}_3$ and measures the extent to which energy poverty affects life satisfaction through its impact on the mediator, holding constant energy poverty status, observed covariates, and unobserved individual and time-specific factors. Note that the vector $\mathbf{X}_{it}$ is identical to that used in the baseline fixed-effects specification and includes time-varying material, health, social, and housing characteristics. All mediation models are estimated using the same fixed-effects structure as the baseline specification, ensuring that identification of mediation effects relies on within-individual variation over time.

4.6 Indirect Effects: Mediation Results

Given the large number of potential mediators, we focus the main text on psychological and emotional channels, which emerge as quantitatively and statistically dominant. Results for physical health and health care utilization mediators are reported in the Appendix (see Table A.2) and are discussed briefly for completeness. Across specifications, the mediation results reveal a clear and consistent pattern: psychological and emotional channels account for a substantially larger share of the well-being effects of energy poverty than physical health and health care utilization channels.

4.6.1 Psychological and Emotional Health Channels

Tables 7 show that health worries, happiness, and sadness mediate a sizable share of the total effect of energy poverty on life satisfaction. Energy poverty significantly increases health-related worries and the frequency of sadness, while reducing happiness. These emotional states, in turn, are strongly associated with life satisfaction, resulting in economically meaningful indirect effects across all energy poverty measures.

The magnitude of these mediation effects is particularly pronounced for the consensual and composite energy poverty indicators. For these measures, psychological and emotional channels account for a substantial fraction of the total effect – often exceeding one-third. Indicating that the subjective experience of energy deprivation translates directly into psychological distress and reduced emotional well-being. This pattern is consistent with theoretical and empirical work emphasizing stress, anxiety, and diminished perceived control as key mechanisms through which material hardship affects subjective well-being (Haushofer & Fehr, 2014; Marmot, 2002).

Table 7: Subjective well-being: Mediation Analysis – Mental and Emotional Health

	(1)	(2)	(3)	(4)	(5)	(6)				
	10%		***2M Share***		***LIHC***		***Consensual***		***Composite***	
	Mediator	SWB	Mediator	SWB	Mediator	SWB	Mediator	SWB	Mediator	SWB
Panel I: Health Worries										
Health worries		-0.282***		-0.282***		-0.282***		-0.301***		-0.282***
		(0.00589)		(0.00589)		(0.00589)		(0.0101)		(0.00589)
Energy Poverty	0.0141***	-0.0292***	0.0126***	-0.0164*	0.0119**	-0.0207	0.0552***	-0.244***	0.00985**	-0.0469***
	(0.00357)	(0.00981)	(0.00345)	(0.00943)	(0.00591)	(0.0173)	(0.0147)	(0.0466)	(0.00398)	(0.0114)
Observations	311,668	311,668	311,668	311,668	311,668	311,668	119,739	119,739	311,668	311,668
Within R^2	0.0620	0.0528	0.0620	0.0528	0.0619	0.0528	0.0548	0.0521	0.0619	0.0529
Mediation effect		-0.0039703***		-0.0035591***		-0.0033511*		-0.0166377***		-0.0027824**
		(0.0010379)		(0.0010024)		(0.0017451)		(0.0048983)		(0.001151)
Direct effect		-0.0291623**		-0.016379*		-0.0206657		-0.2444487***		-0.0469009***
		(0.0098058)		(0.0094433)		(0.0175166)		(0.050443)		(0.0112991)
Total effect		-0.0352065***		-0.0198219**		-0.030736*		-0.2630893***		-0.0555937***
		(0.0093685)		(0.0092826)		(0.0164086)		(0.0506767)		(0.0109132)
Panel II: Happiness										
Happiness		0.501***		0.501***		0.501***		0.483***		0.501***
		(0.00526)		(0.00526)		(0.00526)		(0.00863)		(0.00526)
Energy Poverty	-0.0172***	-0.0358***	-0.0136***	-0.0314***	-0.0167*	-0.0346*	-0.0695***	-0.191***	-0.0279***	-0.0441***
	(0.00519)	(0.00961)	(0.00502)	(0.00922)	(0.00942)	(0.0181)	(0.0221)	(0.0463)	(0.00597)	(0.0112)
Observations	286,703	286,703	286,703	286,703	286,703	286,703	108,532	108,532	286,703	286,703
Within R^2	0.0186	0.112	0.0185	0.112	0.0185	0.112	0.0172	0.104	0.0186	0.112
Mediation effect		-0.0086203**		-0.006799***		-0.0083761*		-0.0335378***		-0.0139904***
		(0.0026212)		(0.0025465)		(0.0048093)		(0.0116181)		(0.0030226)
Direct effect		-0.0358109**		-0.0313539***		-0.0346187*		-0.1905267***		-0.0440833***
		(0.0097282)		(0.0094938)		(0.0187107)		(0.0499198)		(0.0113091)
Total effect		-0.0352065***		-0.0198219**		-0.030736*		-0.2630893***		-0.0555937***
		(0.0093685)		(0.0092826)		(0.0164086)		(0.0506767)		(0.0109132)
Panel III: Sadness										
Sadness		-0.340***		-0.340***		-0.340***		-0.335***		-0.340***
		(0.00397)		(0.00397)		(0.00397)		(0.00640)		(0.00397)
Energy Poverty	0.0296***	-0.0346***	0.0360***	-0.0255***	0.0187*	-0.0348*	0.101***	-0.191***	0.0380***	-0.0448***
	(0.00630)	(0.00974)	(0.00610)	(0.00930)	(0.0109)	(0.0184)	(0.0271)	(0.0469)	(0.00717)	(0.0113)
Observations	286,747	286,747	286,747	286,747	286,747	286,747	108,541	108,541	286,747	286,747
Within R^2	0.0200	0.0937	0.0201	0.0937	0.0199	0.0936	0.0165	0.0899	0.0200	0.0937
Controls/Year/Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mediation effect		-0.010088***		-0.012263***		-0.0063501*		-0.0336882***		-0.0129218***
		(0.0021777)		(0.0021012)		(0.0037915)		(0.009732)		(0.0025012)
Direct effect		-0.0345514***		-0.0255088***		-0.0347507*		-0.1912901***		-0.0448374***
		(0.0098688)		(0.0095434)		(0.0189824)		(0.050362)		(0.0114535)
Total effect		-0.0352065***		-0.0198219**		-0.030736*		-0.2630893***		-0.0555937***
		(0.0093685)		(0.0092826)		(0.0164086)		(0.0506767)		(0.0109132)

Notes: This table shows the coefficients of a causal mediation regressions of all four energy poverty indicators on Pane I – worries about own health (1 =not concerned at all, 3 =very concerned); Panel II – frequency of being happy in the last 4 weeks (1 =very seldom, 5 =very often) and Panel III – frequency of being sad in the last 4 weeks (1 =very seldom, 5 =very often). The data is from SOEP version 40. The main outcome variable is Overall life satisfaction (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied). The column labels represents the measure for energy poverty. Each column comes from a unique regression.
Mediation regressions are estimated using 5,000 bootstrap replications and its standard errors are based on non-parametric bootstrap resampling.
Clustered standard errors at the individual level are shown in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

4.6.2 Physical Health and Health Care Utilization

In contrast, mediation through physical health and health care utilization appears limited. Energy poverty is associated with a higher number of doctor visits, and doctor visits are, in turn, negatively related to life satisfaction (see Table A.2). This generates statistically significant indirect effects in some specifications. However, the magnitude of these mediation effects is small relative to the total effect of energy poverty on subjective well-being. More broadly, the inclusion of health care utilization measures leaves the direct effect of energy poverty on life satisfaction largely unchanged. This suggests that, while energy poverty is linked to increased interaction with the health care system, these effects do not account for a substantial share of the overall well-being loss.

Overall, the evidence indicates that physical health and health care utilization play only a minor mediating role. Compared to the psychological and emotional channels examined above, these pathways contribute little to explaining the relationship between energy poverty and subjective well-being. This pattern suggests that the well-being costs of energy poverty arise primarily through psychological and emotional channels rather than through physical health-related pathways.

4.7 Sensitivity Analysis

4.7.1 Complementary Well-being Outcome: Health Satisfaction

We next examine satisfaction with health as a complementary, domain-specific measure of subjective well-being. While life satisfaction captures individuals overall evaluation of their living conditions, health satisfaction reflects respondents assessment of their own health status, again measured on a 0–10 scale. It therefore occupies an intermediate position between subjective well-being and objective health outcomes. Analysing health satisfaction allows us to assess whether the welfare effects of energy poverty extend beyond general life evaluations to individuals perceptions of their health status (Nie et al., 2021).

Table 8 reports the corresponding results. Panel A presents fixed-effects estimates for health satisfaction. Across specifications, energy poverty is associated with lower satisfaction with health, with negative coefficients for all indicators except the 10% rule. The magnitude of these effects is consistently smaller than for life satisfaction, ranging from modest but statistically significant reductions for the 2M share, LIHC, and composite indicators to a larger effect for the consensual measure. This ranking closely mirrors the life satisfaction results, with subjective and multidimensional indicators exhibiting the strongest associations.

Panels B and C report ordered logit estimates and the corresponding marginal effects. The ordered logit estimates confirm the negative relationship between energy poverty and health satisfaction. The odds ratios are below one for all indicators and statistically significant for the 2M share, LIHC, consensual, and composite measures. The

Table 8: Energy Poverty and Satisfaction with Health

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Health satisfaction				
	10% Rule	2M Share	LIHC	Consensual	Composite
	Panel A: TWFE				
Energy Poverty	-0.0179	-0.0329***	-0.0393**	-0.204***	-0.0408***
	(0.0112)	(0.0112)	(0.0192)	(0.0507)	(0.0131)
Within R^2	0.0132	0.0133	0.0132	0.00770	0.0133
	Panel B: Ordered Logistics Estimates				
Energy Poverty	0.978	0.968**	0.963*	0.805***	0.957***
	(0.0134)	(0.0133)	(0.0210)	(0.0455)	(0.0150)
Pseudo R^2	0.012	0.012	0.012	0.008	0.012
Number of Individuals	51,710	51,710	51,710	30,946	51,710
Observations	333,860	333,860	333,860	123,458	333,860
All Controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes
	Panel C: Marginal Effects – Ordered Logistics Estimates				
Satisfaction with health					
0	0.000244	0.000352**	0.000407*	0.00236***	0.000482***
	(0.000150)	(0.000150)	(0.000238)	(0.000615)	(0.000171)
1	0.000229	0.000330**	0.000381*	0.00228***	0.000452***
	(0.000141)	(0.000140)	(0.000223)	(0.000595)	(0.000160)
2	0.000563	0.000812**	0.000940*	0.00545***	0.00111***
	(0.000347)	(0.000346)	(0.000550)	(0.00142)	(0.000396)
3	0.000919	0.00133**	0.00153*	0.00909***	0.00182***
	(0.000566)	(0.000565)	(0.000897)	(0.00237)	(0.000646)
4	0.000906	0.00131**	0.00151*	0.00892***	0.00179***
	(0.000558)	(0.000556)	(0.000884)	(0.00232)	(0.000636)
5	0.00155	0.00223**	0.00258*	0.0150***	0.00306***
	(0.000954)	(0.000951)	(0.00151)	(0.00391)	(0.00109)
6	0.000805	0.00116**	0.00134*	0.00790***	0.00159***
	(0.000496)	(0.000495)	(0.000786)	(0.00206)	(0.000565)
7	0.000302	0.000436**	0.000504*	0.00227***	0.000597***
	(0.000186)	(0.000186)	(0.000295)	(0.000591)	(0.000212)
8	-0.00187	-0.00269**	-0.00311*	-0.0189***	-0.00369***
	(0.00115)	(0.00115)	(0.00182)	(0.00493)	(0.00131)
9	-0.00199	-0.00286**	-0.00331*	-0.0189***	-0.00392***
	(0.00122)	(0.00122)	(0.00194)	(0.00493)	(0.00139)
10	-0.00167	-0.00240**	-0.00278*	-0.0154***	-0.00329***
	(0.00103)	(0.00102)	(0.00163)	(0.00402)	(0.00117)

Notes: Panel A reports estimates using TWFE. Panel B reports the odd ratios of the ordered logistic regression. In Panel C shows the marginal effects of each energy poverty indicator estimated using ordered logistic regression model in Panel B and the margins are computed at the sample mean of the dependent variable satisfaction with health. The data is from SOEP version 40. The dependent variable is health satisfaction (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied). The column labels represents the measure for energy poverty. Each column comes from a unique regression.
Standard errors correspond to the marginal effects evaluated at the sample mean. Clustered standard errors at the individual level are shown in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

marginal effects further show that energy poverty increases the probability of reporting low levels of health satisfaction while reducing the likelihood of reporting high satisfaction levels. However, these distributional shifts are smaller than those observed for life satisfaction, indicating that health satisfaction responds more moderately to energy deprivation.

The mediation analysis reported in Table A.3 provides further insight into the mechanisms linking energy poverty to health satisfaction. Overall, the results point to an important role for psychological and emotional channels. Energy poverty is associated with greater health-related worries, lower happiness, and higher sadness in many specifications, and each of these mediators is strongly related to lower health satisfaction.

Health worries emerge as a particularly important mediator. For example, under the

2M share indicator the estimated indirect effect through health worries is about -0.015, accounting for a substantial share of the total association with health satisfaction. A similar pattern appears for the LIHC, consensual, and composite indicators, with the largest mediation effect observed for the consensual measure. Mediation through affective states also contributes meaningfully: lower happiness and greater sadness generate additional negative indirect effects, although these channels are generally somewhat smaller than those operating through health worries.

Importantly, once these emotional mediators are included, the remaining direct effect of energy poverty becomes small and statistically insignificant in several specifications, particularly for the expenditure-based and composite indicators. The consensual measure, however, still retains a sizeable direct effect, suggesting that subjectively experienced energy deprivation affects health satisfaction both through emotional stress and through additional channels not fully captured by the mediators considered here.

Taken together, these findings suggest that energy poverty affects health satisfaction primarily through psychological and emotional strain rather than through immediate deterioration in physical health. Health satisfaction therefore responds in the expected direction, but generally less strongly than overall life satisfaction, reinforcing the interpretation that the welfare costs of energy poverty arise mainly from mental and emotional burdens rather than physical health damage.

4.7.2 Good Well-Being

As an additional sensitivity test, we recode life satisfaction into a binary indicator of good well-being and re-estimate the models using both a two-way fixed-effects linear probability model and a logistic specification. The binary outcome equals one if the respondent reports a life-satisfaction score between 5 and 10 (indicating overall satisfaction) and zero if the score lies between 0 and 4 (indicating dissatisfaction). This specification allows us to examine whether energy poverty reduces not only the level of life satisfaction, but also the probability that individuals report being broadly satisfied with their lives.

Table A.4 presents the results. Panel A reports estimates from the fixed-effects linear probability model. Across most indicators, energy poverty is associated with a lower probability of reporting good well-being. The reduction is modest for the expenditure-based indicators – around 0.4 to 0.6 percentage points for the 2M share, LIHC, and composite measures – while the coefficient for the 10% rule is small and statistically insignificant. In contrast, the consensual indicator shows a substantially larger effect, with energy poverty reducing the probability of reporting good well-being by approximately 3.8 percentage points. This pattern closely mirrors the baseline life-satisfaction results, where subjective and multidimensional indicators exhibit the strongest associations.

Panel B reports the results from the logistic specification. The estimated odds ratios are below one and statistically significant across all indicators, indicating that energy poverty reduces the odds of reporting good well-being. Consistent with the linear estimates, the strongest effect is observed for the consensual indicator, followed by the composite measure.

The marginal effects reported in Panel C provide a more direct interpretation of these relationships. Energy poverty reduces the probability of reporting good well-being by approximately 0.6 to 0.7 percentage points for the expenditure-based indicators and by about one percentage point for the composite measure, while the consensual indicator implies a substantially larger reduction of around 4.6 percentage points. Overall, these results confirm that the negative relationship between energy poverty and subjective well-being is robust to alternative ways of modeling the outcome variable. Energy poverty not only lowers the level of life satisfaction but also reduces the likelihood that individuals report being broadly satisfied with their lives.

4.7.3 Heterogeneity Check: Life Satisfaction

Beyond examining health satisfaction as an alternative well-being outcome, we further assess the robustness of the results by exploring potential heterogeneity in the relationship between energy poverty and subjective well-being. In particular, we investigate whether the effects differ across housing tenure and dwelling characteristics, both of which are closely related to households ability to manage energy costs and improve energy efficiency.

Table A.5 in the Appendix reports fixed-effects estimates for subsamples defined by housing tenure and the construction period of the dwelling. Panels I and II compare homeowners and tenants. For both groups, energy poverty is associated with lower life satisfaction across most indicators. However, the magnitude of the effects tends to be larger for tenants, particularly for subjective and multidimensional measures. The consensual indicator shows a substantial negative association for tenants (−0.254), compared with a smaller and only weakly significant effect among homeowners (−0.165). Similarly, the composite indicator yields a larger effect for tenants (−0.063) than for homeowners (−0.040). At the same time, some expenditure-based indicators remain statistically significant among homeowners but not among tenants, suggesting that while renters experience stronger well-being losses, the effects among homeowners are more broadly distributed across different measures. Overall, these patterns indicate that renters may be more vulnerable to the well-being consequences of energy deprivation, possibly because they face fewer opportunities to invest in energy efficiency or adjust heating technologies.

Panels III to V examine heterogeneity by dwelling age as a proxy for housing quality and energy efficiency. For dwellings built after 2000, none of the estimated coefficients are statistically significant, indicating that energy poverty in newer and more energy-efficient housing is not strongly associated with reductions in life satisfaction. In contrast, the effects become more pronounced for older housing units. For dwellings constructed between 1976 and 2000, the consensual indicator shows a sizeable negative effect (−0.306), while the 10% rule and the composite indicator also yield statistically significant reductions in life satisfaction. The strongest and most consistent effects emerge for dwellings built before 1976, where nearly all indicators display statistically significant negative associations.

In summary, these results suggest that the well-being costs of energy poverty are not evenly distributed across households. In particular, renters and residents of older, less energy-efficient dwellings experience larger reductions in life satisfaction when facing energy affordability constraints. This pattern is consistent with the view that poor housing quality and limited control over energy efficiency investments amplify the subjective burden associated with energy poverty.

5 Conclusion and Policy Implications

This paper examines the welfare consequences of energy poverty in Germany through the lens of subjective well-being. Using longitudinal data from the German SOEP over the period 2010–2023 and exploiting within-individual variation, we estimate the impact of energy poverty on life satisfaction using a range of objective, subjective, and composite indicators. By combining fixed-effects models, causal mediation analysis, and a series of robustness and sensitivity checks, the analysis provides comprehensive evidence on how energy affordability constraints affect individual well-being in a high-income country context.

Across our baseline specifications, energy poverty is associated with statistically significant and economically meaningful reductions in subjective well-being. These effects remain robust after controlling for income levels, income poverty, health status, labour market status, and other household characteristics, and are confirmed across alternative estimation approaches. Importantly, the negative association persists even among individuals who are not income-poor, further reinforcing the interpretation that energy poverty constitutes a distinct dimension of material deprivation rather than merely reflecting insufficient income.

The magnitude of the estimated effects varies systematically across energy poverty measures. Subjective and multidimensional indicators – particularly the consensual and composite measures – exhibit substantially larger associations with life satisfaction than purely expenditure-based indicators. This pattern highlights that the lived experience of energy deprivation, including feelings of inadequacy, insecurity, and loss of control over essential energy services, plays a central role in shaping individual well-being. Energy poverty thus operates not only through financial constraints, but also through experiential and psychological dimensions.

The mediation analysis provides evidence on the mechanisms underlying these effects. Psychological and emotional channels – including increased health-related worries, reduced happiness, and higher levels of sadness – account for a substantial share of the total effect of energy poverty on well-being. In contrast, mediation through physical health conditions and health care utilization is present but quantitatively limited in magnitude. These findings suggest that the welfare costs of energy poverty arise primarily through psychological and emotional channels rather than through physical health-related pathways.

A series of robustness and sensitivity analyses further reinforces these conclusions. When health satisfaction is used as an alternative outcome, energy poverty remains negatively associated with well-being, albeit with smaller magnitudes. Similarly, recoding life satisfaction into a binary indicator of good well-being shows that energy poverty significantly reduces the likelihood that individuals report being satisfied with their lives. These results confirm that the observed relationship is not driven by specific modeling choices or outcome definitions.

The analysis also reveals important heterogeneity in the effects of energy poverty. The negative association with life satisfaction is generally stronger among tenants than among homeowners and is particularly pronounced for households living in older, less energy-efficient dwellings. In contrast, no statistically significant effects are observed for newer housing units. These patterns suggest the importance of structural housing conditions and constraints on households ability to adjust energy efficiency, and indicate that the burden of energy poverty is unevenly distributed across the population.

Taken together, these findings have important implications for energy and social policy. First, they demonstrate that the social costs of energy poverty extend well beyond observable financial hardship or immediate physical health outcomes. Persistent exposure to energy affordability constraints generates substantial welfare losses through psychological and emotional channels, reflected in increased health-related worries, reduced happiness, and higher levels of sadness. Policies that focus solely on preventing extreme outcomes – such as disconnections or severe health deterioration – are therefore likely to underestimate the broader welfare consequences of energy poverty.

Second, the results suggest that income-based transfers alone may be insufficient to address these well-being losses. Even after accounting for income poverty, energy poverty remains strongly associated with lower life satisfaction. This highlights the importance of targeted energy-related interventions, particularly those aimed at improving housing energy efficiency and reducing exposure to energy price volatility. Investments in building retrofits, insulation, and efficient heating technologies are therefore likely to yield substantial welfare gains alongside environmental benefits. Third, the heterogeneity findings point to the need for policies that address structural constraints faced by renters and households in older dwellings. Because tenants often lack the ability or incentives to invest in energy efficiency improvements, policy frameworks that incentivize landlords or directly support energy-efficient housing upgrades may be especially effective in reducing the welfare burden of energy poverty.

More broadly, the results contribute to ongoing debates on the distributional consequences of climate and energy policies. As decarbonization strategies increasingly rely on price-based instruments such as carbon pricing, understanding their welfare implications requires accounting not only for income effects but also for how energy affordability constraints shape individuals lived experiences and subjective well-being. Incorporating well-being considerations into policy evaluation may therefore lead to more comprehensive assessments of policy trade-offs and to policy designs that better balance efficiency, equity, and social acceptance.

Several limitations should be acknowledged. While the empirical strategy – combining fixed effects with an instrumental-variable approach – helps address endogeneity concerns, isolating fully exogenous variation in energy poverty remains challenging. The IV results should therefore be interpreted as a robustness exercise rather than definitive causal estimates. In addition, the analysis focuses on short- to medium-term outcomes and may not fully capture longer-term physical health effects.

Future research could extend this work by examining the long-term health consequences of sustained energy deprivation, incorporating more detailed information on housing characteristics and energy efficiency, and evaluating the well-being impacts of specific policy interventions. Furthermore, exploring how energy poverty influences political attitudes and support for climate policies would provide valuable insights into the broader societal implications of energy affordability in the context of the energy transition.

In sum, this paper shows that energy poverty is not only an issue of affordability and material deprivation, but also a significant determinant of individual well-being. Addressing energy poverty should therefore be seen as a central component of policies aimed at ensuring a socially sustainable and politically viable transition to a low-carbon energy system.

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A Appendix

Table A.1: Energy Poverty and Subjective Well-Being: IV Estimates

	(1) 10% Rule	(2) 2M Share	(3) LIHC	(4) Consensual	(5) Composite
Second Stage					
Energy Poverty	-0.126	-0.106	-0.0418	-0.164	-0.167*
	(0.0849)	(0.105)	(0.0655)	(0.174)	(0.0870)
First Stage					
Heating Energy CPI	0.000778***	0.000721***	0.000332***	0.0000116	0.000651***
	(0.000118)	(0.000125)	(0.0000559)	(0.0000485)	(0.000111)
Observations	111,177	111,177	111,177	111,177	111,177
Under-ID-stat	544.3***	306.7***	1603.0***	146.3***	784.6***
Weak-ID F-stat	39.03	16.96	204.0	17.64	59.40
First-stage F-stat	120.1	120.2	120.0	120.1	120.3
Hansen J-test (p-value)	0.0705	0.597	0.429	0.151	0.373
Individual FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes

Notes: The table reports instrumental-variable estimates of the impact of energy poverty on life satisfaction using the restricted sample for which all energy poverty indicators are jointly observed. Energy poverty indicators are instrumented using lagged household-specific heating energy price indices combined with heteroskedasticity-based internal instruments following Lewbel (2012). The first-stage results report the coefficient on the external heating energy price instrument. The *Under-ID-stat* is the Kleibergen-Paap rk LM statistic tests for underidentification, while the Weak-ID F-stat evaluates potential weak instrument concerns. The First-stage F-statistic reports the joint significance of the instruments in the first stage. The Hansen J-test reports the p-value for overidentifying restrictions. Standard errors clustered at the individual level are shown in parentheses.
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A.2: Subjective well-being: Mediation Analysis – Physical health and health care utilization

	(1)	(2)	(3)	(4)	(5)	(6)				
	10%		***2M Share***		***LIHC***		***Consensual***		***Composite***	
	Regression on Mediator	Regression on SWB	Regression on Mediator	Regression on SWB	Regression on Mediator	Regression on SWB	Regression on Mediator	Regression on SWB	Regression on Mediator	Regression on SWB
Panel I: No. Doc. visits										
No. Doc. visits		-0.0717***		-0.0717***		-0.0717***		-0.0697***		-0.0717***
		(0.00354)		(0.00354)		(0.00354)		(0.00609)		(0.00354)
Energy Poverty	0.0175***	-0.0491***	0.0101*	-0.0401***	0.0185**	-0.0458***	0.0323	-0.225***	0.0122**	-0.0615***
	(0.00536)	(0.00962)	(0.00532)	(0.00941)	(0.00925)	(0.0175)	(0.0252)	(0.0484)	(0.00616)	(0.0113)
Observations	311,391	311,391	311,391	311,391	311,391	311,391	108,446	108,446	311,391	311,391
Within R^2	0.0443	0.0461	0.0442	0.0461	0.0442	0.0460	0.0398	0.0461	0.0442	0.0461
Controls/year/Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mediation effect		-0.0012527***		-0.0007218*		-0.0013238*		-0.0022505		-0.0008769*
		(0.0004009)		(0.0003911)		(0.0006793)		(0.001928)		(0.0004497)
Direct effect		-0.0491208***		-0.0401216***		-0.0458063**		-0.22539***		-0.0615463***
		(0.0096824)		(0.0095398)		(0.0177975)		(0.0519954)		(0.0112877)
Total effect		-0.0352065***		-0.0198219**		-0.030736*		-0.2630893***		-0.0555937***
		(0.0093685)		(0.0092826)		(0.0164086)		(0.0506767)		(0.0109132)
Panel II: No. Sick day										
No. Sick days		-0.0302***		-0.0302***		-0.0302***		-0.0390***		-0.0302***
		(0.00275)		(0.00275)		(0.00275)		(0.00497)		(0.00275)
Energy Poverty	-0.0165	-0.0555***	0.00696	-0.0270*	0.00806	-0.0272	0.0461	-0.317***	0.0125	-0.0843***
	(0.0161)	(0.0146)	(0.0157)	(0.0138)	(0.0288)	(0.0278)	(0.0759)	(0.0734)	(0.0196)	(0.0182)
Observations	167,494	167,494	167,494	167,494	167,494	167,494	60,173	60,173	167,494	167,494
Within R^2	0.0442	0.0443	0.0442	0.0442	0.0442	0.0442	0.0389	0.0463	0.0442	0.0444
Mediation effect		0.0004987		-0.0002103		-0.0002435		-0.0017944		-0.0003772
		(0.000518)		(0.0004962)		(0.0009322)		(0.0034222)		(0.0006279)
Direct effect		-0.05554***		-0.026987*		-0.0271942		-0.3173312***		-0.0843165***
		(0.0150841)		(0.0143216)		(0.0284275)		(0.0835548)		(0.0182344)
Total effect		-0.0352065***		-0.0198219**		-0.030736*		-0.2630893***		-0.0555937***
		(0.0093685)		(0.0092826)		(0.0164086)		(0.0506767)		(0.0109132)
Panel III: Hospitalized Days										
Hospitalized Days		-0.0536***		-0.0535***		-0.0536***		-0.0744***		-0.0534***
		(0.00852)		(0.00853)		(0.00853)		(0.0149)		(0.00852)
Energy Poverty	0.00150	-0.0407***	0.00729**	-0.0291***	0.00624	-0.0228	0.0118	-0.246***	0.00760**	-0.0519***
	(0.00305)	(0.0106)	(0.00297)	(0.0102)	(0.00494)	(0.0191)	(0.0153)	(0.0570)	(0.00362)	(0.0126)
Observations	259,516	259,516	259,516	259,516	259,516	259,516	88,118	88,118	259,516	259,516
Within R^2	0.0101	0.0415	0.0101	0.0414	0.0101	0.0414	0.00604	0.0422	0.0101	0.0415
Controls/year/Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mediation effect		-0.0000802		-0.0003901**		-0.0003343		-0.0008814		-0.0004064*
		(0.0001751)		(0.000181)		(0.0002914)		(0.0013571)		(0.0002152)
Direct effect		-0.0406989***		-0.0290645***		-0.0228341		-0.2463645***		-0.0519241***
		(0.0107019)		(0.0104421)		(0.0197384)		(0.0637122)		(0.0125428)
Total effect		-0.0352065***		-0.0198219**		-0.030736*		-0.2630893***		-0.0555937***
		(0.0093685)		(0.0092826)		(0.0164086)		(0.0506767)		(0.0109132)

Notes: This table shows the coefficients of a causal mediation regressions of all four energy poverty indicators on Panel I – inverse hyperbolic sine transformed number of doctor visits in last three months; Panel II–inverse hyperbolic sine transformed sick days in the previous survey year. and Panel III–inverse hyperbolic sine transformed hospitalized days in the survey year. The data is from SOEP version 40. The main outcome variable is Overall life satisfaction (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied). The column labels represents the measure for energy poverty. Each column comes from a unique regression.
Mediation regressions are estimated using 5,000 bootstrap replications and its standard errors are based on non-parametric bootstrap resampling.
Clustered standard errors at the individual level are shown in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table A.3: Satisfaction with Health: Mediation Analysis – Mental and Emotional Health

	(1)	(2)	(3)	(4)	(5)	(6)				
	10%		***2M Share***		***LIHC***		***Consensual***		***Composite***	
	Regression on Mediator	Regression on SWH	Regression on Mediator	Regression on SWH	Regression on Mediator	Regression on SWH	Regression on Mediator	Regression on SWH	Regression on Mediator	Regression on SWH
Panel I: Health worries										
Health worries		-0.892***		-0.892***		-0.892***		-0.885***		-0.892***
		(0.00773)		(0.00773)		(0.00773)		(0.0120)		(0.00773)
Energy Poverty	0.0153***	-0.000224	0.0170***	-0.0127	0.0160***	-0.00880	0.0671***	-0.145***	0.0135***	-0.0191
	(0.00370)	(0.0111)	(0.00360)	(0.0109)	(0.00619)	(0.0191)	(0.0152)	(0.0484)	(0.00414)	(0.0128)
Observations	312,601	312,601	312,601	312,601	312,601	312,601	123,074	123,074	312,601	312,601
Within R^2	0.00528	0.0948	0.00530	0.0948	0.00523	0.0948	0.00431	0.0853	0.00525	0.0948
Mediation effect		-0.0136871***		-0.0151915***		-0.0143104**		-0.0593598***		-0.0120106***
		(0.0033184)		(0.0032531)		(0.0057176)		(0.0153317)		(0.0037903)
Direct effect		-0.0002237		-.0127072		-0.0087986		-0.145037***		-0.0190897
		(0.0113138)		(0.0112712)		(0.0196413)		(0.0531926)		(0.0131662)
Total effect		-0.017939		-0.0329447***		-0.0393337**		-0.2042767***		-0.0408362***
		(0.0113146)		(0.0114162)		(0.0193962)		(0.0560094)		(0.013287)
Panel II: Happiness										
Happiness		0.370***		0.370***		0.370***		0.375***		0.370***
		(0.00585)		(0.00585)		(0.00585)		(0.00951)		(0.00585)
Energy Poverty	-0.0174***	0.000210	-0.0144***	-0.0155	-0.0147	-0.00815	-0.0815***	-0.152***	-0.0296***	-0.0148
	(0.00521)	(0.0118)	(0.00503)	(0.0115)	(0.00950)	(0.0214)	(0.0223)	(0.0505)	(0.00600)	(0.0136)
Observations	290,305	290,305	290,305	290,305	290,305	290,305	113,159	113,159	290,305	290,305
Within R^2	0.00505	0.0361	0.00503	0.0361	0.00501	0.0361	0.00416	0.0339	0.00512	0.0361
Mediation effect		-0.0064616***		-0.005322***		-0.0054477		-0.0305611***		-0.0109728***
		(0.0019263)		(0.0018615)		(0.0035809)		(0.0092403)		(0.0022136)
Direct effect		0.0002099		-0.0155113		-0.0081475		-0.1523534***		-0.0147527
		(0.0120684)		(0.0119026)		(0.021873)		(0.0562911)		(0.0140303)
Total effect		-0.017939		-0.0329447***		-0.0393337**		-0.2042767***		-0.0408362***
		(0.011314)6		(0.0114162)		(0.0193962)		(0.0560094)		(0.013287)
Panel III: Sadness										
Sadness		-0.294***		-0.294***		-0.294***		-0.290***		-0.294***
		(0.00459)		(0.00459)		(0.00459)		(0.00741)		(0.00459)
Energy Poverty	0.0320***	0.00311	0.0386***	-0.00975	0.0215*	-0.00830	0.125***	-0.143***	0.0418***	-0.0134
	(0.00632)	(0.0118)	(0.00612)	(0.0115)	(0.0110)	(0.0213)	(0.0270)	(0.0504)	(0.00720)	(0.0136)
Observations	290,341	290,341	290,341	290,341	290,341	290,341	113,171	113,171	290,341	290,341
Within R^2	0.00519	0.0361	0.00526	0.0361	0.00509	0.0361	0.00315	0.0327	0.00523	0.0361
Controls/year/Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mediation effect		-0.0094103***		-0.0113617***		-0.0063159*		-0.0361563***		-0.0122999***
		(0.0018824)		(0.0018166)		(0.0033813)		(0.0085774)		(0.0021574)
Direct effect		0.0031053		-0.0097512		-0.0082985		-0.1431785**		-0.0134304
		(0.012055)		(0.0119159)		(0.0219449)		(0.0562288)		(0.0140748)
Total effect		-0.017939		-0.0329447***		-0.0393337**		-0.2042767***		-0.0408362***
		(0.0113146)		(0.0114162)		(0.0193962)		(0.0560094)		(0.013287)

Notes: This table shows the coefficients of a causal mediation regressions of all four energy poverty indicators on Pane I – worries about own health (1 =not concerned at all, 3 =very concerned); Panel II – frequency of being happy in the last 4 weeks (1 =very seldom, 5 =very often) and Panel III – frequency of being sad in the last 4 weeks (1 =very seldom, 5 =very often). The data is from SOEP version 40. The dependent variable is health satisfaction (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied). The column labels represents the measure for energy poverty. Each column comes from a unique regression.
Mediation regressions are estimated using 5,000 bootstrap replications and its standard errors are based on non-parametric bootstrap resampling.
Clustered standard errors at the individual level are shown in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table A.4: Energy Poverty and Good well-being

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Good Well-being				
	10% Rule	2M Share	LIHC	Consensual	Composite
	Panel A: TWFE				
Energy Poverty	-0.00162	-0.00391**	-0.00456*	-0.0381***	-0.00595***
	(0.00160)	(0.00160)	(0.00275)	(0.00918)	(0.00196)
Within R^2	0.0211	0.0211	0.0211	0.0200	0.0211
	Panel B: Logistics Estimates				
Energy Poverty	0.890***	0.892***	0.884***	0.428***	0.824***
	(0.0209)	(0.0207)	(0.0287)	(0.0301)	(0.0210)
Pseudo R^2	0.144	0.144	0.144	0.146	0.144
Number of Individuals	51,508	51,508	51,508	30,264	51,508
Observations	334,158	334,158	334,158	120,060	334,158
All Controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes
	Panel C: Marginal Effects – Logistics Estimates				
Good Life (1)	-0.00628***	-0.00618***	-0.00667***	-0.0455***	-0.0104***
	(0.00127)	(0.00125)	(0.00175)	(0.00379)	(0.00138)

Notes: Panel A reports estimates from a two-way fixed-effects linear probability model. Panel B reports odds ratios from a logistic regression, and Panel C reports the corresponding marginal effects evaluated at the sample mean. The dependent variable is a binary indicator for good well-being, equal to 1 if overall life satisfaction is between 5 and 10 (satisfied) and 0 if it is between 0 and 4 (dissatisfied). The data is from SOEP version 40. Column labels indicate the energy poverty measure used in each specification. Clustered standard errors at the individual level are shown in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table A.5: Heterogeneous Effects – FE Estimates

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Life Satisfaction				
	10% Rule	2M Share	LIHC	Consensual	Composite
Panel I: Sub-sample with Home Owners					
Energy Poverty	-0.0232*	-0.0351**	-0.102***	-0.165*	-0.0404**
	(0.0135)	(0.0144)	(0.0324)	(0.0966)	(0.0158)
Observations	170,059	170,059	170,059	66,387	170,059
Within R-squared	0.0422	0.0422	0.0423	0.0404	0.0422
Panel II: Sub-sample with Tenants					
Energy Poverty	-0.0407***	-0.0137	-0.0264	-0.254***	-0.0632***
	(0.0124)	(0.0124)	(0.0184)	(0.0494)	(0.0145)
Observations	204,730	204,730	204,730	78,616	204,730
Within R-squared	0.0398	0.0397	0.0398	0.0400	0.0399
Panel III: Sub-sample with House Built After 2000					
Energy Poverty	-0.0243	-0.0416	-0.0437	-0.0530	-0.0640
	(0.0371)	(0.0360)	(0.0676)	(0.202)	(0.0448)
Observations	50,738	50,738	50,738	20,417	50,738
Within R-squared	0.0436	0.0436	0.0436	0.0437	0.0437
Panel IV: Sub-sample with House Built 1976-to-2000					
Energy Poverty	-0.0686***	-0.0180	-0.0185	-0.306***	-0.0501**
	(0.0186)	(0.0181)	(0.0349)	(0.0929)	(0.0220)
Observations	91,648	91,648	91,648	35,088	91,648
Within R-squared	0.0428	0.0426	0.0426	0.0437	0.0427
Panel V: Sub-sample with House Built Before 1976					
Energy Poverty	-0.0391***	-0.0477***	-0.0506**	-0.257***	-0.0547***
	(0.0123)	(0.0121)	(0.0229)	(0.0632)	(0.0143)
Observations	175,374	175,374	175,374	65,931	175,374
Within R-squared	0.0420	0.0420	0.0419	0.0417	0.0420
All Controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes

Notes: The data is from SOEP version 40. The dependent variable is Overall life satisfaction (scale 0-10: 0=Completely dissatisfied, 10=Completely satisfied). The column labels represents the measure for energy poverty. Panels report subsample fixed-effects regressions by housing tenure (homeowners vs. tenants) and dwelling age. Each column and panel corresponds to a separate regression.

Clustered standard errors at the individual level are shown in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

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