

Evaluation of Fuel Poverty in Urban Regeneration Areas: A Case Study of Ankara, Türkiye

M. Anil Senyel Kurkcuoglu
Middle East Technical University
senyel@metu.edu.tr
ORCID: 0000-0002-9423-6932

Abstract

This paper discusses fuel poverty in urban regeneration areas, as regeneration activities aim to improve socio-economic and structural conditions. Low Income High Cost method is adopted to assess fuel poverty, and a logistic regression is conducted to determine the factors affecting fuel poverty. The results indicate that fuel poverty level among households living in urban regeneration areas is 11.7%. Structural and design components such as aspect, size, heating duration and heating system, alongside global socio-economic factors like household size, employed households, and young children in the household appear to be influential on fuel poverty level. Structural and design factors can be addressed in future regeneration activities, while broader socio-economic factors require complex and large-scale interventions to deal with fuel poverty.

Keywords: Urban regeneration, fuel poverty, energy justice, energy efficiency.

1. Introduction

Urban regeneration, aimed at enhancing social, environmental, and economic conditions through the improvement of urban fabric, has been a longstanding focus of Türkiye's housing and development agenda. Regeneration interventions specifically concentrate on squatter settlements, which are characterised by challenges in infrastructure provision, low environmental quality, and substandard building conditions. Energy efficiency and accordingly fuel poverty, stand as prominent environmental and economic issues to which urban regeneration is expected to provide responsive solutions while enhancing energy justice. The buildings that replace squatter units need to be higher quality with improved energy efficiency, thereby mitigating fuel poverty among residents of these settlements who exhibit heightened vulnerability to fuel poverty in terms of demographic and socio-economic characteristics, besides the structural conditions.

To understand how urban regeneration addresses fuel poverty, it is necessary to first determine the level of fuel poverty in these areas. Then, discussing factors influencing fuel poverty can help highlight problem areas in the housing units obtained through urban transformation, providing insights for future regeneration activities in terms of better design strategies and policies. This paper aims to identify fuel poverty level and explore the variables contributing to it, using Ankara's Mamak district as an example. In the following part, the concepts of fuel poverty and urban regeneration will be framed within the context of the literature. Study area will be introduced next, followed by the data and the method. After presenting the analysis results, the study concludes with a discussion and conclusion section.

2. Fuel Poverty

In the literature, it is relevant to describe fuel poverty as a subset of the broader concept of energy poverty. While both terms address issues related to the inadequacy and the inefficiency of energy resources for meeting basic human needs, there are certain distinctions between them. Fuel poverty is integrally linked to financial aspects of energy access which primarily focuses on affordability and is specifically concerned with the economic constraints that prevent households from heating their home to an adequate level or powering household devices (Moniruzzaman and Day, 2020). The condition is particularly identified by the proportion of income that is spent on energy, leading to excessive costs or not being able to allocate income for energy needs. Although early definitions of fuel poverty consider only heating, more recent and comprehensive definitions cover all residential energy needs including heating, cooking, lighting, and the operation of devices (Boardman, 2010; Hills, 2011; Moore, 2012). Energy poverty, however, is a more comprehensive framework which encompasses a wider range of issues. It includes not only affordability but also the physical access to modern energy services (Bouzarovski, 2014). This broader term covers the quality and reliability besides health and safety issues.

Spatial variations in energy poverty can be considered as the outcome of structural geographic injustices ingrained in different phases of energy systems as well as in the economic, cultural and infrastructural components of society (Bouzarovski and Simcock, 2017). Similarly, fuel poverty constitutes a multidimensional challenge, regarding household income, fuel prices, and the energy efficiency levels of buildings (Sovacool, 2015). In this context, squatter settlements exhibit an elevated risk of fuel poverty due to a significant proportion of vulnerable groups in terms of low-income, child and elderly populations, as well as low structural quality. Ho et al. (2012) mentions energy efficiency one of the problems in urban regeneration, while Ng et al. (2001) state that it is aimed to prevent the decline of the built environment and to upgrade the appearance and structural conditions.

Vulnerable groups in terms of low income, elderly, children, refugees etc. are more at risk of being fuel poor. However, the problem is also evident in the developed countries. Fuel poverty levels appear to be 13% in England, 25% in Scotland, 12% in the Wales and 18% in North Ireland (Hinson and Bolton, 2021). In Belgium, fuel poverty is reported to be 14% in 2013, while in more recent studies, the value increases to 27.6% in Belgium (Lyons, 2021). The issue is related to socio-economic conditions as well as old housing stock with poor insulation. The only national-level study for Türkiye is conducted by Dogan et al. (2021) using 2018 data concluded that the fuel poverty levels are %17, %18 and %7 with regard to 10%, 2-median and LIHC criteria. The study of Senyel Kurkcuoglu (2023) asserted 23.6% fuel poverty for the city of Ankara using LIHC criterion.

It is expected for squatter settlements to have higher fuel poverty due to low income and structural issues. Urban regeneration suggests the potential alleviation of fuel poverty, primarily through improvements in building quality. The actual impact of urban regeneration on fuel poverty, however, remains an understudied issue in the existing literature. Therefore, this research investigates the impact of urban regeneration on fuel poverty, aiming to provide insights into whether urban regeneration activities enhance energy efficiency and accordingly decrease the levels of fuel poverty. In the following section, urban regeneration and its development in Türkiye is discussed.

3. Urban Regeneration in Türkiye

Housing development has been characterised by political and socio-economic realms of Türkiye. Candas et al. (2016) states that population growth, informal settlements and hazard-prone buildings and infrastructure are the most prominent issues in Turkish cities. Beginning in the second half of

the 40s, a substantial influx of rural migrants to urban areas was spurred by a combination of factors. On the one hand, there was an urban pull driven by job prospects, especially in the industrial sector. On the other hand, there was a rural push fueled by diminishing employment opportunities in agriculture due to mechanisation of production. Housing supply fell short of accommodating the needs of incoming residents, and the government struggled to implement timely solutions for rapid and affordable housing production. Consequently, informal settlements in terms of squatter areas, began to proliferate, offering a short-term solution to the housing shortage at the expense of exacerbating structural, environmental, and socio-economic issues. Throughout years, laws and regulations intended to prevent further illegal housing developments and upgrade the existing ones ended up with legalizing those areas particularly due to political concerns. Urban regeneration or rehabilitation efforts remained at plot or single structure scale, often entailing the replacement of one or two-story squatter housing units with multi-apartment story buildings until mid-2000s.

Urban regeneration can be considered as a government-lead initiative (Guzey, 2009; Oktem Unsal, 2015) with the objective of creating enhanced living spaces that are more sustainable and viable in socio-economic senses. The process aimed to replace the outdated and risky buildings and infrastructure with the new ones while upgrading the structural, environmental and social qualities. Although practiced for years, regeneration activities gained momentum with regulations that expedited the process and expanded the scale and the coverage of the projects put into effect in late 2000s. Municipality Law (No:5393, 2005) and the Law on Transformation of Areas under Disaster Risk which has been abbreviated in daily use as Urban Transformation Law (6306, 2012) particularly addressed to urban regeneration. The Urban Transformation Directorate was established within the Ministry of Environment, Urbanisation and Climate change, in accordance with the Urban Transformation Law. With all these developments, comprehensive and widespread urban transformation projects began in cities. This period is also characterised by the neo-liberal discourse focusing on the increasing urban land-rents and real estate development, while the process includes private sector actors as well as state institutions such as the Mass Housing Development Administration (Eren & Tökmeci, 2012). Gozozkut and Somuncu (2019) mention that although the legal bases is created, the sustainability of these areas following the completion of regeneration remains open to debate.

One of the areas that sustainable urban regeneration deals with is energy efficiency and resource use (Korkmaz, C., 2016; Gonullu Sutcuoglu and Kalayci Onac, 2022). Although the goals of urban regeneration are straightforward, the outcomes – especially those concerning energy efficiency – remain unclear and not being discussed in detail. There are some studies in the literature considering sustainability-oriented aspects which evaluate regeneration projects from environmental point of view besides the economic and social assessments, mostly through qualitative methods (Eren & Tökmeci, 2012; Uzun & Celik Simsek, 2015; Korkmaz & Balaban, 2020). Tuç (2018) mentions that the regeneration focuses on beautification and image-building through better environmental services and large green spaces in his study of North Ankara Urban Entrance regeneration project. Demirtaş (2019) and Korkmaz and Balaban (2000) discusses the same project while indicating the benefits of the provision of large green spaces and landscaping but lacking the adoption of renewable energy. Akkose (2022) states that urban regeneration practices in Türkiye lack sustainability approach while her study on Bursa Doganbey urban regeneration project concludes that environmental impacts have not been considered at all. However, none of these studies address to energy issues other than the criticism of not adopting the use of renewables.

4. Study Area

Ankara is the capital city, located at the centre of Türkiye. It has a temperate continental climate with colder winters and house heating expenses can be overwhelming in household budget in winter. The research focuses on the urban regeneration areas in Mamak district of Ankara (Figure 1) due to the high prevalence of squatter settlements in the district, which has been subject to widespread urban regeneration projects. Starting from the 1940s, an uncontrolled growth has been experienced in cities such as Ankara, İstanbul and İzmir, yet, due to the lack of adequate affordable housing provision to respond the rapid urbanisation, squatter areas formed (Uzun, 2006). Arık (2021) refers to a study conducted by the Ministry of Construction and Settlement in 1964 analyzing the thirteen largest cities of Türkiye in terms of the presence of squatter settlements, which noted that these areas used to constitute 64.4% of the total housing stock in Ankara, making the city with the highest rate in the entire country. Mamak locates at the eastern part of Ankara, which received many immigrants from the eastern part of the country for years (Gözözkut and Somuncu, 2019). Housing areas for middle- and higher-income groups are located in the western corridor, whereas squatter settlements emerged in the eastern, southern and northern fringes of the city (Duyar-Kienast, 2005). For a long time, Mamak was an area known for its squatter neighborhoods, thus urban regeneration projects are considered to change the image of Mamak for the better (Gözözkut, 2016).



Figure 1. Mamak District of Ankara

Four urban regeneration areas are selected, which cover urban regeneration areas: Gulseren Neighborhood, Altiagac Neighborhood, Derbent Neighborhood and Uregil Neighborhood (Figure 2). In Gulseren Neighborhood, 1222 squatter units have already been demolished. The first stage with 688 housing units and the third stage with 1219 housing units in high-rise apartments have already been constructed. The construction of the second stage with 1312 housing units are about to be completed while the activities in other stages are ongoing. In this study, only the first and the third stage areas, which have already been finalised are included. Urban regeneration in Uregil Neighborhood is the first stage of the North Ankara Urban Entrance Project was completed in 2015 with the transformation of 2160 housing units. In Altiagac Neighborhood, 1350 squatter units were replaced by 3881 residences in 25 point-blocks and more than 100 high-rise apartments. Urban regeneration activities are completed in the neighborhood, but not all flats have been occupied yet. Derbent Neighborhood also locates within the North Ankara Urban Entrance Project; however, the construction is still going on in the area so that only the completed residences are included in the

study, which are Zirve Residences, Ihlamur Residences and Palmiye Residences. The contractors for Uregil and Altiagac are private companies, whereas the residences in Derbent were undertaken by Portas A.S., a subsidiary of the Ankara Metropolitan Municipality.



Figure 2. Study areas

5. Data

Data is collected from 4 urban regeneration neighborhoods given in the previous section. All calculations are done at monthly level, since the data covers winter season only. The study includes a household survey with 400 participants. In the household survey, precise questions were asked to the respondents covering information about their household size, age distribution of the household, monthly income, monthly natural gas and electricity payments. These variables are utilised in fuel poverty calculations. Some additional variables in terms of the socio-economic characteristics of the household such as total employed individuals in the household, home ownership, receiving social help, household head's education level, as well as the energy-related and structural characteristics of their houses such as insulation, aspect and size of the house, and total heating months are included in the questions to understand the factors affecting fuel poverty. Descriptive statistics for the variables are presented in Table 1.

Table 1. Descriptive Statistics for the Household Survey

	N	Minimum	Maximum	Mean	Std. Dev.
Ownership (1 owner, 0 renter)	400	1	0	1.34	.473
Rent (TL/month)	400	0	5000	847.20	1413.36
Mortgage (TL/month)	400	0	2550	688.22	891.32
Household size (# person)	400	1	6	2.95	.99
Employed household (# household)	400	0	3	.96	.79
Income (TL/month)	400	3000	50000	17122.50	9209.11
Heating system (1:central, 2: individual)	400	0	1	1.10	.30

Insulation (1:yes, 2:no)	400	1	2	1.02	.14
Heating duration (# months)	400	3	7	5.69	.84
Social Help (1:yes, 2: no)	400	1	2	1.97	.17
Natural gas expenses (TL/month)	400	350	13000	1306.87	1799.44
Electricity expenses (TL/month)	400	100	4000	439.65	592.20
Aspect (1: North, 0: all others)	400	.00	1.00	.2975	.45773
Children under 5 (1:yes, 0: no)	400	.00	1.00	.2129	.40984
Size (1:Less than 80m ² , 2: 80-100m ² , 3: 100-120m ² , 4:120-150 m ² , 5: 150m ² and more)	400	1	5	2.94	1.56
Household head education (1:primary, 2:secondary, 3:high, 4:university, 5: graduate)	400	1	5	3.36	1.18

6. Method

This study covers a mixed method framework. First, fuel poverty level in the urban regeneration areas is calculated, then, a logistic regression is run to reveal the variables contributing to fuel poverty.

6.1. Fuel Poverty Assessment with LIHC Criterion

Fuel poverty does not have an agreed upon definition since some studies consider only the heating costs while particularly the most recent ones include energy costs of household appliances. The size and the scale of the issue varies with the definition (Moore, 2012), thus, assessment methods of fuel poverty have evolved over time with changing definitions and different perspectives. UK is at the forefront of research into fuel poverty, leading both in the study of its implications and in the development of methods to assess it. In the early 1990s, evaluation criteria started to be developed and included it in the policy documents in UK.

Isherwood and Hancock mentioned that the household with fuel expenses more than 2 median of the national average are in poverty (Osbaldeston and Liddel et al., 1984), while the term fuel poverty was not mentioned explicitly (Heindl and Schüssler, 2015). Brenda Boardman (1990) defined fuel poverty first, stating that household allocating more than 10% of their income to fuel expenses are considered as fuel poor, and the criterion was included in the official documents. Hills (2012) developed another criterion in fuel poverty assessment considering not only fuel expenditures but also household income with regard to national averages. The criterion, named as Low Income High Cost (LIHC) was published in the Fuel Poverty Methodology Handbook (FPMH) in April 2020 (BEIS, 2020). The most recent criterion, Low Income Low Energy Efficiency (LILEE) considers energy efficiency besides fuel expenses of the households, and was published in FPMH in 2022.

This study adopts LIHC criterion, and fuel poverty level is calculated accordingly. The assessment has two parts: income and fuel cost, while equivalent values of both with regard to household size are considered since different households have different spending requirements (BEIS, 2020). The equivalisation factors are taken from FPMH (Table 2)

Table 2. Equalisation factors for the fuel cost and income (BEIS, 2020)

Household	Equalisation Factor
	<i>Fuel Cost</i>
1 individual	0.82
2 individuals	1
3 individuals	1.07
4 individuals	1.21
5+ individuals	1.32
	<i>After Housing Cost Income</i>
First adult	0.58
Other individuals aged 14 and over	0.42
Individuals under 14	0.20

Income is the amount after mortgage and rent payments, and fuel costs include natural gas and electricity payments. Household net income and fuel cost are compared to corresponding threshold values, and the ones with lower income than the income threshold and higher fuel expenses than the fuel threshold are accepted as fuel poor.

6.2. Logistic Regression

After identifying fuel poor households, a logistic regression analysis is conducted to reveal factors influencing fuel poverty. Logistic regression is a statistical method used to model the probability of a binary dependent variable with one or more independent variables. The model estimates the coefficients, which represent the change in log-odds of the dependent variable with a unit change in the independent variable. In this study, output is a binary categorical variable (1: fuel poor, 0: not fuel poor). SPSS software is utilised for the binary logistic regression analysis.

7. Results

The results of the fuel poverty analysis with LIHC and the interview are presented in the following parts. First, the calculation of income and fuel cost thresholds for LIHC analysis is given, followed by the analysis of fuel poverty levels. Then, the findings of the content analysis are discussed.

7.1. Fuel Poverty

The fuel poverty level of the urban regeneration areas is calculated according to LIHC criterion. First, net incomes are calculated through subtracting the rent and mortgage payments from the monthly income. The fuel costs are the sum of average monthly natural gas and electricity bills. After the calculation of equalised income and fuel cost, the values are compared to income and fuel cost thresholds. In the FPMH, the threshold values are the national median levels for both values. In terms of income, national median can be a reasonable threshold, however since the climate variations are high in Türkiye, median fuel cost of the whole country can be misleading. Moreover, natural gas unit prices and electricity distribution costs vary in different cities. Dubois (2020) discusses this issue as some local specificities might be existent while national level research may miss them, so that energy poverty analysis at regional level is suggested. Therefore, a benchmark value is calculated for Ankara, considering the average electricity and natural gas

consumption for a household with 4 people. Then, the value is equalised for a household with 2 people since the equalisation factors in Table 1 consider 2 people as the base value.

Income threshold is assumed to be the national median income level. Annual equalised median household income is 83808 Turkish Liras (TL) for 2023 (Turkish Statistical Institute, 2024), which corresponds to 6984TL monthly, which sets the Low Income (LI) benchmark. Household with monthly income less than 6984TL is considered as LI.

A fuel cost threshold which is accountable for Ankara is calculated through average natural gas and electricity bills with the following method. Average monthly electricity consumption is 230kWh for a 4-person household (Chamber of Electricity Engineers, 2021), while the unit electricity price for residential is 1.73 in the first quarter of 2023 (Rep. of Türkiye Energy Market Regulatory Authority, 2023). The monthly average electricity cost turns out to be 449.6TL including taxes 4-person household. Daily average natural gas consumption is 4.83m³, which is equal to 145m³ monthly, while the natural gas unit price is 5.06TL in 2022-2023 winter season in Ankara (BaskentGaz, 2024). Average natural gas cost turns out to be 859.7TL including taxes. Total average monthly fuel cost is, then, 1315.3TL. When the value is converted to a 2-person household, the benchmark value for high cost (HC) becomes 1229.3TL. Households spending more than 1229.3TL for energy bills are accepted HC. The households below LI threshold and above HC threshold constitute 11.7% of the entire sample according to LIHC criterion.

7.2. Logistic Regression

When the factors affecting fuel poverty are investigated, the binary logistic regression shows that the odds of being fuel power is decreased by being an owner, having children under age 5, and the number of households being employed, whereas increased by the household size, having individual heating system instead of central heating, and number of months required heating, having north-faced apartment, and very large houses (more than 150m²) (Table 3). Other variables such as household head's education level, insulation and social help do not have statistically significant effects. In fact, 97.8% of the houses have insulation, which minimizes its distinguishing effect.

Table 3. Results of the binary logistic regression

	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI. for EXP(B)	
							Lower	Upper
Ownership	-1.527	.547	7.785	1	.005	.217	.074	.635
Household size	.893	.211	17.858	1	<.001	2.442	1.614	3.696
Employed household	-1.969	.357	30.432	1	<.001	.140	.069	.281
Heating duration	1.066	.321	11.057	1	<.001	2.904	1.549	5.444
North Aspect	1.081	.444	5.942	1	.015	2.949	1.236	7.036
Very Large Size	1.277	.470	7.380	1	.007	3.584	1.427	9.004
Children under 5	-1.975	.618	10.210	1	.001	.139	.041	.466
Heating system	2.905	.696	17.426	1	<.001	18.260	4.669	71.416
Constant	-11.27	2.423	21.654	1	<.001	.000		

The logistic regression model was statistically significant $X^2(8, N=400)=79.624, p= <.001$, and the model explained 35% (Nagelkerke R^2) of the variance in fuel poverty and correctly classified 90% of observations.

8. Discussion

When the components of LIHC are investigated, it can be concluded that almost half of the households are low-income groups. It is reasonable that the area just went through a structural transformation that the residents' economic circumstances have not changed much. Households classified as HC, representing 21.2% of the entire sample, indicate that the fuel costs of nearly one in five households exceed average spending on energy in Ankara. Fuel poverty, which presents 11.7% of the households, is observed in lower levels than LI and HC groups, which can be concluded that either the ones with higher incomes are able to spend more for energy so that they turn out to be HC but not LI, or the household with LI could not spend more than average values for energy so that they are LI but not HC. The second group can be further investigated in terms of hidden fuel poverty. When the result is compared to the literature, it is evident that the fuel poverty levels in urban regeneration areas tend to be lower in general. When considering the studies conducted in Türkiye, this research indicates a fuel poverty level that falls between the rates reported by Dogan et al. (2021) at 7% for the national level and Senyel Kurkcuoglu (2023) at 23.6% exclusively for the city of Ankara.

Home ownership, household size, employed households, heating months, north-facing apartments, very large houses, young children and house heating system turns out to be influential on fuel poverty. Home owners tend to be less prone to fuel poverty when compared to renters. When the number of employed individuals increase it becomes less likely to be fuel poor. Having at least a child under 5 years old also decreases the chances of being fuel poor, of which impact is the slightest among all variables. When at least one young child is present in the household, the family is 0.139 times less likely to be fuel poor. Increasing size of household affects fuel poverty in a positive way, so that large households are more likely to be fuel poor. When the number of months increase for heating, fuel poverty risk increases as well. Indeed, some apartments may need to heat their homes for longer durations due to the lighting conditions as a result of housing design, having a vacant flat upstairs or downstairs, having individuals with critical health issues, etc. North-faced apartments receive less sunlight during winter, leading to higher energy consumption. As a result, their chance of being fuel poor increases 2.94 times compared to apartments facing other directions. Additionally, heating very large spaces is costly. Therefore, houses exceeding 150m² increase the probability of experiencing fuel poverty by 3.58 times more than smaller houses. The most influential variable appears to be the house heating system while households with individual house heating are 18.2 times more likely to be fuel poor than the ones with central heating. It is plausible because central heating systems typically heat all spaces and rooms equally. In contrast, individual heating systems allow occupants to turn off heating in certain rooms, which can result in increased energy usage in other apartments and cooler overall building spaces.

9. Conclusion

Urban regeneration activities in Türkiye, particularly the ones targeting transformation of squatter settlements, are anticipated to improve living conditions by enhancing structural quality, efficiency, and environmental standards. Although the various aspects of urban regeneration have been discussed in the literature, environmental outcomes, particularly those related to energy, have been overlooked in the literature. The discussions in the existing literature revolve around the positive impacts of the providing large green spaces, while criticisms focus on the lack of adoption of

renewables in any urban regeneration projects. Fuel poverty, however, has not been addressed in the studies.

Fuel poverty is a multi-dimensional issue that arises from both the socio-economic situation of the household and the structural conditions of the housing units. The problem has a spatial dimension, leading to its prevalence in specific areas. Squatter settlements are those which has an increased risk of fuel poverty due to having low-income residents and low structural qualities. Urban regeneration is expected to eliminate fuel poverty in such areas by improving building quality and infrastructure. Therefore, this study focused on assessment of fuel poverty in urban regeneration areas, using Ankara's Mamak district. Due to its history of high rates of squatter settlements, Mamak has been subject to numerous urban regeneration projects. A household survey conducted in four different urban regeneration project areas in Mamak revealed that nearly one in every ten households experiences fuel poverty. The observed rate is lower than figures reported in the literature, but it cannot be argued that fuel poverty is fully eliminated after urban regeneration.

The analysis of the factors influencing fuel poverty provides valuable insights for future policies in urban regeneration. Structural and design strategies can be implemented to address the issues such as very large houses, north-facing apartments, longer heating months and individual heating systems, which are associated with increased probabilities of experiencing fuel poverty. The remaining variables are primarily associated with the broader socio-economic context, necessitating comprehensive policies and strategies beyond the scope of urban regeneration. For instance, state-level policies could be developed to provide mortgages with long-term low-interest rates, thereby facilitating home ownership and potentially reduce fuel poverty. Finally, further analysis can be conducted to determine the presence of hidden fuel poverty, where households struggle to allocate sufficient funds for energy expenses, leading to inadequate heating and limited use of other appliances.

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