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Energy Poverty in Japan: Current Trends and Future Challenges

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Abstract

Despite being one of the world's largest economies, Japan is still behind other European countries on energy poverty recognition. There are several scholars who have been investigating the issues of energy poverty in Japan, but those results have not been considered seriously by the public yet, leading energy poverty to not be recognized as a social issue. This chapter, through a literature review, aims to delve into some peculiarities of the Japanese context in order to provide a better understanding of how energy poverty should be measured, assessed, and conceptualized in this country. Fot this purpose, this chapter aims at providing a comprehensive overview of the main challenges faced currently by the country, how they could be addressed by public policy, and how the near future might unfold. Results show that greater efforts are needed to move forward in the definition, measurement, and mitigation of energy poverty. Furthermore, aging population, rural and urban gap, lack of affordable and sustainable energy resources, and poor energy-efficiency of existing housing stock have been highlighted as the main challenges that Japan will face in the near future.

Introduction

Japan, in spite of being one of the world's largest economies, still lags behind other developed nations in terms of the conceptualization of energy poverty as a societal problem. The country has a long tradition of measuring the income and expenditure of households nationwide through the National Survey of Family Income and Expenditure (now, the National Survey of Family Income, Consumption and Wealth) and the Family Income and Expenditure Survey [1], an accurate portrait of the financial situation of the Japanese population, which also consider the expenditure on energy services. Accordingly, research investigating the factors associated with energy poverty has mainly focused on econometric approaches, framing the problem as an imbalance between income and expenditure.

However, during the past decade, newly emerging research has started to shed light on the underlying factors behind energy poverty, placing the accent on issues such as the role of the energy market, the availability of energy services, the gap between urban and rural areas, and the aging of the building stock. Such seminal research has paved the way for the conceptualization of energy poverty as a multifaceted problem, which goes far beyond a simple problem on households' monetary situation.

In spite of more than two decades after the publication of Boardman's seminal work on energy or fuel poverty [2], and one after the follow-up book in 2010 [3], a clear reference to energy poverty could not be found in Japan until 2016, when the

first research paper making an explicit mention to this term within the Japanese context was published [4]. This research analyzed energy poverty using the microdata on household income and expenditure from more than 50.000 households and, with the 10% indicator, concluded that the percentage of energy-poor families raised from 4.7% in 2004 to 8.4% in 2013. A smaller scale study, based on its own surveys and conducted in 2018 in Hokkaido (the coldest region of Japan), revealed that energy poverty was an acute problem in several municipalities, affecting 12-32% of the families [5]. Since then, studies have striven to clarify different aspects pertaining to energy poverty. Some studies focused on the specific context of the cold region of Hokkaido [6][7], where energy demand is clearly dominated by the heating expenditure; some bridged between the energy poverty analysis and the multidimensional poverty approach [8][9]; others started to shed light on the relationship of energy poverty with inclusive low-carbon transition [10][11].

As the most comprehensive study until now, Castaño-Rosa & Okushima [12] carried out an extensive analysis of energy poverty vulnerabilities in Japan, highlighting location, infrastructure and household characteristics as the main drivers of energy poverty in Japan. This study also assessed energy poverty prevalence in both summer and winter. The results show a high prevalence of energy poverty in northern regions during winter and southernmost regions during summer. As a novel aspect, the influence of new technologies on Japanese energy poverty has also been investigated through various case studies, showing elderly population as those most vulnerable groups to suffer from energy poverty at present time, and also in the future.

While progress has been seen during the last decade, it is evident that there is a relatively small body of literature that is concerned with the energy poverty in Japan. What is more, the research landscape seems to be fragmented, particularly the networking of researchers due to the lack of a common understanding of the concept of energy poverty, as well as an official definition of energy poverty: At present time, this problem has no political or societal recognition in Japan. Too much of the debate has been about the rise in the energy price and the decline of household income in the context of its stagnated economy, overlooking other facets of this problem, such as the effects on physical and mental health, the new ways of living in relation with the definition of "household", or the renovation of the extant housing stock.

This chapter aims to unravel some of the specificities of the Japanese context, which are deemed necessary to understand how energy poverty should be measured, assessed, and conceptualized. Particularly, this work focuses on the main challenges that this country faces at present time, how public policy could address them, and how the near future might unfold.

Current issues in the Japanese context

In order to understand the landscape of energy poverty in Japan, it is deemed necessary to consider several key issues that the country has been confronting during the last decades. They are mainly related to the costs and availability of different energy resources, the dichotomy between urban and rural Japan, aging population, and how public authorities are tackling this situation.

Japan is a country that heavily depends on imported energy. The Agency for Natural Resources and Energy Japan annually publishes a report entitled "Japan's Energy", which provides a detailed analysis on the current situation of the country [13]. The latest edition shows that the country's self-sufficiency ratio in terms of energy production was only 11.8% in 2018. It heavily relies on fossil fuels (Coal, Oil and LNG) which are imported mainly from the Middle East and Australia. Consequently, domestic energy prices in Japan remarkably depend on the international context. As an example, the report outlines that the average electric power rate for domestic use has increased from 20.4 yen/kWh in 2010 to 25.5 yen/kWh in 2014, representing an increase of around 25%. The study by Okushima [4] came to similar conclusions using a composite index that considers domestic energy prices for electricity, gas, and other fuels; the price index for energy increased from 100 in 2010 to 124 in 2014 (an increase of approximately 24%). This increase may be explained by a variety of factors, but in this case the Great East Japan Earthquake played a decisive role, halting Japanese nuclear plants, whose contribution to the national energy mix plummeted from 24.6% in 2010 to a mere 0.9% in 2015 [14]. On the contrary, during this period, household income has been stagnated. If compared with the base index of 100 in 2010, household income in 2015 was virtually the same [4]. Together, this data indicates that from an affordability perspective, energy expenditure has been gradually becoming a greater burden for Japanese families in that period.

Another key issue is the gap between urban and rural Japan, which, in the context of energy poverty, can be explained in terms of availability of energy sources, housing typologies and demographic profiles. On average, Japanese households use approximately the same amount of electricity and gas, and kerosene to a much lesser extent (seen in GJ) [9]. Electricity is widely available across the country, but city gas supply is limited to the major urban conurbations and mid-size cities. Rural locations must resort to bottled gas, namely LPG or propane. Besides, kerosene is still widely used in cold regions of Japan, such as Hokkaido, Tohoku, and Hokuriku, for heating purposes [9][12].

Speaking about housing typologies, the Housing and Land Survey provides a detailed record of the housing stock nationwide every five years; the latest estion is the year of 2018 [15]. The immense majority of the housing stock corresponds to two typologies, detached houses and apartments, which account for approximately 97% of the total (Table 1). Another surprising aspect is the construction material; 92.7% of detached houses are made of timber, 70% of the apartment houses are made of reinforced concrete, 16% of steel, and 12% of timber. Moreover, around

one third of extant houses were built before 1980, when the first energy conservation standard for residential buildings was enacted, with successive amendments in 1992, 1999 and 2013. Previous studies, such as the one conducted by Iwamura et al. [18], have raised the issue of the aging residential st ock with poor energy performance which, in turn, represents an economic burden for their residents.

	Detached houses	Apartments	Other	Total
Not reported	3.64%	4.55%	0.59%	8.78%
Before 1950	2.37%	0.07%	0.09%	2.53%
1950-1970	4.44%	1.28%	0.27%	5.98%
1971-1980	8.91%	4.57%	0.41%	13.89%
1981-1990	9.08%	7.62%	0.32%	17.01%
1991-1995	4.82%	4.74%	0.16%	9.71%
1996-2000	5.14%	5.10%	0.16%	10.40%
2001-2005	4.43%	4.67%	0.17%	9.27%
2006-2010	4.32%	4.95%	0.22%	9.49%
2011-2015	4.45%	4.06%	0.28%	8.80%
2016-2018(*)	2.05%	1.94%	0.15%	4.13%
Total	53.64%	43.56%	2.81%	

Table 1. Housing typologies classified by the year of construction. Source: Own elaboration using data from the Housing and land survey 2018 [15].. (*) Data until September 2018.

Another essential factor is the particular demographic structure. Japan has one of the longest life expectancies in the world, 84,3 years in 2019, and its population has slowly started to decline from its peak in 2010 (128.057.352 people) [19], losing around 2.7 million inhabitants in 10 years; as per the latest data from December 2020, the Japanese population is 125.360.000 [20]. However, there is an imbalance between rural prefectures, which continue losing population, and the major urban areas, whose population is stable or even has a slight increase due to population inflow. The latest population census in 2015 indicated that although 23 out of 47 Japanese prefectures lost population from 2010 to 2015, the greater Tokyo area had increased its population. In Japan, one third of the households are single-person households, and this percentage is much higher in urban areas, such as Tokyo (47.3%). Moreover, in Japan, there are 838.000 single-parent households, with an average of 2.5 members per family; the great majority of them are led by mothers (754.000).

Overall, this indicates the dichotomy between rural and urban Japan, and how the prevalence of one-person, single-parent, and senior households represents a challenge in coining a new definition to identify what "vulnerable households" is. This concept has been widely discussed by seminal authors like Boardman, as per the definition by the English Department of Trade and Industry, vulnerable groups are "*Older householders, families with children and householders who are disabled, or suffering from a long-term illness*" [3, p. 24]. In the case of Japan, it

seems evident that single-elderly households, i.e., the combination between one-person and elderly, represent a remarkable percentage of the Japanese population. The aging trend become more eminent in the future and being an essential condition for considering future energy poverty in Japan [8] [21].

Public policy oriented towards energy poverty.

Adopting an official definition of energy poverty has a pivotal role in recognizing the problem, making it visible, and finally, in adopting the necessary measures to counteract it. From the seminal definition of Boardman in 1991, the UK has been leading the way in conceptualizing energy or fuel poverty beyond the econometric approach as well as in devising a systematic approach towards policymaking. This discussion permeated the EU, where the debate moved onto a complex conceptualization, surpassing the 10% indicator. At the present time, the EU Energy Poverty Observatory centralizes the knowledge on this issue [22]. There is still an on-going heated debate about what energy poverty is, what causes it, and how it can be measured, however, this portal provides some interesting hints. First, energy poverty can be measured using various indicators: Energy costs and income, self-assessment, direct measurement, and proxy indicators. Second, the main drivers of energy poverty may be: socio-economic characteristics, housing situation, energy carrier, and location. Third, policies to tackle energy poverty can be oriented towards: financial improvement in the energy use situation, energy audits, financial assistance, protection against disconnection, information and awareness, and social support.

The current state of affairs suggests that Japan is lagging behind other developed countries in recognizing energy poverty as a social problem in the same way as other geographical contexts do, such as the EU. There are several possible causes for this, but a likely explanation is the fragmentation of government policies and the lack of social awareness.

At first, it is notable that the country does not have an official indicator for measuring energy poverty, although it has a long tradition of surveying household income and expenditure in a systematic way. The Statistics Bureau of Japan has periodically been conducting different surveys to assess the state of the economy of Japanese households. The National survey of Family Income and Expenditure (now the National Survey of Family Income, Consumption and Wealth) are published every five years, and so far, five open datasets are available online (1994, 1999, 2004, 2009, 2014, 2019) [1], which provide a detailed breakdown for all categories of family expenditures, including specific items directly related to energy poverty: expenditures for electricity, gas, and other fuels and light. This data is presented for different types of households, classified by their level of income, number of residents, including elderly members, place of residence, type of dwelling. etc. The Family Income and Expenditure Survey, which is conducted on a monthly basis, also aims at offering a snapshot of the income and expenses of

Japanese families [1]. Despite this vast amount of data being available, it has not been used by official bodies to estimate the prevalence of energy poverty. As mentioned before, Okushima used anonymized microdata from such household surveys to estimate the percentage of Japanese families affected by energy poverty [4][8][12], but only academic studies assessed the energy poverty situation in Japan. Turning now to alternative indicators, there is no official indicators or surveys considering self-assessment by dwellers or direct measurement conducted on-site to estimate energy poverty. Several authors have marginally dealt with the issue of thermal comfort inside Japanese homes, focusing on the behavior of residents and their assessment of comfortable temperatures [23][24], but these studies do not establish a direct relation with energy poverty.

Another much debated question pertains to the main drivers of energy poverty; and again, Japan presents a landscape comprising plenty of data but lacking official policies. Household surveys, such as the National survey of Family Income and Expenditure, provide a breakdown of expenditure by prefecture and income level, among others, which could be used as a proxy to characterize those drivers of energy poverty. Besides, the aforementioned studies offered an insight of the energy use by source in different Japanese regions [9] [12]. It seems evident that further research is still needed to clarify how the availability of energy sources, such as city gas and solar, and the location of the house, all together, may be drivers of energy poverty in the different regions of Japan.

Finally, owing to the fragmentation of information, and the lack of a comprehensive approach, Japanese government has not yet addressed energy poverty as a political or societal issue. The available information suggests that the government could first approach it as an economic problem, as many other countries have done before, because plenty of official data is available, yet to be analyzed in detail. Afterwards, policies might move towards a more complex conceptualization that also considers other theoretical underpinnings of energy poverty. Nevertheless, at the present time, there is virtually no information available about energy poverty in Japan, apart from the studies hereby mentioned.

What lies ahead for Japan

In terms of energy poverty phenomenon, Japan faces similar problems as many other developed countries, but also has peculiarities which make the study of this context remarkably challenging. In this concluding section, some hints that may help in understanding how the future might unfold are presented.

Japan is a signatory of the Paris Agreement, and therefore has committed to achieving carbon neutrality by 2050, building sectors being also included in this objective [25]. One of the measures adopted by the government is the statistical survey on household carbon dioxide emissions, which has been conducted by the Ministry of the Environment since 2017 on an annual basis [26]. According to the latest report released for the fiscal year of 2019, the CO_2 emissions per household

decreased by 15% when compared with 2017; almost 75% of those were related to electricity, and the remaining 25% corresponded to different types of energy (kerosene, city gas and LPG). Although this is a promising trend, it is also noteworthy that electricity prices have risen in the recent years, and that the country is still highly dependent on imported fossil fuels. These findings suggest that despite the reduction in household energy consumption and, therefore, CO_2 emissions, their energy is becoming expensive due to the dependence on imported fossil fuels. Fluctuations in energy prices seem to be one of the main drivers of energy poverty in Japan, mainly affecting vulnerable households, who, even though not being energy poor, are at risk from becoming so in the future. Policies are needed to reduce the dependency on imported energy sources, e.g. through promoting renewable energy, while keeping domestic energy prices as stable as possible, especially for vulnerable households.

In this context, climate change should not be disregarded as another contributing factor. There is still no clear consensus on which strategy could better tackle its effects. The latest report from the International Panel on Climate Change (IPCC) suggests that improving the efficiency of houses in terms of insulation and airtightness could bring energy savings up to 90% for heating, and 67% for cooling, and that a change in user's behavior could reduce these figures between 10-30%, and 50-67%, respectively [27]. Nevertheless, these figures are highly dependent on the climatic condition and socioeconomic context of each country. In terms of climate, Japan has a stark contrast between northern regions, where heating is predominant, and southern regions, where hot and humid summers imply a significant cooling demand. So far, policies in Japan have mainly focused on improving energy efficiency of building stock. Two initiatives, the BELS (Building-Housing Energy-efficiency Labeling System) [28] and CASBEE (Comprehensive Building Assessment for Built Environment Efficiency) [29] systems, have been recently implemented. BELS was launched in 2014 with the aim of introducing a system for labeling buildings according to their energy efficiency, making a distinction between 5 categories: ZEH (Zero Energy House), Nearly ZEH, ZEH ready, ZEH oriented, and ZEH equivalent. Regarding CASBEE, different versions have been released from 2015, targeting a variety of building typologies, as well as urban development projects. It started to be gradually implemented in different Japanese prefectures from 2005 onwards, and its main aim was to implement a system through which the environmental impact of a building could be assessed by balancing its "environmental load" as a negative input, and its "environmental quality" as a positive output . Both systems were developed by independent organizations with the support from the Japanese government, but there is not yet a legal basis to make them mandatory. As a result, their implementation has proved rather unsuccessful: Only 146.099 dwellings obtained a BELS label as per data from April 2021 [30]; by 2018, only 21.241 buildings obtained a CASBEE certification [31].

Regarding the role of user's behavior, a recent study by Rijal et al. [32], which specifically focused on Japan, investigated the relation between window opening and indoor temperatures in dwellings. This type of study stresses the importance

of adaptive measures, namely opening windows to allow for natural ventilation, changing clothes, and modifying the metabolic activity of occupants, to achieve comfort without resorting to air conditioning systems. However, climate change could seriously affect these behavioral patterns, affecting northern and southern Japan differently [33].

Therefore, a reasonable approach to decrease the energy consumption of houses could be to strengthen the implementation of new standards for the construction of Japanese dwellings and, at the same time, raise awareness of the importance of the user's role in achieving a low energy consumption without relinquishing acceptable levels of comfort. The key issue here, as pointed out by international organizations, is to make building industry and population resilient against climate change and to cut the dependency on artificial air-conditioning systems.

Finally, the future prospects of Japanese population in relation to the trends in the housing market also deserve further attention. Regarding the present situation, the latest data shows a prevalence of single-person households in urban areas, in contrast with rural Japan [34]. It is also worth noting that in Japan, a high percentage of families live in the houses that do not meet the "housing area standard". This standard, regarding the minimum usable area available per person, has been set by the Japanese government as a target to be met [35]. The basic unit for a person living alone should be 40 m^2 in urban areas and 55 m^2 in rural areas; the, in urban areas, 15 m2 should be added for the second dweller (55 m2 in total), and 20 m2 for each additional resident (75 m2 for a 3 people household, 95 m2 for a 4 people household, and so on). In the countryside, an additional 25 m2 is deemed necessary for the second dweller, and each additional member needs 25 m2 of additional surface. Minors are applied a reduction factor: 0.25 to children under the age of 3, 0.5 to children under the age of 6, and 0.75 if they are younger than 10 years old (Table 2). It is also remarkable that 24% of households in Japan are people over 65 years old; moreover, around half of them are living alone.

	Urban areas		Rural areas	
	Households exceeding housing standard	Household under housing standard	Households exceeding housing standard	Household under housing standard
1 person	9,580	12,764	21,079	8,443
2 people	5,002	6,558	5,056	880
3 people	3,059	2,378	8,145	1,562
4 people	1,103	1,909	4,244	1,921
5 people	366	1,508	2,386	2,440
6 or more people	45	357	814	1,091

Table 2. Number of households living under the housing standard for urban and rural areas by household member (Unit: 10,000). Source: Japan Statistical Yearbook (2021) [29].

Urban areas	Rural areas

	Households exceeding housing standard	Household under housing standard	Households exceeding housing standard	Household under housing standard
Households of aged persons.	2,413	1,460	7,789	1,173
One-person household of a person aged 65 or older.	1,469	996	3,409	487
Households either or both of a couple are age 65 or older	945	464	4,380	686

According to the projections from the National Institute of Population and Social Security Research in Japan, the demographic situation will worsen in the future [36]. The country will lose between one fourth and one third of its population, and elderly population (65 and over) will represent around 40% of the total.

Consequently, the profile of vulnerable households in terms of energy poverty might likely change in the future, and this could manifest in three areas. First, the change in the demographic structure, specifically single-person households, specifically those over 65 years old living alone. Second, the gap between urban and rural Japan might also become wider, hence the need for a distinctive approach, based on identifying the availability of energy sources and their affordability on a regional basis, rather than on nationwide scale. Third, an aging residential building stock with poor energy efficiency in a context of declining population and economic turndown, leading to an increase in the number of abandoned houses, especially in rural areas. If the country aims at tackling energy poverty as a societal issue, we consider that at least this triad should be considered.

This chapter has presented some of the distinctive issues to be considered in relation to energy poverty phenomenon in Japan. The country has done a remarkable effort in compiling data about household income and expenditure, as well as the demographic profile of households, but still lags behind other advanced economies in conceptualizing energy poverty as a social issue. Although a group of scholars are starting to raise awareness on this problem by surpassing the traditional approach to energy poverty based on an imbalance between income and expenditure, the research landscape is still fragmented, thus, there is not yet a strong theoretical and empirical bases to support public policies.

As a conclusion, greater efforts are needed to advance in a conceptualization of energy poverty, specifically tailored to the Japanese context, which should encompass challenges such as the aging population, the gap between urban and rural contexts, the securement of affordable and sustainable energy resources, and the implementation of policies towards enhancing energy efficiency of new, but specially existing houses.

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