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Research Article

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Evaluating the Impact of Modern Energy Access on the Social-Economic Situation of Households in Turkey

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Abstract
This study investigated the correlation between access to modern energy systems and the socioeconomic condition of families in Turkey. For this purpose, a survey was prepared for the urban residents. Based on statistical calculations, the sample size found to be 214 households with an acceptable error rate of 6.7% and a confidence level of 95%. The survey asked questions such as education level, income level, monthly consumed electrical energy, and natural gas consumption of the people living in the household. The results show that the level of access to modern energy systems varies according to the income levels and education levels of the households living in urban areas. It was observed that in the city center, where access to electricity is not lacking, the inadequacy of households' access to electricity was only due to income differences. In addition, a direct correlation revealed that fossil fuels and their derivatives are consumed more by low-income and low-education households.

Keywords: Energy Access, Turkey, Electricity, Socio-Economic Situation

Introduction
There have been various attempts to define energy access in so far. Many people struggle with accessing 'modern' or 'traditional' energy sources. Coal, kerosene, LPG, and biofuels, as well as electricity, are more efficient and reliable than traditional biomass fuels, but grid electricity and natural gas are often considered modern. At the on the basis of its access strategy, it assumes that with modern fuels comes a higher quality of service with fewer negative consequences. However, the emphasis on access alone is considered to be overly simplistic. As an alternative strategy researcher has been to focus on the total amount of energy families can consume regularly, and have sought to determine acceptable minimum levels at which actual consumption can be assessed based on a range of products and services [1-5].

Another modern energy access strategy is often related to freedom of choice. In contrast, lack of access is frequently connected with deprivation, or, in other words, a restriction on people's choices due to their inability to access particular commodities, services, assets, capacities, freedoms, and opportunities [5, 6]. Physical availability, acceptability, adequacy, affordability, dependability, and supply quality have all been used to describe access. Aside from these dimensions, there is also interest in evaluating the development implications of contemporary energy carriers and technologies on human welfare and health, efficiency and productivity, as well as environmental impacts. Access to modern energy is also the most significant factor in a country's growth [2-7].

In addition, lack of access to modern energy sources and services highlights inequalities, affects well-being, harms health and hinders the development of billions of people.The time women and young children devote to obtaining traditional fuels limits educational and economic opportunities [8].Without electricity, households have inadequate lighting, communication and entertainment services, and communities have limited access to basic services such as healthcare and public lighting Finally, the burning of biomass fuels in conventional stoves produces aerosols such as greenhouse gases and black carbon [9]. Extensive use of biomass can also cause forest, land and soil degradation leading to net CO_2 emissions.

Access to modern energy is also an important aspect of a country's development.There is a strong correlation between energy availability and socioeconomic growth [10]. Without energy, no activity such as industrialization, social life, transportation, or communication can take place. Also, when access to modern energy is insufficient, households cannot cook, heating, benefit from cultural activities, and receive a quality education [10, 11]. Fossil fuels used in rural areas, for example, which do not have access to modern energy systems, threaten human health, education, and productivity and also cause environmental pollution with the particles they emit [8, 10]. Therefore, access to modern energy is one of the requirements for millions of people to reach basic living standards.Sufficiency or adequacy is harder to define because this may vary tremendously from region to region depending on climate, customs, and living standards. However, ensuring adequate energy for a healthy life implies that the types and amounts of energy should meet basic minimum needs without adverse health impacts, where minimum needs might be defined locally and could include both consumptive and productive end-uses (see table 1). Adequacy can also be defined in terms of security and quality of supplies, that is, for energy to be available regularly, reliably, and be of a standard quality such that supplies are uninterrupted and unadulterated [12].

The ability of developing-country populations to profit from chances for economic growth and higher living standards is limited by the lack of access to modern energy services. Ironically, but crucially for future planning, the quantity of energy necessary to pull people out of poverty is quite low by developed-country standards [5]. While there may be some possibility for creating new and extending current electrical grid systems in developing nations, it is expected that access to electricity services will be given in the majority of situations by standalone systems based on renewable energy resources. Households lack the benefits of modern energy carriers owing to unavailability and inaccessibility, among other factors [13-15]. Lack of access to modern energy carriers prevents productive activities, limits employment prospects, and pushes people to rely on wood and biomass, which has negative consequences for human health and the environment. Households in rural locations are more likely to encounter access, cost, or supply issues than those in urban areas [3-10]. It creates social, economic, and environmental models to reach poor and isolated homes that lack access to electricity. In recent years, social, economic, and environmental models have been developed to reach poor households without access to energy, as well as those living in remote areas [5].

Table 1: Total Energy Access Minimum Standards Proposed by Practical Action

Energy system	Minimum Standards of Access
Lighting	300 lumens for a minimum of 4 h per night per household
Cooking and water heating	It takes less than 30 minutes per household per day to obtain 1 kg of wood fuel, 0.3 kg of charcoal, 0.04 kg of LPG, or 0.2 l of kerosene or ethanol per person per day. Minimum efficiency of improved solid fuel stoves to be 40% greater than a three-stone fire in terms of fuel use Annual mean concentrations of particulate matter (PM2.5) < 10 $\mu g/m^3$ in households, with interim goals of 15 $\mu g/m^3$, 25 $\mu g/m^3$ and 35 $\mu g/m^3$
Space heating	A minimum daytime indoor air temperature of 18 °C is required
Cooling	Households can extend the life of perishable products by a minimum of 50% over that allowed by ambient storage Maximum apparent indoor air temperature of 30 °C
Information and communications	People can communicate electronic information from within their household People can access electronic media relevant to their lives and livelihoods in their household
Source:[2]	

According to recent reports, approximately 1.6 million people worldwide still lack access to electricity [4, 5]. Two out of every three people in Sub-Saharan Africa, the IEA's 2014 priority region, do not have access to electricity. For those who do have access, power is frequently insufficient, unreliable, and among the most costly in the world. Furthermore, 2.7 billion people utilize conventional biomass for cooking, space and water heating, such as dung, wood, and other crops and crop leftovers [1, 4, 5]. Despite increased rhetoric about the need to enhance worldwide access to clean-burning fuels and electricity, the number of households relying on solid fuels is growing, and the number of new electrical connections in Sub-Saharan Africa and Asia is surpassing population growth [1, 3, 5, 16]. According to the same estimate, by 2040, almost one billion people will have access to power from renewable energy sources, while more than half a billion would still be without electricity. Few universal investigations of the advantages and investments for increasing household energy access have been conducted. with the majority of research being local, regional, or national in scale and focused on the technical and economic elements of expanding energy infrastructure and supply. Electrification choices for developing-country rural regions are more thoroughly evaluated, but there is no quantitative examination of options for triggering the shift to cleaner-burning cooking fuels or equipment [17]. Recent research has increasingly focused on multiple elements of poverty, such as the economics, education, and health, and access to modern energy, such as electricity and natural gas, is considered as a potential solution. Various existing ways of defining access are addressed in the following sections.

Kanagawa and Nakata purposed to reveal relations between access to electricity and advancement in a socio-economic condition in rural areas in India [17]. They studied unelectrified rural regions in Assam, India, as a case study. They created an energy-economic model to examine the prospect of electrification through the widespread distribution of electric lighting products. They determined, using multiple regression and model analysis, that increased access to electricity may raise Assam's literacy rate from 63.3 percent to 74.4 percent.

Balachandra et al. stated that in 2005 in India, only 364 million people out of the rural population of 809 million had access to electricity, and 726 million people were deprived of modern cooking fuels, and improvement work should be done in this regard [14]. According to the author, expanding energy access to India's rural population poses a critical challenge for its government. The existence of millions of people who do not have access to electricity and rely on fossil fuels for cooking demonstrates both the failure of past policies and programs and the need for a radical restructuring of the current system. Ultimately, they propose the establishment of rural energy access authorities and energy access funds at both national and regional levels, as well as support for regulatory policies, capital resources, and multi-stakeholder partnerships. Ultimately, they propose the establishment of rural energy access authorities and energy access funds at both national and regional levels, as well as support for regulatory policies, capital resources, and multi-stakeholder partnerships.

Mensah et al. briefly review different types of energy access indicators and analyze access to modern energy in Ghana [18]. The study concludes that Ghana has gained commendable access to modern energy services compared to other countries in sub-Saharan Africa. However, the authors recommend further efforts to reach the targets for access to electricity and 50% access to LPG by 2020 [11].

The study by Abdoulaye Fall et al. emphasized the importance of access to energy services for households and small businesses in the urban areas of Dakar, Senegal [19]. To investigate this issue, 280 households and 70 enterprises were surveyed in Dakar's regions around 7 cities. Also, recommendations have been made to develop policy options to overcome potential barriers to energy access in these areas. The results showed that there are many barriers to modern energy access in the urban environment of Dakar. These are the misunderstanding of the characteristics of the surrounding areas and the energy policy gap; land tenancy problems; the policy of prohibitive connection for households located away from the grid; and the gradual withdrawal of state subsidy for LPG for the poor around the city.

Bhattacharyya studies India's energy consumption by different expenditure groups in rural and urban regions individually and concludes that rural electrification alone is unlikely to solve the energy access problem [20]. According to the study, the consumption of firewood in urban areas has declined dramatically with increased wealth. Regardless of the degree of investment, firewood is employed in up to 90% of rural cooking in India (therefore income). It has been noted that higher-income classes are increasing their consumption of electricity and LPG. The paper also emphasized that the lack of access to renewable energy resources in urban and rural regions is related to poverty.

Day et al. assess the magnitude of energy poverty in India, impacting individuals in both rural and urban regions, in their study based on a statistical analysis of national survey data [21]. According to the author, the ultimate concerns of an individual or family are fundamental energy capacities such as sustaining health, avoiding early death, and engaging in social engagement. As a result, they highlight the need for economical and dependable energy services.

Much research has been conducted on the condition of energy consumption in rural and urban areas in developing countries. But, as shown in the above studies, access to modern energy services is still a problem with (access to grid electricity, and clean energy sources) today. In Asia, which is located in Turkey, it has been reported that 100 million people cannot be reached electricity that one of the modern energy systems in 2015 [1, 3, 16]. However, even though the data are in this direction, no detailed research has been conducted on access to modern energy systems in Turkey. There is a limited number of descriptive and experimental studies in the literature. In particular, few studies deal with the socio-economic impact of the results of the statistical analysis.For this reason, in this study, we researched the extent to which households living in urban areas had access to electricity and natural gas, depending on their education level and income situation. As a case study, in Yalova province in western Turkey, the socio-economic and cultural status of the households who can access clean energy services have been investigated. For this purpose, we conducted a survey covering Yalova central region in 2017.

Data used is based on national-level survey data of households and focuses in particular on income levels, which may not be the best indicator of the willingness and ability of users to use modern energy sources. The need for a detailed understanding of the situation of urban communities, in the context of energy access and in a way that can be utilized by researchers and policymakers, is clear. The survey used in this study provides a range of baseline socioeconomic and technical data relevant to those intending to study and improve the current energy access of rural communities in Turkey. It also relies heavily on understanding the timing and amount of electricity demand from the many renewable energy sources that can be used, particularly solar photovoltaics (PV) and wind power. The results of the survey are presented in the following sections. Unless otherwise stated, the mean presented for a given dataset is the mean value with standard error. First-hand data was collected to provide a better understanding of the situation.Yalova's urban census data were used where appropriate for fieldwork.This study includes two initial sections, one giving the background of the study and the region where it was conducted, and the universe size, and the other providing the respondents' information on the current access sizes of households to modern energy.The current access and use of modern and traditional energy sources are analyzed based on the resulting survey data.

Energy Access in Turkey

Natural Gas Access in Turkey

Natural gas, which is one of the modern energy sources, has a major effect on the growth of the economy, the increase in the welfare of the people, and the development of countries. In Turkey, natural gas was used for the first time in industry in 1976 [22]. Natural gas consumption, which started at 500 million cubic meters, reached 45 billion cubic meters in 2013. 26.1% of this is used for space heating [23]. A total of 1.203.155 new subscriptions were made by the distribution companies in 2011, and approximately 93% of these subscriptions consist of residences, 4% of business offices, 2% of official offices, and other subscriptions. As of the end of 2012, the total number of subscribers in provinces where natural gas service is provided has reached 9.171.624. Approximately 95% of this is residential and 5% non-residential (see Table 2). In 2015, there were 11.274.091 natural gas subscribers in Turkey [22]. With recent studies, access to gas has been supplied in their rural areas.

Yalova province began using natural gas for residential purposes in 2005. The distribution zones in Yalova have laid 653 km of natural gas lines so far. As a result of the completion of the lines in the distribution regions, it nowadays delivers natural gas to 130 thousand households. Table 2 gives the number of natural gas subscribers and their annual consumption in some provinces [22, 23].

Table 2: The Amount of Annual Natural Gas Consumption Per Household in Turkey

Years	Number of residential subscribers using natural gas (million)	Annual natural gas consumption (billionm^3)	Annual naturalgas consumed by the household (billion m^3)	Natural gas consumption per household (m^3)
2011	7.968.469	43	11.18	1403
2012	9.171.624	44.5	11.57	1261
2013	9.484.324	45	11.7	1233
2014	10.765.377	45.6	11.85	1100

Explanation: It is estimated that 26% of the total natural gas consumption is consumed by the residential sector [22].

Table 3: Number of Natural Gas Subscribers and Their Consumption in Some Provinces [23]

Province name	Number of subscribers	Consumption (m^3)
İstanbul	3.498.203	3.468.049.153
Ankara	1.458.975	1.494.330.548
Bursa	726.768	585.006.430
Kocaeli	379.926	321.584.999

Electricity Access in Turkey

In Turkey, electricity was produced for the first time from a hydroelectric power plant in 1902. In the following years, the installed power reached 33 MW, and the annual electricity production reached 45 million kWh. In 1935, the installed power increased to 126.2 MW, and electricity production reached 213 million kWh. In the same year, the number of provinces that can access electrical energy was 43. The national interconnected system was established in 1952 with the installation of a 154 kV energy transmission line. While 7% of the total rural areas were electrified in 1970, this rate reached 61% in 1982. In 2015, the installed capacity of the Republic of Turkey reached 69.681 MW [22-24]. Today, Turkey has access to electricity for almost the entire population. Figure 1 depicts the evolution of electricity consumption in relation to population growth between 1990 and 2015. With the advancement of electrification technologies, nearly all of the population now has access to electricity. Some rural communities, however, may have difficulty achieving universal electrification. Renewable energy sources and independent and mini-grid solutions, such as solar and wind, could help to solve this problem.

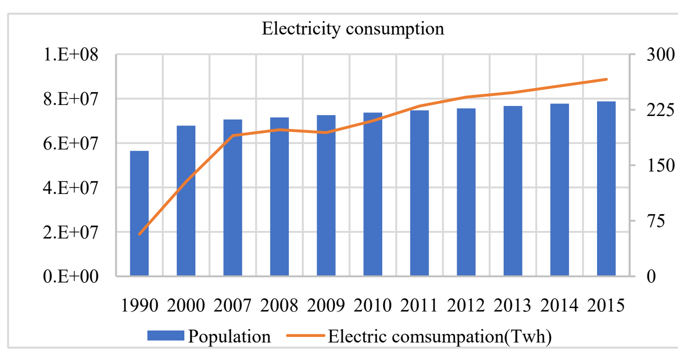


Figure 1: Electricity Access Trends in Turkey

Survey Area and Research Method

Determination of Access to Energy Systems of Households

Yalova is a province in western Turkey. According to the latest data, approximately 62 thousand of households lived in Yalova rural zone [25, 26]. Distribution of households in Yalova is as follows; 70.99% of them live in provincial and district centers and 29.01% in villages. Figure 2 shows survey area.

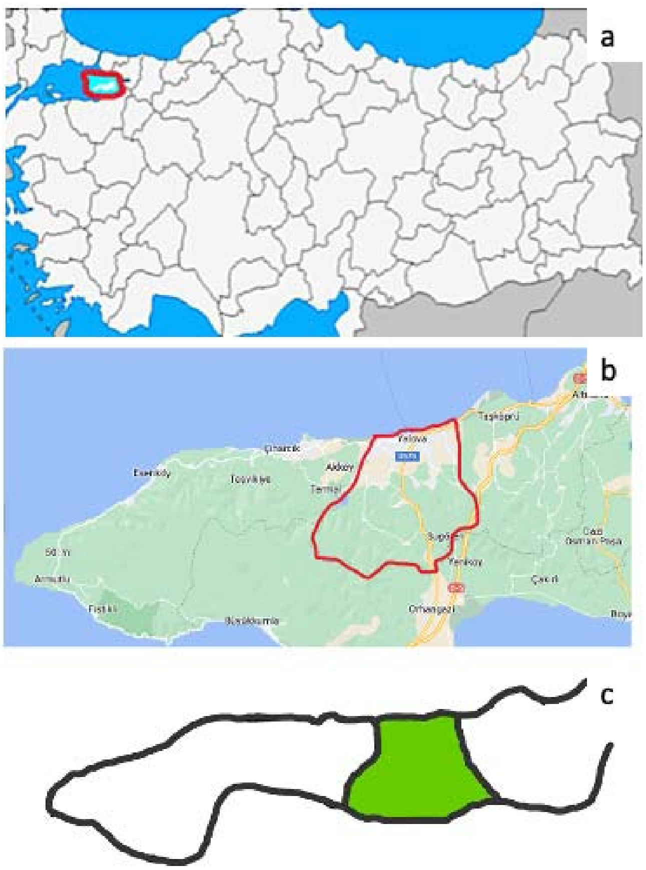


Figure 2: Map of Study Area,a) Map of Turkey b and c) Survey Area

Preparing the Survey

Fieldwork was carried out as follows; Firstly, the survey questions were prepared. After determining where or in which region (population size) the survey will be conducted, the significance level of the sample and the acceptable error rate were determined. Finally, estimates for energy use were made from the results obtained from the survey results.

According to the data obtained from the survey results, the following subjects were investigated: These:

1. Type of fuel used by households for general space heating
2. The relationship between household income and level of education
3. Natural gas/electricity consumption by income level
4. Preferred fuel type according to education level:

Households were asked whether their income level and educational status affect their energy consumption and access. A face-to-face survey method was chosen to maximize the efficiency of the survey study.

Methodology

Almost all events studied in the survey can be expressed as rates, such as the cost of using natural gas.

The estimated values of these rates are needed in determining the sample size. These values are taken as $p = 0.8/q = 0.2$ when the sample is homogeneous (meaning showing similar characteristics related to the questionnaire subject), and $p = 0.5/q = 0.5$ when it is not homogeneous (meaning showing very different properties). Other measures to be used in determining the sample size are the sampling error, [d] and the significance level to be determined according to the frequency of occurrence (probability of occurrence) [α] [27]. The process of selecting a portion of the research that demonstrates all of the features of the universe under study is known as sampling. When choosing a sample, keep in mind what it is capable of representing and whether it is large enough to account for the research's economics in terms of time and cost [28]. Regardless of how good the sample is, because the population size cannot be examined in its entirety, certain deviations between sample values and population values are possible.

The following formulas were utilized in the study to determine the number of samples [27].

If the number of individuals in the target audience is unknown,

$$n = t^2pq / d^2 \quad (1)$$

If the number of individuals in the target audience is known;

$$N = Nt^2pq / d^2 (N-1) + t^2pq \quad (2)$$

N: Number of individuals in the target audience
n: Number of individuals to be sampled
p: Frequency of occurrence of the event under review (probability of occurrence)
q: Frequency of the incident under review (probability of failure)
t: Theoretical value found at a certain level of significance according to the table of t
d: ± sampling error accepted according to the frequency of occurrence of the event.

If there is no p estimate for the universe, $p = q = 0.5$ can be taken and in this case the variance (p.q) takes the highest value (0.25) and thus reaches the largest sample size.

As the main population grows, the size to be sampled increases. For example, if we plan to conduct a survey on a residential area with 5000 adults, we believe that the respondents have very different views and features about the questionnaire. In this case, we can see from the table that you need to meet with 880 people for a questionnaire with a sampling error of ± 3% at the level of α = 0.05 significance. If your financial plan does not allow for 880 people, the acceptable sampling error can be increased to 10%, and this figure is reduced to 94.

In this case, the sample size was calculated for specific masses using formula 2 to reduce the accuracy of the results even further. In total, 217 surveys were evaluated in the results. While analyzing the survey results, general fuel use is classified into three categories: natural gas, wood-coal, and electricity users; and natural gas users are classified into two categories: central system and individual users.

Evaluation of the Survey Study

While determining the use of natural gas and electricity per household, the statistical formulas given below are used for necessary calculations.

If calculation is made with weighted arithmetic mean:

As a non-empty data set,

$$[x_1, x_2, \ldots, x_n], \tag{3}$$

weight function for each element

$$[w_1, w_2, \ldots, w_n], \tag{4}$$

Given as the weighted average formula.

$$\bar{x} = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}, \tag{5}$$

It is written more clearly,

$$\bar{x} = \frac{w_1 x_1 + w_2 x_2 + \cdots + w_n x_n}{w_1 + w_2 + \cdots + w_n}. \tag{6}$$

The normalized weighted arithmetic mean is a specially weighted arithmetic mean that can be applied in practice. The normalization is calculated by taking the sum of the weight function. In this case, the denominator of the weighted arithmetic means formula is equal to equation 3.
So, in the denominator:

$$w_1 + w_2 + \cdots + w_n = 1 \tag{7}$$

Since this is a condition, the following normalized weighted arithmetic mean is found:

$$\bar{x} = w_1 x_1 + w_2 x_2 + \cdots + w_n x_n \tag{8}$$

The following steps have been followed to find out how much a household's monthly natural gas consumption is. While evaluating on natural gas consumption, the weighted average of the survey results was calculated, and the monthly amount paid for natural gas per household was found. It is calculated separately for the winter period (October-April) and the summer period (May-September). In addition, the following steps were followed to find out how much a household's monthly electricity consumption is. Surveys for transactions made by income level 1000-2000TL (Turkish liras) = Low, 2000-4000TL = Medium, and 4000-5000 TL and more = High divided into three groups.

All survey groups (wood-coal, natural gas and electricity users) were evaluated together. The survey results were classified by income level, with 112 low-income, 73 middle-income, and 32 high-income households identified. When examining the natural gas/electricity access/consumption status by education level, all users are divided into four groups according to their education level: primary education (primary school + secondary school), high school, graduate, and higher education.

There are 92 primary school graduates, 76 high school graduates, 46 graduates, and 3 high school graduates among the survey participants. The graphs show the weighted averages of these groups' monthly electricity and natural gas consumptions, as well as their distribution as a percentage.

Results

Determining the Amount of Natural Gas / Electricity Consumed Per Household in Turkey

Natural gas users were separated from all survey groups when evaluating this section.
The households were asked in the survey about their monthly average natural gas consumption in TL, which was then converted to m^3 for calculations. The natural gas consumption of the household is calculated for two separate periods by taking the natural gas consumption for winter (October-April) and the summer period (May-September). The average of the natural gas ranges was utilized to simplify the calculations. In Table 4, the amount of natural gas consumed by household monthly was seen. Table 5 shows the distribution of household's natural gas consumption for the winter period.In tables, m^3 conversion of the natural gas consumption intervals (TL) used in the survey has been made.

Table 4: Household Average Monthly Natural Gas Consumption Calculation

Natural gas consumption cost (winter) (TL)	Natural gas amount (m^3)	Average consumption (m^3)	Natural Gas consumption cost (summer) (TL)	Natural gas amount (m^3)	Average consumption (m^3)
100-150	85-127	106	10-15	9-13	11
150-200	127-170	148	15-20	13-18	15.5
200-250	170-212	190	20-25	18-22	20
250-300	212-255	233	25-30	22-25	23.5
300-350	255-295	275	30-35	25-30	27.5

Table 5: Winter Gas Consumption Distribution

Natural gas amount (m^3)	85-127	127-170	170-212	212-255	255-295	Total
Sample size	40	31	48	31	33	183
%	21.8	16.93	26.22	16.9	18.03	100
Number of households	13551	10502	16262	10502	11180	62000

Monthly natural gas consumption is calculated by multiplying the average natural gas consumption amounts in Table 4 by the percentages and weighted averages in Table 5. As a result, using equation 6, the average 6-month natural gas consumption of a household (winter period) was determined to be 1121 m^3. The same calculations were performed for the winter and summer seasons, and the average natural gas consumption of a household was found to be 21.27 m^3. This means that a household's average 6-month natural gas consumption during the summer is 127.6 m^3. The average annual natural gas consumption of a Yalova household is calculated by adding the amount of natural gas consumed by the household during the winter and summer seasons. As a result, with a 95 percent confidence level and a 5.35 percent margin of error, a household's annual natural gas consumption is 1248.6.

Table 6: Summer Period Natural Gas Consumption

Natural gas amount (m^3)	9-13	13-18	18-22	22-25	25-30	Total
Sample size	18	27	45	44	49	183
%	9.83	14.7	24.5	24.04	26.78	100
Number of households	6098	9147	15245	14907	16601	62000

The same calculations were used to determine the household's average annual electricity consumption. The ranges and average values of electricity consumption asked in the survey are given in Table 7. Each of the average values here has been multiplied by the weighted averages in Table 8. Based on survey results and calculations with a 5.35 percent sampling error, a household's annual electricity consumption was determined to be 4061.8 kWh.

Table 7: Monthly Electricity Consumption of Household

Electricity consumption cost (TL / month)	Electricity amount (kWh / month)	Average (kWh / month)
25-50	80-160	120
50-75	160-240	200
75-100	240-320	280
100-125	320-400	320

Table 8: Distribution of Households According to Electricity Consumption Intervals					
Electricity consumption (kWh)	80-160	160-240	240-320	320-400	Total
Sample size	32	84	76	25	217
%	14.7	32.2	42.1	10	100
Number of households	9920	19840	26040	6200	62000

Access to Energy by the Income Level

All questionnaire groups were examined to determine the general energy consumption used by households for space heating, cooling, and water heating according to their income level. In Figure 3, 58% of fossil fuel is the most consumed by low-income households. The majority of wood and coal users are low and middle-income households. The graph shows that households with an income of 4.000 and above prefer natural gas more. The results show that access to clean energy systems increases as income levels rise. However, with the increase in natural gas distribution, it is observed that using natural gas is high among households of all income levels. When energy distribution prices rise, poor households must reduce their energy consumption. Because if they want to use the same amount of energy as high-income households, they need to give up or reduce other fundamental costs such as food and healthcare.

This brings about inequalities. It can be concluded here that the using of natural gas by poor households is not a necessity but an obligation most of the time.

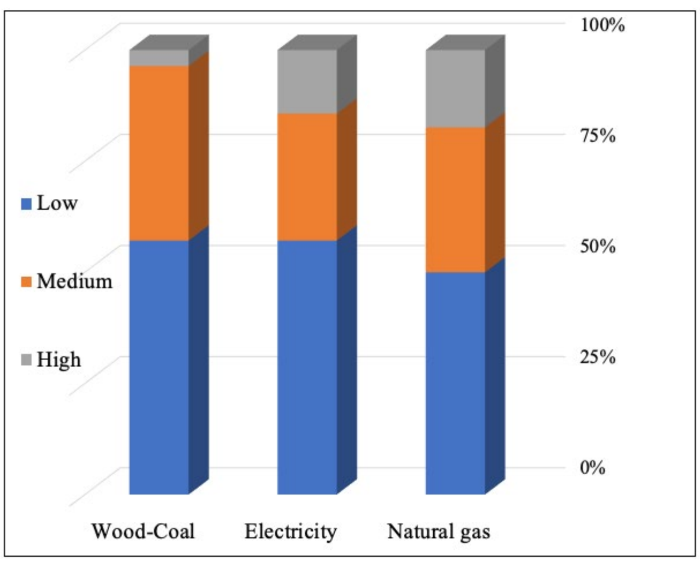


Figure 3: Percentage Distribution of Households by the Source of Energy Used in Urban Area

The variation in household electricity usage by income level is given in Figure 4. When the results of access to electricity are analyzed, no household does not have access to electricity. Considering the distribution of 62 thousand households by low, middle, and high-income groups, it is seen that the electricity usage of 160–320 kWh is at the highest level for all groups (approximately 46 thousand households). According to the survey results, as the income level increased, the electricity consumption rose to a certain level. It is seen in the figure that the electricity consumption of households at all income levels is between 160 kWh and 320 kWh at the highest level.

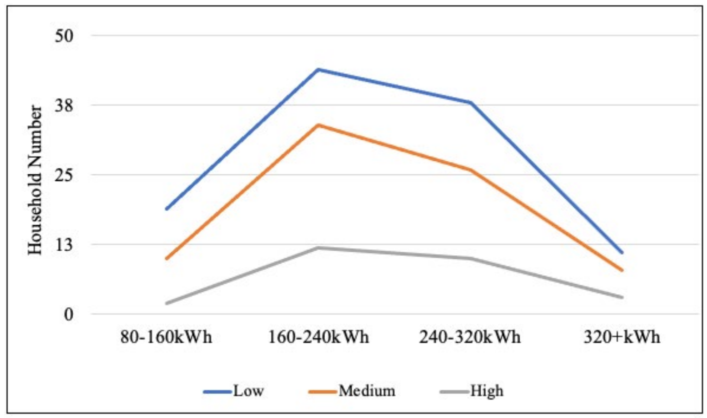


Figure 4: Distribution of Electricity Consumption to Income Levels of Household

In Table 4, the amount of natural gas consumed monthly is calculated. Figure 5 shows the distribution of natural gas consumption used by households according to income level. Clearly seen in the graph, the highest consumption of natural gas consumption interval for all income groups is 170-212 m^3. It can be concluded that the use of natural gas, like electricity, is also a basic need for all income levels, and consumption increases as the income level increases, but does not change after a certain level.

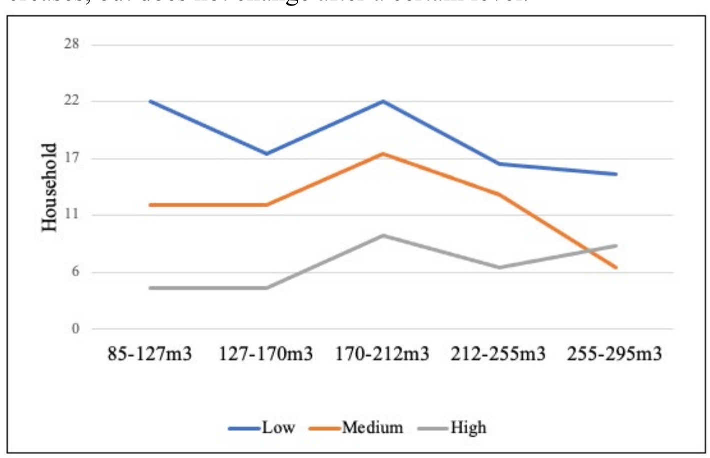


Figure 5: Distribution of Natural Gas Consumption to Income Levels of Household

Access to Energy by the Level of Education

Aside from the effects of the economic situation on energy access, there is also an interaction between education level and energy access. Improving energy access, especially access to electricity, is an important parameter that has a profound impact on education. Access to electricity and other modern energy sources provides a better educational environment for households [29]. While conducting studies in this section, all users divided into four groups according to their educational status. The percentage distribution was made by taking the weighted average of the monthly electricity and natural gas consumption of these groups.

Figure 6 shows the change in energy used by households in space heating, cooking, and water heating, according to their educational status.

It is seen in the chart that all households with a high level of education use clean energy systems such as natural gas.

This shows that as the level of education increases, the use of fossil fuels decreases, and there is an inverse correlation between them. It is seen that those who use fossil fuels such as wood are mostly primary and high school graduates, while those who graduate from undergraduate and graduate programs prefer natural gas. From here, it can be said that the level of income increases as the level of education increases, and therefore, access to modern energy systems increases.

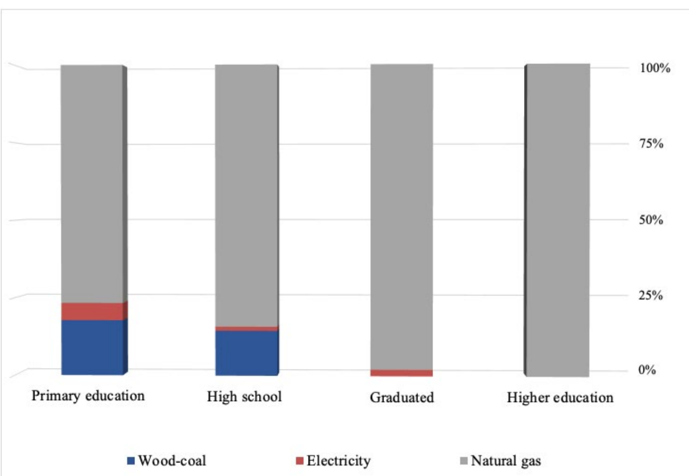
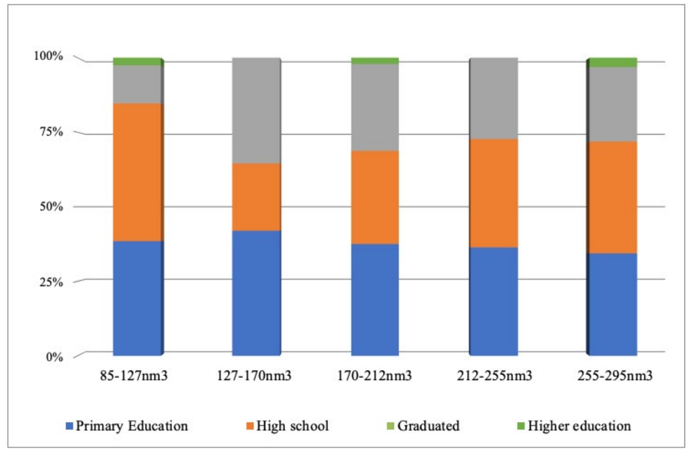


Figure 6: Percentage Distribution of Energy Source Households in Urban Areas by Education Level



Explanation: nm^3 is normal cubic meter

Figure 7: Household Distribution of Natural Gas Consumption by Educational Level

In Figure 7, the distribution of natural gas consumption among households by education level is given.

When the distribution of natural gas utilization across all educational groups is examined, it is noticed that there is no uniform distribution. According to the survey results, households in each educational group have access to natural gas consumption at all rates. Figure 8 shows the percentage of electricity consumption among all survey groups by education level. It has been found that access to electricity does not change due to the increase in education level. On the contrary, as the education level increased, excess electricity consumption decreased.

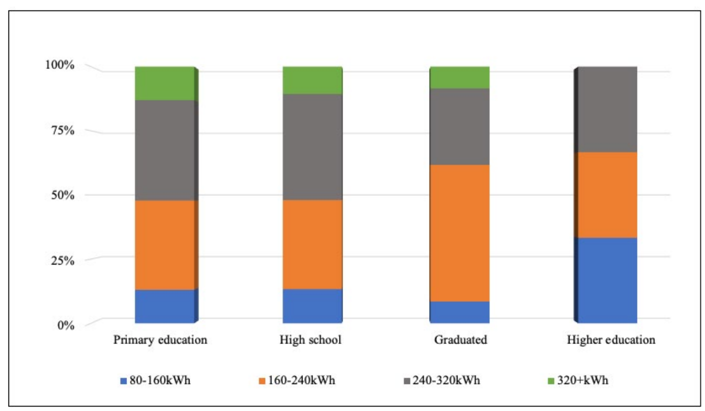


Figure 8: Electricity Consumption by Educational Status

Conclusion

In this study, we evaluated the relationship between modern energy access and the social-economic status of households in urban areas in Turkey's western province of Yalova.

A survey was conducted covering the Yalova city center area, and inferences regarding access to energy were made according to the survey results.

The results showed that income inequalities are essential to energy access.

*In the city center, where access to electricity is not lacking, it has been determined that the inadequacy of households in accessing electricity is only due to income differences.

*Fossil fuels and derivatives are mostly consumed by low-income and low-education households. Based on this, it can be stated that access to clean energy systems will increase as income and education levels rise.

* Due to the widespread use of natural gas in the city center, almost every home in Turkey has access to natural gas. Natural gas use in the city center is a basic need for all income levels, and as household income levels increased, consumption increased as well but did not change after a certain level.

* If income inequality problems are not addressed, urban poverty is likely to worsen with increased urbanization, and ignoring or forgetting poor households could be the source of a significant future problem. Because, electricity and natural gas energy consumption are only a small part of the poor household needs.

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