Household Energy Consumption and Energy Poverty in Kazakhstan

By Aiymgul Kerimray, Rocco De Miglio, Luis Rojas-Solórzano, and Brian Ó Gallachóir

INTRODUCTION

Lack of access to modern fuels, high fuel prices, poor building insulation, and income poverty are among the underlying causes of current global energy problem. Kazakhstan may be particularly highly affected by this phenomenon due to the high heating demand and the severe continental climate, as well as due to the high use of coal and biomass in some of its regions. On the other hand, Kazakhstan is rich with energy resources and prices for energy remain low and not reflective of the true cost of supply.

Despite widespread access to district heating and natural gas networks in urban areas, many households in remote regions still use solid fuels for heating purposes in Kazakhstan. Residential coal consumption per capita in Kazakhstan is one of the highest in the world (IEA, 2015). A 30% share of all households used coal as a primary source for heating, increasing to 67% in rural areas (Atakhanova and Howie, 2013). Incidences of deaths due to carbon monoxide poisoning in households in Kazakhstan are reported periodically during winter time in the local media. However, there are very few studies on indoor air pollution and household energy consumption in Kazakhstan. It is essential for decision makers and the general public to understand the patterns, determinants and implications of household energy consumption. This paper reviews residential energy consumption trends in Kazakhstan, energy efficiency potential in buildings as well as the incidence energy poverty across the regions of the country.

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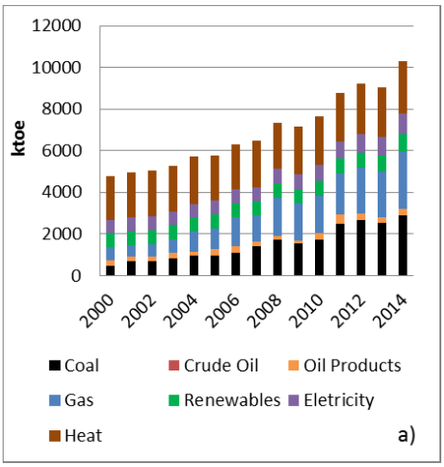
RESIDENTIAL ENERGY CONSUMPTION TRENDS

Between 2000-2014, energy consumption in the residential sector has grown rapidly, with the average annual 6.3% growth rate (Figure 1) (Kerimray et al., 2016a). The growth has been mainly driven by income growth, penetration of household appliances, as well as expansion of household living spaces. With the economic development of the country dependent mainly on oil and gas revenues, average household income has grown by a factor of 3.4 (Committee of Statistics of the Republic of Kazakhstan, 2015) during that period of time (2000-2014). Low energy prices and lack of interest in energy efficiency measures have also contributed to the rising energy consumption. Population growth affected energy consumption to a lesser extent, since during the same period it has grown only by 17% (Committee of Statistics of the Republic of Kazakhsta, 2016a). Policies to stimulate energy efficiency improvements such as installation of heat metering devices, mechanisms for financing building retrofits have been adopted recently in 2013 and the impacts may still not be evident from 2000-2014 energy consumption trend.

Coal and network gas were the highest growing fuels in the final consumption of the household sector (Figure 1). Coal is the least expensive energy source and there are large reserves of coal in Kazakhstan. The growth of network gas consumption is explained by expansion of natural gas distribution pipelines in the communities located near the main pipeline in the West and South Kazakhstan. District heating system gross participation remained nearly constant between 2000-2014 since the district heating system was not expanded significantly. (Figure 1). District heating is generated at CHP plants (55%) and heat plants (45%), with coal used as a fuel in 64% of total heat generation (Kerimray et al., 2016a).

In 2013 total residential energy consumption per capita in Kazakhstan almost reached the average OECD level, while electricity consumption per capita in the country remains 3.5 times lower that OECD average (IEA, 2015). High consumption of non-electricity commodities in Kazakhstan is due to several reasons. Heating is one of the basic living needs in Kazakhstan due to severe continental climate, and it is the largest end-use energy demand in residential buildings. The heating season is more than half a year long in most of its regions and resulting in approx. 6,000 heating-degree days in its Northern and Central regions. The annual building energy consumption for heating is 270 kWh/m2 on average, which is more than two times higher than average European levels (100-120 kWh/m2) (Government of the Republic of Kazakhstan, 2013). Severe climatic conditions coupled with dilapidation of housing stock and poor penetration of energy efficiency technologies contribute to the high energy consumption. In urban areas, inefficient district heating system, and absence of customized heat supply stations



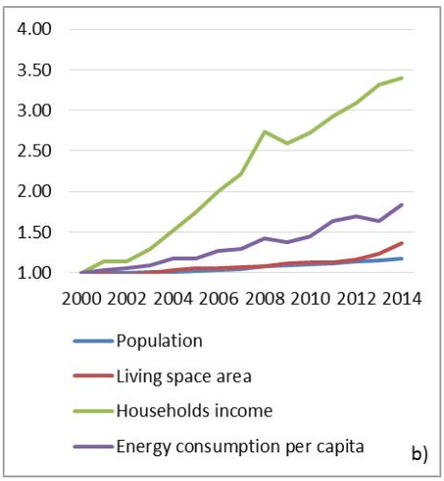


Figure 1 – a) Residential energy consumption trend in Kazakhstan 2000-2014 (Reclassified Energy Balance NU-NLA, Kerimray et al., 2016a) and b) Indices of population, living space area, households income (constant prices) and energy consumption (2000=1) (Committee of Statistics of the Republic of Kazakhstan, 2015)

often lead to overheating. Furthermore, the results from Households Survey demonstrated that electricity is rarely used for heating purposes, despite 100% electrification rate in the country and relatively low electricity prices.

HOUSEHOLD FUELS USE. INSIGHTS FROM HOUSEHOLDS LIVING CONDITIONS SURVEY

This study combines and analyses data for the year 2013 from the Households Survey on Living Conditions and Households Budget Survey (Kerimray et al., 2016b). These surveys are administered by Committee of Statistics of the Republic of Kazakhstan. The households were selected by random sampling based on Population Census. The survey covered 12000 households representative at urban/rural and regional level.

The electricity access rate in Kazakhstan is 100%, although access to network gas and district heating system remains largely uneven between urban/rural households. Rural households in Kazakhstan have lower access to district heating and to the gas network, hence these areas mainly rely on coal, wood and LPG for heating and cooking (Figure 2). Notably, 33% of surveyed households used more than 2 fuels during the year, the use of which varies by quarter.

The highest number (2636) of households in the survey use central heating and gas, mainly in urban areas. The second most popular fuel combination is coal, LPG and firewood, used mainly by rural households having no access to gas or district heating. A further 1656 households, mainly in rural areas, use a combination of coal and LPG. Importantly, combinations with central heating are mainly urban, and combinations with coal are mainly rural. LPG penetration is significant in the country and it is used by 54% of all surveyed households.

Regional disaggregation of the survey results helps to provide insights into the underlying reasons for fuel choice, as shown in Figure 3. Most of the oil and gas reserves of the country are located in Western regions and gasification of these regions is the highest in the country with nearly zero coal consumption (except for Aktobe region). The survey result demonstrate that 40% of all surveyed households use coal. There is a strong (up to 91%) dependence on coal in rural areas of North, Central and some South regions. Analysis of income levels of coal users demonstrated that 23-34% of the richest income deciles (8-10) still used coal, indicating that there is a lack of access to other cleaner alternatives and/or low awareness of negative health effects from solid fuels combustion and on benefits of cleaner alternatives.

Analysis of quarterly variations of energy expenditures has shown that coal and firewood are mainly used for heating during cold seasons, while LPG and electricity are used throughout the year. Importantly, firewood and coal were commonly used together with LPG, with the last being used mainly for cooking purposes.

BUILDING ENERGY EFFICIENCY. INSIGHTS FROM BUILDINGS ENERGY AUDIT REPORTS

To explore energy efficiency potential, 586 residential building energy audit reports conducted across the country were collected and analysed. The results depicted that most of the buildings had high potential for energy efficiency improvement since most of them had poor insulation properties, heating pipes were uninsulated, automated heat supply stations were absent, among many other defficiencies.

The heat transfer coefficient of building walls (U value) in Kazakhstan is significantly higher than in European countries with similar climates. Within European countries, U values of walls range from 0.2 W/m²K to 0.8 W/m²K (IEA, 2008). In Kazakhstan by contrast, despite its more severe climatic conditions walls have poorer insulation properties, with U value of 0.85-1.2 W/m²K.

From the 586 buildings energy audit reports being analysed, the energy efficiency options which were proposed in the majority of buildings were listed as: installation of heat metering device (469), insulation of heat distribution station and heating pipes (445), installation of automated heat supply station (384) and replacement of incandescent lamps with energy saving units (378). This clearly indicates that even the basic energy efficiency measures and energy monitoring are not utilized currently in Kazakhstan. These measures have a payback period of less than 10 years. While, such measures as the insulation

of walls, installation of automated heat supply station, insulation of roofs and the replacement of general windows have a payback period of more than 40 years and, therefore, are unlikely to be implemented by homeowners, without supporting mechanisms from the Government. Importantly, the prices for energy used by energy auditors assume gradual increases as planned by the Government.

Low energy prices, lack of energy metering devices and, as a consequence, low interest of homeowners to pay for refurbishment and low effectiveness of mechanisms for maintenance and refurbishment of buildings are the main barriers for energy efficiency improvement in Kazakhstan (Government of the Republic of Kazakhstan, 2013). In 2012 the Government created a fund for the development of housing and utilities with the aim to provide credits for housing and utilities projects with a return financing mechanism. However, up to now there is no information of progress towards achieving this target and the effectiveness of the fund. Removing energy subsidies and the rise of energy prices alone may impact on low income, energy poor population. In this regard, effective financial subsidies and government interventions are necessary to achieve energy efficiency improvements in residential buildings.

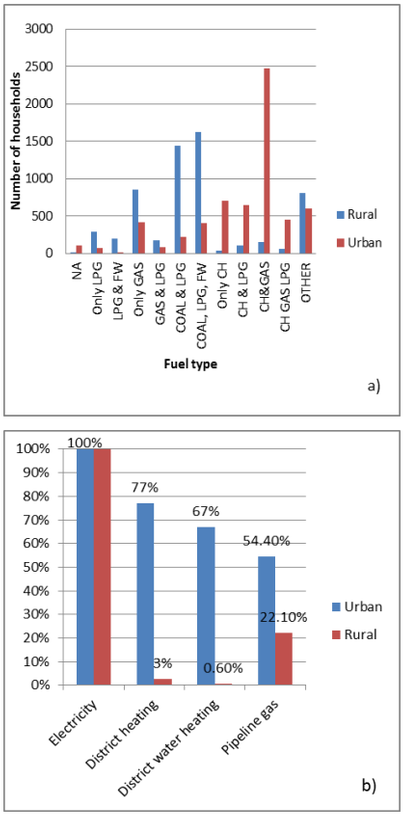


Figure 2 – Number of households by fuel combinations used by urban/ rural divide (CH- central heating, GAS-distribution network gas, LPG- liquefied petroleum gas, FW – firewood) and b) Households access to energy services in 2014 (Committee of Statistics of the Republic of Kazakhstan, 2015)

ENERGY POVERTY

Within the EU, the most commonly used metrics for determining whether households are experiencing fuel poverty are the ratio of energy expenditure (necessary to heat homes to a comfortable level) and household income (Pye et al., 2015). The IEA (2010) provided a definition of energy poverty as a lack of access to clean and commercial fuels, efficient equipment and electricity, and a high dependence on traditional biomass. In the case of Kazakhstan both definitions may be applicable: fuel poverty from energy affordability perspective and energy poverty taking into account fuel cleanness.

One of the main challenges in estimating fuel poverty in Kazakhstan is the lack of data and the need for complex modelling. Thus, 10% income indicator to Kazakhstan requires estimating the "theoretical" energy consumption required to heat a home to the comfortable level (according to WHO recommendations). Pye et al. (2015) highlight that modeling of households energy requirement is complex, and it requires understanding of the building stock, household composition, occupancy and geographical location. In Kazakhstan the specifically dedicated Households Energy Consumption Survey has not been conducted, which makes it very complex to perform such analysis. In this study, based on the Households Budget Survey data, the households spending on energy (all energy sources) more than 10% threshold were filtered to analyze energy affordability aspect as a first estimate of energy poverty. Thus, this paper uses "actual" energy expenditure instead of "required" energy expenditure, due to data limitation.

Applying "10% household income expenditure on energy" metric to data for Kazakhstan, resulted in 28% of surveyed households being energy poor, with the majority (68%) located in rural areas. Results indicate that despite relatively low energy prices and energy resourses abundance in the country, there are still issues of energy affordability in many households due to combination of income inequality, high heating demand and buildings inefficiencies. Figure 4 below compares income poverty (first three income deciles), Gross Regional Product (GRP), energy poverty (10% indicator) and coal users by regions of Kazakhstan. The survey results demonstrate that there are significant differences in income poverty and GRP by regions of Kazakhstan.

In most of the regions there is a strong cor-

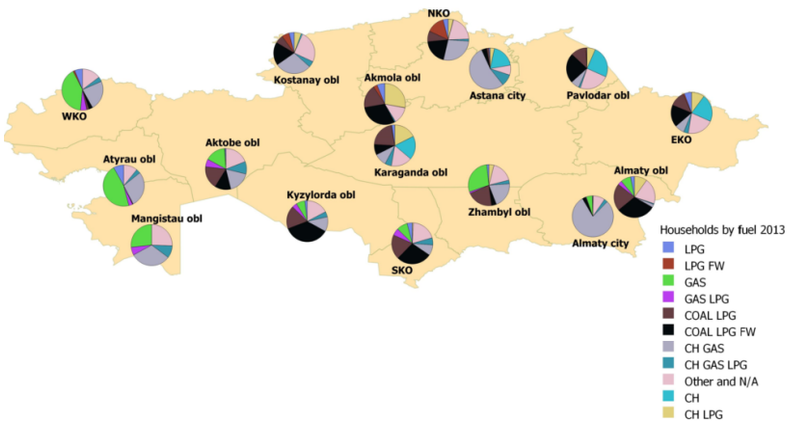


Figure 3 - Share of households by fuels used by regions of Kazakhstan (CH- central heating, GAS-distribution network gas, LPG- liquefied petroleum gas, FW – firewood)

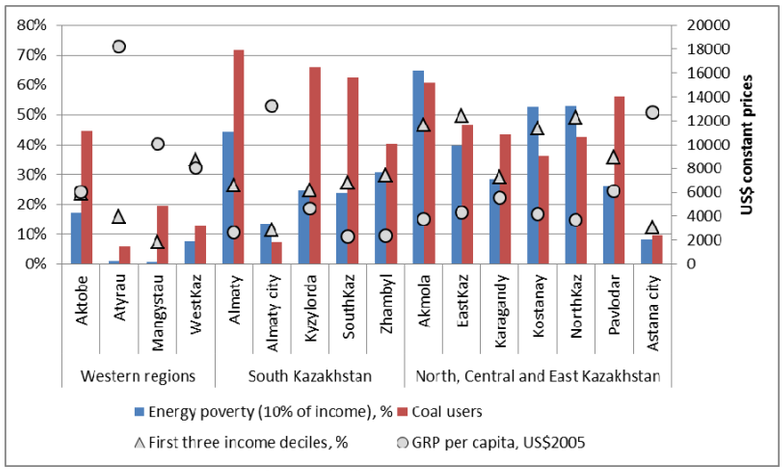


***Figure 4 - Percentage of households energy poor, percentage of households in the first three deciles in 2013 (with 10% indicator and clean fuel* access indicator) (left axis); GRP per capita, US$ 2005 (right axis) (Committee of Statistics of the Republic of Kazakhstan, 2016).**

relation between income poverty and energy affordability. Thus, richer western regions (oil and gas producers) and two cities have low incidence of energy poverty and coal users, while there is much higher prevalence of income poverty, energy poverty and coal users in the North, Central Kazakhstan. Thus, diversification of the economy, regional economic development and reducing income inequality should play a crucial role in alleviating incidence of energy poverty in the country.

CONCLUSIONS

Kazakhstan is a country rich in energy resources with energy prices considerably lower than in developed nations, but with very particular conditions that affect the level of energy poverty in its population. Household survey results and analysis including energy audits depicted that there are problems with energy affordability and with access to clean energy in Kazakhstan, which can be summarized as:

- 40% of surveyed households used coal, with 21% of them being in the richest three deciles;
- 28% of surveyed households were energy poor according to "10% of income"indicator.
- Nearly absent penetration of basic energy efficiency options such as heat metering devices, heating pipes insulation and energy efficient ligting system.
- There are large disparities in fuel use, household income, and energy affordability between regions of Kazakhstan.
- In most of the regions there is a strong correlation between income poverty and energy affordability. Households in the West are generally richer, while the higher number of poor households are in North and Central Kazakhstan. Households located in the North Kazakhstan, Central and East Kazakhstan mainly suffer from lack of cleaner fuel options, income poverty, longer and colder winters as well as energy affordability.

Therefore, from the analysis presented in this paper, the authors suggest the following list of actions to be considered in further detail in upcoming studies in order to tackle the energy problem in the country:

- Development of more relevant to local realities "composite" metrics and definition of energy poverty for Kazakhstan, which considers important aspects including energy affordability, clean fuel access and fuel poverty "depth". Future work should be conducted to model required fuel use and costs. Specifically dedicated surveys which take into account housing conditions, heating technologies and thermal comfort are needed to identify energy poor and to conduct targeted interventions for energy poor.
- Development of effective programs to stimulate energy efficiency improvements in households.
- Improvement of regional economic condition and reduction of income poverty in the poorer regions should become one priority.
- Extension of gas network will improve the access to cleaner alternatives, but higher gas prices may worsen affordability aspect. Since gas pipeline construction is timely and costly and if finally realized will not cover all the remote regions, support schemes and other alternatives such as renewable and alternative energy sources of heat (e.g., heat pumps, LPG, solar thermal) should be implemented.
- Regionally specific intervention programs and indicators are crucial due to vast disparities in climate, economy and access to energy among the regions of Kazakhstan.

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