

ISCKMC 2022**International Scientific Congress «KNOWLEDGE, MAN AND CIVILIZATION»****ENERGY CONSUMPTION BY HOUSEHOLDS UNDER THE
CURRENT CONDITIONS IN GERMANY AND RUSSIA**

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Abstract

The paper takes into consideration an essential topic for the modern world, i.e., energy consumption and energy saving. Exploring energy consumption and energy saving on representative examples of two regions (Salzland district and Perm region), the policy of Germany and Russia, two countries with different climates and lifestyles, are compared. The current trends in energy consumption in the domestic sector of both countries are described. The criteria for comparative statistical analysis are such parameters as interannual energy consumption, the standard of living, socio-demographic and economic situations in the country, etc. However, the available statistical information does not allow us to establish a correlation between the change in production volumes in the regions and energy consumption in the Russian Federation at the moment. Despite this, the article draws important conclusions that will make it possible to conduct an accurate analysis of energy consumption at the municipal level to form energy-saving strategies and, subsequently, to develop unified approaches to the development of energy supply for individual clusters and population groups.

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1. Introduction

The structure of energy consumption by households around the world varies greatly according to the climate, living standards and lifestyles. Therefore, a very complicated task due to the variability of the consumer is to determine energy consumption profiles (Blokhin & Lozenko, 2018; Nakagami et al., 2008; Ponniran et al., 2012). It has already been repeatedly noted that “... there is not being studied the contribution of various factors to the dynamics of the energy consumption of the regional economy at the municipal level” (Bogachkova et al., 2017, p. 194). Here, we propose a way for investigating the features of energy consumption by households while comparing them in two countries with different climate, living standards, and lifestyles.

In this paper, we follow our long-term research agenda of defining criteria for comparative statistical analysis of the energy consumption by households, which would be capable of predicting future trends in the studied area and contribute to the energy saving (Mokhov et al., 2021). We address the following research questions considering the task of energy consumption by households:

RQ₁ Is there a great difference in policy of energy consumption by households in Germany and in Russia?

RQ₂ What are the current trends of energy consumption in the domestic sector in both countries?

RQ₃ Which criteria for comparative statistical analysis can be defined in this paper?

This paper is structured as follows: after presenting the related work (Section 2), we describe the energy consumption policy in Germany in Section 3. Section 4 presents the strategy of the Russian Federation (RF) for energy consumption by households. Section 5 concludes and outlines future work.

2. Problem Statement

The problem of energy consumption by households as a part of a more general problem of power consumption and energy saving management is of great scientific and practical interest all around the world (Akintande et al., 2020; Escobar et al., 2020; Eltyshv, 2017; Haonan et al., 2020; Meisel et al., 2020; Nakagami et al., 2008; Ponniran et al., 2012; Soto, 2016; Sinitsyna et al., 2019; Tanveer & Dongdong, 2020).

There are a number of interesting observations and studies in the Russian literature that have identified certain regularities or factors of power consumption. Among many works on this topic, we should mention the paper by Blokhin and Lozenko (2018) which analyzed the energy consumption for RF regions with the limiting values of population deviation. Gasho et al. (2017) noted insufficient study of regularities in the urban energy system development and non-linear nature of relations between urban energy system and social-economic and natural-climatic factors. A number of papers (e.g., Antonov et al., 2020; Gerasimova, 2020; Klimenko et al., 2011; Zaytseva, 2016, etc.) carried out the analysis of regional features of energy consumption by regions of RF. In particular, a low correlation between energy consumption and such factors as household area, number of residents and number of rooms was established for rural areas (Dulesova & Kharitonova, 2018). Much attention is given to the study of individual factors influencing energy consumption by the population (Shulga & Zatonkiy, 2016). Galperova (2019) has come to the conclusion that:

absolute growth of energy consumption by the population (with its growth rate slowing down) continues..., ...an accelerated reduction of specific power and energy consumption (per m^2 of household area) ..., a steady increase in the share of electric power in energy consumption structure is observed due to the expansion of household electrification. (p. 148)

Some attention is paid to the experience of other countries in saving energy resources in households (Escobar et al., 2020; Mokhov et al., 2021; Nakagami et al., 2008; Tanveer & Dongdong, 2020; Sokolova, 2016).

3. Research Questions

3.1. Energy consumption policy in the German domestic sector

3.1.1. General overview of the current situation

The energy consumption by German households ranks third in total energy consumption in 2017 after gas and fuel oil which is a trend having been declining since 2010. In the 2010 energy concept, the German government set a goal to reduce energy consumption by 10 % by 2020 compared to 2008, and the deadline for switching to renewable sources should be reached as soon as possible in order to phase out nuclear power. Figure 01 represents the situation with energy consumption by different sectors in Germany from 1990 till 2017.

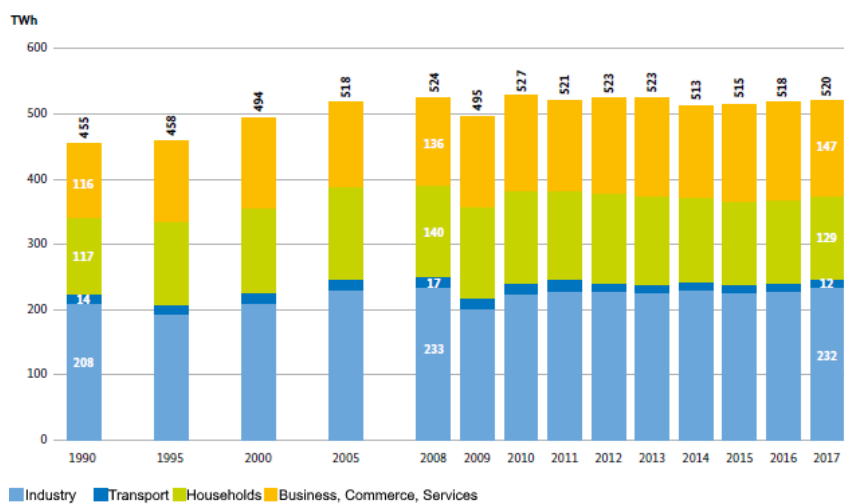


Figure 1. Dynamics of net energy consumption by sectors (Schlomann et al., 2016)

This goal for energy policy is to produce energy without emitting greenhouse gases and pollutants. Fossil energy sources must be replaced, therefore, the goal is to save energy and increase the use of renewable energy sources. The legal basis required is constantly being amended. These changes are clearly visible according to the statements in the annual reports of the municipal utilities of the Salzland district resulting in, e.g., price pressures on energy suppliers increase (Mokhov et al., 2021).

In this context, power generation in the first half of 2020 tends to decrease: 248.2 billion kilowatt-hours of power were fed into the grid. Nevertheless, energy generated from renewable sources

(amounting to 128.4 billion kilowatt-hours) has a significantly increasing share of 51.8 % compared to 43.4 % in the first half of 2019. According to an analysis of the preliminary results of the Federal Statistical Office (Destatis) (https://www.destatis.de/DE/Home/_inhalt.html), energy production from renewable sources increased by 8.3 % compared to the first half of 2019. The largest increase was recorded for energy from wind power (+ 12.9 %) mainly due to the very windy 1st quarter of 2020. Wind power delivered to the grid 29 % of energy, therefore, it was also the most important energy source for domestic sector power generation in the first half of 2020.

The German government aims to improve energy efficiency in order to make a positive contribution to the energy transition. Nowadays a private household in Germany consumes about 3,500 kWh per year (Meisel et al., 2020). Growing demands for living comfort and the demographic situation in the country also play an important role in an ever-changing world. Here it should be noted that the number of private households in Germany increased by 10.1 % between 2000 and 2019. In 2019, 42.3 % of all households in Germany consisted of one person compared to 25.1 % in 1970 and 35 % in 1990. In contrast, the percentage of households of 3 persons has decreased significantly: from 19.6 % in 1970 and 16.7 % in 1990 to only 11.9 % in 2019.

According to these statements, development of digitalization in the energy industry is also leading to comprehensive structural changes. Current trends in the energy industry include, for example:

- i. Virtual power plants (consolidation of services and centralized management of multiple small power plants);
- ii. Energy sharing (virtual market for energy generation);
- iii. Smart power grid;
- iv. Smart home management;
- v. Flexible rates;
- vi. Fibre network expansion as a key technology for digitalization and, therefore, for the energy sector;
- vii. Smart meter (smart metering systems).

Energy produced decentrally (e.g., by solar or wind power) must be provided in the future according to the needs of the consumer. Furthermore, strengthened measures are taken in the field of energy-efficient renovation of buildings and housing construction.

3.2. About the situation in Salzland district

Salzland district's utilities see great opportunities in e-mobility and are already noticing positive developments (Bauer et al., 2019). Sales of energy in the household sector have been steadily falling. Salzland district with an area of 1,426.76 km² has a local supplier structure with the municipal utilities of Stadtwerke Bernburg, Stadtwerke Stasfurt, Stadtwerke Aschersleben, Stadtwerke Schönebeck and the natural gas center in Saxony. In Germany it is possible to conclude a contract with an energy and gas supplier on your own, regardless of their location. However, there is a difference between a basic supply contract and a competitive energy supply contract. The energy supply companies must provide each household consumer for their network areas under appropriate conditions and prices.

In order to reduce the growing energy consumption and thus CO₂ emissions, the federal government has developed various funding programs as part of investments and energy savings. One of them is for industry, e.g., to obtain process heat from renewable energy sources and to improve the energy efficiency of its use in the economy. The state also offers attractive subsidy programs for private house owners to reduce their energy consumption or even to save a lot of energy. There are subsidies, e.g., for better home insulation or new, more economical heating systems. Citizens who save energy can also count on financial support from municipalities and local energy suppliers.

4. Purpose of the Study

In addition, in public administration, the federal government has taken a position that, on the one hand, there is great potential for savings in energy production costs and, on the other hand, a well-structured administration of energy consumption processes leads to better results.

Therefore, Salzland district has also included the reduction of CO₂ emissions, cost savings and resource optimisation in its 2030 strategy document for the district (<https://www.salzlandkreis.de/verwaltung/satzungen/#EK>). This can particularly be explained by the fact that in the preceding period (before the first tender for energy supply contracts in 2015), Salzland district had a large number of different individual contracts which were already in place before the district reform in 2007. Only since this time, it became possible to establish a uniform working price for the respective energy source.

District heating contracts are not affected by this consideration as there is an obligation to purchase from the local providers. These contracts are usually several decades old and only occasionally adapt to innovations. There is only potential for savings if you do not accept anything or if you manage to make adjustments to the acceptance point. Since this can only be provided with the consent of the respective supplier, this is sometimes / mostly difficult.

The district administration aims to achieve sustainable economic and ecological management of the area. The focus is also on influencing the trading of own employees. In addition, 1,200,000 EUR will be annually spent for the supply of energy as well as supply and disposal for the responsible objects of the FD11. However, for the future planning, a large number of processes need to be networked and adapted to new tasks. Building, monitoring and managing system technology requires advanced and fundamental planning of the technology and training of the necessary specialised staff. This inevitably leads to higher maintenance and replacement costs for the installed technology on a regular basis.

5. Research Methods

The Energy Strategy of the RF until 2035, approved by RF Government Decree No. 1523-r of June 9, 2020, identifies, among other things, transition to clean and resource-efficient energy as well as sustainable environmental management and energy efficiency as the main priorities of state policy (On approval of the energy strategy ...). Within the frameworks of implementing these strategic priorities, the RF Government adopted the Decree No.161 of February 11, 2021 which set the requirements for regional and municipal programs for energy saving and enhancement of energy efficiency. In particular, it

provides for mandatory measures to "equip the housing stock with metering devices for energy resources used including the use of smart metering devices, automated systems and dispatching systems; to save energy and increase energy efficiency of the housing stock including energy efficient overhaul of common property in apartment buildings" (On approval of requirements for regional ...). With regard to state and municipal institutions, Resolution No. 1289 of October 7, 2019 of the Government of RF establishes requirements for the reduction in comparable conditions of the total volume of diesel and other fuel, fuel oil, natural gas, thermal energy, electricity, coal, as well as the volume of water consumed by them (Requirements for the reduction by state ...).

By now, the Perm Region has completed implementation of the long-term target program "Energy Saving and Energy Efficiency Improvement in the Perm Region" for 2015–2019. The main measures of state regulation under the state program included 1) obligations for energy saving and energy efficiency measures with regard to the common property of owners of premises in an apartment building; 2) information support for energy saving and energy efficiency measures; 3) state support for energy saving and energy efficiency improvements (On approval of the State Program ...).

Measures focused on the end user of energy in households were aimed to

- start *educational activities*, i.e., events "Dissemination of materials on energy saving and energy efficiency improvement in mass media", "Organization of work of the project "School for Literate Consumer" in the Perm Region. According to the annual report on the implementing the program, students of the "School for Literate Consumer" presented a project of training CBT chairpersons and building superintendent in specialized knowledge in housing and communal services. The project provides assistance and advice to citizens on the protection of consumer rights in the utilities sphere.
- improve energy accounting systems and energy audit (measures "Assistance in equipping residential buildings connected to centralised energy supply systems with sub-domestic commercial metering devices", "Organisation and performance of energy inspection (audit) of apartment buildings located in Perm Region, formation and implementation of a set of energy saving measures in apartment buildings"). Hence, reporting documents include measures implemented in the interests of state and municipal institutions (Rosstat official site).

Analysis of energy consumption in RF shows that in 2020 compared to 2019, energy consumption decreased by 2.3 % from 1085045.1 billion kWh to 1110050.3 billion kWh (Federal state statistics service), in households it decreased by 1.3 % over the period 2018–2020 (Industrial production in Russia in 2019). In 2018, the population of RF consumed 14.3 % of the energy produced (Summary of the comprehensive ..., 2020). The analysis of energy consumption in in the domestic sector in RF is based on Comprehensive Observations of Living Conditions of the Population for 2016, 2018, 2020, which are representative for entire RF, urban and rural settlements with different population sizes, with individual socio-demographic groups of the population. Since comprehensive surveys are carried out every two years, it will only be possible to make confident judgments about trends in energy consumption by households during the pandemic several years after the pandemic is over. Therefore, it is only possible to make some assumptions based on the survey data now.

It is important for the analysis that the comprehensive survey took place from October, 14 to November, 2, 2020, i.e., when coronavirus infection had already spread in RF, including the sanitary and anti-epidemiological restrictions that began to be imposed in different regions of the country. In entire RF, 47 constituent entities showed a decrease in energy consumption in the domestic sector while 38 constituent entities demonstrated an increase. However, these changes were mostly relatively: 5 % or more (decrease or increase in consumption) was recorded in 49 constituent entities of RF (including 28 constituent entities with a decrease in consumption), 10 % or more in 23 constituent entities of RF (including 14 constituent entities with decrease in consumption).

The reasons for divergent trends in energy consumption can range from changes in natural and climatic conditions to the impact of the pandemic during which there was a drop in production resulting in lower incomes of the population that could not but affect the reduction of household spending on everything necessary including energy. It is necessary to take into account that during the periods of lockdowns, transition to e-learning for students and schoolchildren, restrictions on movement of various categories of residents, QR-code action and other measures aimed at limiting the spread of infection, the amount of time spent by the population in their own living has increased, which inevitably had to manifest itself in energy use. At the same time, the opposite trend was also at work: the ruin of many entrepreneurs in the conditions of the pandemic, the sharp decline in people's incomes, the increased costs of medicines, etc. inevitably had to cause the development of austerity measures in households, including the energy use. However, it is not possible to establish an unambiguous correlation between changes in regional production volumes and energy consumption by households in RF based on available statistical information.

6. Findings

It can be assumed with some certainty that the second trend has prevailed. However, this general trend was formed primarily due to reduction of energy consumption by large consumers due to the fact that during the pandemic a certain part of employees was telecommuting in order to limit contacts of people during working hours, reduce transport load, etc. For example, in RF it was rather warm in winter in the first quarter of 2020, the agreement with OPEC+ was in force, which resulted in 11.9 % drop in demand for energy from oil and gas production companies, oil transportation companies and gas pumping stations – by 18 % (Bulletin of laws of Perm Region..., 2021).

The Perm Region revealed a record drop in energy consumption in 2019–2020. Abnormally warm temperatures, reduction in industrial production and housing construction, as well as the 2020 crisis, reduction of energy-intensive metallurgical and petrochemical production facilities had an impact.

Thus, the complex processes of organization and consumption of power in households face a variety of factors that have a multi-directional influence on power consumers. Economic factors are important, but the only, and often not determining factors in shaping households' energy consumption strategy.

7. Conclusion

In this paper, we have precisely described features of households energy consumption under current conditions in Germany and Russia, compared policy of energy consumption in the domestic sector in Germany and in Russia and current trends of energy consumption by households in both countries. The state policy in both countries aims at a transition to clean and resource-efficient energy as well as sustainable environmental management and energy saving. Moreover, we indicated some criteria for comparative statistical analysis (e.g., inter-annual energy consumption, living standards, the social-demographic situation in the country, the economic situation in the country etc.). For investigating this, we defined three research questions that were answered by our study. However, it is not possible at the moment to establish the definite correlation between changes in regional production volumes and energy consumption in RF based on the available statistical information.

The future work may require a precise analysis of energy consumption on the municipal level to formulate the energy saving strategies, on the one hand, and, on the other hand, the elaboration of common approaches to the energy supply development for individual clusters and groups of municipalities depending on the main factors influencing the energy consumption.

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