# Impact of household electricity consumption on the load of the electricity system

*Summary of analytical report*

Energy consumption in buildings is one of the main factors that determines the capacity and nature of energy production facilities, and which has been identified as a target indicator for European Union policies. A major share of this consumption is accounted for by households, where there is significant potential for reducing both the final energy consumption (FEC) and the loads in country's electricity system (ES) in the long term.

Current projections for household final energy consumption (Figure 1) expect growth in both household usable area and electricity consumption, at the expense of reduced consumption of other energy sources.

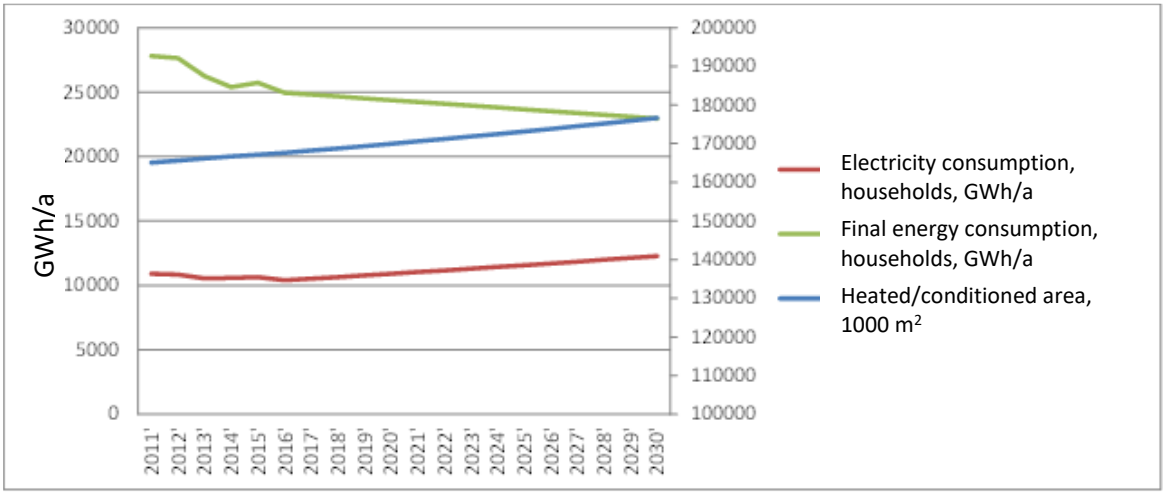


**Figure 1.** End-use projection in the building stock
*(source: BAS Report, 2018)*

It should be noted, however, that these projections are based on the current levels of renovation of multi-family buildings in a quantitative and qualitative terms, namely, renovation to energy class C and 100 % grant funding, without considering the potential for achieving Energy Class A and the opportunities for attracting private investment.

In this perspective, the increased use of electricity of customers connected to low-voltage networks, as well as the imminent introduction of full liberalization of the electricity market, bring forth questions regarding the load management in residential buildings.

In order to demonstrate the possibilities for energy savings and for the management of load characteristics in residential buildings, load profiles for dwellings with high energy efficiency class, low energy efficiency class, and a dwelling with centralised heating and standardised load profile (SLP) were analysed. The comparison was made with real data for January 2021, which is characterized by relatively mild weather but also with short periods

of lower temperatures and can serve as a generalisation for the entire winter season. The resulting load schedules are shown in Figure 2 and the calculated electricity costs in Table 1.

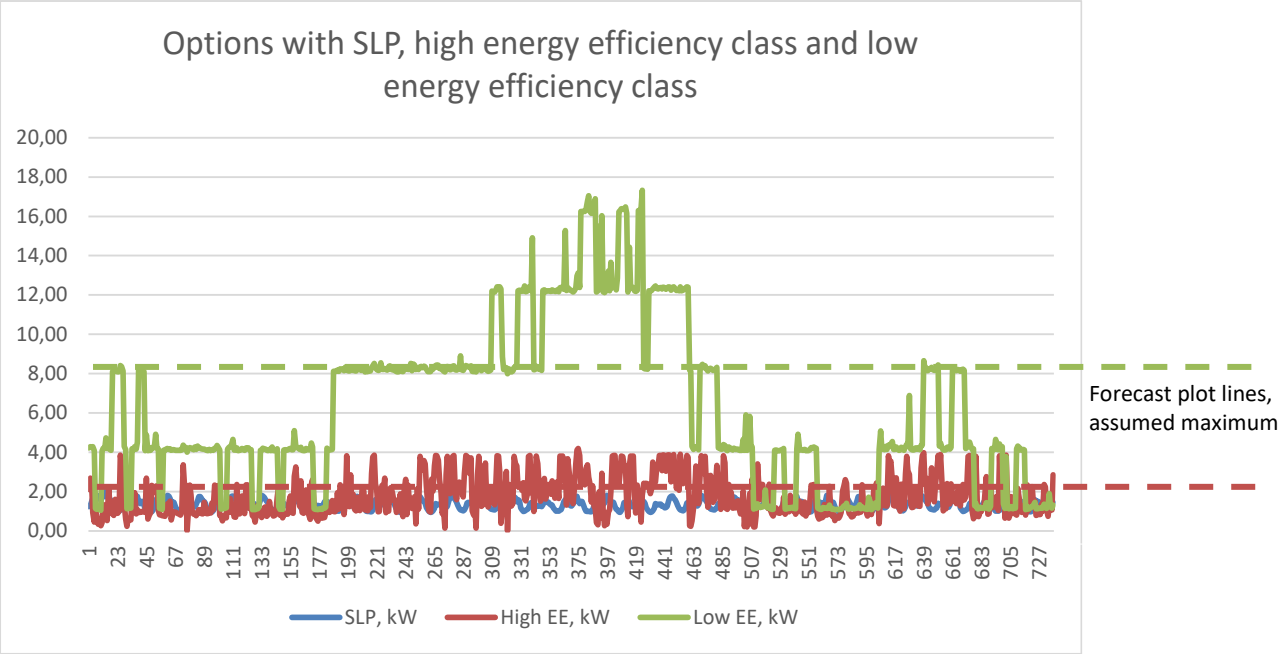


**Figure 2.** Options with SLP, high energy efficiency and low energy efficiency homes
*Source: own analysis according to data from IBEE, CEZ and real measurements*

**Table 1.** Comparison of electricity costs energy on regulated and free market

| | | Central heating and SLP | High EE home | Low EE home |
|---|---|---|---|---|
| Consumption of electricity | kWh | 1 000 | 1 308 | 4 611 |
| only for heating | kWh | 0 | 1 185 | 4 414 |
| Expenses on regulated market | BGN | 93 | 122 | 428 |
| Expenses on free market | BGN | 106 | 156 | 567 |
| Balancing when exceeded | kWh | 0 | 145 | 709 |
| Expenses for exceeding | BGN | 0 | 32 | 150 |
| Balance line | kW | 1,99 | 2,38 | 8,00 |

It is obvious that for low energy efficiency homes using electricity for heating, it is not profitable to join the free market. Unfortunately, their heating alternatives are in most cases linked to emissions of harmful gases and substances and low raw material utilisation rates. The impending mass entry into the free market will present many households with the challenge of providing the necessary comfort and adequate cost management.

According *to the Long-Term National Strategy to support the renovation of the national building stock of residential and non-residential buildings by 2050* about 91% of the residential buildings are characterised by poor energy performance –energy classes E, F and G. It is for this reason that a macro-level assessment of the impact of deep building renovation on the loads of the ES (Figure 3) has been assessed below, under the following assumptions:

- only non-district heated multi-family residential buildings are included;
- total number of buildings included – 29 300;
- floor area - 57 million $m^2$;
- achieving energy class A after renovation.

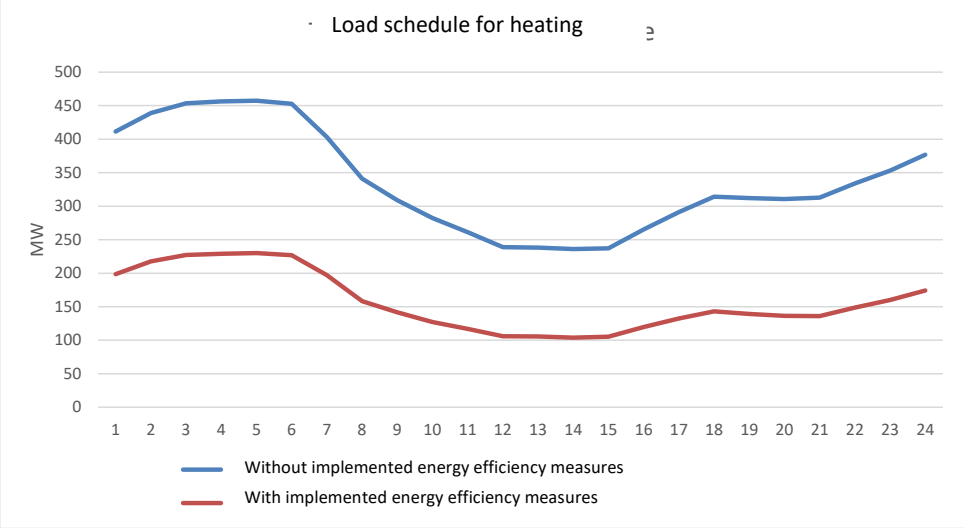


**Figure 3.** Average daily electricity consumption for heating during the heating season

The deep renovation of the considered group of buildings will lead to a reduction of the required power at national level in the range of 130 –230 MW, with the most significant effect during the night hours corresponding to the lowest temperatures. The potential electricity savings for the specific group of buildings, calculated on the basis of the above assumptions, amount to about 1,5 TWh/year.

Data from the NSI on the national energy balance for 2018, as well as data from Eurostat, were used to confirm the results obtained and to produce systematic assessments regarding the impact of electricity consumption in the national electricity system. Figure 4 shows the energy distribution, by type of use, for the entire building stock of the country. Interpolating the results of the previous analyses, the total potential for reduction of electricity for heating in the household sector can be estimated. In case the total residential building stock meets the national nZEB definition, we can expect reduction of the electricity consumption in the amount to 3 TWh/year.

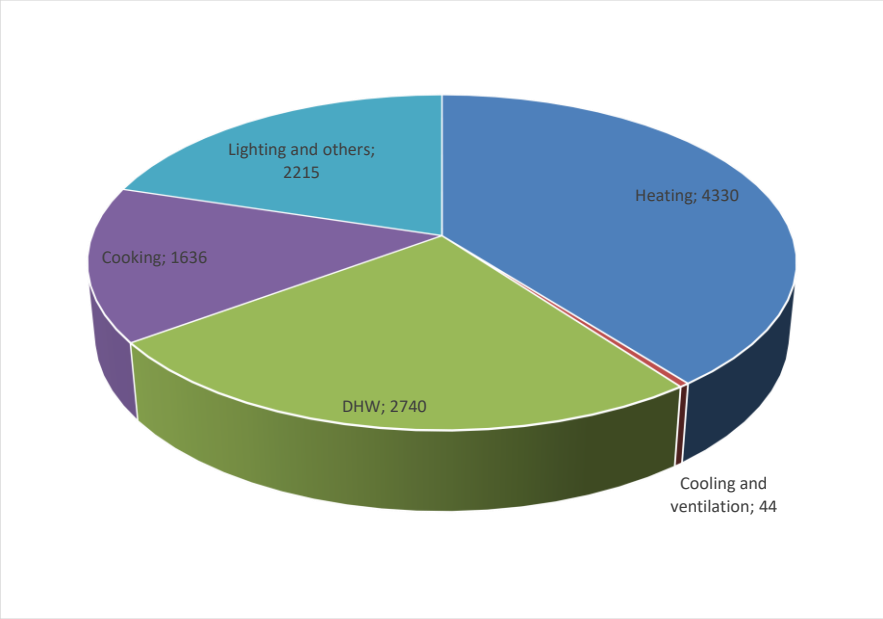


**Figure 4.** Distribution of electricity consumption in households according to 2018 data (GWh/year)

However, it should be borne in mind that the main measures to achieve deep renovation, namely the building envelop measures, are of a rather static nature and the harnessing of this potential, although it will reduce the overall load on the system during the winter months, will not result in a significant 'smoothing' of peak loads. These loads are mostly dependent on dynamic household consumption associated with DHW, cooking, lighting, and appliance needs.

In order to analyse the available potential for reducing the load on the ES during relatively significant cold periods, an assessment of the peak load in the household sector during cold winter periods has been carried out and the results are presented in Table 2.

**Table 2.** Assessment of household consumption at peak winter load

| **Computational winter load for households, MW** | | Simultaneity coefficient |
|---|---|---|
| Heating | 1391,7 | 90% |
| DHW | 938,3 | 75% |
| Lighting, etc. | 252,8 | 50% |
| Cooking | 93,4 | 25% |
| Air conditioning | 7,5 | 75% |
| **Expected maximum** | **2683,7** | |

These results are consistent with the observed peaks in consumption on February 14, 2021 due to extremely low temperatures. In order to limit the load on the system at such times, it is particularly important to reduce the simultaneous use of the main electricity consumers, such as heating and DHW systems and more energy-intensive household appliances. Implementing these solutions in periods with daily outdoor temperatures below -5°C will lead to a significant improvement in the possibilities to manage the ES and limit the use of expensive peak generating capacity.

The results of the analysis show that deep building renovation can reduce the total ES load during the heating season without significantly changing the consumption profile. As a supplementary measure, the introduction of intelligent building management will lead to a 'smoothing' of load schedules, which will significantly improve the possibilities to manage the ES. However, in order to achieve these effects, the scope and depth of the building renovation should be significantly increased and the process of introducing the so-called 'smart networks' at national level should be accelerated. This process is expected to be stimulated by the transition of individual consumers from a regulated to a free electricity market, where, in addition to the increased cost-effectiveness of energy efficiency measures due to higher electricity prices, market opportunities are expected to be created to reduce household costs by limiting energy consumption at peak times using smart management systems.

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Full report (in Bulgarian):
http://www.eneffect.bg/images/upload/new/Potreblenie%20domakinstva_FINAL.pdf