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CONSUMPTION PROFILE AS A BASE FOR DESIGNING RES USING SIMULATION TOOLS

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Abstract: Nowadays, projecting of the renewable energy sources (RES) through simulation program is the very popular. In case usage RES in systems with stable consumption the simulations are sufficiently the exact. The problem arises, when it is necessary to simulate the supply from an unpredictable energy source to a system with unstable or unknown consumption. In particular, in residential buildings, it is very important to know the detailed consumption profile of heat and hot water consumers in the proper design of the RES. Underestimating its importance may lead to significant financial losses of the investor, user of RES technology.

1 Introduction

In discussions about the energy intensity of housing, it said more and more about the notion "consumer profile", recently. Its importance is growing with the increasing share of renewable energy use due to its unpredictability. In fact, it is very important taken into account their instability with potential energy instability. The same proportion of its importance can be attributed to the size and type of the customer. If we move only at the level of the communal sphere, the most problematic is the consumer profile of the apartment houses [16]. It is almost impossible to find two type identical apartment buildings with an identical profile of consumption of heat, hot water and electricity. The reason is simple - people.

The energy performance in buildings is influenced by many factors, such as ambient weather conditions, building structure and characteristics, the operation of sub-level components like lighting and HVAC systems, occupancy and their behaviour [3]. It is important to identify the cluster of households when analyse the load profile, because the load profile depends very much on the occupancy pattern [4]. Parker [5] noticed occupant number as the key determinants of DHW consumption and importance of occupancy pattern for modelling of domestic energy consumption [6]. The consumption of energy in case of using appliances, lighting, DHW was depended on the activity of the apartment residents [7].

2 Need for energy versus consumption in apartment buildings

When assessing apartment buildings in terms of their energy intensity are usage two main processes – standardized vs. operational evaluation. Common practice is combination both processes. The basic difference in determining the energy intensity is that while in a standardized assessment, technical factors are taken into account, such as:

- thermal technical properties of the building envelope,
- technical parameter of thermal source,
- floor and utility area of the building,
- estimated number of users,
- location and so on,

In operation assessment is considered in addition to the above, in addition to these data:

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- real measured consumption of the house for as long as possible,
- operating time of appliances,
- operating parameters of heating systems and system for DHW,
- behaviour of consumers and other.

In general, a standardized calculation is used to design the energy system of the new house, and the experienced designer will also take into account experience with the operation of similar buildings. If a "standard" source, such as district heating, boiler, electric heating, etc. is proposed as a source of energy, the potential difference between planned demand and real consumption is not problematic [9]. These heat sources have a sufficiently large range to cover the resulting supply differences, such as the AH in Spišská Nová Ves. The figure below shows the difference in actual heat consumption compared to the need for standardized calculations. The differences range from about 1,500 kWh per month in winter to about 300 kWh / month during the summer season.

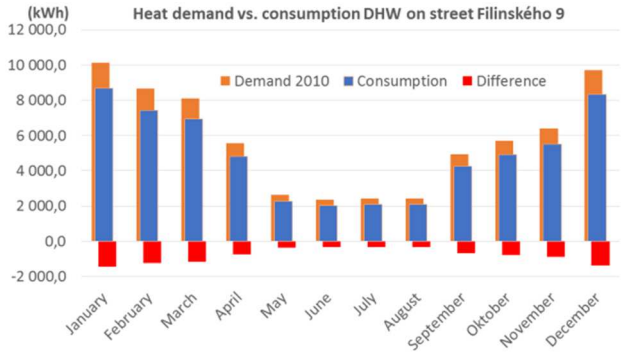

Figure 1 Heat demand vs. heat consumption in the apartment house in 2010

For larger differences caused by, for example, thermal insulation of the house or behaviour of the inhabitants, it is necessary to consider change, respectively. adjustment of the heat source. In this case, the heat consumption in three months is lower by almost 3,000 kWh / month and the year-round difference is almost 40 MWh.

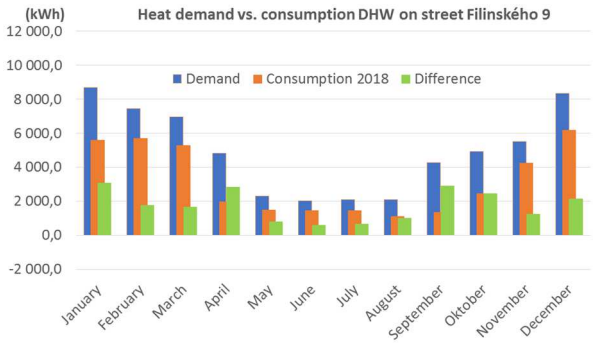

Figure 2 Heat demand vs. heat consumption in the apartment house in 2010

It is therefore obvious that knowing the heat consumption is important. However, when providing heat for heating, the minimum difference between calculation and measurement is more likely than to determine the need for heat for the preparation DHW. Although, of course, exceptions confirm the rule. Consumption of heat water is very affected consumer behaviour regardless of the thermal performance of the building envelope (if not considered in extreme cases) [13]. Establishing a relatively accurate DHW consumption in a residential building by calculation is virtually impossible, and only a very complex modelling process can be used to produce a serious consumption profile. However, even these cannot be developed without the values obtained by detailed and long-term measurements.

As is evident from the graphical representation of the hot water consumption trends in the house under consideration, the differences with the standard values are more pronounced every year, which may be due to more responsible behaviour of the population, a certain weight can be attributed to the modernization of the distribution system in the house.

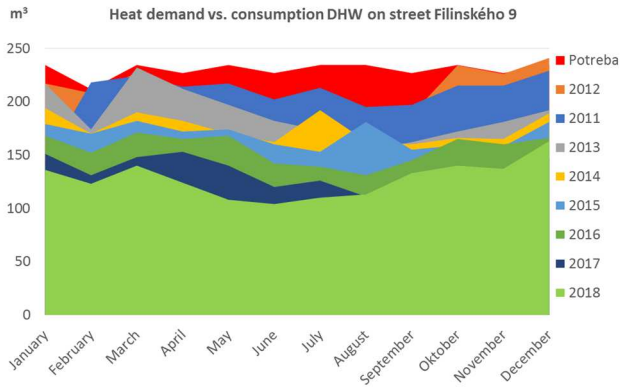

Figure 3 Heat demand vs. heat consumption in the apartment house in 2011 - 2018

The difference in DHW consumption by more than 55% compared to the standardized value of the need is already considerable and not only technological but also economic difference represents a significant difference in the use of renewable resources. While in the case of a traditional energy source, excess heat is neither produced nor taken away, in the case of a RES-based improperly sized energy source, excess energy is produced regardless of consumption, so it is very easy to get into the situation when the owners' money goes in unused energy. Precise design of a renewable resource is necessary but impossible without knowing the behaviour of the population - i.e. without a detailed consumption profile. In the case of investing in the renovation of a house and a renewable energy source such as EPC, this is doubly true. In the case of a stable alternative source of energy, for example, based

on the production and use of hydrogen, this problem is not so striking [9-17].

3 Consumption profile and financing RES in apartment buildings

Because RES technologies still represent a significant higher financial burden than "standard" energy sources, their projecting and planning use must be solved precisely and always in more variations.

This is the only way for the future user to choose the one that best suits his needs and the behaviour of the residents of the house. As an example, the AB in Spišská Nová Ves with the average monthly energy consumption for DHW preparation in the last years at the level of 7,000 kWh and the consumption profile according to the graph in fig. 4.

By appropriately dimensioning the solar system, it is possible to provide coverage of the total heat demand for DHW preparation at 58%, while overproduction of heat is not present in summer despite the lowest monthly consumption. 50 pcs of selected solar collectors will suffice for this consumption. For the sake of simplicity, only the numbers and prices of solar collectors are given, the relevant technologies are not quantified. However, the solar system designed in this way already has a solar heat deficit in March, April and September and October.

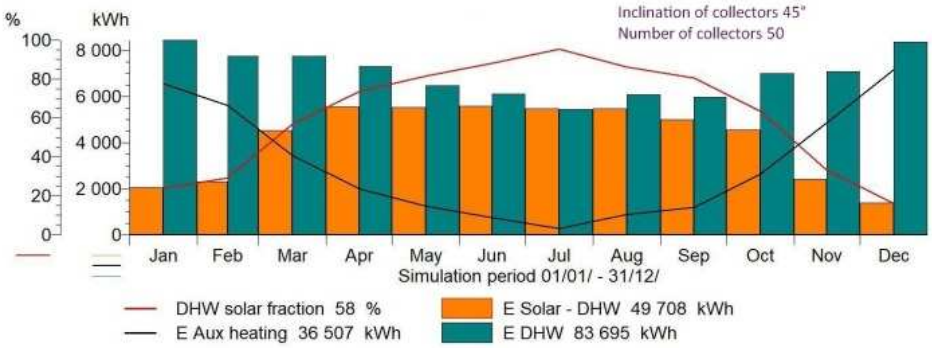

Figure 4 Solar energy contribution to DHW from solar system with 50 collectors, inclination 45°

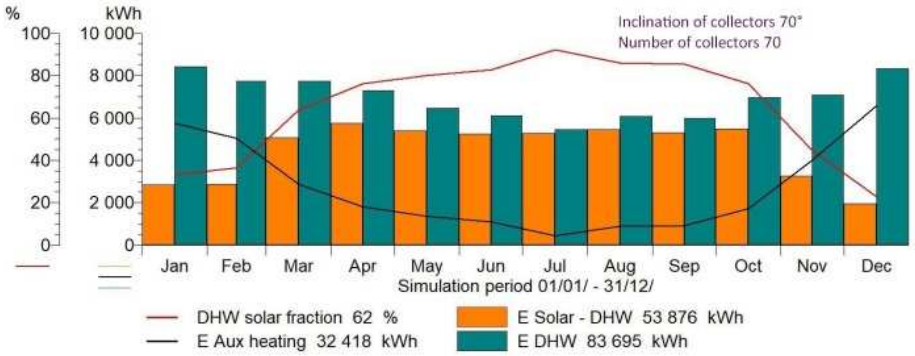

Figure 5 Solar energy contribution to DHW from solar system with 70 collectors, inclination 70°

If the user is interested in increasing the solar share even in the aforementioned problematic months, the solar system can be adjusted by increasing the inclination of the collectors and increasing their number. At a inclination of 70 ° and a number of collectors 70, the solar share has increased significantly in the required months and the total solar energy benefit has risen to 62%.

However, it is questionable whether a 4% increase in the solar share represents the same financial benefit for users. For the price of natural gas in a given dwelling house € 0.054 / kWh (for the sake of simplicity it is not considered again with other costs for the natural gas), such a solar benefit for an apartment building amounts to € 180.00 per year.

So the price of one solar collector at the level of 700, - €, the investment is increased by 14 000, - €, which in terms of a return is 78 years!

Thus, if the designer does not have a detailed and stable consumption profile and is based only on standard values, it is possible to oversize the solar system by tens of percent! The heat produced in summer will not be utilized and the return on investment may exceed the life of the system.

A similar situation may arise if apartment owners decide to finance the renewal of the house and new RES-based energy equipment in the form of EPC (Energy Performance Contracting), thus one of the forms of energy guaranteed service. The essence of the EPC is that the EPC provider itself will provide financing for home renovation

and energy technology. The owner of the house repays the investment only from the savings achieved, while the contract is set so that part of them remain to him.

However, the service of guaranteed energy service requires a great responsibility of the customer. A precondition for maintaining guaranteed savings is the strict adherence to the operation of the building as set out in the EPC project. This point is a critical point for residential buildings, because it is very difficult, if not impossible, to guarantee the operation of energy systems according to the rules, among others:

- fixed and maintained temperature of individual spaces, including apartments,
- default hot water consumption.

In an apartment building with dozens of dwelling units and hundreds of users, such operations are very difficult to maintain, and this is the reason why EPC service providers are cautious. However, as there is some tolerance in determining energy behaviour rules, in the case of a sufficiently detailed long-term and stable consumption profile, EPC service providers are willing to discuss with the administrators and owners the conditions of mutual cooperation.

4 Conclusion

The conclusion can be summed up in a single sentence - No measurement no steering! This is especially true for the relationship between apartment buildings and renewable energy sources. Two non-predictable systems are very difficult to align into an optimal system from an energy, economic and user-friendly perspective.

It is necessary to get used to the fact that high-quality measuring systems in a residential building are not a burden, but to help reduce energy costs. Whether energy management or the use of energy that is renewable and clean.

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