Calculation of energy consumption and energy savings

This document describes the method for the social housing organisations how to calculate the energy consumption and the energy savings that the residents have achieved during the Energy Ambassador program.

Gas consumption, electricity consumption and heat consumption (for communal or district heating) can be calculated. For a fair comparison of the energy consumption of different households and different periods, the consumption data need to be normalized for a certain period, such as one day or one year.

The electricity consumption is nearly constant over the whole year. Therefore, for comparison between households and between periods, the electricity consumption is converted to a consumption per day. The gas and heat consumption depend on the outdoor temperature, because most of it is used for heating. To compensate for the outdoor temperature, gas and heat consumption data are converted to consumption per degree day. Degree days are the number of days weighted for the temperature. Detailed degree day data are available from national meteorological institutes. If a dwelling is heated using electricity, then the calculation of the energy consumption should also include the correction for degree days, but the results are less accurate because of the large share of electricity consumption for e.g. lighting and appliances.

Degree days

Heating degree days is a measure for the need for heating a house. To maintain a certain indoor temperature (e.g. 20°C), no heating is required above a certain outdoor temperature (e.g. 18°C). This temperature is called the reference temperature (typically 18°C). Below this reference temperature, heating is required in proportion with the number of degrees below the reference temperature. If the average outdoor temperature of one day is 1°C below the reference temperature, then it is accounted as 1 degree day. The sum of degree days over a period is a measure for the amount of heating needed in that period.

What is needed for the calculations?
For the calculation of the energy consumption, you need:

- A meter reading at the start of the monitoring period
- A meter reading at the end of the monitoring period
- For gas or heat consumption, the number of degree days during the monitoring period (available from national meteorological institute)

For the calculation of the energy savings, you also need:

- The energy consumption in the same period one year earlier (e.g. energy bill)
- For gas or heat consumption, the number of degree days during this previous period (available from national meteorological institute)

Calculation of the electricity consumption

To calculate the daily electricity consumption, the difference between the meter readings is divided by the number of days in the period covered. To calculate the electricity consumption extrapolated to 1 year, the daily electricity consumption can be multiplied with 365 days. The electricity consumption in the previous period, extrapolated to 1 year, can be calculated by dividing the electricity consumption in the previous period by the number of days in that period, and multiplying with 365 days. The difference between the yearly electricity consumption in the previous period and in the monitoring period is the annual electricity savings achieved.

$$Electricity\ consumption\ _{day}\ (kWh/day) = \frac{meter\ reading_{end} - meter\ reading_{start}}{days\ in\ period}$$

$$Electricity\ consumption\ _{year}\ (kWh/yr) = Electricity\ consumption\ _{day} * 365\ days$$

$$Electricity\ savings\ (kWh/yr) = \ 365 * \frac{Electricity\ consumption_{previous}}{days\ in\ previous\ period} - Electricity\ consumption_{year}$$

Calculation example

A household has the following meter readings: 12300 (1 December 2016); 13200 (28 February 2017). The previous energy bill was: 3960 kWh (from 10 November 2015 to 5 November 2016).

The daily electricity consumption during the monitoring period is: (13200 – 12300) / 90 days = 10 kWh/day

The electricity consumption extrapolated to 1 year is: 10 kWh/day * 365 days = 3650 kWh/yr

The electricity savings extrapolated to 1 year is: 365 * (3960 kWh / 360 days) – 3650 kWh/yr = 365 kWh/yr

Calculation of the gas consumption

The calculation of the gas consumption is similar to that of electricity consumption, but the gas consumption need to be normalized using the degree days in a period. To calculate the gas consumption per degree day, the difference between the meter readings is divided by the number of degree days in the period covered. To calculate the yearly gas consumption, the gas consumption per degree day can be multiplied with the number of degree days in one year.

$$Gas\ consumption\ _{degree\ day}\ (m^3/degree\ day) = \frac{meter\ reading_{end} - meter\ reading_{start}}{degree\ days\ in\ period}$$

$$Gas\ consumption\ _{year}\ (m^3/yr) = Gas\ consumption\ _{degree\ day} * degree\ days_{year}$$

$$Gas\ savings\ (m^3/yr) = \ degree\ days_{year} * \frac{Gas\ consumption_{previous}}{degree\ days\ in\ previous\ period} - Gas\ consumption_{year}$$

Calculation example

A household has the following meter readings: 9870 (1 December 2016); 10520 (28 February 2017). The previous energy bill was: 1700 m^3 (from 10 November 2015 to 5 November 2016). The period 1 December 2016 – 28 February 2017 accounted for 1100 degree days. The period 10 November 2015 – 5 November 2016 accounted for 2700 degree days. The year 2016 has 2785 degree days.

The gas consumption per degree day during the monitoring period is: (10520 – 9870) / 1100 degree days = 0.59 m^3/degree day

The gas consumption extrapolated to 1 year is: 0.59 m^3/degree day * 2785 degree days = 1640 m^3/yr

The gas savings extrapolated to 1 year is: 2785 * (1700 m^3 / 2700 degree days) – 1640 m^3/yr = 114 m^3/yr

Calculation of the heat consumption (for communal or district heating)

The calculation of the heat consumption is similar to the calculation of gas consumption, but with heat consumption and meter readings (in MJ or GJ) instead of gas consumption and meter readings (in m^3).

Combining different types of energy in one total

To combine the energy consumption of different energy carriers such as electricity and gas, the consumption figures need to be converted into primary energy. Primary energy is the energy contained in raw fuels and other forms of energy input in a system.

For electricity, the primary energy is the amount of electrical energy divided by the generation efficiency of electricity. The generation efficiency is different per country and is provided by the national government.

For gas, the primary energy is the gas consumption multiplied with the upper caloric value of natural gas. This value is different per country and is provided by the national government or by natural gas suppliers.

For heat, the primary energy is the amount of electrical energy divided by the generation efficiency. The generation efficiency is provided by the heat suppliers or the producer of the boilers, or else a default efficiency of 90% can be assumed.

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TRIME is a Pan-European project helping social housing customers reduce their energy use; enabling them to save money and live a healthier lifestyle.