Improving the performance of District Heating Systems in Central and Eastern Europe

KeepWarm Impact Monitoring

Horizon 2020 (H2020-EE-2017-PPI)
Project N°784966

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KeepWarm Impact Monitoring

The KeepWarm project has defined seven Indicators, which will contribute to the validation of the project's impact. The following section provides an overview of these indicators as well as a short explanation and the guidance on how the KeepWarm project will assess these impacts during and beyond the project lifetime.

Baseline for the expected improvements are the Feasibility Studies and the related Business Plans including funding. Since the individual DHS approaches will not be completely implemented by the end of the project, KeepWarm will multiply the expected outcome with 20 since this is the average lifetime of such an improvement/ installation.

Primary energy savings

This indicator has two sub-components:

1. improvements of the efficiency of the system in each target DHS
2. the combined primary energy savings triggered by the project in its pilot systems

In both cases, energy efficiency measures will occur in different areas: improvements to the plant or the grid, better organizational management or improved consumption by the end-consumer. The exact ratio of energy inputs versus heat consumption can only be measured by the end of the project and will depend on the measures to be taken (i.e. in the future business plans).

Needed Values for the calculation:

- Primary energy input baseline ($Energy_{base}$)
- Heat consumption baseline ($Consum_{base}$)
- Primary energy input after optimization ($Energy_{final}$)
- Heat consumption after optimisation ($Consum_{final}$)

Calculate the total baseline and total final efficiency of the DHS:

$$efficiency_{base} = \frac{consum_{base}}{energy_{base}}$$

$$efficiency_{final} = \frac{consum_{final}}{energy_{final}}$$

Calculate a new adjusted baseline primary energy input, adjusted by the new final consumption and the baseline efficiency:

$$energy_{base-adjusted} = \frac{consum_{final}}{efficiency_{base}}$$

Subtract the final primary energy input from the new baseline primary energy input:

$$energy\ savings = energy_{base-adjuste} - energy_{fina}$$

<u>*Example*</u>:

A DHS has a baseline primary energy input of 1800 GWh per year and 1260 GWh of heat have been delivered to customers. *During the project the DHS increased their number of customers. After the optimisation, the DHS has a final primary energy input of 2000 GWh and sells 1600 GWh of heat.*

$$efficiency_{base} = \frac{1260\ GWh}{1800\ GWh} = 70\ \%$$

$$efficiency_{final} = \frac{1600\ GWh}{2000\ GWh} = 80\ \%$$

$$energy_{base-adjusted} = \frac{1600\ GWh}{70\ \%} = 2285\ GWh$$

$$energy\ savings = 2285\ GWh - 2000\ GWh = 285\ GWh\ savings$$

Increased share of renewables

Based on the mentioned feasibility studies and business plans it is expected that the improvements/ new installations will allow some of the systems to switch heat generation at least partially to less CO_2 intensive options.

For this measure, KeepWarm uses the absolute increased amount of used RES from primary energy demand. However, a decreased primary consumption of RES through efficiency gains will be counted with 0.

<u>Calculation:</u>

$$RES\ increase = energy_{\ final\ from\ RES} - energy_{base\ from\ RES}$$

<u>*Example 1:*</u>

A DHS has a baseline primary energy input of 1800 GWh per year from gas. During the project, they install a biomass boiler. After the project the input is: 1500 GWh Gas and 300 GWh biomass.

$$RES\ increase\ = 300\ GWh -\ 0\ GWh\ = 300\ GWh\ increase$$

Increased RES share = 300GWh/1500GWh – 0GWh/1800GWh = + 20%

Example 2:

A DHS has a baseline primary energy input of 1800 GWh per year from gas and 200 GWh biomass. During the project, they install a bigger biomass boiler. After the project the input is: 1800 GWh Gas and 500 GWh biomass.

$$RES\ increase\ = 500\ GWh -\ 200\ GWh\ = 300\ GWh\ increase$$

Increased RES share = 500GWh/(1800+500)GWh – 200GWh/(1800+200)GWh = 21.7% - 10% = 11,7%

Example 3:

A DHS has a baseline primary energy input of 1800 GWh per year from biomass. During the project optimize and have efficiency gains. After the project, the input is 1500 GWh biomass.

$$RES\ increase\ = 1500\ GWh -\ 1800\ GWh\ = 0\ GWh\ increase$$

Increased RES share = 1500GWh/1500GWh – 1800GWh/1800GWh = 0%

Reduction of greenhouse gas emissions

GHG reduction is due to efficiency gains, switching from fossil fuels to RES or due to a switch from less intense fuels. This combination may lead to a 15-50% reduction of GHG emissions, which can be calculated from the expected primary energy savings and RES production that replaces heat generation using fossil fuels.

The conversion factors are based on sources according to IPCC[26].

Calculation:

There are two types of calculation of the greenhouse gas emissions depending of the change in primary energy demand:

The primary energy input stays constant or reduces because of efficiency gains or a switch to a less intense fuel: KeepWarm will subtract the final CO_2 emissions by the CO_2 emissions baseline.

$$CO2\ reduction\ = CO2\ emissions_{\ base} -\ CO2\ emissions_{final}$$

The primary energy input increases: KeepWarm will calculate adjusted baseline CO_2 emissions according to the new final primary energy input and calculate the CO_2 reduction

[26] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

afterwards like it has been done in the first example 1.

$$CO2\ emissions_{\ base-adjuste} \quad = energy_{\ final} \times Conversion\ factor_{base}$$

$$CO2\ reduction \ = CO2\ emissions_{\ base-adjusted} - \ CO2\ emissions_{final}$$

Example 1:

A DHS has a baseline primary energy input of 1800 GWh per year from gas. The baseline CO_2 emissions are about 95 500 tons. During the project, they install a biomass boiler. After the project the input is: 1500 GWh Gas and 300 GWh biomass. The final CO_2 emissions are about 79 500 tons.

$$CO2\ reduction \ = 95\,500\ tons - \ 79\,500\ tons \ = 16\,000\ tons$$

Example 2:

A DHS has a baseline primary energy input of 1800 GWh per year from oil. The baseline CO_2 emissions are about 139 000 tons. During the project, they install a gas boiler and gain efficiency gains. After the project the input is: 1000 GWh Oil and 500 GWh gas. The final CO_2 emissions are about 104 000 tons.

$$CO2\ reduction \ = 139\,000\ tons - \ 104\,000\ tons \ = 35\,000\ tons$$

Example 3:

A DHS has a baseline primary energy input of 1800 GWh per year from gas. The baseline CO_2 Emissions are about 95 500 tons. During the project, they install a biomass boiler and connect new customers. After the project the input is: 2000 GWh Gas and 300 GWh biomass. The final CO_2 emissions are about 106 200 tons.

$$CO2\ emissions_{\ base-adjusted} \ = 2300\ GWh_{final} \times 53.1_{conversion\ factor\ base\ (gas)} = 122\,100\ tons$$

$$CO2\ reduction \ = 122\,100\ tons - \ 106\,200\ tons \ = 15\,900\ tons$$