**Energy efficiency and $CO_2$ emissions reduction**
**Evaluation and calculation methods**

User instructions

Within the framework of the project Urb.Energy, the Center of Competence for Major Housing Estates with its associated partners, the Department for Urban Development of the Senate of Berlin, the Lichtenberg district and HOWOGE Housing Association Ltd. implemented the task to evaluate and depicts measures and results of integrated urban development as well as energy refurbishment of the past twenty years on the example of two residential areas.

For this purpose it was necessary to develop a calculation model that is as simple as possible and can also provide a comprehensive overview regarding the achieved results.

The developed model meets these requirements (in a particular way). There is a simple scheme, which can produce an overview of the energy situation of an entire city district regardless of its respective building structure, which is sufficiently accurate for this purpose.

This gives the owners and especially the municipalities the opportunity to achieve a basic overview on the energy situation of an urban district and to formulate priorities for necessary action, without the need of getting additional information from other apartment owners.

The benefits for transnational cooperation of cities are diverse and include the following points in particular:

- The calculation tool is independent of the building structure of the respective urban district. For this reason it can be used by municipalities for the entire city.
- The calculation tool is independent of the ownership structure in the respective country. This makes it particular interesting for countries and municipalities where there is still a lack of a well-organized housing economy and otherwise a large effort in data collection would occur.
- It offers municipalities an easy way to compare neighborhoods, to develop neighborhood-specific strategies and to set priorities for urban development policies.
- The calculation tool sets a uniform/standardized calculation scheme, so that equal numbers, values, and results are available and can be compared in various countries/transnational.

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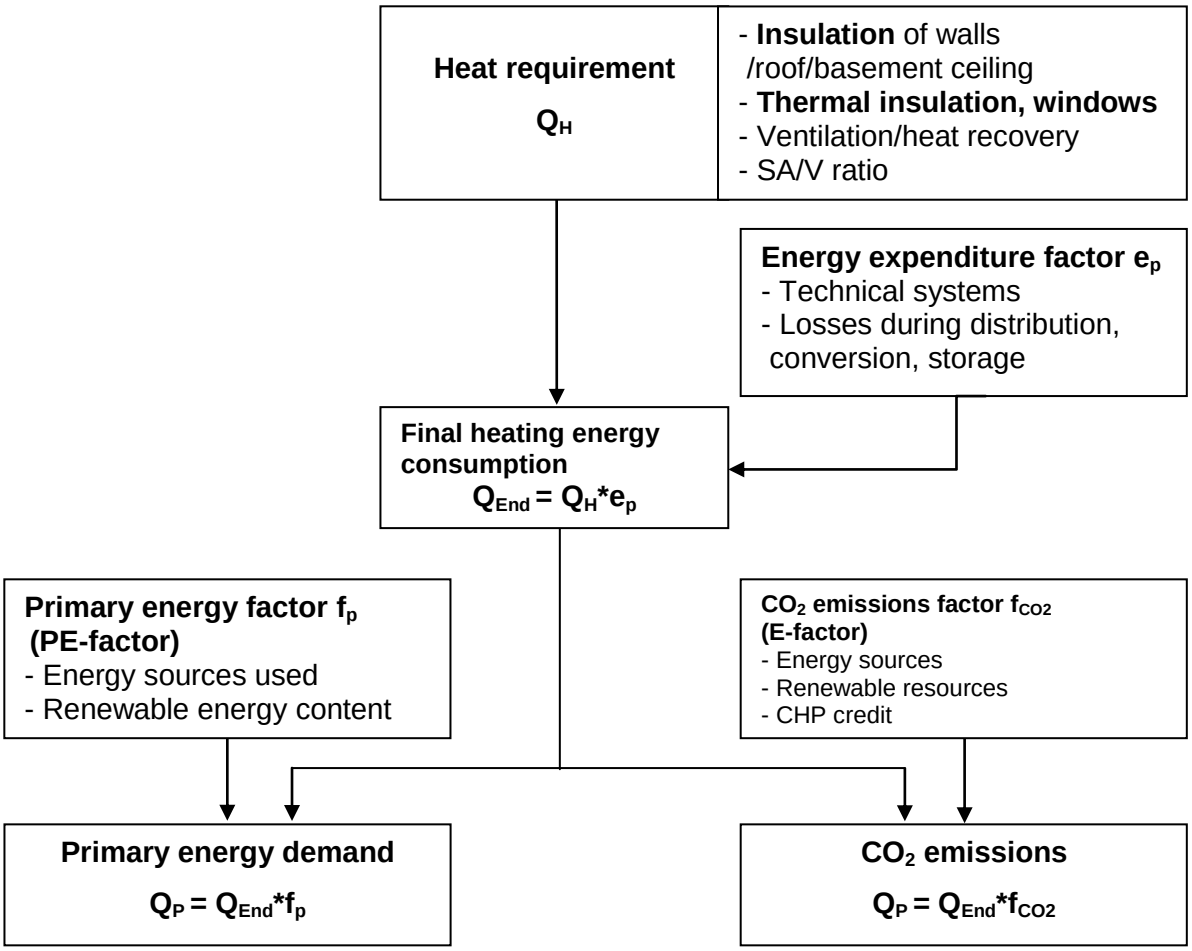
# 1 Principle

The calculation tool depicted allows the determination of key energy values for buildings, neighbourhoods or municipal districts. That determination takes place on the basis of the calculated energy requirement.
This involves performing an assessment of the initial state (e.g. pre-renovation state) and an assessment, in principle identical, for the target state (e.g. post-renovation or planning state), enabling a calculation of the difference between the two states.

On the basis of key values for useful energy (heat requirement, potable water heating heat requirement), the final and/or primary energy requirement and $CO_2$ emissions are calculated, taking into account the building's technical systems, equipment and features and/or the energy sources used.

The chart below illustrates the calculation process:



## 2 Calculation table

The calculation table is set up such that one row is used to model the heating of space and one row is used for the use of energy to heat potable water for each building or type of building with identical or comparable building equipment.
As a result, in the case of maximal differentiation, one row is generated/used for heating and one for hot potable water for each building. If the buildings in an area are completely identical, only a single row is used.

The entries and calculations are performed per building/group of buildings in each row first for the initial state (columns B–O) and then for the target state (columns R–AD).

The following inputs/characteristics are required for the purposes of describing the initial state:

| | |
|---|---|
| Column A | Name of the building / type of buildings or group of buildings<br>(freely selectable) |
| Column B | Differentiation according to heating technology and/or potable water heating technology.<br>The building systems in place in the initial state are selected here. |
| Column C | Selection of the relevant energy source(s) |
| Column D | Input of the respective residential/total floor area<br>(poss. division of the floor area of a building/group of buildings based on presence of different equipment) |
| Column E | Input of useful energy, spec. value per m² residential/total floor area for<br>- heating<br>- hot potable water<br>Determination using example calculations as per DIN 4108, Part 6, or using table values/project documents |
| Column F | Calculated value for useful energy (absolute)<br>(column E * column D) |
| Column G | Input of energy expenditure factor<br>Value for the efficiency of existing building equipment<br>Determination according to table values from DIN 4701, Part 10, DIN 18599 or similar standards, poss. also from project documents |
| Columns H/I | Calculated value for final energy demand (absolute)<br>(column E/F * column G) |
| Column J | Primary energy factor<br>defined according to energy source selected for heating and/or hot water in column C (individual input option in rows 4-16) |
| Columns K / L | Calculated value for primary energy demand<br>(column H/I * column J) |
| Column M | $CO_2$ emissions factor<br>defined according the energy source selected for heating and/or hot water in column C (individual input option in rows 4-16, depending on local/national boundary conditions and/or specifications) |

Columns N / O — Calculated value for $CO_2$ emissions (column H/I * column M)

This generates the key findings for the assessment of the initial state.

Columns P / Q — Option to enter comments for planned/implemented changes

Column R onward — Input/Selection for the target state

Column R — Selection of the energy source after renovation or for the target state

Column S — Input of the residential/total floor area, poss. including changes due to expansion, new construction or demolition

Column T — Input of useful energy, spec. value per m² of residential/total floor area for
- heating
- hot potable water

Determination using example calculations as per DIN 4108, Part 6, poss. through sample calculations with various thermo-technical measures (insulating layer thicknesses, etc.) or from project documents

Columns U–AD
Input/Selection as in columns F–O for the post-renovation/target state

Columns AF–AQ
Calculation of the changes between initial and target states (absolute values)

Columns AS–BD
Calculation of the changes, as percentages