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Integration of Photovoltaic Electricity with Shallow Geothermal Systems for Residential Microgrids: Proof of Concept and Techno-Economic Analysis with RES2GEO Model

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Supplementary material: Algorithm for calculation of thermal demand

The algorithm is based on determining the heating and cooling flags. When heating or cooling flags are on (equal to one) the room temperature is equal to mid value between the max and min threshold values for heating/cooling.

The internal heat gains (from persons, lighting, solar gains) are included in the calculus as additional 3 degrees Celsius.

The algorithm is presented in the form of pseudocode:

get $\{T_{outdoor}\}, q_{m2}, A_{tot}$ ← input data
set $\{T_{indoor,0}\} = \{T_{outdoor}\} + 3°C$ ← indoor temperature, without heating (estimation)
set $i_Heat = 0$ ← flag, = 1 when heating is on, = 0 otherwise
set $i_Cool = 0$ ← flag, = 1 when heating is on, = 0 otherwise
For each hour i in Year:
    get hr → hour in a Day (1, 2, ... 24h)
    if $hr > 7_on$ and $hr < 19$:
        if $T_{indoor,0}(i) < T_{set,H,on}$:
            set $i_Heat = 1$
        if $T_{indoor,0}(i) > T_{set,H,off}$:
            set $i_Heat = 0$
        if $T_{indoor,0}(i) > T_{set,C,on}$:
            set $i_Cool = 1$
        if $T_{indoor,0}(i) < T_{set,C,off}$:
            set $i_Cool = 0$
    if $i_Heat == 1$:
        $T_{indoor}(i) = 0.5\left[T_{set,H,on} + T_{set,H,off}\right]$
        $\Delta T(i) = T_{indoor}(i) - T_{indoor,0}(i)$
    if $i_Cool == 1$:
        $T_{indoor}(i) = 0.5\left[T_{set,C,on} + T_{set,C,off}\right]$
        $\Delta T(i) = T_{indoor}(i) - T_{indoor,0}(i)$
    else:
        if $T_{indoor,0}(i) < T_{set,H,on,min}$:
            set $i_Heat = 1$
        if $T_{indoor,0}(i) > T_{set,H,off,min}$:
            set $i_Heat = 0$

if $i_Heat == 1$:

$T_{indoor}(i) = 0.5\left[T_{set,H,on,min} + T_{set,H,off,min} \right]$

$\Delta T(i) = T_{indoor}(i) - T_{indoor,0}(i)$

$\{\delta_T\} = \{\Delta T\} / \sum \Delta T(i)$ ← normalized temperature difference

$\{q_{net}\} = \{\delta_T\} \cdot Q_{m2} \cdot A_{tot}$ ← net heat flux, output

The results are presented in the Figure 3.a.