Simple method for Converting Installed Solar Collector Area to Annual Collector Output

Jan Erik Nielsen
ESTIF technical consultant
Collector size $\rightarrow$ Annual energy production

- CLIMATE
- SOLAR COLLECTOR
- COLLECTOR TYPE
- HEAT PRODUCED IN ONE YEAR
- APPLICATION TYPE
Solar Thermal Trade Associations

Input

Collector
- Size in m² OR Capacity in kW
- Type
  - Un-glazed
  - Glazed

Application
- Pool heating
- Domestic hot water
- Combined space heating and domestic hot water

Climate
- Global horizontal radiation
Output

To satisfy Eurostat and IEA definitions on primary energy, which is for solar thermal defined as:

- “Solar thermal production is the heat available to the heat transfer medium minus the optical and collector losses”.

Annual solar collector heat production = what comes out of the collectors
Equations (1)

Un-glazed Collectors for pool heating:

\[
Q_{\text{un-glazed collector}} = 0.29 \times H_0 \times A_a
\]

- **Q**: Annual collector output
- **H₀**: Annual global horizontal solar irradiation
- **Aₐ**: Collector aperture area
Equations (2)

Glazed Collectors in DHW:

\[ Q_{\text{glazed collector, DHW}} = 0.44 \times H_0 \times A_a \]

- **Q**: Annual collector output
- **H₀**: Annual global horizontal solar irradiation
- **A₀**: Collector aperture area

Glazed collectors: Glazed flat plate and evacuated tubular collectors
DHW: Domestic hot water systems
Glazed Collectors in Combi-systems:

\[ Q_{\text{glazed collector,Combi}} = 0.33 \times H_0 \times A_a \]

- **Q**: Annual collector output
- **H₀**: Annual global horizontal solar irradiation
- **Aₐ**: Collector aperture area

**Glazed collectors:** Glazed flat plate and evacuated tubular collectors

**Combi-systems:** Systems for combined space heating and domestic hot water system
Equations (4)

Weighted average (all collector types and applications):

\[
Q_{\text{weighted average}} = 0.42 \times H_0 \times A_a
\]

**Q**: Annual collector output

**H₀**: Annual global horizontal solar irradiation

**Aₐ**: Collector aperture area
References / validation

SOLAR HEAT WORLDWIDE

Markets and Contribution to the Energy Supply 2007

Table 3: Calculated collector yield and corresponding oil equivalent as well as CO2 reduction of all solar thermal systems (s) (systems for hot water, space heating and swimming pool heating) at the end of 2007

<table>
<thead>
<tr>
<th>Country</th>
<th>Total collector area [m²]</th>
<th>Total capacity [GW]</th>
<th>Calculated number of systems</th>
<th>Collector yield [GWh/a]</th>
<th>Collector capacity [GW/a]</th>
<th>Energy savings - oil equivalent [GWh/a]</th>
<th>CO2 reduction [t/a]</th>
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</thead>
<tbody>
<tr>
<td>Austria</td>
<td>6,184,000</td>
<td>1,180,000</td>
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<td>1,502,144</td>
<td>6,254</td>
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<td>7,020</td>
<td>2,803,124</td>
<td>3,059,726</td>
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<td>4,246</td>
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</tbody>
</table>

* Energy savings - Oil equivalent
** CO2 reduction - Only components that are relevant
## References / validation

<table>
<thead>
<tr>
<th></th>
<th>Unglazed</th>
<th>DHW-SFH</th>
<th>DHW-MFH</th>
<th>Combi-Systems</th>
<th>Weighted average</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of glazed area</td>
<td></td>
<td>95%</td>
<td>3%</td>
<td>2%</td>
<td>100%</td>
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<tr>
<td>% of total area</td>
<td></td>
<td>18%</td>
<td>79%</td>
<td>3%</td>
<td>100%</td>
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<tr>
<td>Mean value of constant, C</td>
<td>0.26</td>
<td>0.39</td>
<td>0.38</td>
<td>0.29</td>
<td>0.36</td>
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<tr>
<td>Std.dev.</td>
<td>0.04</td>
<td>0.05</td>
<td>0.03</td>
<td>0.05</td>
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<tr>
<td>Std.dev.%</td>
<td>14%</td>
<td>13%</td>
<td>7%</td>
<td>16%</td>
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</tbody>
</table>

*Un-glazed collector yield* = 0.26 * $H_0$

*Glazed collector yield, DHW* = 0.38 * $H_0$

*Glazed collector yield, Combi* = 0.29 * $H_0$

*Weighted average yield*, = 0.36 * $H_0$
Converting **Yield** to **Output**:

**Take into account pipe losses : 15%**

- **Un-glazed collector output** = 0.26 + 15 % = \(0.29\) \(H_0\)
- **Glazed collector output, DHW** = 0.38 + 15 % = \(0.44\) \(H_0\)
- **Glazed collector output, Combi** = 0.29 + 15 % = \(0.33\) \(H_0\)
- **Weighted average output** = 0.36 + 15 % = \(0.42\) \(H_0\)
Conversion factors, $m^2 \rightarrow kWh$, $c_{\text{weight}} \cdot H_0$ for EU-27 + CH

*) Based on weighted average $c = 0.42$
Conversions established:

\( m^2 \rightarrow kW: \)
- All collectors and systems: 0.7

\( m^2 \rightarrow kWh: \)
- Un-glazed collectors & pool heating systems: 0.29*\( H_0 \)
- Glazed collectors and water heating: 0.44*\( H_0 \)
- Glazed collectors and space & water heating: 0.33*\( H_0 \)

- Weighted average: 0.42*\( H_0 \)

\( kW \rightarrow kWh \)
- Weighted average (all collectors and systems): 0.6