Measured versus calculated energy use in Sweden

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Main conclusions

Measured EP in Sweden, normalized with respect to climate and behavior

• Energy use by *occupant’s behavior* explain a large part of the difference between calculated and measured energy use
• *Normal use* is not standardized and therefore not accounted for in the EPC
• Few buildings have energy meters that *separate energy use* for heating from energy use which should not be included in the EPC
• Bad compliance of the number of EPCs reported for new buildings is caused by *lack of follow-up actions*. There are no court cases of home owners lacking an EPC

To improve the EPC scheme, and quality of energy use calculation, further work is needed in the area of *standardizing input data, calculation procedures* and *reporting*
Background and introduction

• Performance based energy use demands in the building code 2006
  — Calculated, sent to municipality with the building permit application

• Energy Performance Certificates (EPC) introduced in 2006
  — Measured energy use (12 m within 24 m after commissioning)
  — Corrected to *normal use* during a *reference year*

• Correction to reference year by using the energy index
• No standardized methodology to account for normal use
System boundary for energy use in SE

1Transmission losses, air leakage, ventilation losses and such.
Methods

• Interviews with energy experts and energy and climate advisors

• Analysis of 44 single family houses from 2009 and onward with calculated and measured energy use

• Detailed study of 6 houses, data in building permit vs. EPC

• Analysis of 1753 EPCs from 2006 and onward in the metropolitan Gothenburg area — 1028 multi-family buildings and 725 single family houses

• Parametric study of the energy use in a single family house
Measured vs. calculated energy use

Average difference 25%. Largest difference 113%. Heated floor area measured wrong.
Large buildings have a lower difference in percentage than smaller buildings.
Detailed study of 6 houses

Energy use (kWh)

Differences for all buildings. Errors in both calculations and EPCs.
Large variation between the buildings, calculations and EPCs.

According to Sveby: 30 kWh/m²
## Parametric study

- Single family house (built in 2012)
- Light-weight wooden construction
- Ground source heat pump
- Exhaust air to water heat exchanger
- Indoor temperature 20°C, 21°C and 22°C

<table>
<thead>
<tr>
<th>Number of persons</th>
<th>Household electricity</th>
<th>Hot water consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.3 W/m² = 5 100 kWh/year</td>
<td>145 l/pers/d = 53 m³/year/pers</td>
</tr>
<tr>
<td>2</td>
<td>1.6 W/m² + 0.52 W/m²/pers = 2 500 kWh/year + 800 kWh/year/pers</td>
<td>38.4 l/pers/d = 14 m³/year/pers</td>
</tr>
<tr>
<td>4</td>
<td>32.9 l/pers/d = 12 m³/year/pers</td>
<td>Low (green/right)</td>
</tr>
</tbody>
</table>
Results of 54 occupant profiles

Indoor temp.  
Housh. elec.

DHW (m³/year)  
Color

1 person  
2 persons  
4 persons

Energy use (kWh/m²)

20°C  21°C  22°C  20°C  21°C  22°C  20°C  21°C  22°C

W/m² W/m² W/m² W/m² W/m² W/m² W/m² W/m² W/m²

2.2  2.2  2.2  2.7  2.7  2.7  3.7  3.7  3.7

3.3  3.3  3.3  3.3  3.3  3.3  3.3  3.3  3.3

Normal use is not defined. Can be 36% difference for 1 vs. 4 pers.
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! To improve the EPC scheme, and quality of energy use calculation, further work is needed in the area of *standardizing input data, calculation procedures* and *reporting*

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