Lighting systems and retrofit potentials based on a detailed assessment of 25 existing buildings

- Preliminary Results -

Anna Hoier, Fraunhofer Institute for Building Physics, Stuttgart, Germany
Industry Workshop Innsbruck, March 10, 2014
Lighting Situation and Retrofit

Knowing where you stand
to
See where you can go
Building Stock Distribution

© Marie-Claude Dubois, Technical Report T50.D1 „Building Stock Distribution and Electricity Use for Lighting“, to be published in 2014

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Building Typology (Germany)

Floor Area of Non-Residential Buildings

Percentage of Non-Residential Building Categories

- Trade & Storage: 27%
- Factory, Workshop: 19%
- Agriculture: 11%
- Office Buildings: 16%
- Educational Buildings: 16%
- Health Care: 16%
- Hotels & Restaurants: 16
- Other: 5%

Legend:
- Mean Values
- BPIE-Germany
- ENQUETE + newly built 1992-2011
- BMVBS-Online (mean value of 2 estimates)
- ENPER-Exist

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Building Typology ↔ Zone Typology

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Data collection by on-site inspections

• Variety of buildings from different types

• Assessing rooms/lighting areas, classified in zones

• Using „reLight“

Android based mobile application for smartphones and tablet-pc’s:

• Digital data recording on site

• Simplified energetic and ergonomic calculations

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Evaluation approach

Automated Process

On-site inspection with reLight → XML-file → Database (Access) → Evaluation of Data

Data from other sources
## Buildings inspected

<table>
<thead>
<tr>
<th>Building category</th>
<th>Building type</th>
<th>#</th>
<th>Total net floor area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade &amp; Storage</td>
<td>Trade</td>
<td>2</td>
<td>9.360 m²</td>
</tr>
<tr>
<td></td>
<td>Storage</td>
<td>3</td>
<td>21.189 m²</td>
</tr>
<tr>
<td>Industrial buildings</td>
<td></td>
<td>3</td>
<td>14.498 m²</td>
</tr>
<tr>
<td>Agricultural buildings</td>
<td></td>
<td>3</td>
<td>6.115 m²</td>
</tr>
<tr>
<td>Office buildings</td>
<td></td>
<td>3</td>
<td>4.196 m²</td>
</tr>
<tr>
<td>Educational buildings</td>
<td>School</td>
<td>3</td>
<td>7.897 m²</td>
</tr>
<tr>
<td></td>
<td>Children day care</td>
<td>3</td>
<td>4.036 m²</td>
</tr>
<tr>
<td>Health Care</td>
<td>Care home</td>
<td>5</td>
<td>12.353 m²</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>25</td>
<td>79645 m²</td>
</tr>
</tbody>
</table>
## Relevant Zones

<table>
<thead>
<tr>
<th>Zones</th>
<th>Number of rooms</th>
<th>Net floor area [m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>1,210</td>
<td>79,645</td>
</tr>
<tr>
<td>Traffic area</td>
<td>108</td>
<td>9,153</td>
</tr>
<tr>
<td>Store/technical rooms</td>
<td>94</td>
<td>3,711</td>
</tr>
<tr>
<td>Toilets, sanitary facilities</td>
<td>314</td>
<td>2,138</td>
</tr>
<tr>
<td>Office - personal</td>
<td>123</td>
<td>2,376</td>
</tr>
<tr>
<td>Office - workgroup (2-6)</td>
<td>72</td>
<td>2,673</td>
</tr>
<tr>
<td>Office - open space</td>
<td>6</td>
<td>465</td>
</tr>
<tr>
<td>Meeting, conference, seminar</td>
<td>19</td>
<td>677</td>
</tr>
<tr>
<td>Classroom</td>
<td>107</td>
<td>5,471</td>
</tr>
<tr>
<td>Sales area</td>
<td>5</td>
<td>7,679</td>
</tr>
<tr>
<td>Warehouse, logistics hall</td>
<td>17</td>
<td>16,394</td>
</tr>
<tr>
<td>Manufacturing hall</td>
<td>5</td>
<td>13,246</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>8</td>
<td>2,335</td>
</tr>
<tr>
<td>Bedroom (hospital)</td>
<td>212</td>
<td>4,427</td>
</tr>
<tr>
<td>Kitchen, canteen</td>
<td>29</td>
<td>1,382</td>
</tr>
<tr>
<td>Agricultural area</td>
<td>10</td>
<td>4,913</td>
</tr>
<tr>
<td>Others</td>
<td>81</td>
<td>2,598</td>
</tr>
</tbody>
</table>

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Evaluation - Electric Light: Type of Illumination

![Type of Illumination Graph]

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Evaluation - Electric Light: Type of Lamp

Type of Lamp

Others (mainly halogen)
LED
Energy saving lamp
Compact Fluorescent
Fluorescent T5
Fluorescent T8
Fluorescent T12
Incandescent

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Evaluation - Electric Light: Ballast
Evaluation - Electric Light: Light Management

Light Management

No control system

Occupancy & daylight dependent

Daylight dependent

Occupancy dependent

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Evaluation - Electric Light: Installed Power

![Graph showing installed power per square meter for different room types.](chart.png)
Evaluation - Daylight: Solar/Glare Protection

Solar / Glare Protection

- No Solar/Glare Protection
- Darkened Glazing
- Manual Solar/Glare Protection
- Automatic Solar/Glare Protection
Evaluation - Daylight: Daylight Availability

Percentage of Area Benefitting from Daylight

- TOTAL
- Traffic area
- Store/technical rooms
- Toilets, sanitary facilities
- Office - personal
- Office - workgroup (2-6)
- Office - open space
- Meeting conference, ...
- Classroom
- Sales area
- Warehouse, logistics hall
- Manufacturing hall
- Manufacturing
- Bedroom (hospital)
- Kitchen, canteen
- Agricultural area
- Others

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Evaluation - Energy Use (Zones)

[kWh/m²a] Energy Use

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Office Building

Industrial Building

Assumptions
- Electricity rate: 20 ct/kWh
- Rise in price: 4%
- Time period: 20 years

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Conclusion and Perspective

• Systematic investigation of building stock
  Building typology, zone approach

• Evaluation of 25 varying buildings
  • Typical lighting installation:
    direct, fluorescent (T8), no control system
  • Dependencies on usage, daylight etc.

• Next Steps
  • Further analysis and data collection
  • Use of data:
    o Basis for benchmarks in Lighting Retrofit Adviser of Task 50
    o Evaluation of standards