TRAINING SEMINAR ON HIGH-PERFORMANCE ENERGY EFFICIENCY STANDARDS IN BUILDINGS IN THE UNECE REGION

St. Petersburg, 5-7 September 2018

Practical examples of highly efficient buildings

Ideas for further steps of the training programme

Dr. Burkhard Schulze Darup, Architect
Co-chair of the Joint Task Force, Germany
Introduction: Development of the Building Code in Germany & Europe

- **Electricity**
- **Line loss**
- **Hot water**
- **Heating**

Source: Dr. Burkhard Schulze Darup, Architekt
Target: 95-percent reduction of greenhouse gas emissions until 2050

Balance between energy efficiency and renewables

Quelle: DGS / Schulze Darup: Gebäudetypologie und Energieeffizienzstrategie BRD, Berlin 2015
<table>
<thead>
<tr>
<th></th>
<th>Heating/Cooling</th>
<th>Hot Water</th>
<th>Ventilation Heat recovery</th>
<th>Electric Power Requirement</th>
</tr>
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<tbody>
<tr>
<td>Energy demand</td>
<td></td>
<td>25 kWh/(m²a)</td>
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<tr>
<td>Primary energy demand</td>
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<td>45 kWh/(m²a)</td>
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<tr>
<td>Primary energy demand</td>
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<td>90 kWh/(m²a)</td>
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renewable HVACR systems, Plus energy techniques

Efficiency components

Ventilation ≥ 80 %
heat recovery

High-efficiency-windows
Uw < 0.80 W/m²K

Air-tightness
n50 ≤ 0.6 h⁻¹

Main Passive House criterions:
energy requirement for heating ≤ 15 kWh/(m²·y)
combined primary energy consumption
heating, warm water, electricity ≤ 120 kWh/(m²·y)
### Building envelope

#### Development of standards since 1980

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<tr>
<td>Wall</td>
<td>0.40</td>
<td>0.30</td>
<td>0.24</td>
<td>0.20</td>
<td>0.18</td>
<td>0.15</td>
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<td>Roof</td>
<td>0.30</td>
<td>0.24</td>
<td>0.18</td>
<td>0.16</td>
<td>0.14</td>
<td>0.15</td>
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<tr>
<td>Ground</td>
<td>0.50</td>
<td>0.35</td>
<td>0.28</td>
<td>0.24</td>
<td>0.20</td>
<td>0.15</td>
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### Insulation Materials

- **Aerogel - Insulation**
  \[ \lambda_R = 0.014 - 0.019 \text{ W/(mK)} \]

- **Vacuum - Insulation**
  \[ \lambda_R = 0.006 - 0.008 \text{ W/(mK)} \]

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**Quelle:** Wienerberger Ziegelindustrie GmbH

**Quelle:** Variotec

**Quelle:** TEKOFIX

**Quelle:** KS-Piano
Development of Window-Standards

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<tr>
<td>$U_g$ [W/(m²K)]</td>
<td>1,8</td>
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<td>0,45</td>
<td>0,4</td>
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<tr>
<td>$U_f$ [W/(m²K)]</td>
<td>1,8</td>
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<td>0,6</td>
<td>0,55</td>
<td>0,5</td>
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<tr>
<td>g-value</td>
<td>60%</td>
<td>50%</td>
<td>52%</td>
<td>55%</td>
<td>55%</td>
<td>58%</td>
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Best practice – development 1980 - 2050

Source: Holger Barske
Development of Window-Standards

Best practice – development 1980 - 2050

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<td>55%</td>
<td>58%</td>
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Source: PHC
Franz Freundorfer

Quelle: Holger Barske
Investment costs for windows (€) per m² window area

Source: Ecofys, Schulze Darup: Preisentwicklung Gebäudeenergieeffizienz. – Im Auftrag der DENEFF Berlin 2014
### Ventilation with heat recovery

<table>
<thead>
<tr>
<th>Year</th>
<th>1980</th>
<th>1995</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2050</th>
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<tr>
<td>Heat recovery</td>
<td>65%</td>
<td>80%</td>
<td>85%</td>
<td>90%</td>
<td>92%</td>
<td>94%</td>
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<td>Electric-Efficiency [W/m³]</td>
<td>0,8</td>
<td>0,45</td>
<td>0,4</td>
<td>0,35</td>
<td>0,3</td>
<td>0,27</td>
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</tbody>
</table>
Cost reduction of decentral renewables – Windpower onshore

$/kW

- 61%

Source: Dr. Rainer Saliger, Siemens AG, CoC Dezentrale Energiesysteme; LBNL, Wind technologies market report 2014, Fraunhofer ISE PV report 2014, IHS Technology Battery report 2015, BNEF 2015
Cost reduction of decentral Renewables – Photovoltaics

Source: Dr. Rainer Saliger, Siemens AG, CoC Dezentrale Energiesysteme; LBNL, Wind technologies market report 2014, Fraunhofer ISE PV report 2014, IHS Technology Battery report 2015, BNEF 2015
Cost reduction of decentral Renewables – Li-Battery-Systems

Source: Dr. Rainer Saliger, Siemens AG, CoC Dezentrale Energiesysteme; LBNL, Wind technologies market report 2014, Fraunhofer ISE PV report 2014, IHS Technology Battery report 2015, BNEF 2015
Development of heating systems in the building sector until 2050

- Kohlekessel
- Ölkessel
- Gaskessel
- Wärmepumpen
- Biomassekessel
- Biomasse-KWK
- Erdgas-KWK
- Fernwärme

Quelle/Source: IWU / Prof. Dr.-Ing. Dieter Wolff - Ostfalia Hochschule Wolfenbüttel
Building services engineering until now

- Solar (warm water)
- TV
- HIFI
- Computer
- Computer
- Telephone
- Radio
- TV
- Fridge
- Dishwasher
- Refrigerator
- Drying
- Washing
- Regulation
- Heating & Warm water
- Storage
- Regulation
- Ventilation with heat recovery
Building services engineering in future

Facade- and roof integrated Photovoltaics

Internal grid – W-LAN

Info-tainment

Info-tainment

Info-tainment

IT, Communication, Entertainment, Regulation

Ventilation

Heating & Cooling

Storage

Kitchen

Bathroom & Washing

Internet

Smart grid

Feed-in
Life Cycle Analysis & Embodied energy: eLCA & Energetic calculation

Bauteil / Component

PHPP
EnEV

eLCA

Aussenwand
Outer wall

Innenwand
Inner wall

Dach
Roof

Bodenplatte
Floor slab

Decken
Pavements

Fenster
Windows

Quelle/Source: BBSR Germany, Electronic Lifecycle Analysis - eLCA: https://www.bauteileeditor.de/
Urban & Regional identity
### Multy family building (1520 / 2010)

Pfeifergasse 9, Nürnberg

Source: Alexandra Fritsch, Fritsch & Knodt + Klug, Nuremberg
Urban planning & Monument conservation

Multy family building (1876 / 2000)
Mathildenstraße, Fürth

Source: Schulze Darup
Innovation &
Highest efficiency

One family building (1958 / 2011)
Nuremberg

Source: Wimmer - Schulze Darup & Partners
Energy efficiency & Plus energy balance

Junior high school Feuchtwangen

Source: Schulze Darup (energy concept)
Energy efficiency & Plus energy balance

Townhall Herzogenaurach

- Prime energy
- Photovoltaics
- Electricity
- IT-Systems
- Cooling
- Lightening
- Warm Water
- Heating

Source: Schulze Darup & Partner
Architectural- & Energy Concept
High sustainability & Life Cycle Optimising

Monastery Plankstetten

Source: Schulze Darup (energy concept)
Research-Project with Building Companies
KfW Effizienzhaus 40 Plus, Berlin, Sewanstraße
Research-Project with Building Companies
KfW Effizienzhaus 40 Plus, Berlin, Sewanstraße

Quelle/Source: Planung THOMA Architekten / Bauherr: HOWOGE Berlin / Forschungsvorhaben mit 5 Wohnungsunternehmen; Schulze Darup: Kostengünstiger und zukunftsfähiger Geschosswohnungsbau im Quartier. – DBU-gefördert AZ 33119/01-25
Research Project with Building Companies
KfW Effizienzhaus 40 Plus, Berlin, Sewanstraße

Quelle/Source: Planung THOMA Architekten / Bauherr: HOWOGE Berlin /Forschungsvorhaben mit 5 Wohnungsunternehmen
Monthly costs – Appartement 100 m² (€)
(including promotion programs)

<table>
<thead>
<tr>
<th></th>
<th>WSVO 90</th>
<th>EnEV 2002</th>
<th>EnEV 2014</th>
<th>KfW EH 40</th>
<th>Passivhaus</th>
<th>KfW EH 40 Plus</th>
<th>Passiv Plus</th>
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</thead>
<tbody>
<tr>
<td>Heating</td>
<td>1.028 €</td>
<td>1.048 €</td>
<td>1.040 €</td>
<td>105 €</td>
<td>105 €</td>
<td>114 €</td>
<td>114 €</td>
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<tr>
<td>Electricity</td>
<td></td>
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<td>Maintenance</td>
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<tr>
<td>Photovoltaic</td>
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<tr>
<td>Financing costs</td>
<td></td>
<td></td>
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<tr>
<td>Actual Energy-Standard</td>
<td>920</td>
<td>904 €</td>
<td>942 €</td>
<td>944 €</td>
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<td></td>
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<tr>
<td>Additional Invest vs. EnEV (Actual Standard)</td>
<td>84 €/m²</td>
<td>65 €/m²</td>
<td>117 €/m²</td>
<td>120 €/m²</td>
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</table>

Quelle/Source: Ecofys / Schulze Darup: Preisentwicklung Gebäudeenergieeffizienz. – Im Auftrag der DENEFF, Berlin 11-2014
Plusenergy building Erlangen-Büchenbach

Quelle/Source: Schulze Darup & Wimmer, schulze darup & partner Berlin-Nürnberg
Top runner Efficiency & Highly renewable

Multy family building „WOOD5“ (B & O)

Renewable Heating
Photovoltaics
Smart Grid

Roof
U = 0.11 W/(m²K)

Windows
Uw = 0.85 W/(m²K)

Outer Wall
U = 0.14 W/(m²K)

Ground
U = 0.10 W/(m²K)

Source: Schankula / Schulze Darup & B&O Bad Aibling

Ventilation with heat recovery

Quality management

Efficiency & Highly renewable

Renewable Heating
Photovoltaics
Smart Grid

Roof
U = 0.11 W/(m²K)

Windows
Uw = 0.85 W/(m²K)

Outer Wall
U = 0.14 W/(m²K)

Ground
U = 0.10 W/(m²K)

Source: Schankula / Schulze Darup & B&O Bad Aibling
Accommodation Nuremberg-West (1961-1964), 1030 Apartments

Quelle/Source: Rahmenplanung: Schulze Darup & fkk – Im Auftrag WBG Nürnberg 2008-2010
Accommodation Nuremberg-West (1961-1964), Bernadottestr. 42-48

Quelle/Source: Architekt Schulze Darup – Im Auftrag WBG Nürnberg 2006

Quelle/Source: Quartierskonzept & Energiekonzept: Schulze Darup. – Im Auftrag SIR/Stadt Salzburg 2010-2012

Quelle/Source: Quartierskonzept & Energiekonzept: Schulze Darup. – Im Auftrag SIR/Stadt Salzburg 2010-2012
New old urban heart
DomRömer Frankfurt - Reconstruction of the old historic core
New old urban heart
DomRömer Frankfurt - Reconstruction of the old historic core
<table>
<thead>
<tr>
<th>National promotion program for UNECE Energy Efficiency Standards in Buildings</th>
<th>First year</th>
<th>Second year</th>
<th>Third year</th>
<th>Fourth year</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>UNECE-Invitation for Participation</td>
<td></td>
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<td>2</td>
<td>Participating Nations: Letter of confirmation</td>
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<td>3</td>
<td>Preliminary Meeting (round table)</td>
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<td>4</td>
<td>Kick-off conference with:</td>
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<td>4.1</td>
<td>Roadmap &quot;efficiency standards&quot;</td>
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<td>4.2</td>
<td>Nomination of pilot projects</td>
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<td>4.3</td>
<td>Plan for the Training Program</td>
<td></td>
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<td>4.4</td>
<td>Establishing of Expert Group</td>
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<td>4.5</td>
<td>Start National Network &amp; Energy Agencies</td>
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<td>4.6</td>
<td>Yearly National Efficiency Conferences</td>
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<tr>
<td>5</td>
<td>Training Program</td>
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<tr>
<td>5.1</td>
<td>Train the Trainers (by UNECE Experts)</td>
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<td>5.2</td>
<td>Adaptation to the national requirements</td>
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<td>5.3</td>
<td>Train the Trainers - national</td>
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<td>5.4</td>
<td>Multiplying National Training Program (energy agencies, universities, chambers, institutes ...</td>
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<tr>
<td>6</td>
<td>Implementation of the UNECE Framework Guidelines to the building code of the country</td>
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<tr>
<td>6.1</td>
<td>Political Process</td>
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<td>6.2</td>
<td>Round Table of politics, experts &amp; co</td>
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<td>6.3</td>
<td>Workshops of Experts</td>
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<td>6.4</td>
<td>Scientific groundwork</td>
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<td>6.5</td>
<td>Research Projects for the implementation</td>
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<td>6.6</td>
<td>Political Process - Resolution / Act</td>
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<td>National promotion program for UNECE Energy Efficiency Standards in Buildings</td>
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- **7** Financiation & Promotion Program
  - 7.1 Political Process - Form of Promotion
  - 7.2 Scientific groundwork & economic aspects
  - 7.3 Decision for a promotion program
  - 7.4 Programs of financing institutes for efficiency
  - 7.5 Training Progr. Financing Institut./Decision Makers

- **8** Pilot Projects
  - 8.1 Planning Phase for 5-12 projects
  - 8.2 Realising Phase / Monitoring
  - 8.4 Second Phase for 50 - 100 projects
  - 8.5 Third Phase for 500 - 1000 projects
  - 8.6 Broad multiplying with UNECE Efficiency Standard

- **9** Information & Marketing
  - 9.1 Marketing for efficiency
  - 9.2 Information for landlords & consumers
  - 9.3 Multiplying by media
  - 9.4 Multiplying by Culture - making Efficiency sexy

- **Another year**
- **Ongoing**