Energy Renovations in Germany –

What Finland can learn

Heike Erhorn-Kluttig
Fraunhofer Institute for Building Physics
Rakennusten energiaseminaari
Finlandia-talossa
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The Fraunhofer-Gesellschaft

- 66 institutes and independent research units
- more than 22,000 employees

Fraunhofer Institute for Building Physics

- > 430 employees
- budget: 29.3 million Euro (2013)
- Core competences:
  - Acoustics, noise control
  - Energy efficiency, building systems
  - Lighting technology, indoor environment
  - Hygrothermics
  - Durability, preventive conservation
  - Chemistry, microbiology, hygiene
  - Life cycle engineering
Statistics Germany

**Building stock**

- **Residential buildings**: 19,000,000
- **Non-residential buildings**: 1,500,000

- **Good statistical data on residential buildings**: types, age, status, energy supply, ownership
- **Limited statistical data on non-residential buildings**: further analyses needed
- Energy efficiency strategy for buildings of the Federal Ministry of Economy is concentrating on residential buildings
11.72 million houses have been built with no specific U-value requirements in place (Basic U-values for mould and moisture prevention, some renovations have been made in between)
Statistics Germany

Residential buildings

- Single-family houses: 1 or 2 residential units
- Multi-family houses contain 53% of the residential units
- Building sector corresponds to nearly 40% of the total final energy use in Germany
Energy Renovation in Germany: Legal Requirements

- Renovation has to stay **voluntary**
- **Specific legal retrofitting obligations** (Nachrüstverpflichtung):
  - Replacement of heating boilers installed before 1985 (older than 30 years)
  - Insulation of distribution pipes in unheated areas
  - Insulation of the ceiling to the attic
    -> should be profitable very quickly
- **Maximum U-values** for the installation, replacement and renewal of building components (major renovations, EPBD):
  - Wall: $U_{\text{max}} = 0.35 \text{ W/m}^2\text{K}$
  - Windows: $U_{\text{max}} = 1.3 \text{ W/m}^2\text{K}$
  - Pitched roof: $U_{\text{max}} = 0.24 \text{ W/m}^2\text{K}$
  - Flat roof: $U_{\text{max}} = 0.20 \text{ W/m}^2\text{K}$
  - Cellar ceiling/base plate: $U_{\text{max}} = 0.50 \text{ W/m}^2\text{K}$
- **Whole building renovation**: 140% of the primary energy requirement for new buildings

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Energy Renovation in Germany: Renovation Rate

- dena (Germany Energy Agency) study:
  ~ 50% of the 19 million residential buildings are up for renovation within the next 20 years

- ~ 1 million buildings per year in need of renovation
  ~ 2.6% of the residential building stock

- Average renovation cycle of the building envelope: ~ 30 - 40 years
  -> opportunity to couple renovations with energy efficiency improvement has to be taken

- Current renovation rate of the building envelope: ~ 1% per year
- Exchange rate of the heating system: ~ 3% per year

- Objective of the Energy Concept of the German Government: Doubling of the renovation rate: from 1% per year to 2% per year
Energy Renovation in Germany: Additional Instruments

- Financial subsidies: e.g. KfW bank
- Market stimulation programmes: BAFA
- Regional legal requirements: RES integration
- Renovation roadmap
- Research initiatives / demonstration programmes
- Local retrofit standards
Energy Renovation in Germany: Financial Subsidies

- KfW bank (state owned) offers the following financial subsidies:
  - **Cheap loans**: 0.75%
    - Maximum 100,000 € / residential unit
    - Redemption subsidy up to 27.5%
  - **Investment subsidy**: up to 30,000 € (single-family house), 60,000 € (two residential units)

- **Different programmes**:
  - Single measures: insulation of building envelope components, renewal of windows/doors, installation of mechanical ventilation, renewal of heating system, optimisation of heating systems
  - KfW Efficiency House 55 / 70 / 85 / 100 / 115 (= percentage of primary energy requirements for new buildings)
  - Subsidies grow with better energy performance
    - E.g. investment subsidies: 15% for KfW Efficiency House 115, 30% for KfW Efficiency House 55
  - **Combinations** with RES loans, construction site survey, listed buildings, adaption to elderly needs
  - **Additional subsidies** for public buildings and retrofit manager of city districts
Energy Renovation in Germany: Financial Subsidies

- **Monitoring results** of KfW programmes Energy Efficient Retrofit in 2013: (report of IWU and Fraunhofer IFAM)
  - 111,000 approved fundings for 276,000 residential units
  - Applied measures:
    - Insulation of the building envelope: as single measure: 55% of the buildings / within the KfW Efficiency Houses: 98% of the buildings
    - New heating system: > 50% / 79%
    - Solar thermal or PV: 18% / 48%
    - Mechanical ventilation systems (mostly with heat recovery): 6% / 28%
  - **Total savings** of all measures: final energy: 1,745 GWh/year
    primary energy: 2,500 GWh/year
    CO₂ eq. emissions: 650,000 t/year
    heating costs: ~ 200 million €/year

- **Investments:** KfW: 3.9 billion €, **total 6.5 billion €**, 1 billion is VAT
- **Job creation:** 79,000 person-years (80% craftsmen, 20% planners)
- **For 1 € the state gets back about 4 €:** VAT, less unemployment, more taxes
Energy Renovation in Germany: BAFA Market Stimulation Programme

- **Investment subsidies for renewable energy systems:**
  - Solar thermal systems
  - Biomass heating systems
  - Heat pumps

- **Investment subsidies for combined heat and power units (CHP)**

- **Financial support for energy saving consultancy**

- Can be **combined** with KfW promotion programmes
Energy Renovation in Germany: Research Initiatives / Demonstration Programmes

- Building level: EnOB (Energy-Optimised Buildings) [www.enob.info](http://www.enob.info)

- **Demonstration projects** for different building types with innovative technologies

- Energy-efficiency requirements of the energy ordinance have to be topped by at least
  - 30% for non-residential buildings
  - 50% for residential buildings

- Specific **focus on energy efficient schools** includes schools renovated to 3-liter-house level and even plus energy schools

- New **technologies**: e.g. prefabricated façade modules for renovations

- Optimisation of **building operation**
Energy Renovation in Germany: Research Initiatives / Demonstration Programmes

- **District level:** EnEff:Stadt (Energy-Efficient Cities) [www.eneff-stadt.info](http://www.eneff-stadt.info)

  - **Demonstration projects** for different types of city quarters
  - Energy-efficiency requirements: 30% less primary energy use than
    - Before for existing quarters
    - Energy performance requirements of energy ordinance for new quarters
  - Specific focus on **district heating and cooling** networks
  - New **technologies:** Organic rankine cycle (ORC), absorption cooling, alternative motor concepts for biogas, low-Ex-technologies
  - **Planning tools:** E.g. GIS-coupled tools, District ECA
District level: EnEff:Stadt (Energy-Efficient Cities)  
www.eneff-stadt.info

Accompanying research team analysing and comparing the demonstration projects

Primary energy of the city quarters

- Average before
- Average planned

Before project
Planned
Measured year 1
Measured year 2
Energy Renovation in Germany: Research Initiatives / Demonstration Programmes

- District level: EnEff:Stadt (Energy-Efficient Cities)
  www.eneff-stadt.info

- Accompanying research team analysing and comparing the demonstration projects

<table>
<thead>
<tr>
<th>Primary energy savings of the city quarters</th>
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<td>Before project</td>
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<td>Bad Aibling</td>
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<td>Berlin Adlershof: W. am C.</td>
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<td>Lüneburg (Campus)</td>
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<td>München Lilienstraße</td>
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<td>Stuttgart Neckarpark</td>
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<td>Weimar Zöllnerviertel</td>
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Average planned
Requirement defined in research initiative
Energy Renovation in Germany: Regional legal requirements: RES integration

Federal State of Baden-Württemberg launched a regional requirement beyond the national requirement

- **National requirement EEWärmeG:**
  - **New buildings** have to partly use RES for heating (space heating + DHW): 15% solar thermal, 30% biomass, 50% geothermal or ambient energy
  - Specific combinations fulfilling the requirements given e.g. solar thermal in SFH: 0.04 m² apperture area / living area

- **Additional local requirement EEWärmeG Baden-Württemberg:**
  - If the **heating system is changed**, the heating (space heating + DHW) has to be covered by 15% with RES -> residential and non-residential buildings
  - Specific options to fulfill are listed
  - Replacement measures:
    - Increased insulation of building envelope
    - Combined heat and power (CHP), district heating, PV
Energy Renovation in Germany: Renovation Roadmap: A step-by-step procedure

- Replacement measure for local renovation requirement EEWärmeG Baden-Württemberg
  - Residential buildings: Can replace part of RES requirement (from 15% RES to 10% RES)
  - Non-residential buildings: Can replace 100% of RES requirement
- Individual step-by-step renovation plan for a building
- Currently no check concerning realisation of measures over time
Energy Renovation in Germany: Renovation Roadmap: A step-by-step procedure

Today: annual energy costs (calculated and measured), annual CO₂ emissions

Step-by-step renovation: Example with investments, financial support, recommended period of time

Step 1: Gas condensing boiler with partly biogas
Step 2: Insulation of roof, solar thermal system
Step 3: Insulation of wall, window replacement
Step 4: Wood pellet boiler (exchange of gas condensing boiler)
Step 5: Ventilation system with heat recovery

Aim: annual energy costs without and with energy price increase (3.5%), annual CO₂ emissions
Energy Renovation in Germany: City of Stuttgart’s retrofit standard including quality control

- City of Stuttgart has developed its **own retrofit standard** including the following steps offered by the city’s energy consultancy office to ensure a quality control:
  - initial consultation for free
  - energy diagnosis
  - expert network with trained architects, engineers, craftsmen of different trades
  - information on possible funding programmes
  - construction supervision
  - energy performance certificate
  - training courses for professionals
  - information events for building owners

- City offers **investment subsidies** of up to 100 €/m² for energy renovation of buildings (can be coupled with KfW and BAFA)

- Information on quality control: IEE QUALICHeCK
  [www.qualicheck.eu](http://www.qualicheck.eu)
The District Energy Concept Adviser

IEA ECBCS Annex 51: Energy Efficient Communities
Case Studies and Strategic Guidance for Urban Decision Makers

District Energy Concept Adviser
Click on a flag to start the tool
Example of an assessment with the District ECA: Stuttgart-Burgholzhof
Present and future of the District Energy Concept Adviser

- Downloads:
  - 656 downloads of the international version
  - 1065 downloads of the national version „EnEff:Stadt Energiekonzept-Berater für Stadtquartiere“

- Applied in the German BMWi research initiative EnEff:Stadt
  - Berlin Adlershof
  - Neckarpark Stuttgart
  - ...

- Applied for other energy concepts of neighbourhoods (KfW, community planners)

- Tested by the University of Wuppertal

- Further development (costs, additional countries, additional technologies) within EU MODER: cooperation with Sweco and VTT
Focus on Apartment Buildings with multiple Ownership

- EU IEE project LEAF: Low Energy Apartment Futures
- **Buildings with multiple ownership have a low renovation rate**
- Project offers:
  - Case studies
  - Motivation toolkit in 6 languages
  - Technical toolkit in 6 languages
    - What is an energy performance certificate?
    - Recommended measures -> investment cost database, payback
    - User behaviour influence on energy use
    - Other energy saving opportunities: lighting, elevators, household equipment, common lighting (stairways, external lighting)
Building stock is very diverse: office buildings, schools, theatres, police stations, jails, courts, town halls etc.

**Structured process for:**
- Building inspection and data acquisition
- Energy assessment
- Development of energy saving measures
- Documentation
- Tools, checklists etc. -> building profile
- Each building is assessed by a consultant according to the procedure