Environmental and economical assessment of refurbishment concepts Methods and Concepts for sustainable Renovation

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Objective

- New understanding about
  - sustainable refurbishment concepts for residential buildings.
  - environmental and economical impacts of alternative refurbishment concepts
  - suitable methods for the environmental assessment of refurbishment concepts.

- Alternative refurbishment concepts were studied on the level of the Finnish residential building stock.
- Different refurbishment concepts were compared by assessing the impact in terms of energy, greenhouse gases and costs.

Methods

- Information on total floor area of the Finnish housing stock was used as the basis for the analyses.
  - The total floor area of the Finnish housing stock was divided into age groups based on the available statistical information on residential housing stock.
  - The size and performance of buildings in different age groups were defined.
    - The defined performance includes the types of structures, floor height and volume of a building, number of inhabitants, and heating energy, electricity and water consumption.
  - These defined figures were then used as an input for creating exemplary buildings
  - These were dealt with by the energy calculation program WinEtana.
  - En Excel tool was developed and all data was brought into the tool. The tool enables the assessment of the alternative scenarios.

Methods

- By using the information of the exemplary buildings and the composition of the current housing stock, a theoretical maximum energy saving potential for the Finnish residential stock can be calculated.
- The measures under study were:
  - additional thermal insulation,
  - replacement of windows,
  - replacement of ventilation system and
  - implementation of solar heating.

- Based on the assessed energy savings, also savings in GHGs can be calculated.
- These calculations were based on energy production profiles in Finland.

Methods

- The housing stock develops and changes over time.
- New construction adds the floor area of the housing stock and obsolescence, deterioration and finally demolishment decreases it.
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- The degree of building degradation was taken into account.
- The study used an assumption that energy renovations are made only when the buildings would need renovation in any case.

Environmental profiles for electricity and district heat

LCA based environmental profiles for average Finnish electricity (considering net imports).

	Benefit		Energy	
	Electricity	District heat	Electricity	District heat
CO2 fossil, kg/MWh	309	236	222	273
CO2 biogenic, kg/ MWh	121	134	67.5	160
CH4, kg/MWh	0.821	0,364	0.709	0,424
N2O, kg/MWh	0.000654	0.000397	0.000523	0.000448
GHG, kg/MWh	330	245	240	283

The newest prediction made by the Finnish Ministry of Employment and Economy was done in the connection of the new climate and energy strategy. On the basis of preliminary information and in accordance with the newest base scenario the predicted emissions for district heat and electricity are as follows:

Table Predicted emissions for district heat and electricity

Characteristic emission, g CO2/kWh	2010	2020	2030
Electricity delivery	230	179	36
District heat	243	216	191

Results

- The assessed GHG saving potential of different renovation alternatives ranges from 3% (solar heat installation) to 27% (a combination of renovations).

- In addition to energy renovations, buildings may also undergo renovations related to their heating systems.
- The study focused on detached houses, since changes in their heating systems are relatively easy to implement, and, for example conversions from electrical heating to geothermal heating has already become quite popular.

Assessment results for GHG emissions, if all the detached houses with electric heating and oil-heating changed their heating method by 2030.

	CO2 e emissions (Mt)	Saving (%)
2030, no energy renovations	6.37	
2030, electric heating changed to ground heating	4.57	28%
2030, oil heating changed to wood heating	3.92	39%
2030, electric heating changed to ground heating, and oil to wood heating	2.12	67%

Embodied energy and carbon

- Embodied energy and carbon
- The significance of embodied environmental impacts in sustainable refurbishment projects.
- The environmental impact of renovation materials was compared to the saved environmental impact due to the energy saving achieved with the help of refurbishment.
- The demolition and building a new building was also considered as an alternative

Economic assessment

- The assessment of the economical potentials of refurbishment concepts was carried out for cases where an extensive refurbishment is needed for an out-dated building.
- The economical life cycle impacts of refurbishment depend on the investment cost and the reduction of energy consumption.
- A successful refurbishment may also affect the resale value of the building.
  - A significant increase in the value (market value) by means of extensive refurbishment can be achieved when the building is located in a relatively valuable neighbourhood and when the whole neighbourhood is renovated at the same time.
  - Compensation can be achieved by increasing the density of the area (with the help of extensions such as an additional storey or in fill building).

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