Optimization of energy performance investments of buildings, Finland

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Description

- The scope of the project is to determine cost-optimal energy performance improvement measures to be conducted in deep renovations of different building types in Finland
- The main objectives in optimizations are to study how in energy efficiency projects you can determine economically viable and technically feasible energy performance improvement concepts that significantly improve the energy performance and reduce the CO_2 emissions, which means renewable energy sources will also be used, where possible and appropriate.
- The project includes several building types built during different eras, such as apartment buildings, office buildings, educational buildings, commercial buildings and sports facilities
- Target groups are: Public sector, real estate companies, investors and decision-makers, also ministries involved in energy performance legislation
- The project has started in 2015 and is ongoing
- The long term benefits include cost-effective and sustainable deep renovations towards significantly reduced delivered energy consumption and carbon neutrality in the building sector
- Novel multi-objective optimization and simulation methods are applied

Critical success factors

- Critical success factors include accurate cost data to be used in the analyses and comprehensive understanding of the implementation and the overall technical feasibility of the measures recommended for different building types
- The simulation-based multi-objective optimization approach is applied in hundreds of real-life projects in Finland, where both the reliability of the cost data and accuracy of the simulation method, in addition to the technical feasibility of the measures, are thoroughly tested

Innovation

- Automated and highly efficient simulation and calculation analysis is used, no conventional manually conducted analyses
- Novel simulation-based multi-objective optimization approach is applied
- True cost-optimality is achieved in deep renovations of buildings

Outcomes

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Key achievements

- Cost-optimal renovation concepts are determined for different building types
- Decision-making related to energy performance improvement measures and renovation concepts is based in facts, not in guesses or speculations
- Proof of concept has been achieved by completing dozens of actual real-life projects
- On-site renewable energy sources are optimally utilized
- Significant reduction in the delivered energy consumption of the Finnish building stock is achieved

Lesson learned

- Deep renovations of buildings should always be optimized and conducted using a comprehensive approach, where the mandatory repairs, renewals and renovation measures are combined with the optimally selected building type-specific energy performance improvement measures
- In many cases, deep renovations of buildings can be cash flow positive and profitable while the delivered energy consumption and CO_2 emissions are significantly reduced simultaneously
- A multi-objective optimization analysis is highly recommended to be applied for superior efficiency and improved reliability

Changes you would make in the future

- More focus on the external financial support mechanisms and competitive financial solutions, as they are essential factors and motivators to encourage the building owners to take the next step in deep renovations of buildings by lowering the economic risks related to the renovation
- Help the ministries to revise the minimum energy performance improvement requirements applied in deep renovations

Replicating your approach

- The simulation-based multi-objective optimization approach can easily be applied in other Member States as well to determine cost-effective and reasonable, but still ambitious, minimum energy performance improvement requirements to be applied in deep renovations of different building types
- This makes fact-based decision making possible, also taking MS-specific national objectives into account

Further information

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Final comments

- Novel simulation-based multi-objective optimization approach should be applied to determine the cost-optimal renovation concepts
- According to the results, the minimum primary energy performance requirements of the current national building regulations related to improving energy performance of buildings in deep renovations could be tightened by 10% for residential apartment buildings, 30% for educational buildings and 20% for office buildings, depending on the original condition of the building. Higher requirement levels increase both the investment and life-cycle costs of deep renovations
- The proposed national nearly zero-energy building requirements can be cost-effectively achieved in deep renovations
- Investments in on-site renewable energy sources, HVAC systems and especially in heat pump systems are economically viable, more profitable and have a more significant impact on the energy performance and CO_2 emissions (carbon footprint) of buildings than significant investments in the improvement of energy efficiency of the building envelope
- This approach is highly recommended to be applied in other MS as well, when determining regulations, requirements and legislation related to improving energy performance of buildings in deep renovations

Further information

Doctoral dissertation related to the topic (including individual publications):

http://urn.fi/URN:ISBN:978-952-60-7814-4

Master's thesis related to applying the presented simulation-based multi-objective optimization method in deep renovations:

http://urn.fi/URN:NBN:fi:aalto-201505132618

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