



REFURBISHING HERITAGE AND HISTORIC BUILDINGS

KEY MOTIVATION, BENEFITS AND CHALLENGES



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Background



13% of all buildings in Denmark are heritage buildings

- status as listed or worthy of preservation
- 9,000 buildings are listed and protected by the National Heritage Agency
 - which means that all building work, beyond routine maintenance, requires a permit from the National Heritage Agency.
- 350,000 buildings have been assessed as being worthy of preservation and are protected on a regional level by local authorities

Listed buildings have no end-use date, they are forever

Background



- Heritage buildings are privately owned in Denmark
- Climate change policy - reducing the CO₂ emissions
- Reducing the amount of energy used for heating and comfort
- Danish Building Regulations 2008, 2010 and 2015 (each -25%), 2020
(Energy consumption for heating, ventilation, cooling and hot water < 20 kWh/m² pr. year)
- Refurbishment of these buildings is needed to ensure that they remain part of the attractive building stock
- Intensified interest in refurbishing buildings including heritage and historic buildings



Refurbishment of heritage is needed

- Refurbishment of heritage is a complicated process
- Important to
 - identify key motivations and benefits that inspire an owner to refurbish heritage.
 - describe challenges that an owner needs to address
 - record nice a different risk assessment level for the building. Changes in the building physics as
 - changing the air infiltration rate
 - moisture load
 - moisture content over the yearcan increase the risk of degradation of organic materials and mould growth



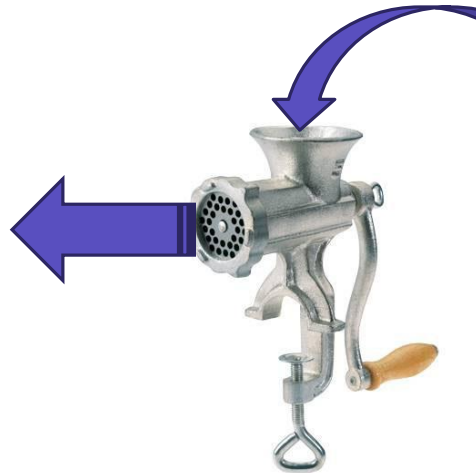
Present three case studies

- involving
 - Restoration
 - Modernization
- To do so a model for refurbishment of heritage buildings was
 - Developed, and
 - Used
- Feasible refurbishment measures



Intention of the model

- Develop a model that can be used for refurbishment of heritage buildings
- The model helps to choose, evaluate and implement measures creating synergy between the interests of preserving the heritage values and to create an affordable refurbishment, meeting the requirements for the use, of the building.
- The model focus on the cooperation and dialogue between authorities and owners who refurbish heritage buildings finding fiasable measures.



Fæstningens Materialgård

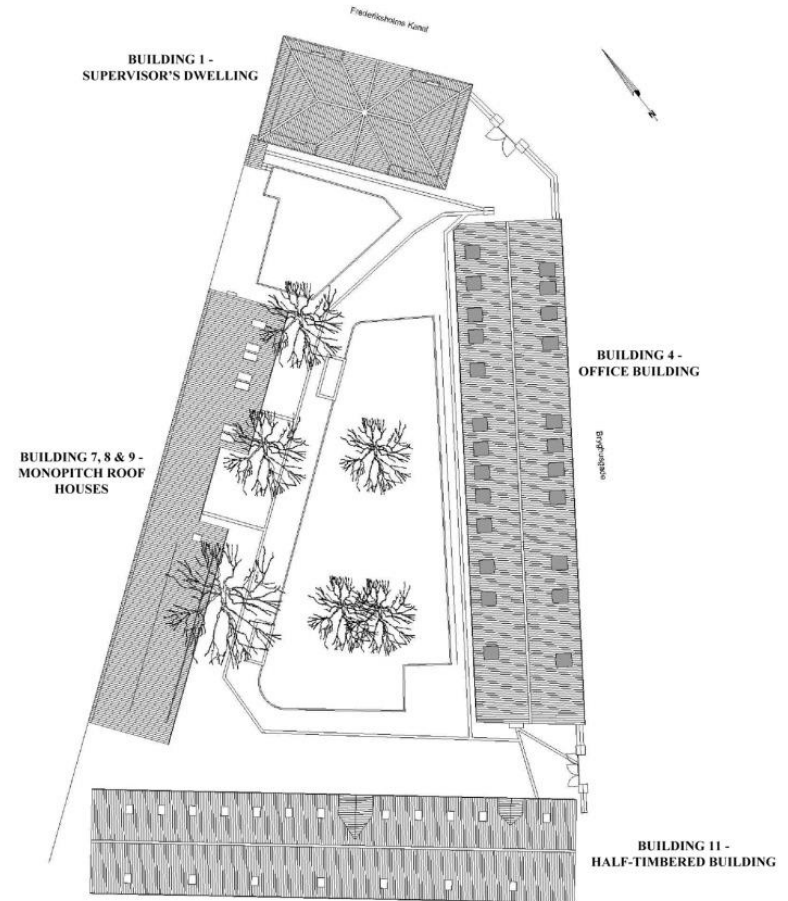
- The model was developed and shown used refurbishing the listed building complex Fæstningens Materialgård, Kavalergården and Elmehuset.
- Refurbishing Fæstningens Materialgård the Heritage Agency, the Danish Working Environment Authority and the owner, supported by ingeneers and architects, as a group cooperated in identifying feasible measures.
- Focus was on identifying potential energy savings and, to decide on energy upgrading measures for the listed building. And to carry out the refurbishment measures.



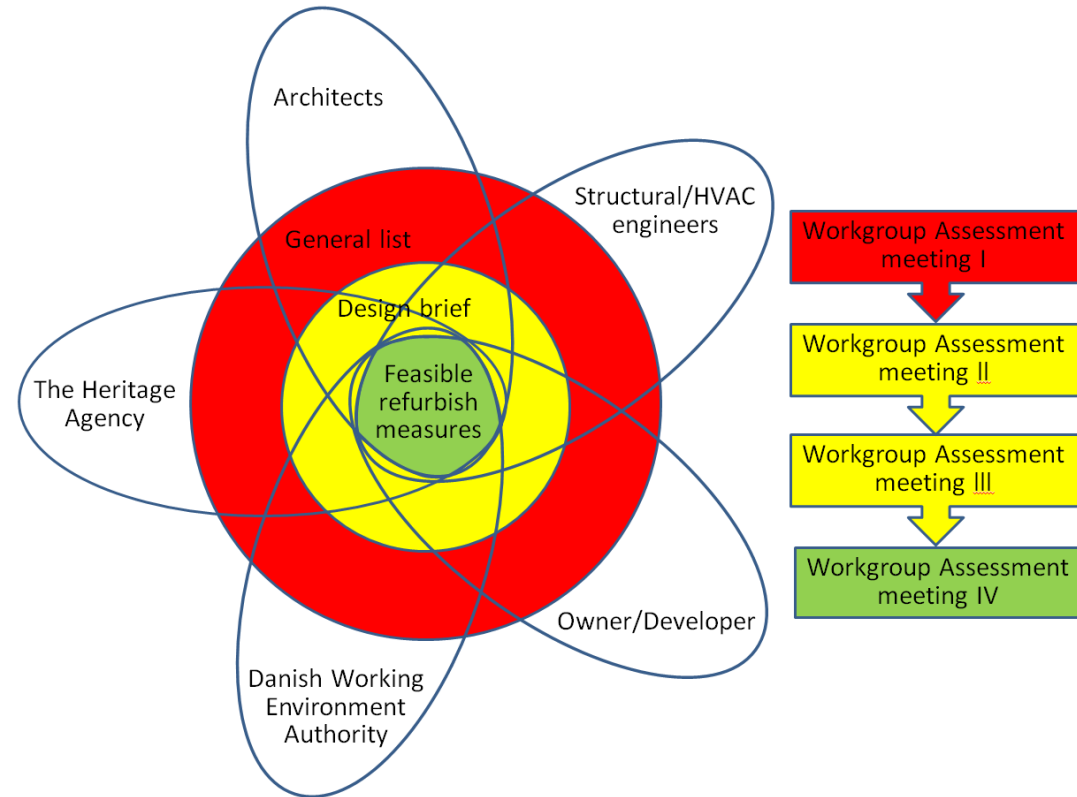
The heritage preservation status and conditions



FÆSTNINGENS MATERIALGÅRD - SITE PLAN

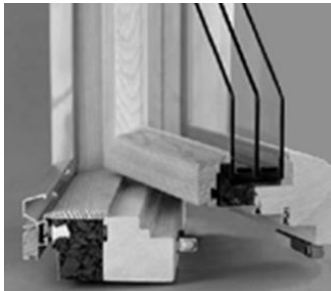
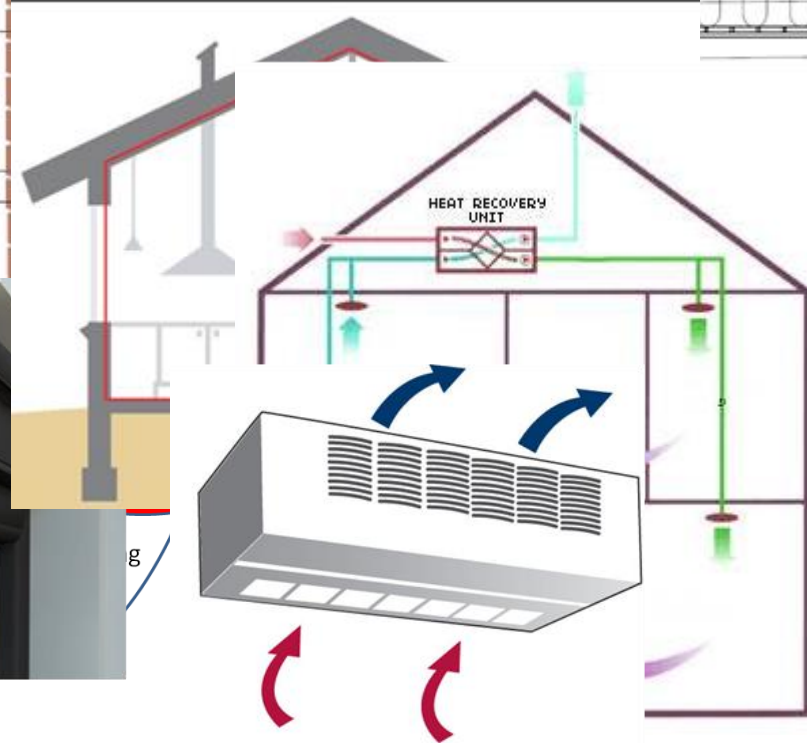
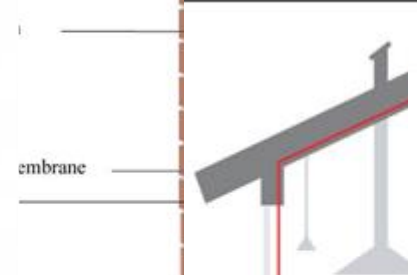
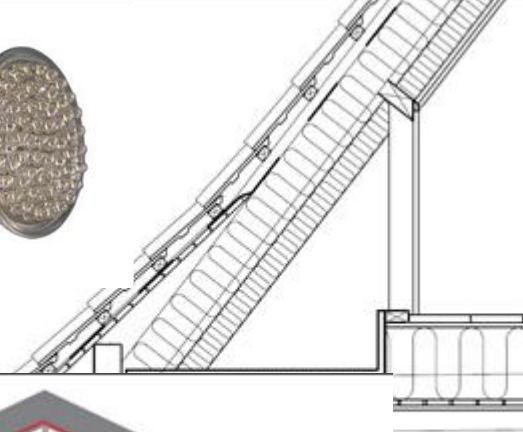
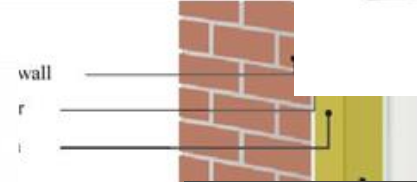
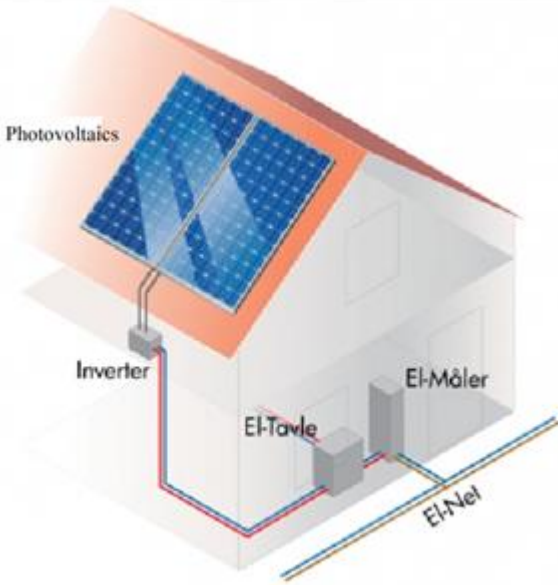


Model locating feasible refurbishment measures



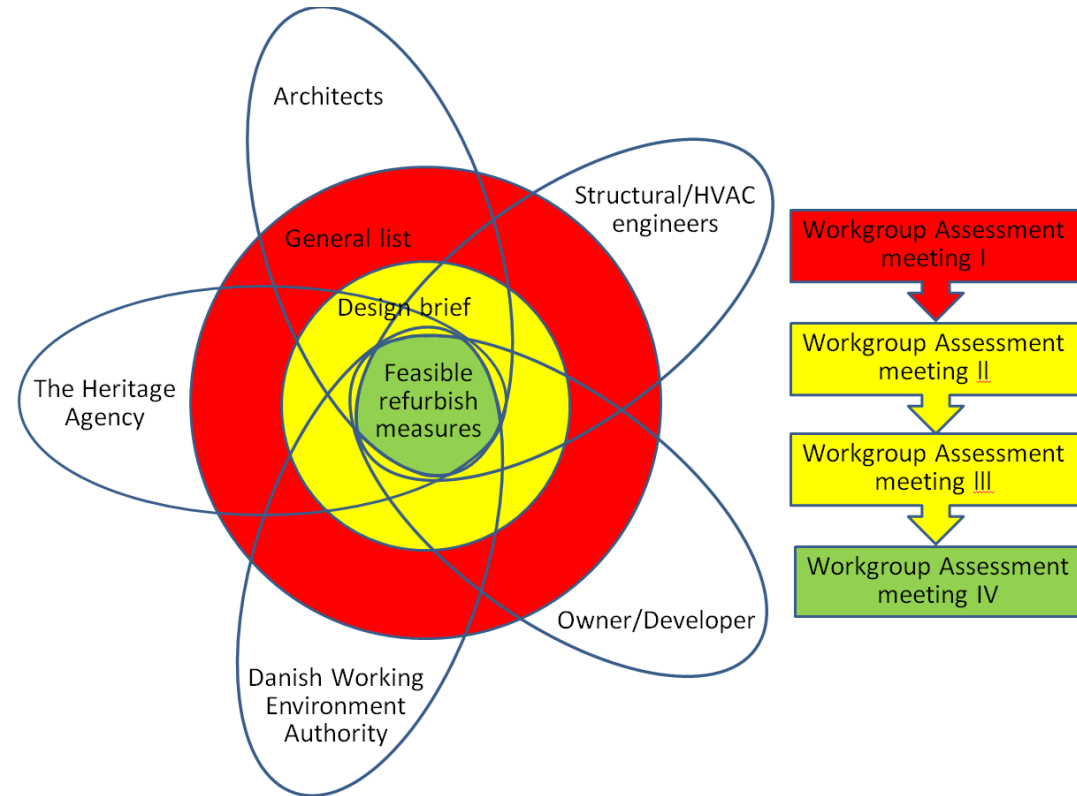
Workgroup Assessment meeting I

- Rough measurement List
- Generate the potential saving should be connected to renovation or restoration building



Workgroup Assessment meeting II – III...

- A row of meetings narrowing down the list of possible refurbishment measures.
- Based on:
 - indoor climate-, energy consumption- and measurement of synergy simulations
 - cost benefit evaluations
 - identified heritage values



Workgroup Assessment meeting IV

- Final meeting narrowing down the list of possible refurbishment measures to Feasible refurbishment measures.
- Based on:
 - indoor climate-, energy consumption- and measurement of synergy simulations
 - cost benefit evaluations
 - identified heritage values

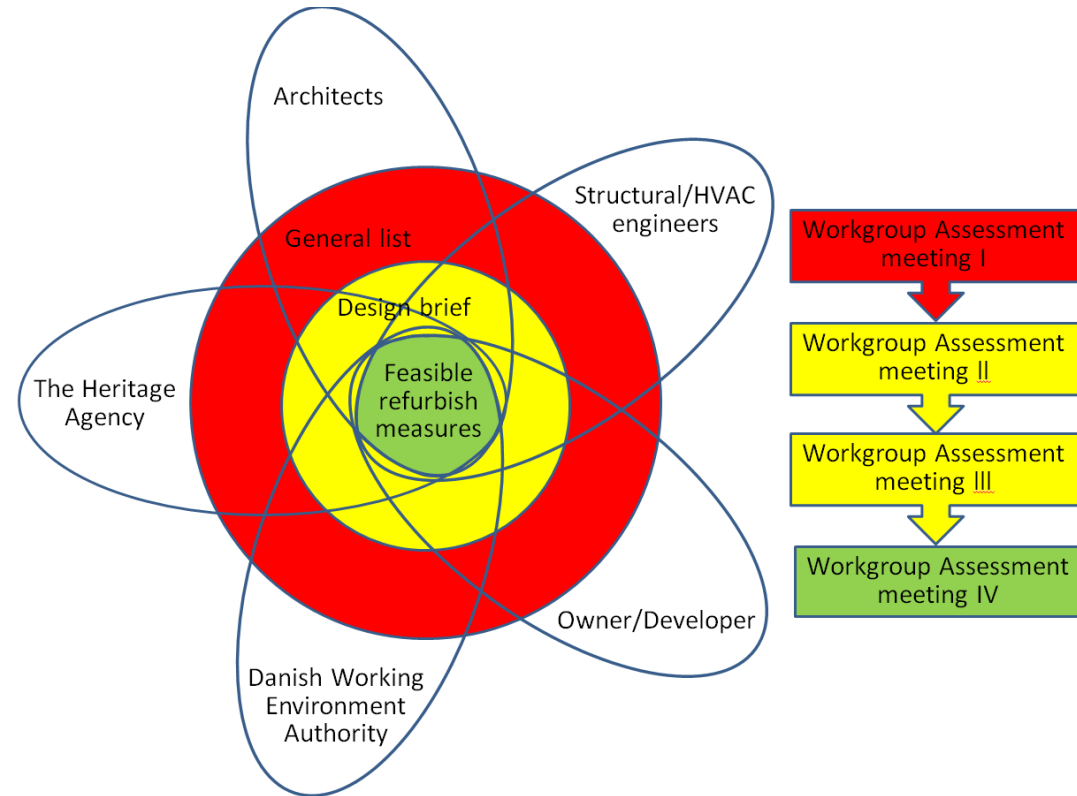


Table 1. Feasible refurbishment measures for the three case studies

Measure	A	B	C
Low-energy glazing	✓	✓	✓
Reduced building envelope air permeability (0.16 to 0.5 h ⁻¹)			✓
Ventilation via opening of windows			✓
Balanced ventilation with a standard exchange including cooling	✓		✓
Centralized domestic hot water supply	✓		✓
Additional insulation of external walls i.e. in the kitchen area and in utility rooms	✓	✓	✓
New insulated ground slab		✓	✓
Radiator heating	✓		✓
Underfloor heating on the ground floor			✓
Improved roof thermal insulation	✓	✓	✓
External solar shading with a reduction factor of 0.5			✓
Energy-saving light sources	✓	✓	✓
Daylight-controlled lighting		✓	✓
Centralized control of electrical components			✓
Cooling via a centrally placed unit where excess heat is transferred to the outside air	✓		✓
Shared canteen, meeting and conference facilities	✓	✓	✓

A is the Case Study [Elmehuset](#)

B is the Case Study [Kavalergården](#)

C is the Case Study [Fæstningens Materialgård](#)

Motivations

- refurbish heritage buildings while not compromising identified heritage values, buildings remain part of the attractive building stock
- develop reasonable cost-benefit solutions that meet the requirements for the future use of the building

Benefits

- Upgrading of the energy performance, thus creating attractive facilities for accommodation, offices, conference and meetings providing an acceptable indoor climate

Challenges

- facilities with a high energy consumption such as a kitchen and a cantina located within a heritage building was learned to increase the overall energy consumption substantially, if provided with an acceptable indoor climate
- limitations in the use of heritage buildings
- establish an airtight building



Conclusions

- Denmark has carried out a number of case studies demonstrating comprehensive refurbishment including energy upgrading of heritage buildings.
- A model for the corporation between authorities and an owner of a heritage buildings has been developed
- The model has been shown useful for refurbishment of heritage buildings
- The model helps to choose, evaluate and implement measures creating synergy between the interests of preserving the heritage values and to create an affordable refurbishment, meeting the requirements for the use, of the building.
- The model can be used for both Listed buildings and for Buildings worthy of preservation



Thank You

