Presentation by Svend Svendsen of highlights of:

Method for planning extensive energy renovation of detached single-family houses

Report: R372 on:
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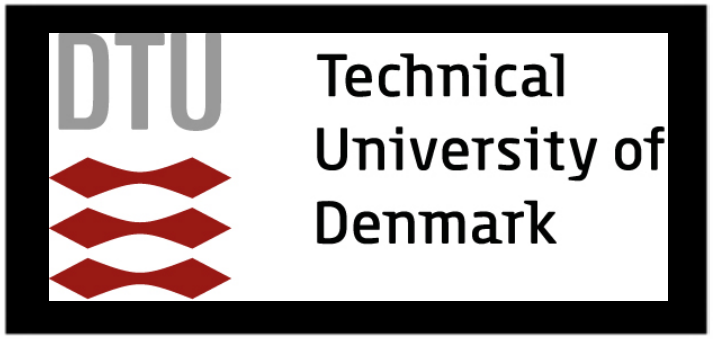

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PhD Thesis

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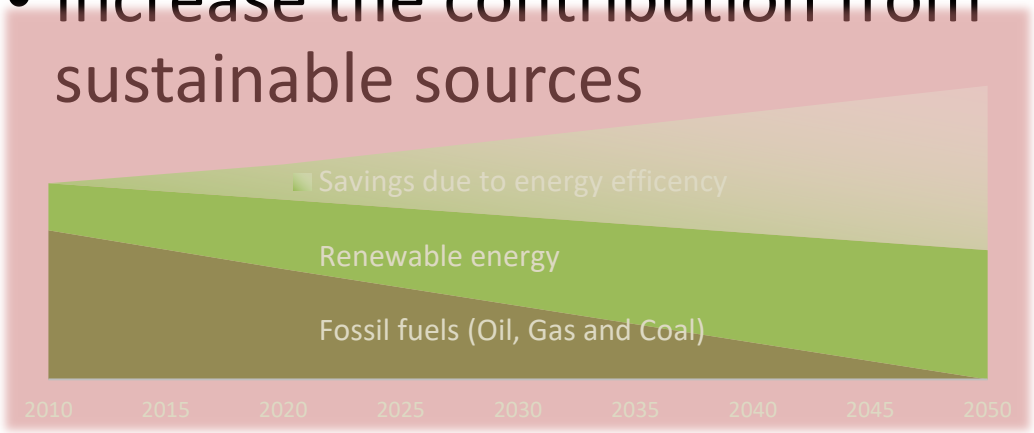
Introduction

Political target

- Independent of fossil fuels by 2050
- Reduce energy consumption
- Increase the contribution from sustainable sources



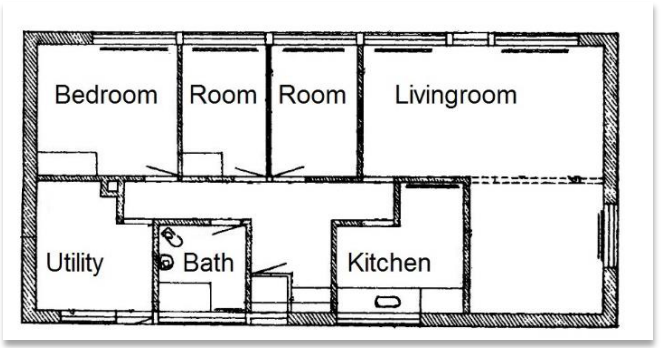
Renovation potential

- 22% of energy consumption in DK takes place in single family houses
- Most single family houses where build in the period 1960-1980
- In need of renovation due to their age

Danish single family houses built in 1960-80 (SFH)

- 450 000 single-family houses built during this period
- Pre-drawn houses at a fixed price in new neighbourhoods
- Initiation of prefabrication on a grand scale

- Light concrete and brick walls
- Fibre-cement roof with low slope on wood construction
- Double insulating glazing units



- One storey high, often no basement
- About 100-140 m^2
- Plan: closed/open, day/night

Renovation potential and backlog

- If not maintained houses deteriorate and loose value
- Maintenance backlog estimated to DKK 27 billion in 2011*
- SBi estimates at least 78% of single family houses in DK are in need of renovation**

Current renovation practice

- Individual improvements instead of overall plan
- Do-it-yourself (DIY)
- Advisors only used rarely
- The energy level of houses sold shows a tendency of renovation

Renovation of single family houses

Maintenance

Based on the current durability and remaining service life, building components are replaced or repaired

- Roof
- Façade
- Windows and doors
- Floor and basement
- Installations

Functions upgrade

Implementation of the wishes of the house owner for better utilisation of the house or updating the appearence

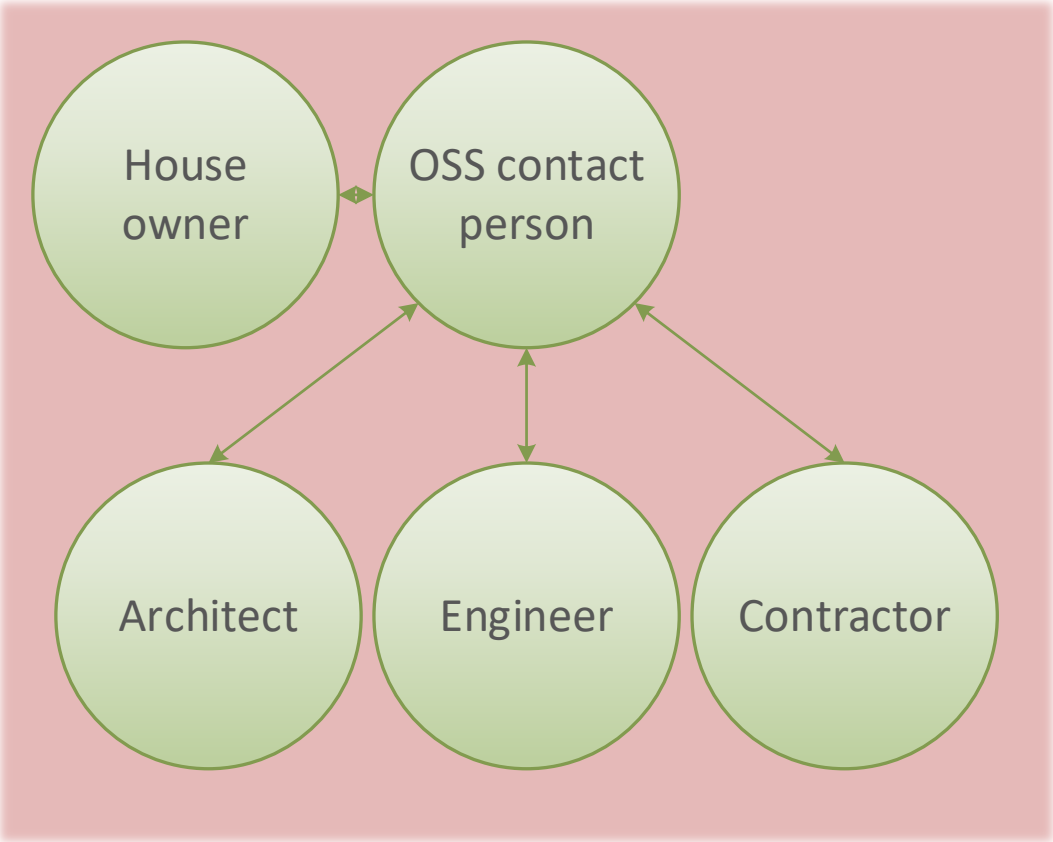
- Improvement of existing functions (new bath, kitchen, utility room etc.)
- Changes to existing room layout e.g. by moving walls or doors
- Establishing new skylights in roof
- Establishing new windows in façade for additional light
- Raising the ceilling height to the roof
- Extension of the house

Energy renovation

Reducing the energy consumption to save energy and money and to improve indoor climate

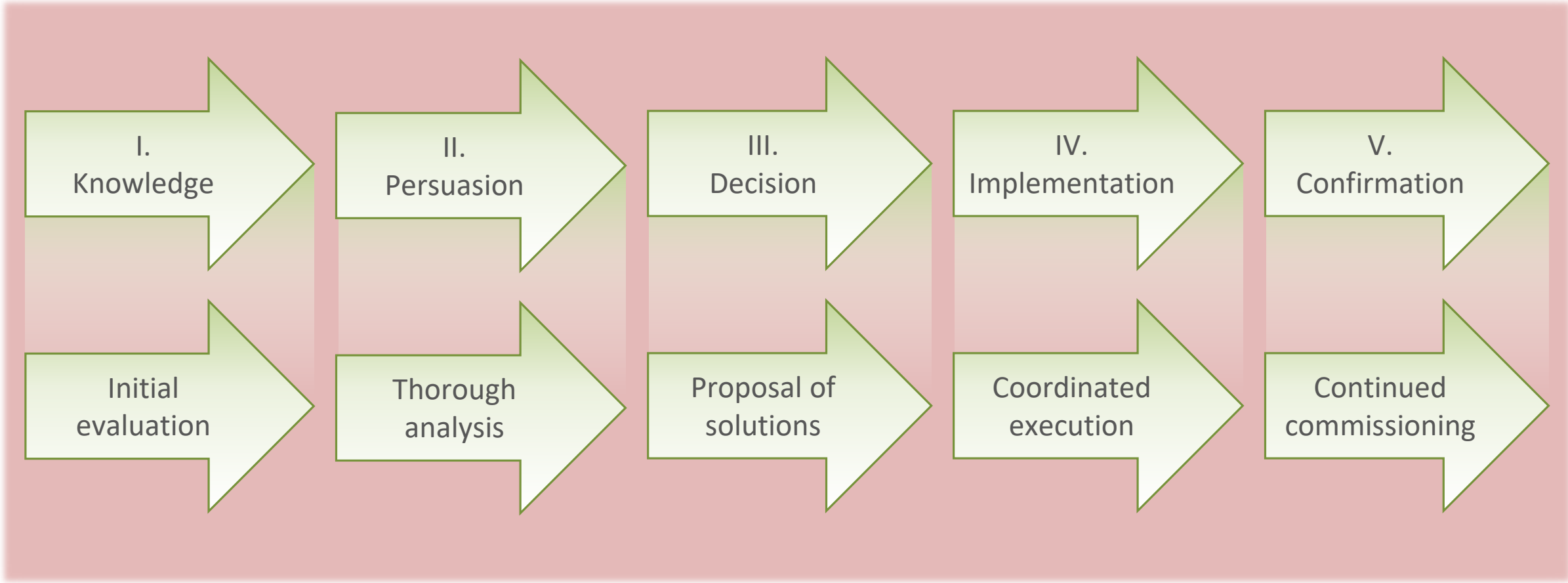
- Extra insulation
- Low-energy windows and doors
- Air tightening
- Mechanical ventilation with heat recovery
- Heating system
- Local energy production

The One-Stop-Shop (OSS)



- The house owner is **informed** about the **best possible solution** for the house
- The house owner is **assisted** through the **decision-making process**
- The house owner have only **one contact person** throughout the process
- The house owner have **less administration**
- The house receive a **relevant renovation**, successfully upgrading the house
- The house gets a **lower energy consumption** than before the renovation

One-stop-shop (OSS) Concept



Results – Process

Step 1 – Initial evaluation

- House evaluated based on
  - Durability
  - Functionality
  - Energy improvements
- Renovation House A
  - Roof, windows and doors, facade insulation, install ventilation

Step 2 - Analysis

- Analysis of facade solutions
  - Replacements of cavity insulation (16 kWh/m^2 a year, CCE 0.09 DKK/kWh)
  - External insulation (44-48 kWh/m^2 a year, CCE 0.63-0.92 DKK/kWh)
  - Energy price 1.11 DKK/kWh
- Chose cavity insulation

Results – Process

Step 3 - Decision

- 3 quotations were sought for the execution of the renovation
- House owner chose the one they preferred

Step 4 – Renovation

- House owner had an independent advisor on site during the renovation

Step 5 - Validation

- Energy level determined using Be10 before and after renovation
- Measured saving on total consumption

Further measurements described in Part II

Partial conclusion

- *Will the use of the One-stop-shop (OSS) concept improve the process of renovating and result in better renovations with a lower energy consumption because the house owners are guided through the process?*

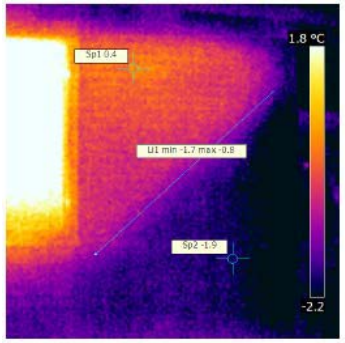
- Scope of study diminished due to high dropout rate
- The study found no evidence that the OSS concept motivate more people to renovate
- It is estimated that the scope and quality of the renovation was increased
- The house owners found it helpful to see remaining lifetime of building parts
- The 5 steps worked well

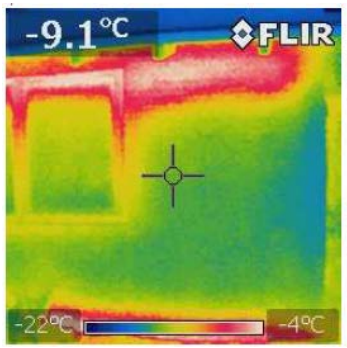
The renovation

THERMAL TRANSMISSION OF BUILDING PARTS		
	Before renovation	After renovation
	W/m²K	W/m²K
Windows	1.07–4.80 (2.74)	0.63–0.87 (0.71)
Doors	2.00–3.54 (2.71)	0.70–1.39 (0.91)
Roof	0.49	0.10
Skylights	3.52–4.93 (4.23)	1.3
Façade	0.67	0.37

Results - Single measurements

Thermography





Blower-door pressurisation

AIR TIGHTNESS, l/s·m²

	Measured		BR, new buildings		
	Before	After	2010	2015	2020
Volume flow through leaks in building envelope, q_{50}	2.5	0.8	1.5	1.0	0.5
Infiltration	0.19	0.09			

Method - Measurements

Measurements, before and after

- Thermography
- Blower-door pressurisation
- Total electricity consumption, 1 year
- Total gas consumption, 1 year
- The house owners opinions, interview
- logging temperature every 10-15 min in all rooms, 1 year

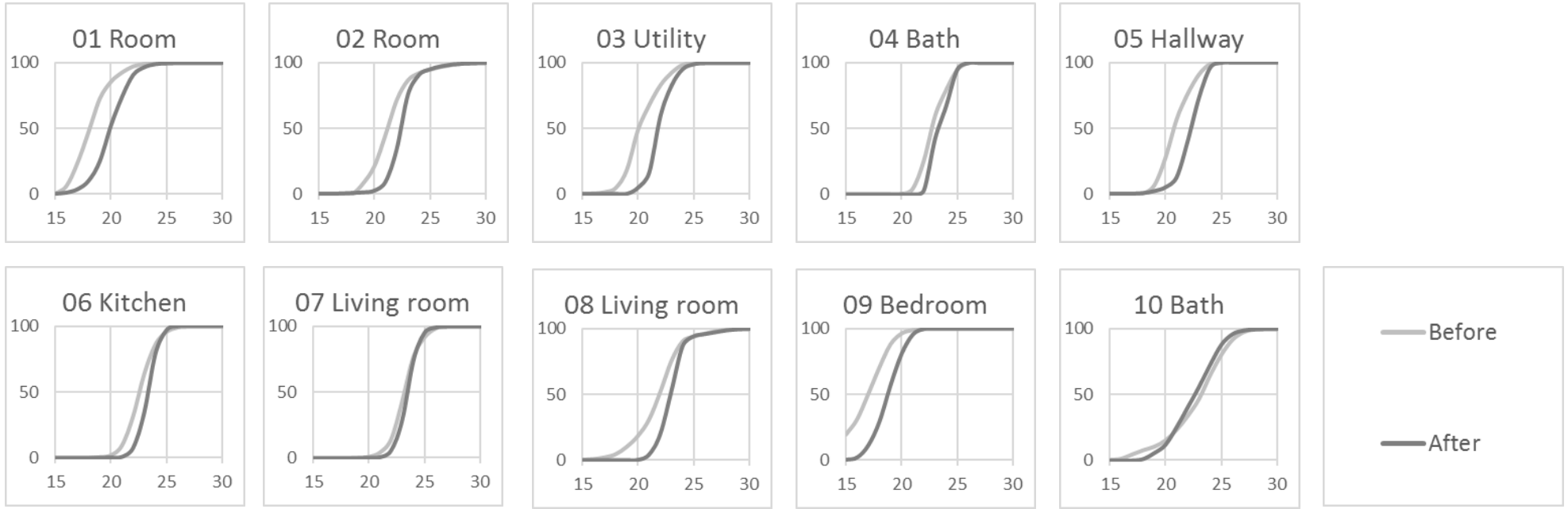
Daily readings by house owner after renovation

- Total electricity consumption
- Total gas consumption
- Electricity consumption by heat pump
- Electricity consumption by convectional heater
- Notes specifying when the house was empty, when the wood burning stove was in use etc.

Method - Analyses

- Measured energy consumption weighted using heating degree days (HDD)
- The contribution from the wood-burning stove was estimated
- The energy saving achieved was found by comparing the energy consumption before and after
- The energy level calculation made in the program BE10 (assign EPC)
- A model of the house before and after renovation in Bsim
- The increase in comfort and changes in user behaviour were evaluated based on the temperatures measured and interviews with the house owners.
- The financial saving was estimated based on the energy savings measured
- The cost of the renovation was evaluated based on the size of the investment and the increased house value estimated by a real estate agent and the house owners' bank
- The overall result was evaluated based on energy, indoor climate, cost and opinions of the house owners

Results – Temperatures



- More even temperature in all rooms
- General temperature increase of 1°C

Results

Energy

- Standard energy consumption measured reduced with 53% or 9,889 kWh
- Simulations estimated a saving of 58%
- EPC went from E to C
- Achieving Renovation Class 2 according to the BR15

Economy

- **Cost** of renovation DKK 1.3 million
- Increased **value gain** due to renovation of DKK 1 million
- **Annual savings** of DKK 8,400 due to reduced running costs (DKK 252,000 over 30 years)
- **Increased comfort** and other non-energy benefits

Partial conclusion

- *When a renovation is based on necessary maintenance and includes energy improvements and functional upgrades, is it possible to improve the house and reduce the energy consumption for heating by 50% within a feasible budget*?

- Documentation of a holistic renovation
  - Based on maintenance, but including functions and better-than-minimum energy improvements
- Heating energy consumption reduced by 53%
- Increase in house value, reduction of running costs
- House owner and measurements confirmed improved comfort

2 – Mapping initiatives in Denmark

- Building regulations (BR15)
- Energy Performance Certificate (EPC)
- BedreBolig (A Better Home)
- Subsidies

The building regulations (BR15)

Requirements for Insulating the building envelope (replacement)

		BR10	BR15
External walls	W/m²K	0.20	0.18
Roof structures	W/m²K	0.15	0.12
External doors	W/m²K	1.65	1.8

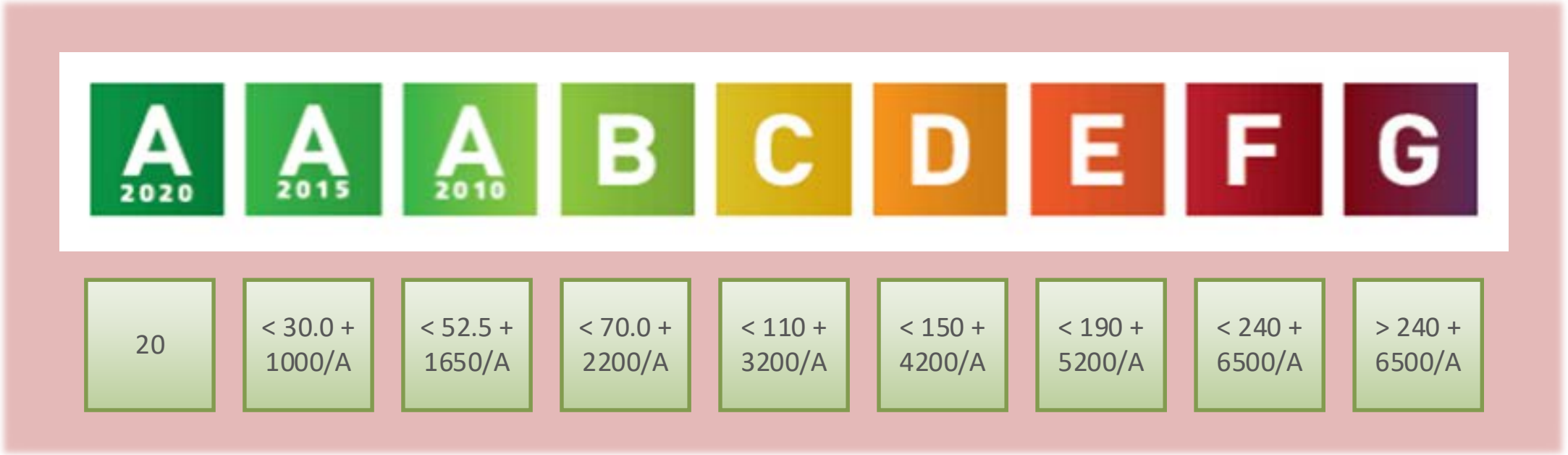
Renovation Class 1

- Total demand for energy supply for heating, ventilation, cooling and domestic hot water must not exeed 52.5 + 1650/A kWh/m2 per year (EPC label A2010)
- Requirement for supplied energy improved by at least 30 kWh/m2 per year
- Part of the total energy supply to buildings must be renewable energy
- Requirements for indoor climate

Renovation Class 2

- Total demand for energy supply for heating, ventilation, cooling and domestic hot water must not exeed 110 + 3200/A kWh/m2 per year (EPC label C)
- Requirement for supplied energy improved by at least 30 kWh/m2 per year
- Part of the total energy supply to buildings must be renewable energy

Energy performance certificate (EPC)



- Level of energy performance
- Based on standard values – Benchmark not actual consumption
- Mandatory when put up for sale
- Very general information/suggestions
- Increase awareness
- Not effective in instigating renovations

BedreBolig (A Better Home)

- Scheme introduced in 2013-2014
- Voluntary and marked-based
- Guiding house owners through renovation process
- Delivering a plan for renovation

Subsidies

”Energiselskabernes energispareindsats” (EE)

- Energy companies are obligated to achieve savings each year
- They can buy the right to report the saving achieved
- Additionality – the agreement must be made before the renovation is initiated
- Each company has their own system
- Very small amount

”BoligJobOrdning” (BJO)

- Tax reduction scheme
- Up to DKK 12.000 per adult in household
- Temporary scheme (since 2011)

3 – Evaluation of current initiatives

EVALUATION OF CURRENT DANISH SCHEMES

	Information			Finance			Decision making		
	A1	A2	A3	B1	B2	B3	C1	C2	C3
BR15									X
EPC-scheme	X	(x)	(x)		X		(x)	(x)	
BedreBolig	X	(x)	X		X		X	X	
Subsidies				X		(x)			

A1 - Raising awareness, A2 - Promoting non-energy benefits, A3 - Educating professionals; B1 - Subsidy motivator, B2 - Investment, B3 - Lack of funds; C1 - Support decisions, C2 - Available solutions, C3 – Regulation.

- A – Information
  - Awareness ok, focus on relevance
  - Promotion of non-energy benefits needed
  - Training of professionals exist
- B – Finance
  - subsidies are too small
  - Too much focus on the financial investment
  - Current policies do not address lack of funds.
- C – Process
  - Initiative with house owner alone
  - Subsidies promotes only small improvements
  - There is little regulation or enforcement.

4 – Suggestions for improvements

Possible improvements

- Focus on maintenance and comfort not savings
- Better financial support
- Long term renovation plan, possibly mandatory
- Maximum level for house energy consumption

Main problem with One Stop Shop Renovation

- The building sector does not offer One Stop Shop Renovation