

Cost implications of energy efficiency renovation measures for a Swedish residential building

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The aim

To study the potential benefit of
residential buildings energy renovation
from an economic point of view

Case-study building



**Multi-story concrete-frame residential
building of 1960s**

Soon to undergo major renovation



Energy efficiency measures

Building envelope elements	Initial U-value, W/m ² K	Energy efficiency measures	New U-value, W/m ² K
Windows	2.9	Removing the existing windows and installing new triple-glazed windows	0.9
External doors	3.0	Removing the existing doors and installing new doors	0.9
East/West facade	0.339	Adding 195mm mineral wool panels (λ -value = 0.036W/mK) with air gap and new cladding	0.119
North/South facade	0.290	Adding 195mm mineral wool panels (λ -value = 0.036W/mK) with air gap and new cladding	0.113
Basement exterior wall	0.63	Adding 200mm insulation of EPS panel (λ -value = 0.039W/mK)	0.149
Attic floor	0.248 (initial)	Adding 250mm mineral wool	0.093
	0.097 (current)	Adding 200mm mineral wool	0.063

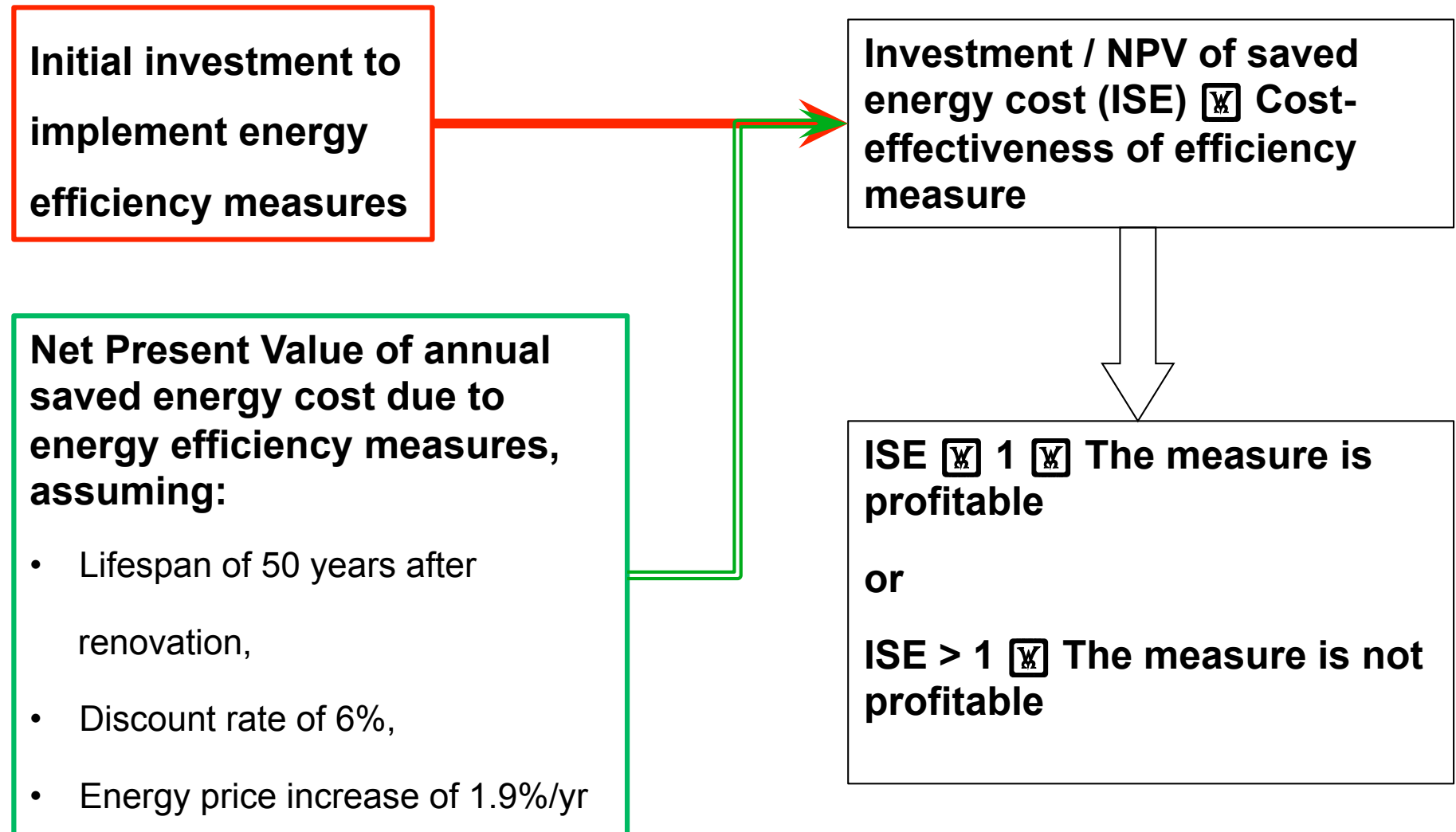


Building energy simulation

- ❑ **Dynamic simulation programme to calculate final energy use for space heating**
- ❑ **Ventilation system: exhaust air fan with:**
 - 50% efficiency
 - 0.35 lit/m²/sec flow rate
- ❑ **Building envelope average airtightness: 0.8 l/m² (at 50 Pa)**
- ❑ **Building envelope indoor temperature: 22°C for living, and 18°C for common areas**



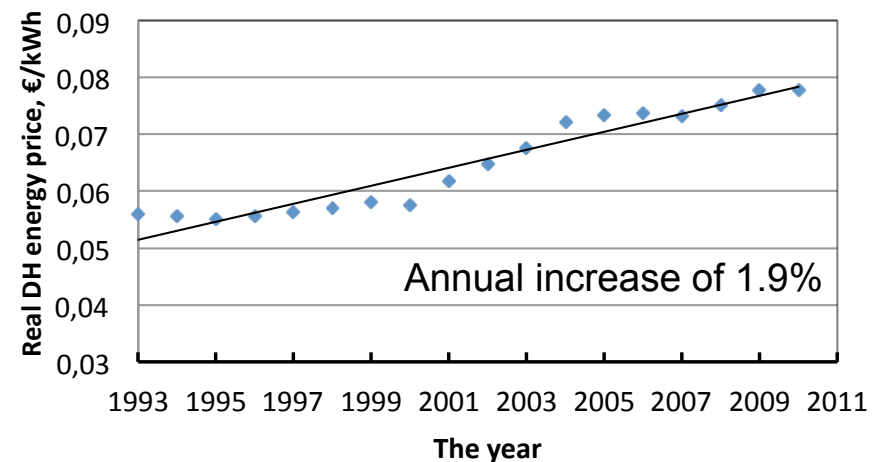
Cost-effectiveness of energy renovation



Economic calculation

DH energy price, Växjö energy supplier tariff (VEAB, 2012)


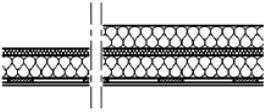
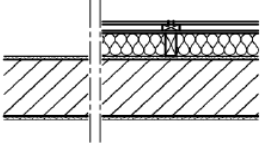
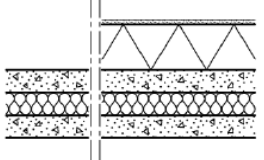
Real DH price (incl. energy tax and VAT), Swedish Energy Agency, 2011



Cost estimation for energy efficiency measures,

Sektionsfakta – ROT,

Wikells ab, 2012

16 snickerier	9 bjälklag	7 ytterväggar	7 ytterväggar
16.002 	9.064 	7.028 	7.025 
windows replacement	extra insulation on attic floor	extra insulation on exterior walls	extra insulation on basement wall



Considered scenarios of energy renovation

Scenario 1: Building in its current state:

no need for building renovation (for repair and maintenance)

Scenario 2: Building in its initial state:

no need for building renovation (for repair and maintenance)

Scenario 3: Building in its initial state:

need for building renovation (for repair and maintenance)

Combined measures as renovation packages


&


Adjustment of heating system (after renovation)



Considered scenarios of energy renovation


Scenario 1: Building in its current state and **no need** for building renovation (for repair and maintenance)


Energy renovation packages	Final energy use for space heating, kWh/m ² /year	Saved energy cost, €/year (in 2012)	Investment cost (cost of efficiency measure implementation), €	NPV  of saved energy cost (50 years life time), €	Investment / NPV of saved final energy cost (after 50 years)
Current state of building (reference)	98.57	0	0	0	n/a
Attic floor extra insulation	97.57	80	8 500	1 700	5.15
+ Basement walls extra insulation	92.57	470	26 400	10 000	2.64
+ Exterior walls extra insulation	72.99	2 010	105 200	42 900	2.45
+ Windows replacement	53.34	3 700	230 400	79 300	2.91
+ Doors replacement	46.04	4 280	268 800	91 600	2.93

 Net Present Value of saved DH cost during assumed life time (50 years).
Discount rate = 6% & Annual energy price increase = 1.9%

Considered scenarios of energy renovation


Scenario 2: Building in its initial state and **no need** for building renovation (for repair and maintenance purpose)


Energy renovation packages	Final energy use for space heating, kWh/m ² /year	Saved energy cost, €/year (in 2012)	Investment cost (cost of efficiency measure implementation), €	NPV  of saved energy cost (50 years life time), €	Investment / NPV of saved final energy cost (after 50 years)
Initial state of building (reference)	107.6	0	0	0	n/a
Attic floor extra insulation	102.8	370	10 900	7 800	1.39
+ Basement walls extra insulation	97.8	770	28 800	16 500	1.74
+ Exterior walls extra insulation	78.1	2320	107 500	49 600	2.17
+ Windows replacement	54.2	4350	228 400	93 100	2.45
+ Doors replacement	46.9	4930	266 800	105 500	2.53

 Net Present Value of saved DH cost during assumed life time (50 years).
Discount rate = 6% & Annual energy price increase = 1.9%

Considered scenarios of energy renovation

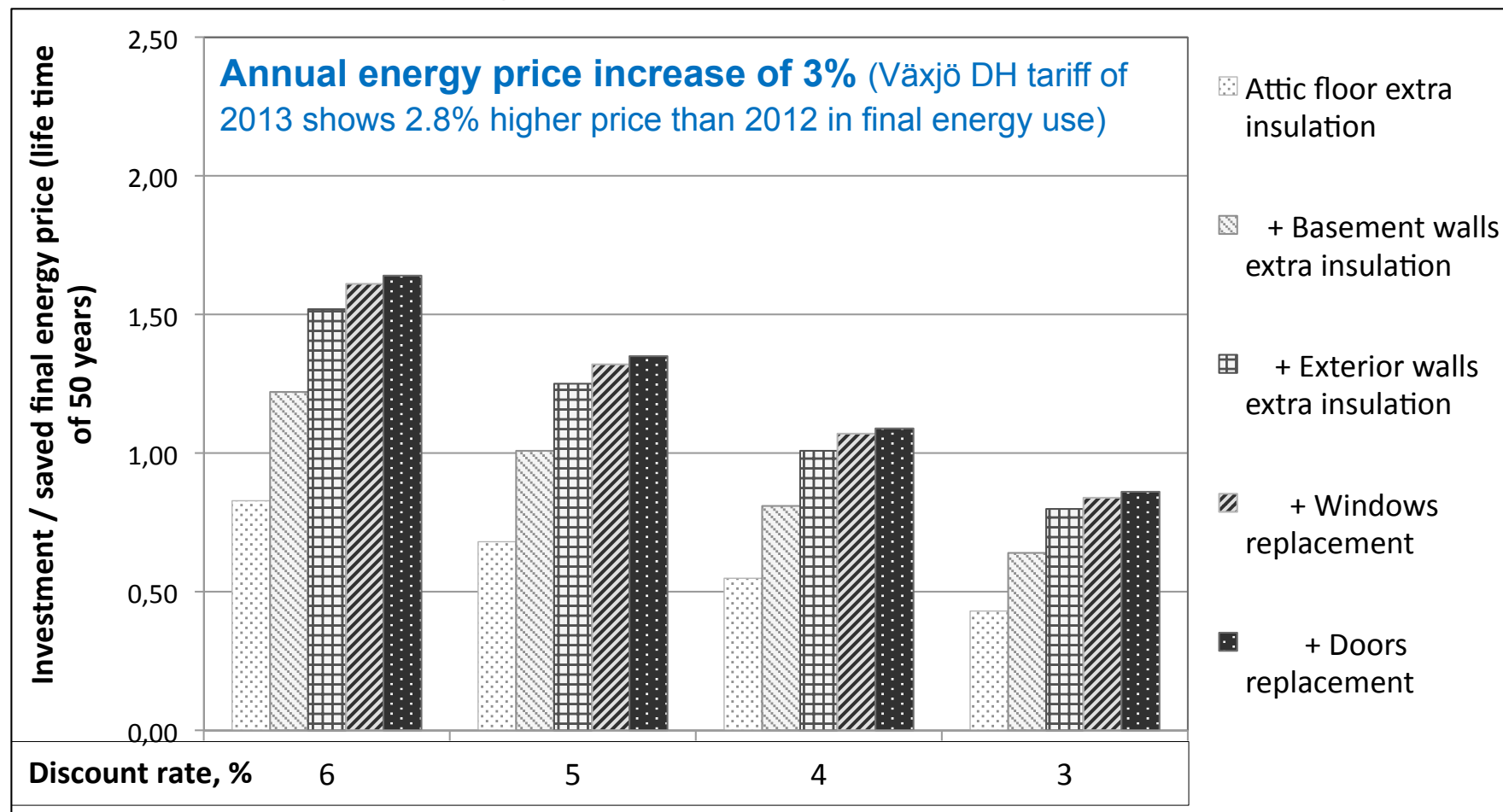
Scenario 3: Building in its initial state and **need** for building renovation (for repair and maintenance purpose)

Energy renovation packages	Final energy use for space heating, kWh/m ² /year	Saved energy cost, €/year (in 2012)	Investment cost (cost of efficiency measure implementation), €	NPV  of saved energy cost (50 years life time), €	Investment / NPV of saved final energy cost (after 50 years)
Initial state of building (reference)	107.6	0	0	0	n/a
Attic floor extra insulation	102.8	370	7 900	7 800	1.01
+ Basement walls extra insulation	97.8	770	24 700	16 500	1.49
+ Exterior walls extra insulation	78.1	2320	92 200	49 600	1.86
+ Windows replacement	54.2	4350	182 800	93 100	1.96
+ Doors replacement	46.9	4930	211 600	105 500	2.01

 Net Present Value of saved DH cost during assumed life time (50 years).
Discount rate = 6% & Annual energy price increase = 1.9%

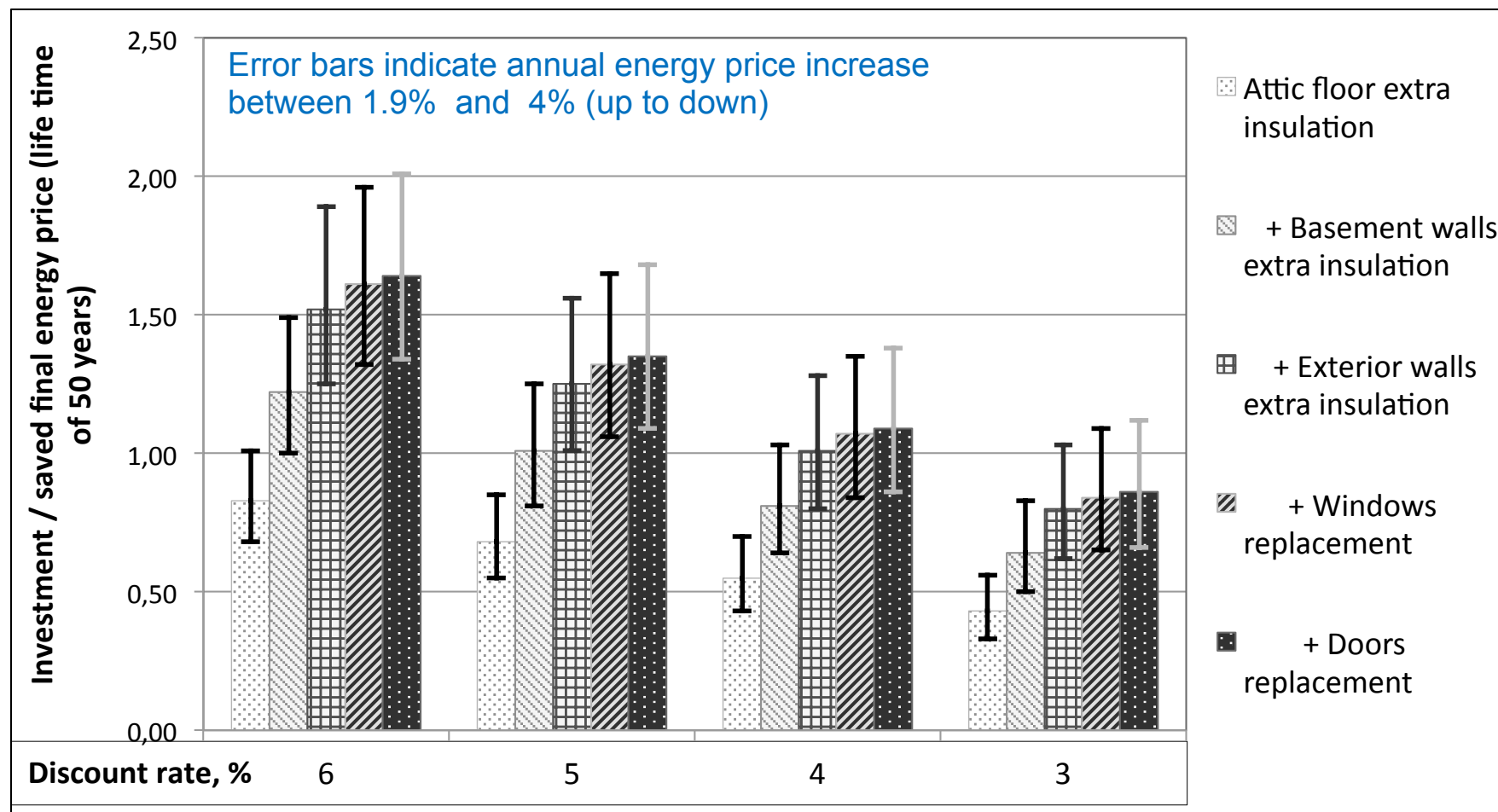
Sensitivity analysis

Influence of discount rate on profitability of energy efficiency measures: for 3rd scenario



Sensitivity analysis

Influence of annual energy price increase on profitability of energy efficiency measures for 3rd scenario



Conclusions

The profitability of energy renovation of building envelope elements depends on, e.g.:

- economic conditions e.g. discount rate, energy price and its increase over the time;

None of the considered renovation packages are profitable BUT;

- 3% discount rate and 3% (or greater) of annual increase in DH price in which all packages are profitable

OR

- 4% discount rate and 3% (or greater) of annual increase in DH price in which most of packages are profitable

- building envelope characteristics (the area of each in the building envelope and their thermal performance);

Comparing the profitability of attic insulation between initial and current states of the building

- the cost of measures implementation

The order of considered measures from end-user profitability point of view:

1. Attic extra insulation
2. Attic + basement extra insulation
3. Attic + basement + exterior walls extra insulation
4. Attic + basement + exterior walls extra insulation + doors and windows replacement



Thank you!

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