Facade Insulation

Roger Malmquist, 2010-12-29

Introduction

On the following pages I will explain and describe what the climate shell of a property looks like, what we can do to reduce our energy costs and how our tenants receive a more comfortable house in which to live.

Energy costs have increased and human CO2 emissions contribute to climate change. Heating of housing accounts for 35% of Sweden's total energy consumption.

Many of the houses being built are not particularly energy efficient, especially in view of the technology and knowledge available today. One reason may be that one party builds the homes, and another party is responsible for managing them. Builders have simply a short-term approach to investment.

Technical lifetime expectancy where no major maintenance or renovation has been estimated to be done is around 50 years. Many of our houses in Sweden are in this situation. These houses were built during the 1960s and 1970s in the suburbs during the so-called million program. These buildings often have very high energy consumption and one major reason is that the buildings are not so draft proof.

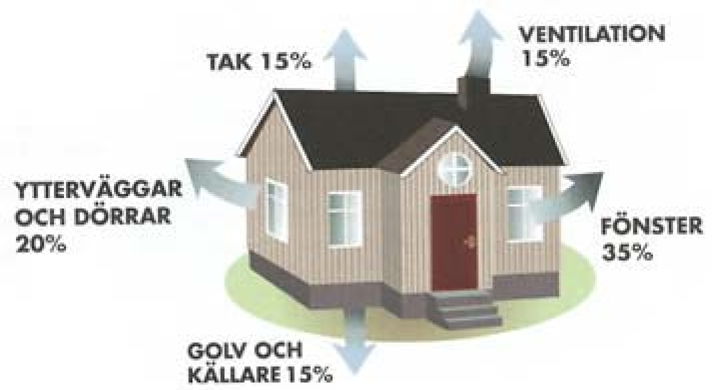
With well insulated houses, we can reduce our energy costs significantly and personally contribute to reducing the ongoing climate change.

Here we can make an effort to both save money and improve the environment.

Climate Shell

What is a climate shell? Quite simply, it is the parts of the building which face the outdoor temperature. It is the foundation, walls, windows, doors and roof. The climate skin acts as a shield to protect the design and to create a good indoor climate. It is here that there are great opportunities to invest in energy efficiency improvements that reduce heat loss.

Heat loss in a building that arises as a result of the outside temperature being lower than the inside temperature. Simply said, the greater the temperature difference is between the outside and the inside, the higher heat loss. Losses will then occur through the floors, walls, windows and roof. Another major area is also something known as cold bridges.

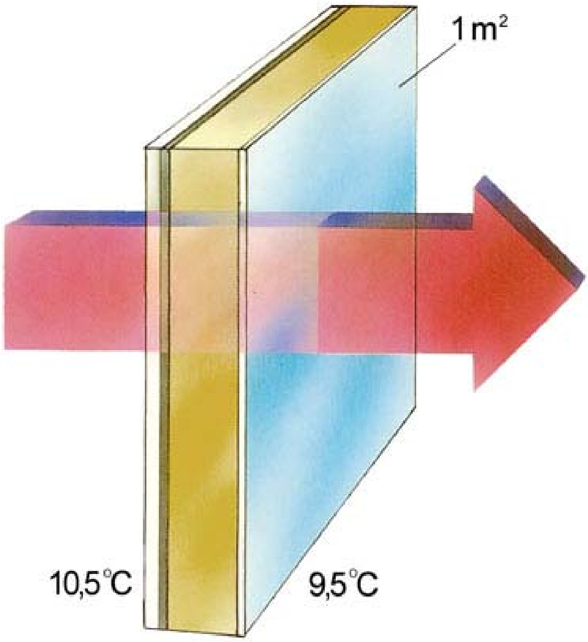


Examples of heat losse: s Floors 15 %, Windows 35%, Walls 20 %, Roof 15 % and ventilation 15 %

U-value

The U-value is calculated from the heat insulating abilities a material possesses, i.e. the measurement of the energy losses through the material. U-value is affected by its thickness and its insulation, better insulation results in a lower u-value. One example is mineral wool that has good insulation and low u-value, whilst steel which leads heat well, has a high u-value.

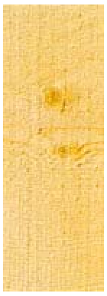
U-value is measured in watts per m^2 and degree. A wall with a u-value of 1.0 W/m^2k, means that it loses 1.0 W/m^2 at a rating of one degree temperature difference.



Example a wall with U-Value of 1.0 W/m^{2}k, means that the wall looses 1.0 Watt in this condition

Walls

External walls are usually the largest part of climate shell and also of the utmost importance that they maintain a low u-value. To retain the u-value energy that energy advisors recommend 0.16 W/m^{2}k, it therefore requires 300 mm isolation on a standard wall.



The more compact a construction material is, the less air it can store up. The lesser the non circulating air, the poorer the insulation. A brick wall must be five times as thick, and a lightweight concrete wall twice as thick as a wooden wall in order to give the same insulating effect.

Additional insulation enhances accommodation quality and indoor climate. Walls with good insulation prevent temperature fluctuation indoors, maintain a stable warmth and drafts are avoided. An insulated wall prevents the formation of condensation on indoor walls in the winter, and an unwanted heating takes place in summer.

Depending on the type of wall you have, it is important to consider, what isolation method you should use.

In-situ concrete is so airtight and dense that problems with condensation do not occur. A special vapor barrier is not needed. Building moisture in the concrete must however be able to be dried out both internally and externally. The facade layer is responsible for the water proofing against driving rain.

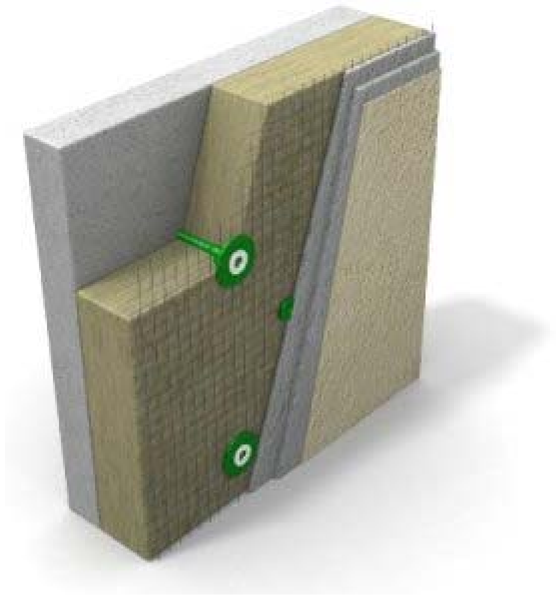
If the concrete wall made of individual elements, the joints must be air-tight.

External insulation of a wall can be made with mineral wool or foam contained in an exterior layer of plaster, sheet metal, wood or a cavity wall. With additional exterior insulation, the original wall to becomes warmer, and moisture conditions will improve. There is no risk of condensation and the new facade layer prevents rain ingress. From a moisture technical point of view, additional exterior insulation should work well.

Solid brick walls are almost never used any more, though it was common before. In Sweden, damage as a result of freezing moisture is one of the most common causes of damage in masonry walls. A prerequisite for frost damage is that the moisture condition is very high while the facade is exposed to a cold winter. If the facade is moist for a long time and while there are nutrients available, you can also have problems with the growth of algae, mosses, lichens or fungi.

If one additionally insulates a solid brick wall internally, this will change the temperature gradient across the brick wall. The wall will become significantly colder. Driving rain that moistens up the wall will not dry out as quickly. If the wall is not airtight and dense on the inside, it can result in moisture from the ambient air condensing against the cold brick wall.

There are often other advantages from additionally insulating from the outside. However carrying out façade insulation can result in changes in the building's exterior visually, this may require planning permission especially if the house is located in the planned city area. So please contact the municipality's Public Works Department before starting the job.



Example of insulation with new trimmed facade

Windows

When we talk about u-value, windows are probably the first thing that comes to mind. It is also the part of the climate shell with the highest u-value. Here we have a major source of energy loss. Energy loss through the windows accounts for approximately ten times greater losses than through the house walls.

There has been a major development in window technology. With today's energy efficient windows that insulate twice as well as regular triple-glazed windows it could make a big difference. An energy efficient window has two or three glasses merged in an insulated box. The gap in the insulating windows is gas-tight sealed unit, and often filled with noble gas for reducing heat loss. The windows let in solar heat but the room heat stays on the inside and does not escape as easily. Frames are designed to minimize heat loss.

These energy-efficient windows provide a better indoor climate because the air next to the window is not chilled as much as a regular window and does not creates down-draughts.

Energy Advisory recommends that we use windows with a maximum u-value of 1.2 W/m^{2}k today.

Example of a triple-glazed insulating window

Roof

The roof is also a major source of energy losses. The overall climate skin depends of course on whether it is a smaller or higher building. In order to meet energy adviser’s recommendations of a u-value of 0.1 W/m^2k, 500 mm insulation of a roof with wooden trusses is required.

The roof is mainly to protect the building from rain and snow. Watertight and roof drainage are important aspects in the design of the roof.

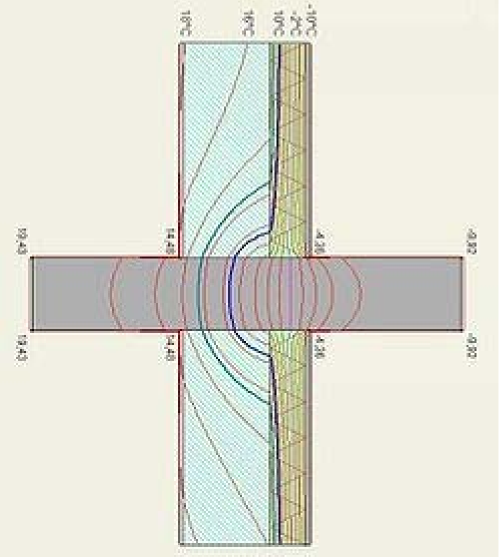
Important to remember is, a ventilated roof over a well-insulated attic floor is susceptible to damage. The better you insulate the floor joists, the colder it becomes in the attic space and thus increases the risk of damage. If moist indoor air comes up to the attic space through leaky doors, chimneystacks or other holes, condensation can occur with serious damage. Even small leaks and small amounts of moist internal air inside can cause major problems. These problems may include mold growth, discoloration and in severe cases even rot, especially on the roof underlay.

Examples of loose wool pulverized over wind

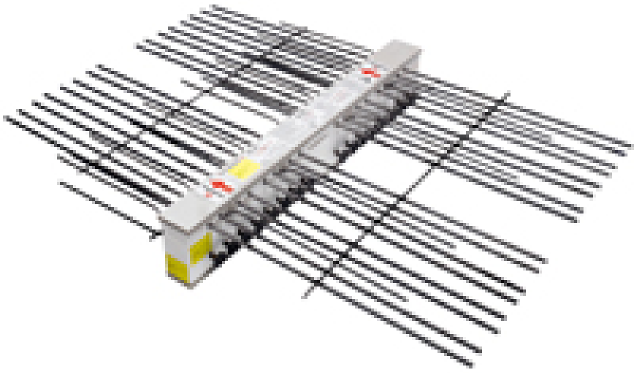
Cold bridges

Cold bridges are the weak point in the climate shell. A cold bridge is a construction part that runs unbroken from the outside into the inside without being sealed off with isolation. It can be a balcony where reinforcement in the floor plate runs into to the floor joists, it can also be a window where the frames are un-insulated.

Cold bridges are normally quite small to the surface but are often a major contributor to energy losses. It is therefore important to try to keep in mind to eliminate these cold bridges when renovating windows or with the new insulation of a facade.



Example of a cold bridge



Example of how to prevent a thermal bridge

Benefits of a good climate shell

- Reduces heating costs.
- Reduces the risk of moisture damage.
- Maintains a more even indoor temperature.
- Increases tenants comfort.
- Increases the value of the building, houses with low energy consumption have a higher market value and are easier to sell or rent.
- Reduces environmental impact, houses consume less energy and emit fewer harmful substances.

References:

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Group Work

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Renen 14

Renen 14, Södertälje

Birkavägen 3-7

Year built	1970
Apartments	45
Floors	4
Area	3,255 m^2
District heating MWh/year	506 MWh/y
Windows	205
External walls	1,225 m^2
Roof	900 m^2

Costs

District heating	83 €/Mwh
New triple-glazed energy windows	560 €/each
Insulation with new trimmed facade	75 €/m^2
Loose wool over the wind	20 €/m^2

Savings

Windows	19 %
Facade	15 %
Roof	11 %

Questions

1. How large is the total investment?

2. Key Ratio, what is the price for district heating per m^2 and what is the consumptions per m^2 before investment?

3. What is the saving in consumption?

4. What is the saving in money?

5. Key Ratio, what is the price for district heating per m^2 and what is the consumption per m^2 after investment?

6. What will the Net Present Value be if inflation is 2% and a discount rate of 7%, with an estimated useful life of at least 30 years?

7. What action would you choose if you could only do one?

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Answers

1. How large is the total investment?

   Windows 205 * 560 = 114,800 €
   Facade 75 * 1 225 = 91,875 €
   Roof 20 * 900 = 18,000 €

   114,800 + 91,875 + 18,000 = 224,675 €

2. Key Ratio, what is the price for district heating per m^2 and what is the consumption per m^2 before investment?

   83 € * 506 MWh = 41,998 €
   41,998 € / 3,255 m^2 = 12.9 € / m^2

   506 MWh / 3,255 m^2 = 0.155 = 155 KWh / m^2

3. What is the saving in consumption?

   506 MWh * 0.45 = 227.7 MWh

4. What is the saving in money?

   41,998 € * 0.45 = 18,899.1 €

5. Key Ratio, what is the price for district heating per m^2 and what is the consumption per m^2 after investment?

   41,998 – 18,899 = 23,099
   23,099 / 3,255 m^2 = 7.1 € / m^2

   506 MWh – 227.7 MWh = 278.3 MWh
   278.3 MWh / 3,255 m^2 = 0.085 MWh = 85 KWh / m^2

6. What is the NPV if inflation is 2% and a discount rate of 7%, with an estimated useful life of at least 30 years?

   63,365 € see excel sheet below

7. What action would you choose if you could only do one?

   Windows cost 114,800 € saves 19 % = 7,979.62 €
   Net Present Value = 6,817 €

   Facade cost 91,875 € saves 15 % = 6,299.7 €
   Net Present Value = 4,138 €

   Roof cost 18,000 € saves 11 % = 4,619.78 €

Net Present Value = 52,410 €

Net Present Value

	A	B	C	D	E	F	G
1	**Energy costs € / MWh**	**83**					
2	**Yearly consumptions MWh**	**506**					
3	**Energy savings in percent**	**45%**					
4	**Renovate cost**	**-225 175**					
5	**Energy savings in money**	**18899,1**					
6	**Inflation**	**2%**					
7	**Discount rate**	**7%**					
8							
9							
10							
11	**year**	**Cashflow**	_	**Present value**	**PV = C /(1+r)**	**Net Present Value**	**NPV = PV - Investment**
12	**0**	**-225175**		**-225175**		**-225175**	
13	**1**	**18899**	=B5	**17663**	=B13/(1+B$7)^A13	**-207512**	=SUMMA(D12:D13)
14	**2**	**19277**	=B13*(1+B$6)	**16837**	=B14/(1+B$7)^A14	**-190675**	=SUMMA(D12:D14)
15	**3**	**19663**	=B14*(1+B$6)	**16051**	=B15/(1+B$7)^A15	**-174624**	=SUMMA(D12:D15)
16	**4**	**20056**	=B15*(1+B$6)	**15301**	=B16/(1+B$7)^A16	**-159324**	=SUMMA(D12:D16)
17	**5**	**20457**	=B16*(1+B$6)	**14586**	=B17/(1+B$7)^A17	**-144738**	=SUMMA(D12:D17)
18	**6**	**20866**	=B17*(1+B$6)	**13904**	=B18/(1+B$7)^A18	**-130834**	=SUMMA(D12:D18)
19	**7**	**21283**	=B18*(1+B$6)	**13254**	=B19/(1+B$7)^A19	**-117580**	=SUMMA(D12:D19)
20	**8**	**21709**	=B19*(1+B$6)	**12635**	=B20/(1+B$7)^A20	**-104945**	=SUMMA(D12:D20)
21	**9**	**22143**	=B20*(1+B$6)	**12044**	=B21/(1+B$7)^A21	**-92901**	=SUMMA(D12:D21)
22	**10**	**22586**	=B21*(1+B$6)	**11482**	=B22/(1+B$7)^A22	**-81419**	=SUMMA(D12:D22)
23	**11**	**23038**	=B22*(1+B$6)	**10945**	=B23/(1+B$7)^A23	**-70474**	=SUMMA(D12:D23)
24	**12**	**23499**	=B23*(1+B$6)	**10434**	=B24/(1+B$7)^A24	**-60040**	=SUMMA(D12:D24)
25	**13**	**23969**	=B24*(1+B$6)	**9946**	=B25/(1+B$7)^A25	**-50094**	=SUMMA(D12:D25)
26	**14**	**24448**	=B25*(1+B$6)	**9481**	=B26/(1+B$7)^A26	**-40613**	=SUMMA(D12:D26)
27	**15**	**24937**	=B26*(1+B$6)	**9038**	=B27/(1+B$7)^A27	**-31574**	=SUMMA(D12:D27)
28	**16**	**25436**	=B27*(1+B$6)	**8616**	=B28/(1+B$7)^A28	**-22958**	=SUMMA(D12:D28)
29	**17**	**25944**	=B28*(1+B$6)	**8213**	=B29/(1+B$7)^A29	**-14745**	=SUMMA(D12:D29)
30	**18**	**26463**	=B29*(1+B$6)	**7830**	=B30/(1+B$7)^A30	**-6916**	=SUMMA(D12:D30)
31	**19**	**26993**	=B30*(1+B$6)	**7464**	=B31/(1+B$7)^A31	**548**	=SUMMA(D12:D31)
32	**20**	**27532**	=B31*(1+B$6)	**7115**	=B32/(1+B$7)^A32	**7663**	=SUMMA(D12:D32)
33	**21**	**28083**	=B32*(1+B$6)	**6782**	=B33/(1+B$7)^A33	**14445**	=SUMMA(D12:D33)
34	**22**	**28645**	=B33*(1+B$6)	**6465**	=B34/(1+B$7)^A34	**20911**	=SUMMA(D12:D34)
35	**23**	**29218**	=B34*(1+B$6)	**6163**	=B35/(1+B$7)^A35	**27074**	=SUMMA(D12:D35)
36	**24**	**29802**	=B35*(1+B$6)	**5875**	=B35/(1+B$7)^A35	**32950**	=SUMMA(D12:D36)
37	**25**	**30398**	=B36*(1+B$6)	**5601**	=B36/(1+B$7)^A36	**38550**	=SUMMA(D12:D37)
38	**26**	**31006**	=B37*(1+B$6)	**5339**	=B37/(1+B$7)^A37	**43890**	=SUMMA(D12:D38)
39	**27**	**31626**	=B38*(1+B$6)	**5090**	=B38/(1+B$7)^A38	**48979**	=SUMMA(D12:D39)
40	**28**	**32259**	=B39*(1+B$6)	**4852**	=B39/(1+B$7)^A39	**53831**	=SUMMA(D12:D40)
41	**29**	**32904**	=B40*(1+B$6)	**4625**	=B40/(1+B$7)^A40	**58456**	=SUMMA(D12:D41)
42	**30**	**33562**	=B41*(1+B$6)	**4409**	=B41/(1+B$7)^A41	**62865**	=SUMMA(D12:D42)
43	**Present value**			**288040**			
44	**Net Present Value**					**62865**	
45	**Initial Yield**					**8,4%**	=B13/-B12
46	**Internal Rate of Return**					**9,4%**	=IR(B12:B42)