ECO-COMPETITIVENESS OF A LOG WALL

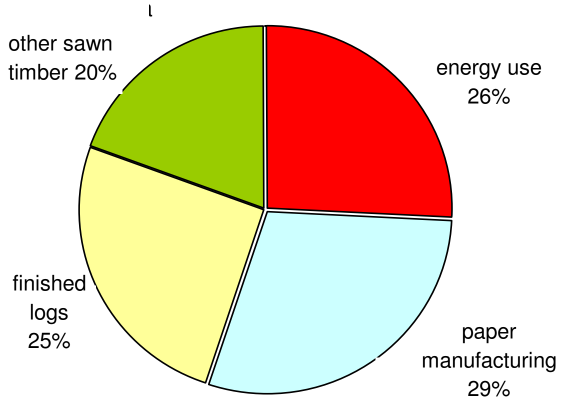
Based on the following study:
"Calculation of environmental effects of a log wall based on a life-cycle analysis"

HIRSITALO TEOLLISUUS

Oulu 11 February 2009
Matti Alasaarela
Architects' office Inspis Oy

HOW MUCH TIMBER IS NEEDED FOR A LOG HOUSE?

A midsize log house with an area of circa 180 m² contains approximately 150 m² of log walls. The manufacturing of 205-mm thick walls for the house takes circa 120 m³ of stocks. This log stock volume comes from an average area of 1.4 hectares in Finland. The stocks yield not only logs (31 m³) but also other sawn timber (24 m³), raw material for the paper industry (35 m³) and energy waste (31 m³). In addition, timber harvesting produces 10 to 12 m³ of logging waste, which is nowadays often collected for energy use. The share of logs of the wood area is 0.35 hectares/house.



In Finland a new forest will grow to replace the one that was felled. The forest will be harvestable again in 80 years. The log house will probably be erect at that time. According to some sources the growth in the volume of carbon dioxide in the atmosphere could be stopped by increasing the volume of forests in the world by 20%. The building of a log house has the same impact on the greenhouse effect as the planting of new forest on an area of 0.64 hectares.

Figure 1. Use of stock at a log house factory

Sources: Metsätilastollinen vuosikirja 2008, Metsäntutkimuslaitos (Statistical Yearbook of Forestry 2008, Forest Re search Institute)
Alasaarela Matti, 2008 Calculation of environmental effects of a log wall based on a life-cycle analysis

WILL THERE BE ENOUGH TIMBER IN FINNISH FORESTS?

Since the 70s fewer trees have been cut down in Finland than new ones grow. The stand of trees has grown by 48% since the 60s. The diagram below shows the relationship between the increment and removal of growing stock.

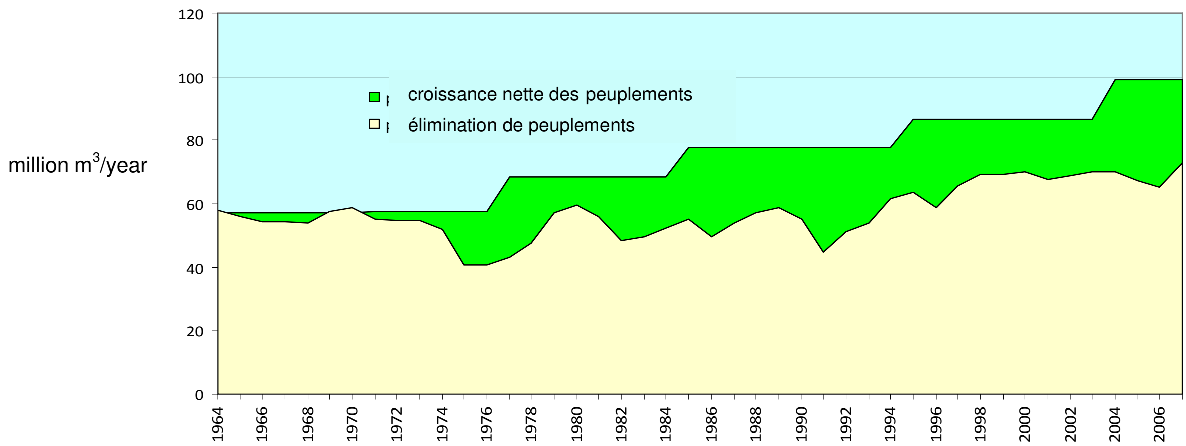


Figure 2. Relationship between increment and removal of growing stock in Finland in 1964–2007.

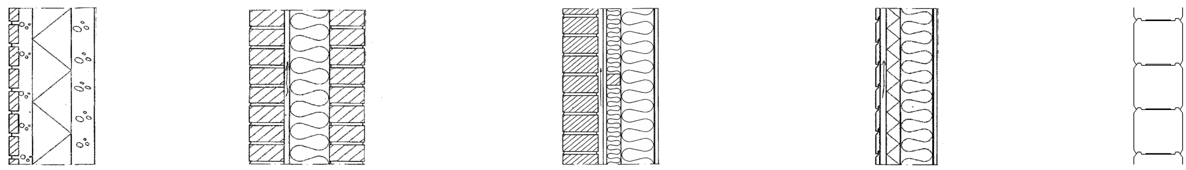
For the past ten years, the average annual increment in wood quantity has been 22.6 million m³. Of this, the share of softwood stocks has been circa 8.6 million m³ per year.

The logging surplus could be used to manufacture 10 million m² of a 205-mm thick log wall. If the whole surplus were used for building log houses, it would suffice for log walls in 70,000 midsize houses. And growing stock would not decrease at all.

Sources: Metsätilastollinen vuosikirja 2008, Metsäntutkimuslaitos (Statistical Yearbook of Forestry 2008, Forest Research Institute)
Alasaarela Matti, 2008 Calculation of environmental effects of a log wall based on a life-cycle analysis

WALL CONSTRUCTIONS USED IN COMPARISON

CONCRETE ELEMENT | SOLID BRICK | BRICK LINING | TIMBER CLADDING | LOG WALL



The data for the structures used in the comparison have been received from the environmental declarations published by The Building Information Foundation RTS. The data have been adjusted to correspond to a standard wall (2007 and 2010) by changing the thickness of insulation course and by taking into account the resulting changes in energy consumption and emissions. The thickness of a log wall in the comparison is 205 mm.

The emission factor CO2-eq for electricity used in the environmental declarations is 220 g/kWh and that for district heat 400 g/kWh. For this analysis, the emission factors for the log wall life-cycle analysis have also been changed accordingly. Likewise, the length of the transportation route of the building elements have been adjusted as 50 kilometres in accordance with the environmental declarations.

Sources: Log wall: Alasaarela Matti, 2008 Calculation of environmental effects of a log wall based on a life-cycle analysis
Other wall constructions: Saari Arto, 2001 Rakennusten ja rakennusosien ympäristöselosteet (Environmental declarations for buildings and building components)

FINAL REPORT BY THE ENVIRONMENT CLUSTER, “FORESTS IN MITIGATING CLIMATE CHANGE”

The report from 2006 presents the following conclusions:

It is advantageous for the carbon balance in the atmosphere if:

1. *the energy inputs for the manufacturing process of a timber product are small, which means that fewer fossil fuels are consumed or bioenergy will be saved for other purposes*

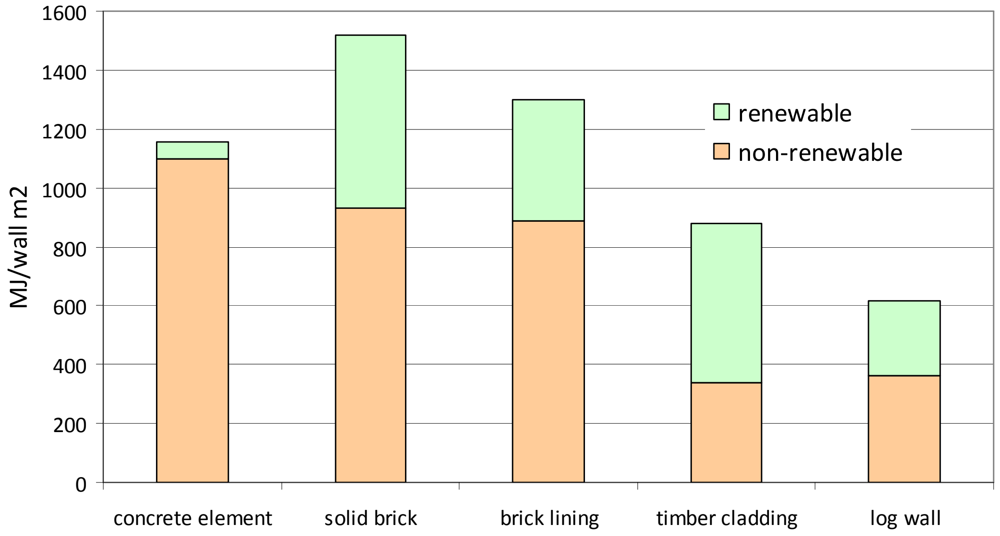
2. *recyclable timber product has a long life-cycle, absorbing more carbon*

3. *at the end of the life-cycle, the product can be recycled into bioenergy, whereby solar energy absorbed into the wood can be utilised.*

4. *wood can be used to replace especially emission-intensive products, thereby indirectly decreasing the use of fossil fuels.*

In the following pages, the characteristics of a log wall are tested against the above four statements.

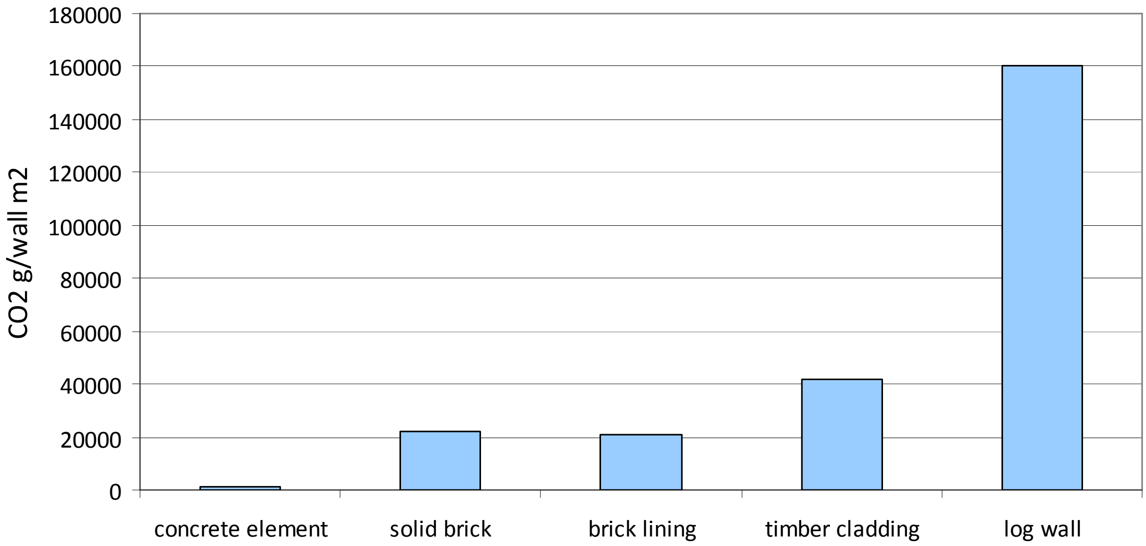
1. ENERGY INPUTS FOR THE MANUFACTURING PROCESS OF A LOG WALL ARE SMALL...



Energy consumption in the manufacturing of a wall

Sources: Log wall: Alasaarela Matti, 2008 Calculation of environmental effects of a log wall based on a life-cycle analysis
Other wall constructions: Saari Arto, 2001 Rakennusten ja rakennusosien ympäristöselosteet (Environmental declarations for buildings and building components)

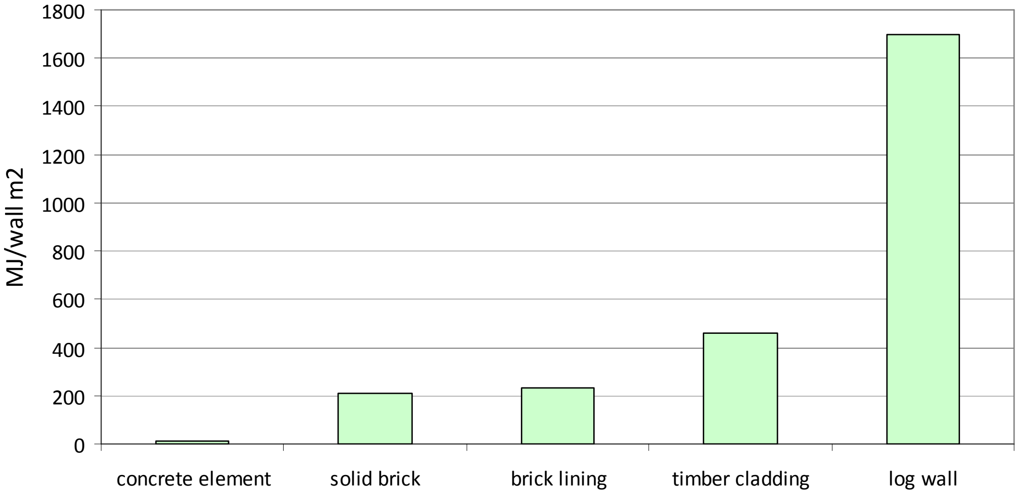
2. LOG WALL HAS A LONG LIFE-CYCLE, CONTAINING MORE CARBON



The carbon content of a wall converted into carbon dioxide

Sources: Log wall: Alasaarela Matti, 2008 Calculation of environmental effects of a log wall based on a life-cycle analysis
Other wall constructions: Saari Arto, 2001 Rakennusten ja rakennusosien ympäristöselosteet (Environmental declarations for buildings and building components)

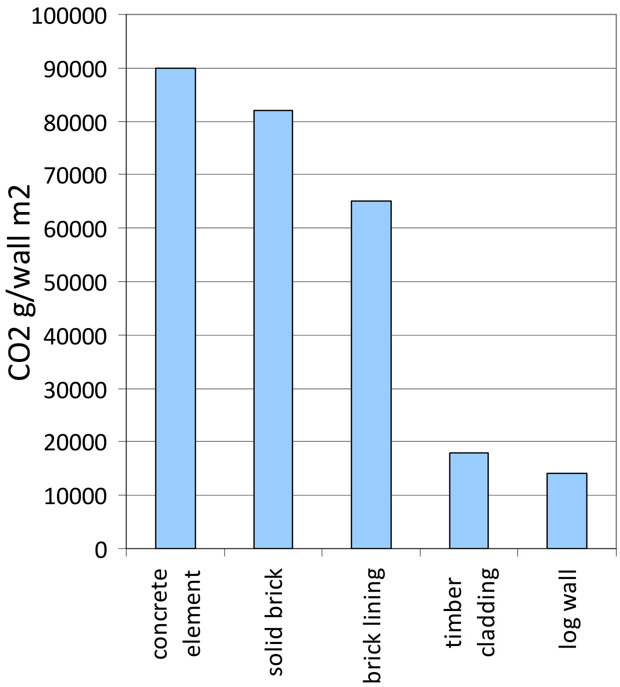
3. LOG IS RECYCLABLE INTO BIOENERGY AT THE END OF ITS LIFE-CYCLE...



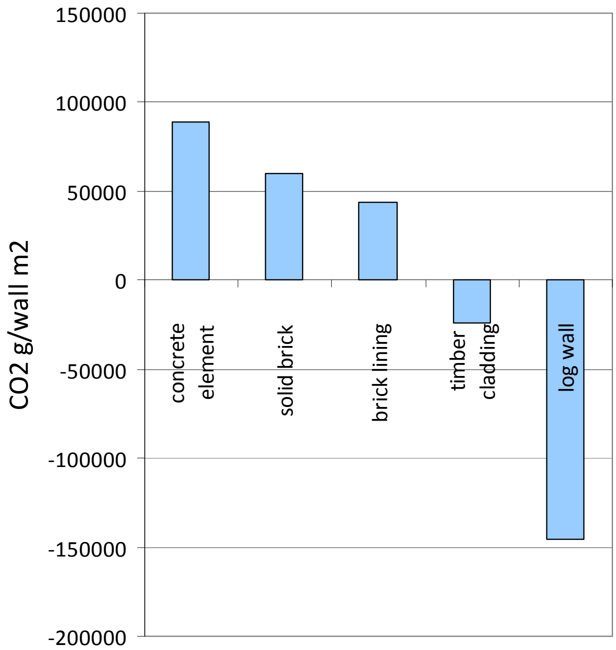
Bioenergy stored in a wall

Sources: Log wall: Alasaarela Matti, 2008 Calculation of environmental effects of a log wall based on a life-cycle analysis
Other wall constructions: Saari Arto, 2001 Rakennusten ja rakennusosien ympäristöselosteet (Environmental declarations for buildings and building components)

4. WOOD CAN REPLACE ESPECIALLY EMISSION-INTENSIVE PRODUCTS...



Carbon dioxide emissions during the manufacturing of a wall

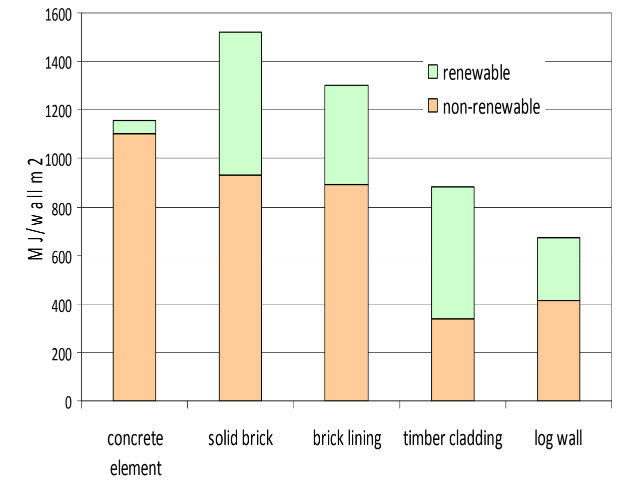


Carbon dioxide emissions during the manufacturing of a wall taking into account the carbon stored in the wall (carbon sink provided by the wall)

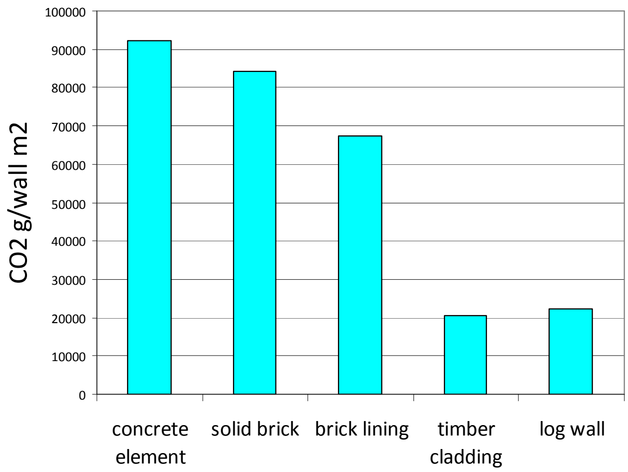
Sources: Log wall: Alasaarela Matti, 2008 Calculation of environmental effects of a log wall based on a life-cycle analysis
Other wall constructions: Saari Arto, 2001 Rakennusten ja rakennusosien ympäristöselosteet (Environmental declarations for buildings and building components)

IMPACT OF COMPENSATING THE U-VALUE OF A LOG WALL ON THE ECOLOGY OF WALL BUILDING

According to the valid Finnish building regulations **C3 (2007)**



Energy consumption in building



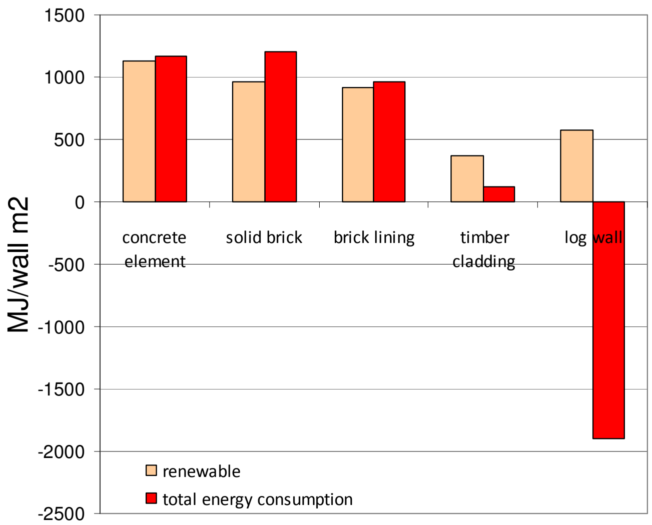
Greenhouse gas emissions in building

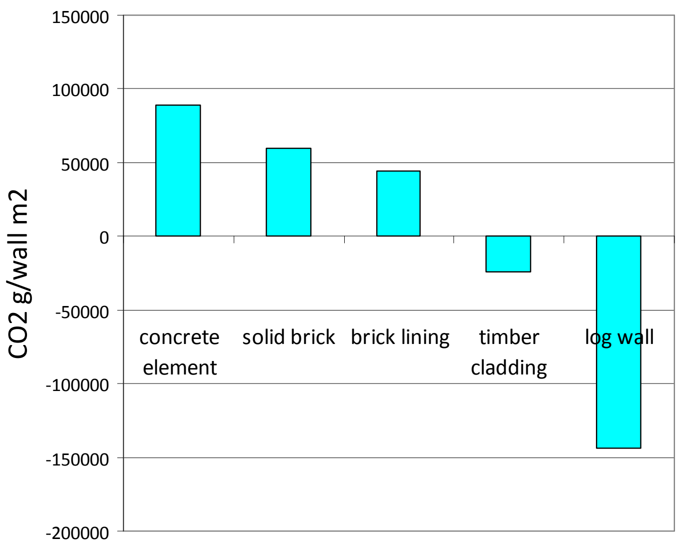
The values for a log wall have been complemented with the energy consumption and emissions caused by the additional insulation of other constructions. In terms of energy consumption during use, the buildings are comparable.

Sources: Log wall: Alasaarela Matti, 2008 Calculation of environmental effects of a log wall based on a life-cycle analysis
Other wall constructions: Saari Arto, 2001 Rakennusten ja rakennusosien ympäristöselosteet (Environmental declarations for buildings and building components)

IMPACT OF COMPENSATING THE U-VALUE OF A LOG WALL ON THE ECOLOGY OF WALL BUILDING

According to the valid Finnish building regulations **C3 (2007)**
Energy wood generated during production and the carbon sink provided by a wall have been taken into account in these diagrams





Energy consumption in building

Greenhouse gas emissions in building

The values for a log wall have been complemented with the energy consumption and emissions caused by the additional insulation of other constructions. In terms of energy consumption during use, the buildings are comparable.

Sources: Log wall: Alasaarela Matti, 2008 Calculation of environmental effects of a log wall based on a life-cycle analysis
Other wall constructions: Saari Arto, 2001 Rakennusten ja rakennusosien ympäristöselosteet (Environmental declarations for buildings and building components)

HEAT INSULATION REQUIREMENTS COMING INTO FORCE IN 2010

The comparison value for thermal transmittance is 0.4 W/(m²K). The U-value for a 205-mm log wall is 0.53 W/(m²K). The difference can be compensated by improving thermal transmittance of other building elements. In a one-storey house this means, for instance, additional 200-mm insulation in the subfloor space.

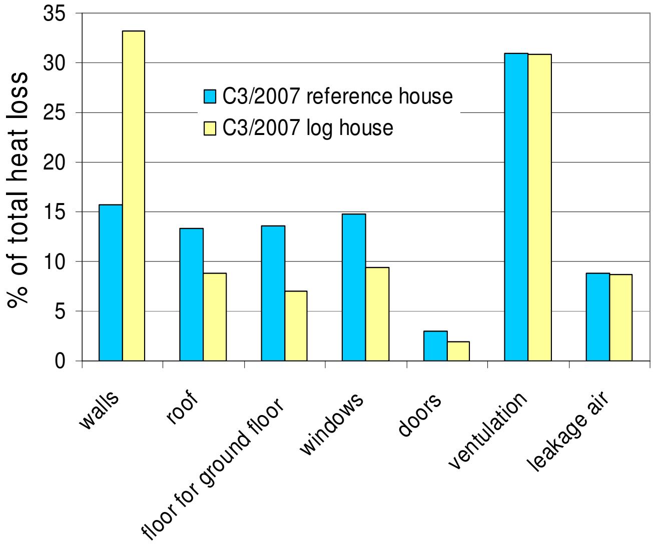
A log house with this kind of additional insulation will meet the requirements in the 2010 standards, *but heating will take* 26 kWh more energy per year per one wall square metre In a one-storey house with an area of 180 m² this will translate into circa 3,000 kWh per year. Impact on the energy performance of the house is 17 kWh/m².

Full-scale compensation of the U-value of a log wall to the level of insulation in the 2010 standards will lead to unreasonable insulation thicknesses in the ceiling and floor. By contrast, compensation by useing more efficient heat recovery in ventilation and by improving airtightness is possible.

The carbon sink provided by a log wall and smaller emissions during manufacturing may enable the decrease of greenhouse gas emissions over the life-cycle to the same level as in a wood house provided that the emission factor of energy used for heating is less than 200 g/kWh.

DISTRIBUTION OF HEAT LOSSES IN DIFFERENT PARTS OF THE ENCLOSURE

House insulated in accordance with the present heat insulation regula-

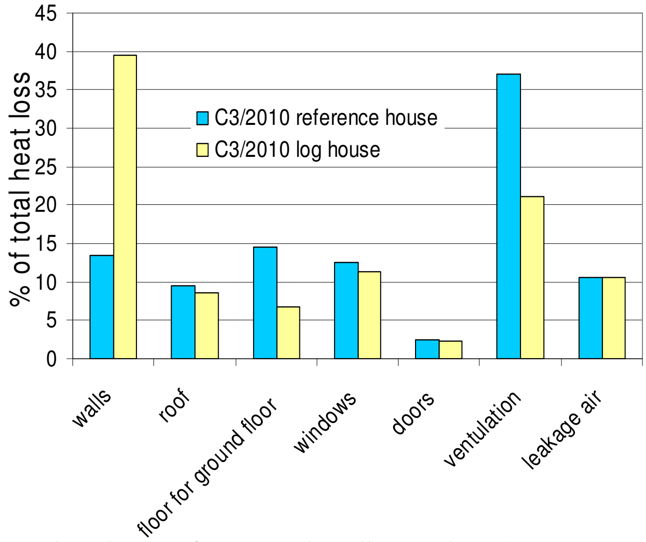


The share of external walls insulated in accordance with the standards (U = 0.24) is circa 16% 16%

In a log house (U = 0.53) the share of external doors goes up to 33% of total heat loss.

The compensation of the U-value of log walls is shown in the roof, subfloor space and windows.

House insulated in accordance with the heat insulation regulations coming into force in



The share of external walls insulated in accordance with the standards (U = 0.24) is circa 14% 14%

In a log house (U = 0.53) the share of external doors goes up to 40% of total heat loss.

The U-value of log walls has been compensated in the example not only in the enclosure but also by improving the efficiency of ventilation.