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RENOVATION OF BUILDINGS USING STEEL TECHNOLOGIES (ROBUST)

RFSR CT 2007-0043

WP4: LIGHT STEEL SYSTEMS TO UPGRADE ROOFS IN RESIDENTIAL AND COMMERCIAL BUILDINGS

- Thermal simulation of upgrading roof -

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Content

1 CASE STUDY: SEMI-DETACHED HOUSE

1.1 Input Data

A detailed study is shown for the case "semi-detached house".

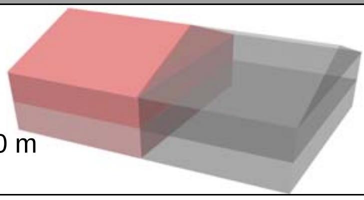
Dwelling Type	Floor Area (m2)	Sketch
Semi-detached house	89	

Figure 1.1 *Semi-detached house, basic information*

The energy demand (net energy, heating) was calculated using the simulation tool TRNSYS for the following cases:

<u>Climate zones:</u>

a) Helsinki

b) Berlin

c) London

<u>Variation of building:</u>

- Base case (total and fraction transmitted by roof)

- Good practise for loft conversion (specific energy demand for new space)

- Best practise for loft conversion (specific energy demand for new space)

For definition of cases see Table 2.1

1.2 Results

The following diagrams (Figure 1.2 - Figure 1.5) show the net heating energy demand (monthly values) for the defined situations.

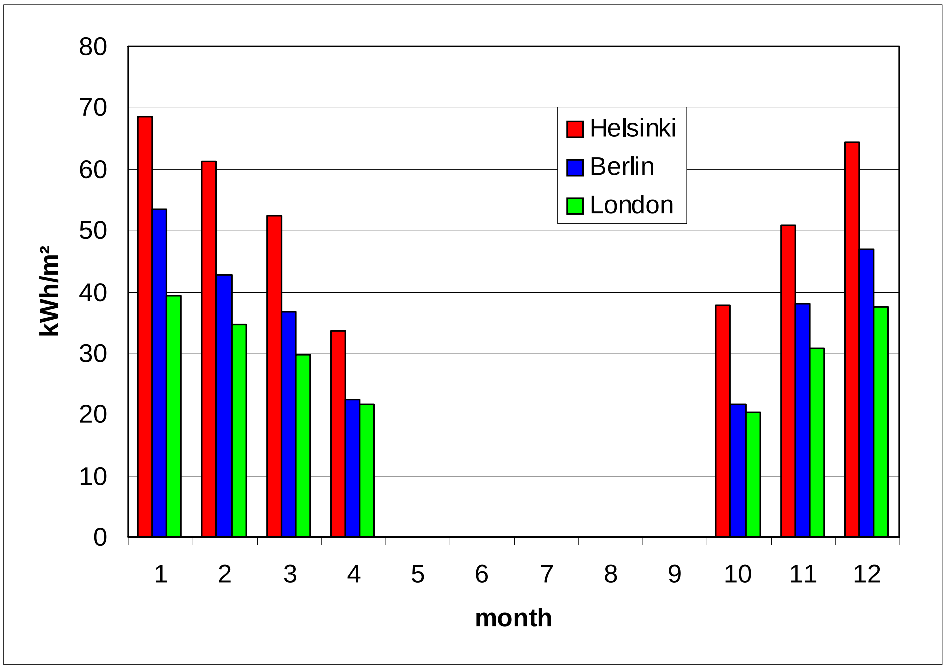


Figure 1.2 *Monthly heating energy demand (semi detached house, base case)*

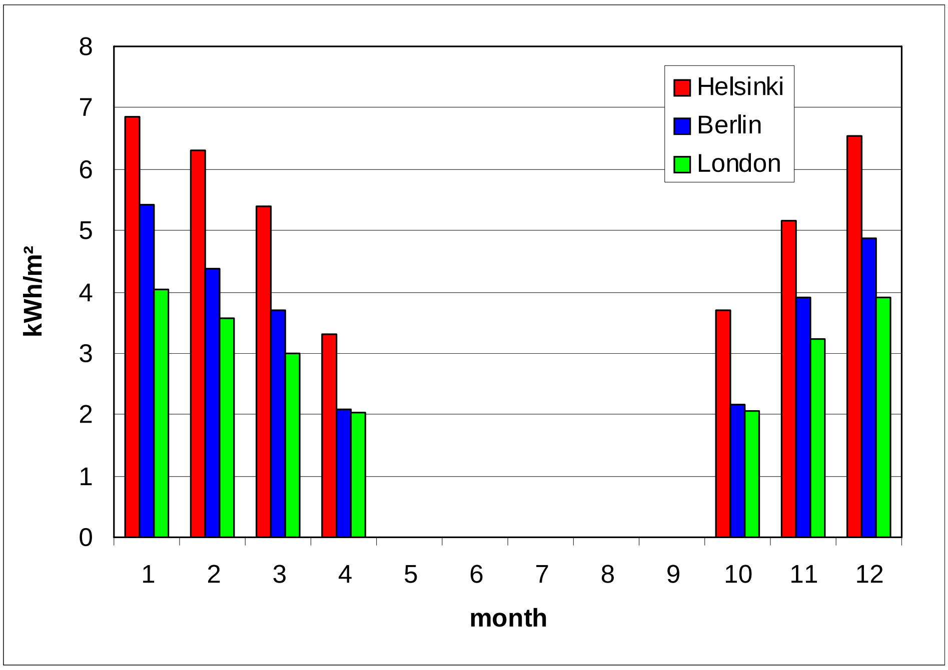


Figure 1.3 *Monthly heating energy demand caused by heat transmission through roof (semi detached house, base case)*

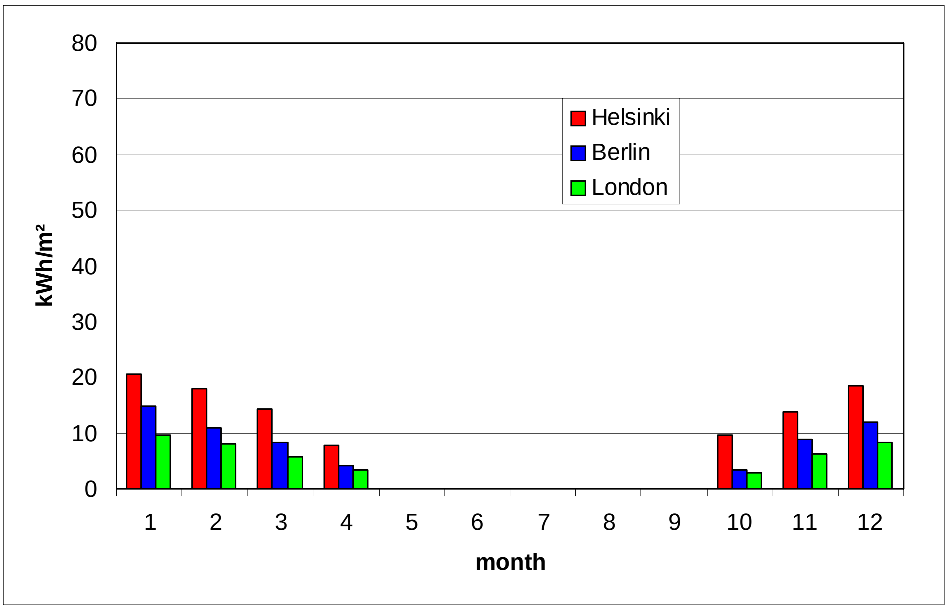


Figure 1.4 *Monthly heating energy demand of converted loft (semi detached house, good practise)*

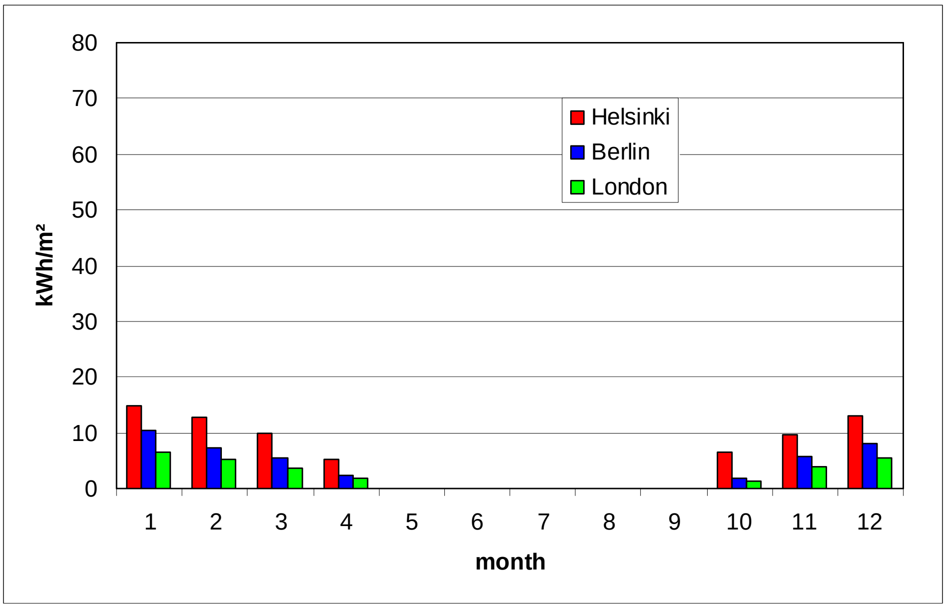


Figure 1.5 *Monthly heating energy demand of converted loft (semi detached house, best practise)*

The energy demand for the new habitable space in the loft is quite small, depending on the quality of the upgrading ("good" or "best" practise). Additionally, the energy losses of the existing old part of the building are reduced, thus finally the heating energy demand of the refurbished building with additional space is lower than of the base case with less floor area (see Table 1.2 and Table 1.3), the additional heating energy demand is negative.

Table 1.1 *Annual heating energy demand, base case*

kWh/m²a	Helsinki	Berlin	London
heating energy demand	369.0	262.0	213.9
heat losses roof	37.3	26.5	21.8

Table 1.2 *Annual heating energy demand for converted loft (good practise) and balancing with energy saving of original building*

[in kWh/m²a]	Helsinki	Berlin	London
heating demand loft	102.7	62.6	44.2
reduction old building	-123.0	-87.5	-71.9
additional heating demand loft	-20.3	-25.0	-27.7

Table 1.3 *Annual heating energy demand for converted loft (best practise) and balancing with energy saving of original building*

[in kWh/m²a]	Helsinki	Berlin	London
heating demand loft	71.8	41.5	27.8
reduction old building	-123.0	-87.5	-71.9
additional heating demand loft	-51.1	-46.0	-44.1

2 CASE STUDIES: OTHER BUILDING TYPES

2.1 Input Data

A number of cases for upgrading of roofs of residential buildings were defined. The simulation work focused on the following range of building types (Figure 2.1):

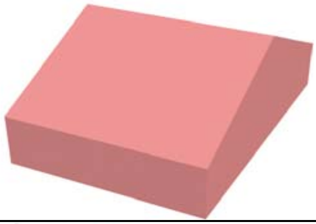
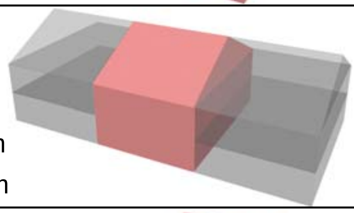
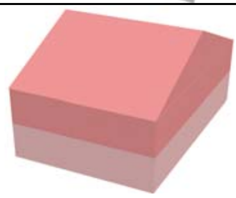
Dwelling Type	Floor Area[1] (m2)	Sketch
Detached bungalow	67	L = 10 m B = 6.7 m 
Mid-terrace house	79	L = 5.0 m B = 7.9 m 
Detached house	104	L = 6.5 m B = 8.0 m 

Figure 2.1 *Examined types of residential houses*

These building types were combined with a number of options for improving the building and for upgrading the roof (see table below).

Table 2.1 *Upgrading of roof and existing building*

Element	Description	Base Case (before loft conversion)	Good practice (with loft conversion)	Best practice (with loft conversion)
			U-value (W/m²k)	
Pitched roof	Uninsulated timber roof	1.9	0.20	0.15
Loft floor	Timber joists, minimal insulation	0.85	0.25	0.2
External wall	Uninsulated solid block	2.1	0.30	0.15
First floor	Uninsulated timber floor	3.0	0.25	0.2
Ground floor	Uninsulated solid floor	0.45 – 0.7	0.25	0.2
Window	Partly double glazed	3.5	2.0	0.7
Window area (%)	Wooden frame window	12 -15%	12 -15%	12 -15%
Airtightness	$m^3/(hm^2)$ @50P	15	10	3

2.2 Results

The following diagrams show the annual energy demand for heating for different building types, different levels of improvement and three European climates.

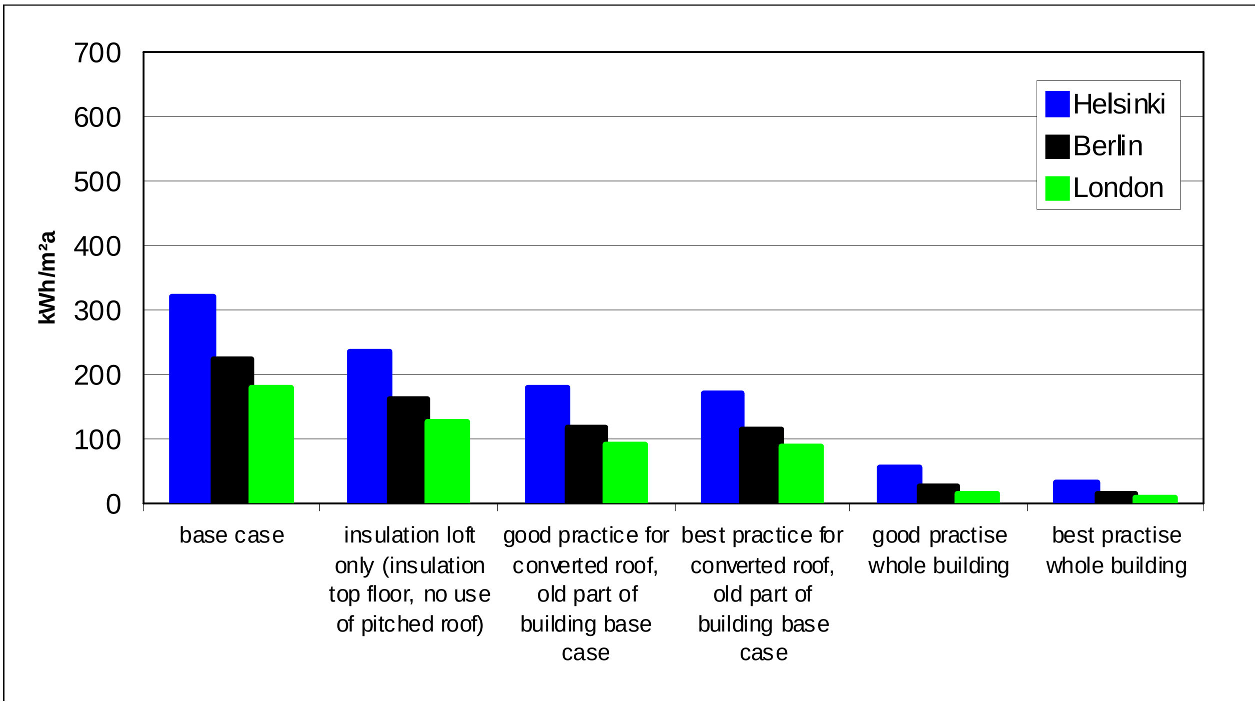


Figure 2.2 *Simulation results heating energy demand - Mid-terrace house*

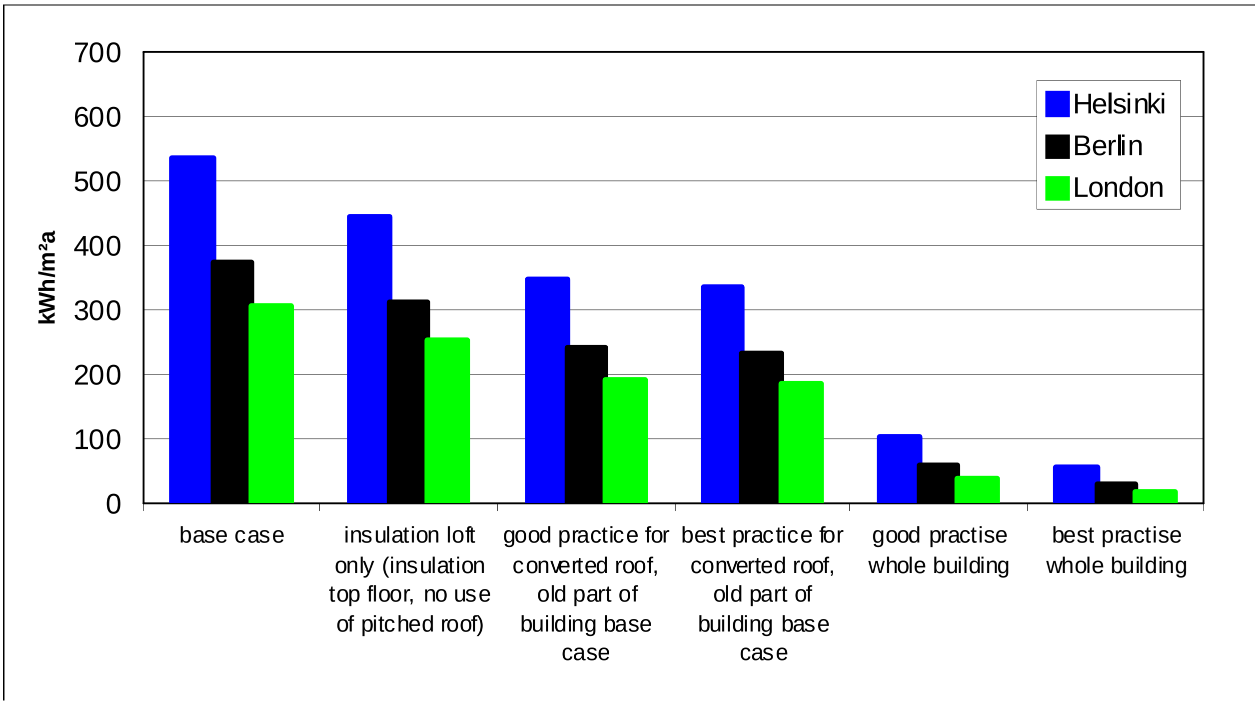


Figure 2.3 *Simulation results heating energy demand - Detached house*

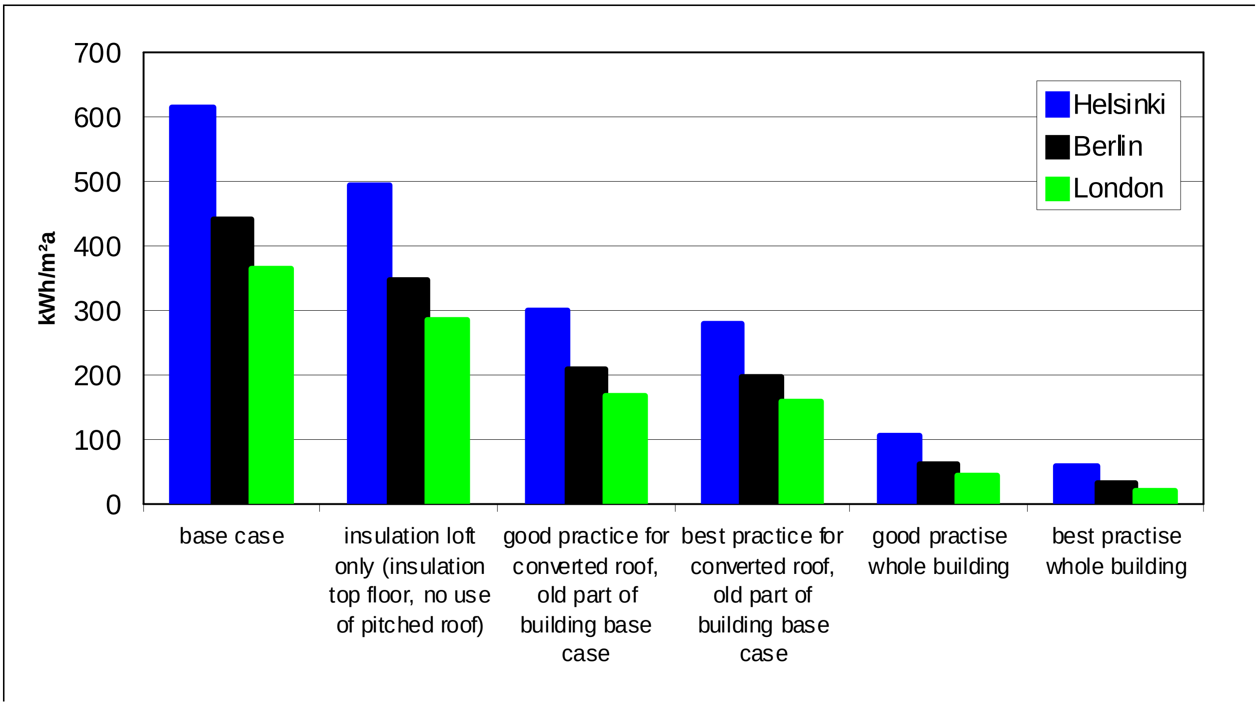


Figure 2.4 *Simulation results heating energy demand - Detached bungalow*

It becomes obvious, that the combination of additional space and retrofit of the existing building leads to a very high energy saving potential