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Appendix C

House models for Dymola to be used in connection with the OPSYS test rig and annual simulations of the performance of heat pumps

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Preface

The present document is part of the documentation of the *Underfloor heating and heat pump optimization* project funded by the Danish Energy Agency through the EUDP programme, project no. 64014-0548.

The purpose of the project is to investigate different possibilities for control of a heat pump and the heat emitting system of a house in order to increase the overall efficiency of the system. This was done in a (OPSYS) test rig (Jensen et al, 2017) and in a simulation environment (Vinther, 2017). In both cases, there was a need for the simulation of realistic heat demands and behaviour of selected houses. Furthermore there was also a need for a very fast simulation of the houses. For that reason, a very simple house model has been developed, yet detailed enough to create a realistic dynamic behaviour of the investigated houses. The house model has been developed including realistic parameters for three types/ages of Danish houses: single floor detached houses of 150 m² with a heat demand typical for a 1970 house, a house built according to the Building Regulation 2010 (BR10), and a Low Energy 2015 house (also built according to BR10).

1. House model

The OPSYS test rig has only four heating loops, while an underfloor heating system in a Danish detached house has 10-11 loops depending of the number and sizes of the rooms. The below layout of a house of 150 m^2 has been chosen. The layout contains both small and large rooms, and the number of connections between the rooms have been minimized.

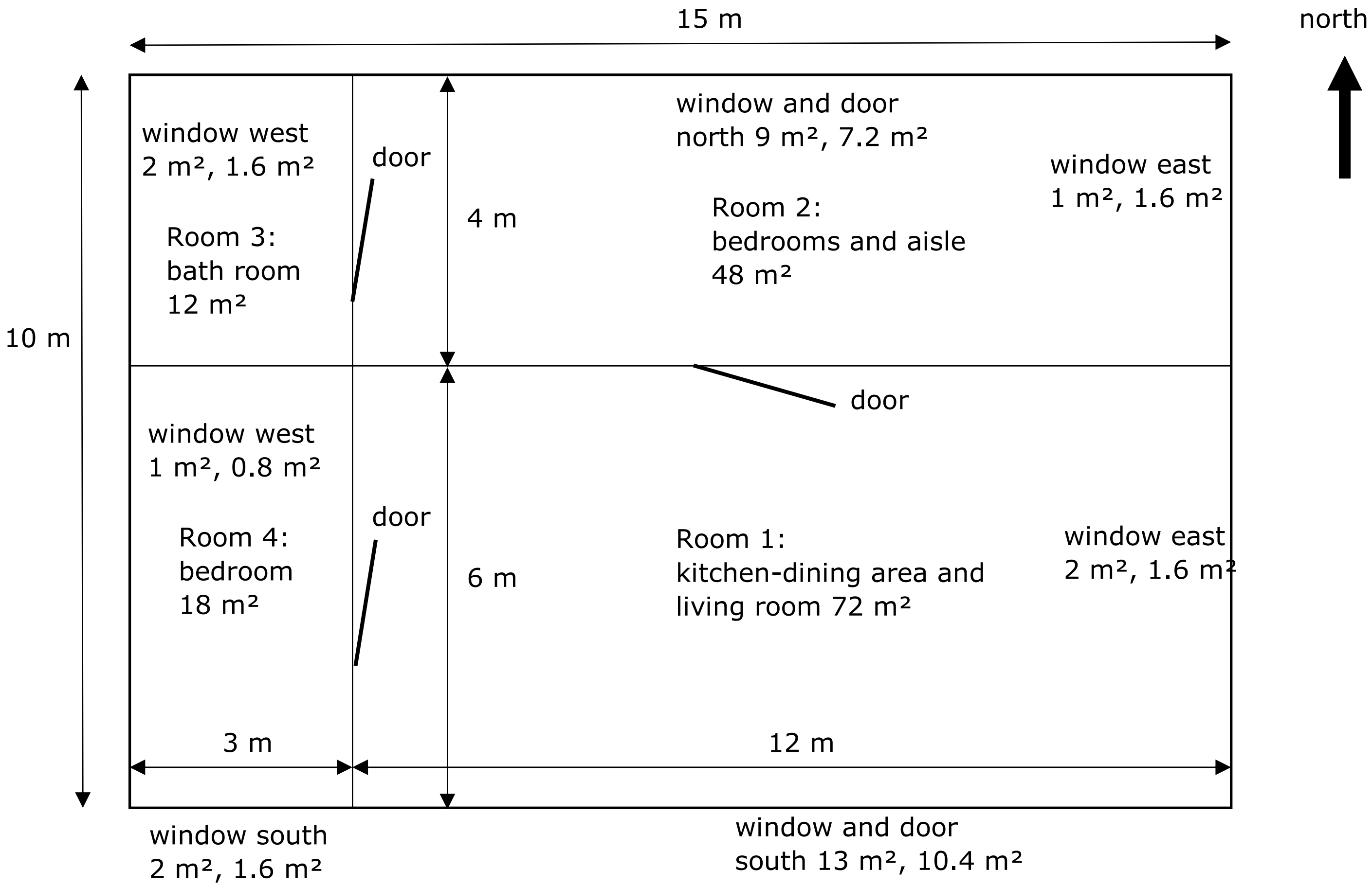


Figure 1. Floor plan of the building model. The two numbers for the windows and doors are: first number is the total area incl. framing, while the second number is the transparent area.

In order to test different scenarios, it has been chosen to have house models from three different periods:

Constructions:		from inside (constructions outside the insulation are left out):	
1970[1] house:	walls:	bricks + insulation:	U=0.6 W/m^2K 2)
	ceiling:	wood + insolation:	U=0.2 W/m^2K 2)
	windows:	two-layered traditional glazing:	U=2.8 W/m^2K 2)
	ventilation:	natural: 0.3 l/s/m^2	

[1] Typical Danish detached house from the 70'ties.
[2] Jensen and Weitzmann, 2010

BR10[3] house:	walls:	lightweight concrete + insulation:	U=0.15 W/m²K [4)]
	ceiling:	gypsum + insulation:	U=0.12 W/m²K [4)]
	windows:	two-layered low-E glazing:	U=1.15 W/m²K [4)]
	ventilation:	balanced mechanical ventilation with heat recovery: 0.19 l/s/m² (decreased due to heat recovery (70 % - BR10)) and infiltration 0.1 l/s/m² (BR10)	
2015[5] house:	walls:	lightweight concrete + insulation:	U=0.12 W/m²K [4)]
	ceiling:	gypsum + insulation:	U=0.09 W/m²K [4)]
	windows:	three-layered low-E glazing:	U=1.0 W/m²K [4)]
	ventilation:	balanced mechanical ventilation with heat recovery: 0.13 l/s/m² (decreased due to heat recovery (85 % (Tommerup and Svendsen, 2008)) and infiltration 0.085 l/s/m² (BR10)	

A typical day profile for people present in the house and their use of electrical devices has also been developed – see section 1.4. Hourly solar irradiation coming through the windows and doors has been calculated – see chapter 2.

1.1. Constructions

Ri and Ru are in the following tables:

- Ri is the thermal resistance from the room to the middle of the capacity
- Ru is the thermal resistance from the thermal capacity to external or an adjacent room
- 1/(Ri+Ru) is the overall U-value of the wall/window

1.1.1. Input data 1970's house

The physical parameters for calculating the heat resistances and capacities shown below are given in appendix A.

Room 1 - living room: south/east corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	external	12/2.5	0.285	1.380	118,800
South window	external	13	0.175	0.182	8,100
East wall	external	6/2.5	0.285	1.380	118,800
East window	external	2	0.175	0.182	8,100
North wall	room 2	12/2.5	0.355	0.355	68,000
West wall	room4	6/2.5	0.355	0.355	68,000
Ceiling	external	12/6	0.224	4.77	16.900

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

[3] BR10 house: requirements for a house built according to the Danish Building Code 2010
[4] Tommerup and Svendsen, 2008. Page 5: BR10 = Lavenergi 2 and BR15 = Lavenergi 1.
[5] 2015 house: requirements for a house built according to the present Danish Building Code 2015

Room 2 - bedrooms and aisle: north/east corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	room 1	12/2.5	0.355	0.355	68,000
East wall	external	4/2.5	0.285	1.380	118,800
East window	external	1	0.175	0.182	8,100
North wall	external	12/2.5	0.285	1.380	118,800
North window	external	9	0.175	0.182	8,100
West wall	room 3	4/2.5	0.355	0.355	68,000
Ceiling	external	12/4	0.224	4.77	16,900

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

Room 3 – bath room: north/west corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	room 4	3/2.5	0.355	0.355	68,000
East wall	room 2	4/2.5	0.355	0.355	68,000
North wall	external	3/2.5	0.285	1.380	118,800
West wall	external	4/2.5	0.285	1.380	118,800
West window	external	2	0.175	0.182	8,100
Ceiling	external	3/4	0.224	4.77	16,900

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

Room 4 - bedroom: south/west corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	external	12/2.5	0.285	1.380	118,800
South window	external	2	0.175	0.182	8,100
East wall	room 1	4/2.5	0.355	0.355	68,000
North wall	room 3	12/2.5	0.355	0.355	68,000
West wall	external	4/2.5	0.285	1.380	118,800
West window	external	1	0.175	0.182	8,100
Ceiling	external	12/4	0.224	4.77	16,900

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

1.1.2. Input data BR10 house

The physical parameters for calculating the below shown heat resistances and capacities are given in appendix A.

Room 1 - living room: south/east corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	external	12/2.5	0.355	6.6	136,000
South window	external	13	0.175	0.695	8,100
East wall	external	6/2.5	0.355	6.6	136,000
East window	external	2	0.175	0.695	8,100
North wall	room 2	12/2.5	0.355	0.355	68,000
West wall	room4	6/2.5	0.355	0.355	68,000
Ceiling	external	12/6	0.208	8.14	10,400

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

Room 2 - bedrooms and aisle: north/east corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	room 1	12/2.5	0.355	0.355	68,000
East wall	external	4/2.5	0.355	6.6	136,000
East window	external	1	0.175	0.695	8,100
North wall	external	12/2.5	0.355	6.6	136,000
North window	external	9	0.175	0.695	8,100
West wall	room 3	4/2.5	0.355	0.355	68,000
Ceiling	external	12/4	0.208	8.14	10,400

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

Room 3 – bath room: north/west corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	room 4	3/2.5	0.355	0.355	68,000
East wall	room 2	4/2.5	0.355	0.355	68,000
North wall	external	3/2.5	0.355	6.6	136,000
West wall	external	4/2.5	0.355	6.6	136,000
West window	external	2	0.175	0.695	8,100
Ceiling	external	3/4	0.208	8.14	10,400

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

Room 4 - bedroom: south/west corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	external	12/2.5	0.355	6.6	136,000
South window	external	2	0.175	0.695	8,100
East wall	room 1	4/2.5	0.355	0.355	68,000
North wall	room 3	12/2.5	0.355	0.355	68,000
West wall	external	4/2.5	0.355	6.6	136,000
West window	external	1	0.175	0.695	8,100
Ceiling	external	12/4	0.208	8.14	10,400

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

1.1.3. Input data BR15 house

The physical parameters for calculating the below shown heat resistances and capacities are given in appendix A.

Room 1 - living room: south/east corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	external	12/2.5	0.355	8.25	136,000
South window	external	13	0.175	0.825	8,100
East wall	external	6/2.5	0.355	8.25	136,000
East window	external	2	0.175	0.825	8,100
North wall	room 2	12/2.5	0.355	0.355	68,000
West wall	room4	6/2.5	0.355	0.355	68,000
Ceiling	external	12/6	0.208	10.94	10.400

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

Room 2 - bedrooms and aisle: north/east corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	room 1	12/2.5	0.355	0.355	68,000
East wall	external	4/2.5	0.355	8.25	136,000
East window	external	1	0.175	0.825	8,100
North wall	external	12/2.5	0.355	8.25	136,000
North window	external	9	0.175	0.825	8,100
West wall	room 3	4/2.5	0.355	0.355	68,000
Ceiling	external	12/4	0.208	10.94	10,400

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

Room 3 – bath room: north/west corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	room 4	3/2.5	0.355	0.355	68,000
East wall	room 2	4/2.5	0.355	0.355	68,000
North wall	external	3/2.5	0.355	8.25	136,000
West wall	external	4/2.5	0.355	8.25	136,000
West window	external	2	0.175	0.825	8,100
Ceiling	external	3/4	0.208	10.94	10,400

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

Room 4 - bedroom: south/west corner of the house

Surface	Facing	Dimension L/H [m] area [m²]*	Ri [m²K/W]	Ru [m²K/W]	Capacity [J/m²K]
South wall	external	12/2.5	0.355	8.25	136,000
South window	external	2	0.175	0.825	8,100
East wall	room 1	4/2.5	0.355	0.355	68,000
North wall	room 3	12/2.5	0.355	0.355	68,000
West wall	external	4/2.5	0.355	8.25	136,000
West window	external	1	0.175	0.825	8,100
Ceiling	external	12/4	0.208	10.94	10,400

*L/H: length*height for walls, length*length for ceiling, total area for windows
The area of the walls is the L*H as given above minus the area of any windows given above

1.2. Underfloor heating

The heat emitting systems in the houses are underfloor heating. The underfloor heating consists of a light weight system with a wooden floor in room 1, 2 and 4 – see figure 2, while the underfloor heating system in room 3 (bath room) is a heavy concrete floor. Figure 3 shows the resistances and capacities applied in model of the underfloor heating system in the four rooms. In order to capture that the temperature of the water in the pipes of the underfloor heating system decreases between the inlet and the outlet to the rooms, the length of the pipes is divided into 10 equal pieces. It is assumed that ground has a fixed temperature of 10°C. The insulation towards the ground differs for the three houses as given below:

Input data 1970's house

U value: 0.18 W/m²K (100 mm insulation) => Ru = 5.55 m²K/W

Input data BR10 house

U value: 0.09 W/m²K (Tommerup and Svendsen, 2008) => Ru = 11.1 m²K/W

Input data BR15 house

U value: 0.07 W/m²K (Tommerup and Svendsen, 2008) => Ru = 14.3 m²K/W

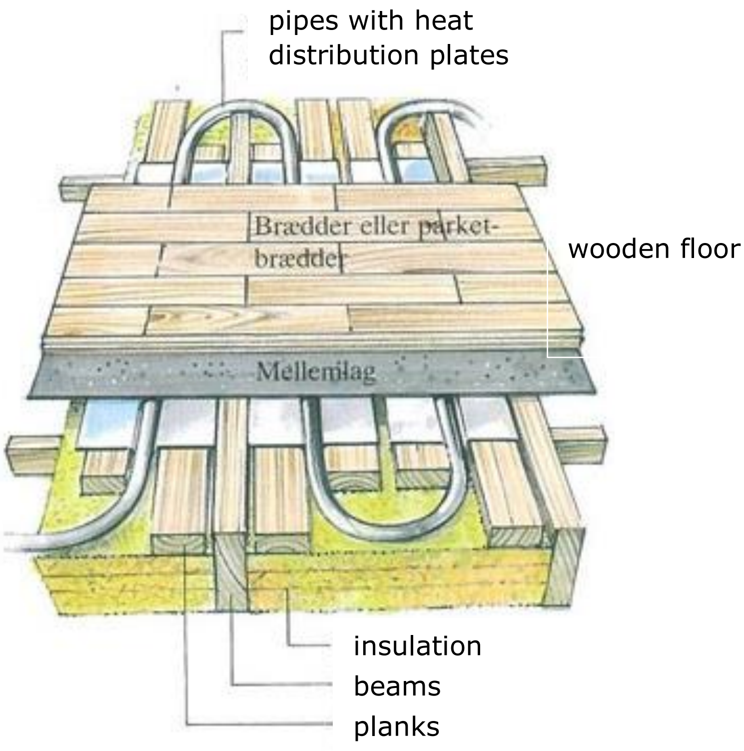


Figure 2. Light weight floor with underfloor heating.

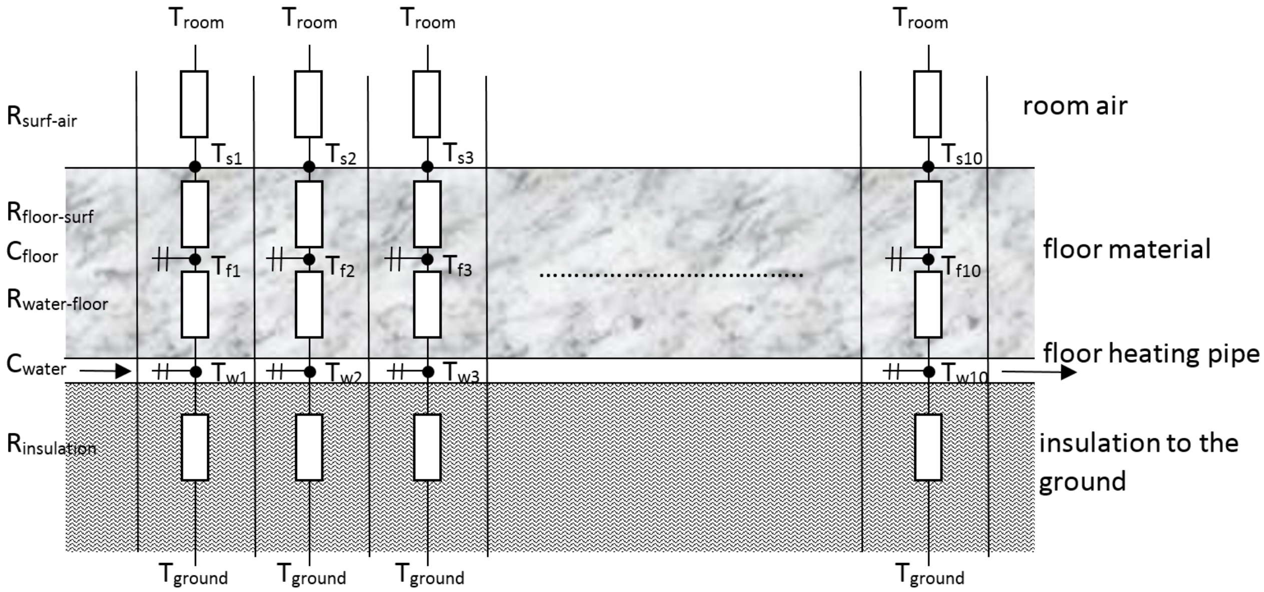


Figure 3. The resistances and capacities of the underfloor heating system.

T_{room}: room air temperature

T_{sx}: temperature of the surface of the floor

T_{fx}: temperature of the floor (wood or concrete)

T_{wx}: temperature of the water in the pipes

T_{ground}: temperature of the ground under the house

T_{wx} changes over time and in the direction of the flow in the pipes according to the necessary heat input to the room. T_{room} also changes over time due to heat input from especially the sun, but also due to possible night set back of the room air temperature. T_{sx} and T_{fx} changes over time as a result of changes in T_{wx} and T_{room}.

The resistances and capacities of figure 3 are given in the below table for the two types of floor material and the ages of the houses.

Parameter	Floor material	
	wood	concrete
$R_{surf-air}$ [m²K/W]	0.099	0.100
$R_{floor-surf}$ [m²K/W]	0.0412	0.0385
C_{floor} [J/m²K]	21,560	180,000
$R_{waster-floor}$ [m²K/W]	0.2927	0.1278
C_{water} [J/m²K]	dependent on the diameter of the tubes	
$R_{insulation}$ [m²K/W]		
1970 house	5.55	5.55
BR10 house	11.1	11.1
BR15 house	14.3	14.3

$R_{surf-air}$: the resistance between the surface of the floor and the room air
$R_{floor-surf}$: the resistance between the material of the floor and the surface of the floor
C_{floor}: the thermal capacity of the material of the floor
$R_{water-floor}$: the resistance between the water in the pipes and the material of the floor
C_{water}: the thermal capacity of the water in the pipes – dependent on the chosen diameter of the pipes
$R_{insulation}$: the resistance between the material of the floor and the ground

1.3. Ventilation/infiltration

The representation of the ventilation and infiltration of the houses, when a balanced mechanical ventilation system is applied in the BR10 and BR15 houses, has been simplified in order to increase the speed of the simulation program. Instead of introducing a heat recovery unit the flow rate through the ventilation system has simply been reduced with the efficiency of the heat recovery.

1.3.1. Input data 1970's house

Ventilation/infiltration: 0.3 l/s/m².

Room 1 - living room: south/east corner of the house
Flow rate of ambient air: 21.6 l/s

Room 2 - bedrooms and aisle: north/east corner of the house
Flow rate of ambient air: 14.4 l/s

Room 3 – bath room: north/west corner of the house
Flow rate of ambient air: 3.6 l/s

Room 4 – bedroom: south/west corner of the house
Flow rate of ambient air: 5.4 l/s

1.3.2. Input data BR10 house

Ventilation/infiltration: 0.3*(1-0.7) + 0.1 = 0.19 l/s/m²

Room 1 - living room: south/east corner of the house
Flow rate of ambient air: 13.7 l/s

Room 2 - bedrooms and aisle: north/east corner of the house
Flow rate of ambient air: 9.1 l/s

Room 3 – bath room: north/west corner of the house
Flow rate of ambient air: 2.3 l/s

Room 4 – bedroom: south/west corner of the house
Flow rate of ambient air: 3.4 l/s

1.3.3. Input data BR15 house

Ventilation/infiltration: 0.3*(1-0.85) + 0.085 = 0.13 l/s/m²

Room 1 - living room: south/east corner of the house
Flow rate of ambient air: 9.4 l/s

Room 2 - bedrooms and aisle: north/east corner of the house
Flow rate of ambient air: 6.2 l/s

Room 3 – bath room: north/west corner of the house
Flow rate of ambient air: 1.6 l/s

Room 4 - bedroom: south/west corner of the house
Flow rate of ambient air: 2.3 l/s

1.3.4. Inter-zonal air flow

Heat is not only exchanged between rooms by means of conduction through walls. Larger heat exchanges often occur in terms of air movements through doors between rooms. The inter-zonal airflow through doors, V_d (mixing flow) is approximated using an empirical relationship (Design Builder Software Ltd, 2016) calculated as:

$$V_d = A_d \alpha_d V_f$$

where: A_d is the door area – here 2 m²,
α_d is the door opening in %
V_f is the Farea-flow (set to 0.1 m³/m²/s).

Furthermore, a schedule is used to define how the door between room 1 and 2 (see figure 1) is open based on occupancy information (50% open from 7:00 to 21:00 on weekdays, 50% open from 9:00 to 21:00 during the weekends, and 0.25% open in-between due to leakage beneath the door). The two other doors between room 2 and 3 and room 1 and 4 are mostly closed and a fixed opening of 1.25% is used all the time (based on averaged occasional opening and leakage).

1.4. Heat supply from persons and appliances

The mean heat supplies from persons and appliances are taken from the calculation tool Be10 (Aggerholm and Grau, 2014): 1.5 W/m² from persons and 3.5 W/m² from appliances. This heat supply has been divided over the day and over the rooms while still giving the two above mentioned mean values (1.5 and 3.5 W/m²). The two heat supplies (persons and appliances) have been summed into one hourly value. Two profile types have been developed: one

identical for all seven days of the week and one where the profile for the weekends is different from the weekdays. Identical profiles are used for all three building types.
The developed profiles are available as files with hourly data for a whole year. Tables of the heat supply are included in Appendix B.

1.4.1. Identical profile for all days of the week

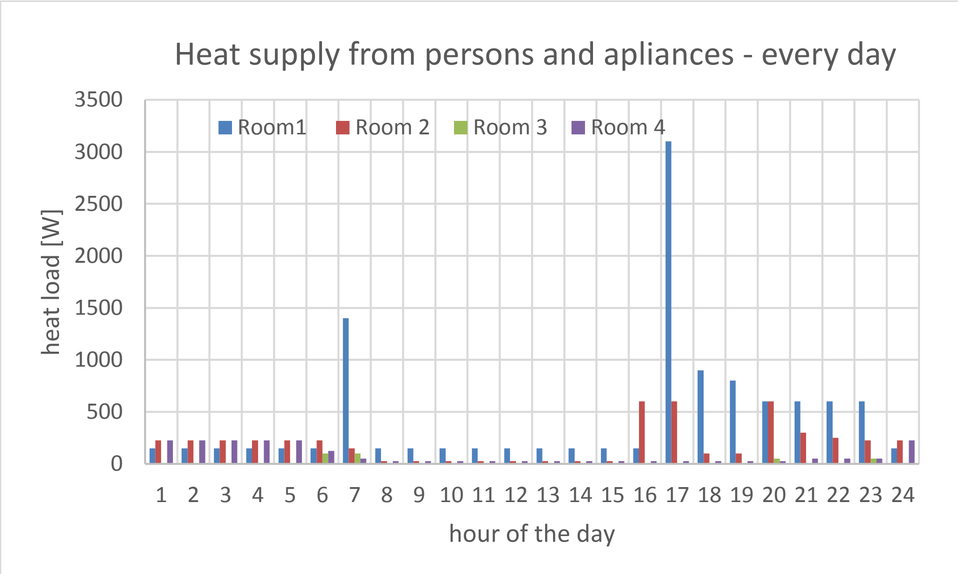


Figure 4. Daily heat supply from persons and appliances.

1.4.2. One profile for weekdays and one profile for weekends

Profile for weekdays

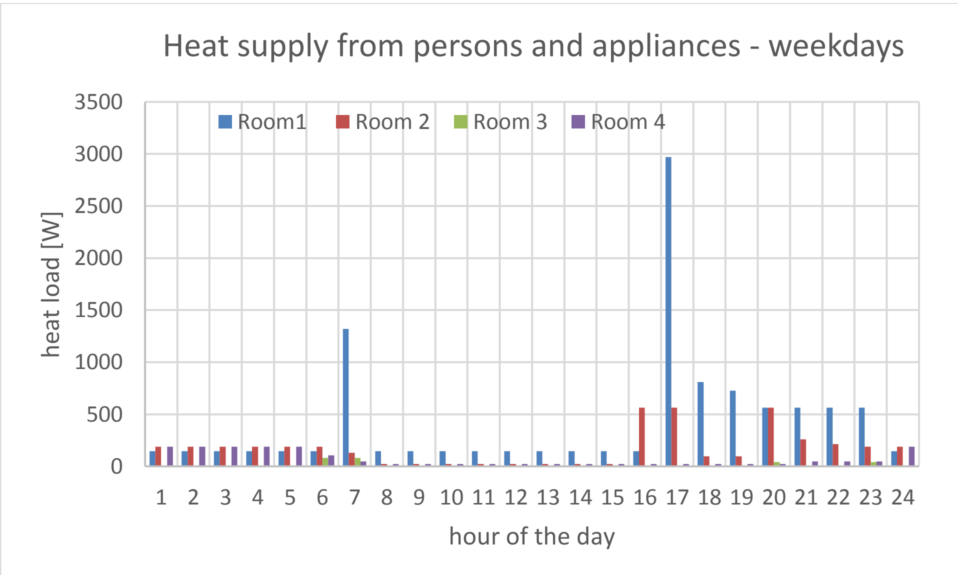


Figure 5. Daily heat supply from persons and appliances during weekdays.

Profile for weekends

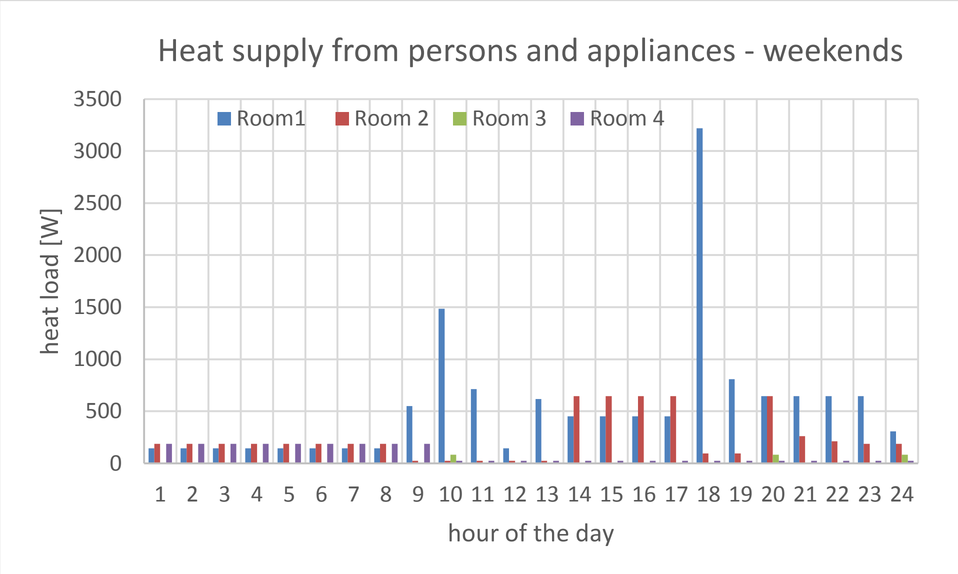


Figure 6. Daily heat supply from persons and appliances during weekends.

2. Ambient temperature and heat supply from the sun

For calculating the heat supply from the sun, data from (Wang, Scharling and Nielsen, 2012) have been applied. The ambient temperature is also taken from this publication

Global and diffuse radiation is from the station 6141 Abed, while the ambient temperature is from the station 6156 Tytofte.

The ambient temperature is identical for all house types, while the incoming solar radiation though the windows is different due to different types of windows in the three house types. The following g-values have been used to calculate the incoming heat from the sun through the windows facing the four directions: east, south, west, and north.

The applied g-values are:

70's house: 0.75 – double-pane window
BR10 house: 0.625 – double-pane energy window with low-E coating
BR15 house: 0.50 – triple-pane low energy window with low-E coating

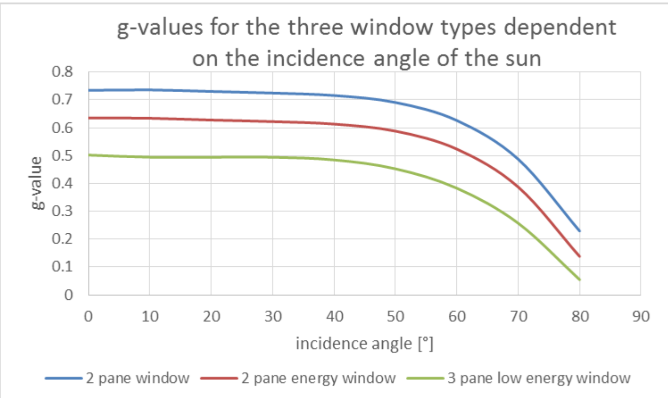


Figure 7. g-values for different types of windows.

The ambient temperature and the solar radiation through the windows in the rooms are collected in files with hourly values covering a whole year, one file for each main compass direction: south, west, north, and east.

3. Temperature of the brine

In Denmark the typical heat pump used for space heating of a whole house is either a liquid/water or an air/water heat pump. Both heat pumps deliver the heat to a water based heating system – underfloor heating or radiators and often also to a domestic hot water tank. Typically, the liquid/water heat pump obtains heat from the ground via tubes buried 0.8-1 m down in the ground, while the air/water heat pump obtains the heat from the ambient air.

Based on measurements from (Pedersen and Jacobsen, 2013) the brine temperature for a liquid/water heat pump has been found to be the following – se also figure 8:

Month	Mean monthly brine temperature [°C]
January	0.41
February	0.49
March	0.96
April	4.90
May	9.50
June	13.05
July	15.10
August	13.58
September	11.58
October	7.86
November	2.74
December	0.24

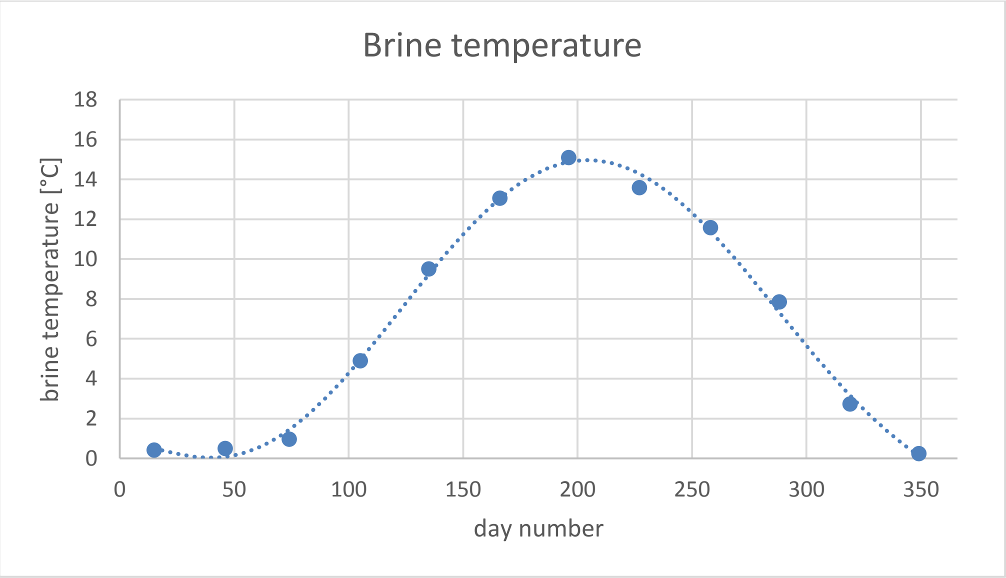


Figure 8. The brine temperature dependent on day number.

The equation for the regression line in figure 8 is:

$$\text{Brine temp.} = 0.8358 - 8.854E\text{-}3 \cdot day - 1.349E\text{-}3 \cdot day^2 + 3.463E\text{-}5 \cdot day^3 - 2.154E\text{-}7 \cdot day^4 + 5.162E\text{-}10 \cdot day^5 - 4.328E\text{-}13 \cdot day^6$$

where day is the day number of the year from 1 to 365.

For the air/water heat pump, the hourly ambient temperature described in chapter 2 should be applied as "brine" temperature.

4. References

Aggerholm and Grau, 2014. The Energy Demand of Buildings (in Danish). The Danish Buildings Research Institute. SBI-report no. 213. http://anvisninger.dk/anvisninger/Pages/213-Bygningers-energibehov-3_1.aspx

Design Builder Software Ltd (2016). DesignBuilder. http://www.designbuilder.co.uk/.

Jensen and Weitzmann, 2010. Energy renovation of a single-family house from the 70'ties (in Danish). Teknologisk Institut. ISBN 87-7756-773-0. https://www.google.dk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&cad=rja&uact=8&ved=0ahUKEwiy6Y_36NHXAhUCVRoKHZ1WCU8QFghYMAQ&url=http%3A%2F%2Fwww.lave.byg.dtu.dk%2F-%2Fmedia%2FSites%2FLavE%2Faktiviteter%2Fformidling%2Fenergirenovering%2520-%2520eksempelsamling%2F70er_hus_final.ashx%3Fla%3Dda&usg=AOvVaw3h4E14ZwoDxkL4wJeaGwJ-

Jensen, S.Ø. et al, 2016. The OPSYS test rig. Appendix A of the present report "Combined optimization of heat pumps and heat emitting systems". Danish Technological Institute.

Pedersen, S.V. and Jacobsen, E., 2013. Approval of eligible systems, measurement, data collection and dissemination (in Danish). Danish Technological Institute. November 2013. http://docplayer.dk/7782113-Godkendelse-af-tilskudsberettigede-anlaeg-maaling-dataindsamling-og-formidling.html.

Tommerup and Svendsen, 2008. Suggestions for new energy requirements for the thermal envelope of existing buildings (in Danish). DTU BYG. https://www.google.dk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwj1xNqg6dHXAhVL1BoKHRd0C7MQFggzMAA&url=http%3A%2F%2Fwww.lave.byg.dtu.dk%2F-%2Fmedia%2FSites%2FLavE%2Faktiviteter%2Fformidling%2Frapporter%2Fkrav_til_klimaskaerm_dtu_byg_2008.ashx%3Fla%3Dda&usg=AOvVaw1RtQOaSEPidfWvoWhE2A_Y

Wang, Scharling and Nielsen, 2012. 2001-2010 Design Reference Year for Denmark (in Danish). DMI. Technical Report 12-17. www.dmi.dk/fileadmin/Rapporter/TR/tr12-17.pdf

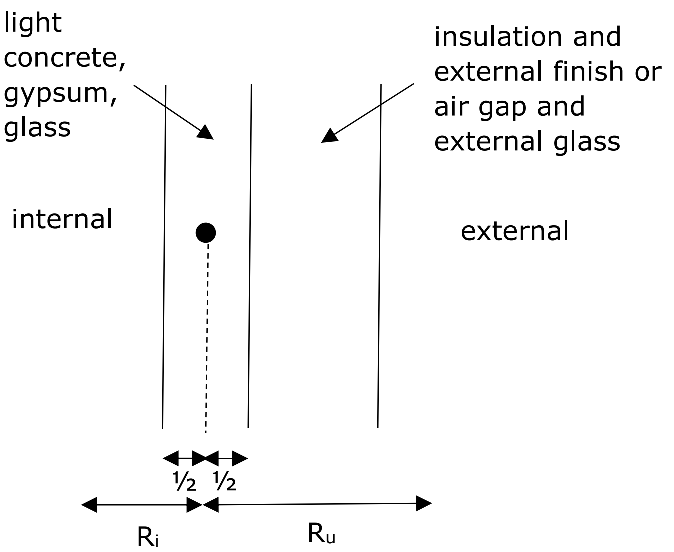
Vinther, K., 2017. Simulation Models. Appendix D of the present report "Combined optimization of heat pumps and heat emitting systems". Aalborg University.

Appendix A

The following physical parameters have be used:

Material	Thickness [m]	Density [kg/m³]	Thermal conductivity [W/mK]	Heat Capacity [J/kgK]
Light weight concrete outer wall in BR10 and BR15 houses	0.1	800	0.27	1,700
Lightweight concrete internal wall	0.05*2	800	0.27	1,700
Gypsum plates ceiling	0.013	800	0.17	1,000
Glass	0.004	2,700	0.8	750
Bricks – outer wall in 70's house	0.11	1200	0.48	900
Wood	0.015	415	0.14	2720

The heat resistances and capacities of the external surfaces have been calculated as follows:



the thickness of the insulation and the resistance of the air gap has been adjusted in order to obtain the wanted R_u

Appendix B

Daily profiles for the sum of heat supply from persons and appliances.

Identical profile for all days of the week

Hour	Room1 Wh	Room 2 Wh	Room 3 Wh	Room 4 Wh
1	150	225	0	225
2	150	225	0	225
3	150	225	0	225
4	150	225	0	225
5	150	225	0	225
6	150	225	100	125
7	1400	150	100	50
8	150	25	0	25
9	150	25	0	25
10	150	25	0	25
11	150	25	0	25
12	150	25	0	25
13	150	25	0	25
14	150	25	0	25
15	150	25	0	25
16	150	600	0	25
17	3100	600	0	25
18	900	100	0	25
19	800	100	0	25
20	600	600	50	25
21	600	300	0	50
22	600	250	0	50
23	600	225	50	50
24	150	225	0	225

One profile for weekdays and one profile for weekends

Profile for weekdays

Hour	Room1 Wh	Room 2 Wh	Room 3 Wh	Room 4 Wh
1	144	188	0	188
2	144	188	0	188
3	144	188	0	188
4	144	188	0	188
5	144	188	0	188
6	144	188	82	106
7	1320	130	82	48
8	144	24	0	24
9	144	24	0	24
10	144	24	0	24
11	144	24	0	24
12	144	24	0	24
13	144	24	0	24
14	144	24	0	24
15	144	24	0	24
16	144	564	0	24
17	2971	564	0	24
18	810	96	0	24
19	728	96	0	24
20	564	564	41	24
21	564	261	0	48
22	564	212	0	48
23	564	188	41	48
24	144	188	0	188

Profile for weekends

Hour	Room1 Wh	Room 2 Wh	Room 3 Wh	Room 4 Wh
1	144	188	0	188
2	144	188	0	188
3	144	188	0	188
4	144	188	0	188
5	144	188	0	188
6	144	188	0	188
7	144	188	0	188
8	144	188	0	188
9	550	24	0	188
10	1484	24	82	24
11	714	24	0	24
12	144	24	0	24
13	618	24	0	24
14	453	646	0	24
15	453	646	0	24
16	453	646	0	24
17	453	646	0	24
18	3218	96	0	24
19	810	96	0	24
20	646	646	82	24
21	646	261	0	24
22	646	212	0	24
23	646	188	0	24
24	309	188	82	24