



Contract No. EIE-2003-RURASU-223

Deliverable D.3.3

**Common computer tool for building simulations
-Manual-**

English version

July 2006

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General information concerning the common software tool

The RURASU common software is a simplified tool which enables the user to examine the effect of different systems and techniques to the required heating and cooling demand. The software code of the program is written in VBA and the interface is a Microsoft® Excel file.

The common software tool can be used to:

- calculate the annual and monthly heating and cooling demand
- calculate the annual and monthly heat gains
- calculate the annual and monthly heat losses
- produce charts showing the heating and cooling demand
- run sensitivity analyses

The program consists of eight main sheets. A short description for each sheet is given in the following. More details are available within the program when the mouse pointer is passed over the red points (red dots are help text giving information about the input data).

The required input data can be found in cells with yellow background, while the results are given in cells with grey background. The latter are locked which means that they can be deleted or edited.

Main sheets

Introduction sheet



The introduction sheet includes RURASU and the national partner logos. The Intelligent Energy Europe logo is part of the RURASU logo. The logos have hyperlinks to the partner homepages while the RURASU logo has a hyperlink to the official RURASU website. All pages have hyperlink to the “Intelligent Energy Europe” programme.

Disclaimer

The sole responsibility for the content of this software lies with the authors. It does not necessarily reflect the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained therein.

The authors do not take any responsibility for the calculated results or any problem that may become due to the use of the software.

The disclaimer sheet contains the legal disclaimer of the Intelligent Energy – Europe programme and a second disclaimer concerning the software use.

Library

	Type of glazing	U value (W/m ² K)		Type of frame	U value (W/m ² K)	Ψ_g (W/mK)	g frame (-)
1	Clear 3mm	6.31	1	Aluminium	5.68	0.00	0.0682
2	Bronze Tinted	6.31	2	Alum. (~50mm), double glazing	5.68	0.02	0.0682
3	Low E Clear 3mm +13mm air+3mm clear	2.79	3	Wood (~70mm)	2.27	0.06	0.0272
4	Low E (0.02) Clear 3mm +13mm argon+3mm clear	1.32	4	Vinyl (~70mm)	1.70	0.06	0.0204
5	Low E (0.08) 3mm +13mm argon+3mm clear	1.46	5				
6	Low E selective (0.04) 3mm +13mm argon+3mm clear	1.37	6				
7	SUPER INSULATING Low E 3mm (0.08)+9.5 mm krypton+ 3mm + 9.5 mm krypton +3 mm low E	0.83	7				
8			8				
9			9				
10			10				
11			11				
12			12				
13			13				
14			14				
15			15				
16			16				
17			17				
18			18				
19			19				
20			20				

New "Windows library" sheet
 U-values of glazings and frames can be an input. Also Ψ_g and g_{frame}.

The table contains information for different glazing and frame types. The given information is:

- The U-value of the glazing
- The U-value of the frame
- The Ψ_g of the frame
- The solar heat gain coefficient (g) of the frame

The user can not specify new types of glazing and frames due to the detailed description of the glazing material. In order to receive more accurate results on the impact of the fenestration system to energy consumption of the building, the values of the solar heat gain coefficient SHGC have been calculated using WINDOW 4.1 software.

Fenestration

Facade area	10.440	Fenestration			
Floor area	16.74				
A_w / A_f	10%	20%	60%	40%	50%
Window area	1.674	3.348	10.044	6.696	8.370
wall area	8.766	7.092	0.396	3.744	2.070

Window type 1		frame width: 0.07					
U_{frame}	5.68	$g_{glazing}$	0.821				
h_{frame}	25	g_{frame}	0.0682				
α_{frame}	0.3						
		glazing area	1.32	2.85	9.17	5.98	7.57
		frame area	0.35	0.50	0.88	0.71	0.80
		$g_{overall}$	0.66	0.71	0.76	0.74	0.75

Window type 2		frame width: 0.05					
U_{frame}	2.27	$g_{glazing}$	0.76				
h_{frame}	25	g_{frame}	0.0272				
α_{frame}	0.3						
		glazing area	1.42	2.99	9.42	6.18	7.80
		frame area	0.25	0.36	0.63	0.51	0.57
		$g_{overall}$	0.65	0.68	0.71	0.70	0.71

Window type 3		frame percentage: 25%					
U_{frame}	1.7	$g_{glazing}$	0.821				
h_{frame}	25	g_{frame}	0.0204				
α_{frame}	0.3						
		glazing area	1.26	2.51	7.53	5.02	6.28
		frame area	0.42	0.84	2.51	1.67	2.09
		$g_{overall}$	0.62				

This is a help sheet for the calculation of the overall value g (glazing and frame) and for comparisons of different combinations of glazing and frames. None of the given values is used within the program for any calculation procedure.

The required information is:

- The U-value of the frame
- The heat transfer coefficient of the frame
- The solar absorptivity of the frame
- The solar heat gain coefficient of the glazing
- The percentage of window to floor area
- The frame width or the percentage of frame to the whole opening area

The result is the overall heat gain coefficient of the whole façade.

Climatic data

Please complete the yellow cells :

Table 1											
Climatic data											
Month	Beam radiation (W/m ²)					Diffuse radiation (W/m ²)					Ambient
	north	south	east	west	horizontal	north	south	east	west	horizontal	temperature (°C)
JAN	0.00	83.10	23.90	26.12	43.08	26.66	26.66	26.66	26.66	37.25	10.05
FEB	0.00	89.43	37.58	37.78	59.30	31.51	31.51	31.51	31.51	42.64	8.08
MAR	0.05	66.13	37.41	43.42	78.29	41.23	41.23	41.23	41.23	55.67	10.93
APR	3.90	71.96	78.56	76.13	154.54	61.38	61.38	61.38	61.38	76.55	16.64
MAY	15.34	41.40	92.27	68.82	175.66	70.38	70.38	70.38	70.38	88.03	21.62
JUN	32.57	34.46	110.74	101.71	228.94	74.33	74.33	74.33	74.33	85.73	25.18
JUL	26.37	41.10	100.02	103.73	218.24	72.98	72.98	72.98	72.98	85.25	26.52
AUG	8.85	73.00	99.49	99.55	208.27	65.75	65.75	65.75	65.75	74.87	27.41
SEP	0.86	108.01	96.16	73.16	157.55	55.94	55.94	55.94	55.94	66.97	23.38
OCT	0.00	110.10	68.38	39.17	92.13	40.39	40.39	40.39	40.39	51.96	16.58
NOV	0.00	107.41	41.27	31.23	60.13	30.74	30.74	30.74	30.74	41.21	15.62
DEC	0.00	98.45	25.00	31.05	45.79	24.01	24.01	24.01	24.01	32.38	12.05

Solar radiation											Temperature
Time (hours)	Beam radiation (W/m ²)					Diffuse radiation (W/m ²)					Temperature (°C)
	north	south	east	west	horizontal	north	south	east	west	horizontal	
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	25.2889	38.9722	0	3	6.9	6.9	6.9	6.9	11	0
9	0	3.17222	3.55278	0	1	33.1111	33.1111	33.1111	33.1111	55	0
10	0	137.694	102.139	0	62	60.8056	60.8056	60.8056	60.8056	91	0
11	0	0	0	0	0	60	60	60	60	100	0
12	0	0	0	0	0	70.1944	70.1944	70.1944	70.1944	117	0
13	0	80.4722	0	11.1556	45	82.5	82.5	82.5	82.5	130	0
14	0	279.722	0	118.944	147	84.8889	84.8889	84.8889	84.8889	117	0
15	0	210.972	0	156.5	95	64.1111	64.1111	64.1111	64.1111	91	0
16	0	88.8056	0	99.5	28	35.8056	35.8056	35.8056	35.8056	55	0
17	0	50.5833	0	77.9444	6	7.2	7.2	7.2	7.2	11	0
18	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0

The hourly values of beam and diffuse radiation shall be inserted here. Also, the hourly or monthly average values of ambient temperature are needed for input. As there is no humidity control ambient humidity needs not to be inserted.

Simplified model

Simplified correlation model for net heat gains through windows					
Inputs					
$T_{i,set}$:	20.00°C	24.00 h	Hours which the HVAC is working (0-24 hours)		(Watt)
$T_{e,set}$:	25.00°C	24.00 h	25.00°C	lighting	0.00
r :	120.00 h			people	0.00
Ventilation:	46 m ² ·h	ambient	24.00 h	machines	0.00
two types :	0 m ² ·h	ambient	24.00 h	other	128.00
Length of the period :				Total	331.78
Heating					
Cooling					
Results (heating load)					
Length of the period : 30 days					
Month	Q _{hd} (kWh/m ²)	Q _L (kWh/m ²)	Q _G (kWh/m ²)		
JAN	12.72	24.03	11.32		
FEB	16.20	28.78	12.59		
MAR	7.39	21.91	14.69		
APR	0.00	8.12	19.62		
MAY	0.00	0.00	0.00		
JUN	0.00	0.00	0.00		
JUL	0.00	0.00	0.00		
AUG	0.00	0.00	0.00		
SEP	0.00	0.00	0.00		
OCT	0.03	8.27	14.33		
NOV	0.54	10.57	12.27		
DEC	8.20	19.20	11.05		
Total	45.08	120.88	95.87		
Elements (walls and windows)					
azimuth	area (m ²)	of wall perimeter	R_{se} (m ² ·K/W)	U_i value (W/m ² ·K)	Heat loss $U_i \times Area$
walls					
North	2.40 m ²	0.80	0.04	0.36	0.88
South	4.00 m ²	0.80	0.04	0.36	1.44
East	2.00 m ²	0.80	0.04	0.36	0.72
West	2.00 m ²	0.80	0.04	0.36	0.72
Roof	16.00 m ²	0.80	0.04	0.00	0.00
Floor	16.00 m ²	0.00	0.08	2.80	44.80
windows					
North	1.60 m ²	1.26 m	0.04	6.15	9.84
South	0.00 m ²	0.00 m	0.04	0.00	0.00
East	2.00 m ²	1.41 m	0.04	6.15	12.31
West	2.00 m ²	1.41 m	0.04	6.15	12.31
Horizontal	0.00 m ²	0.00 m	0.04	0.00	0.00
Frame percentage :	25%			Total	38.20
Height of the zone (m) :	2.90 m		46 m ²	(WALLS+ROOF)	
Latitude of building location:	37.58°		Wood (~70mm)		
			Vinyl (~70mm)		
new location			Low E (0.02) Clear 3mm +13mm argon+3mm clear		
			Low E (0.08) 3mm +13mm argon+3mm clear		
run it once, if you change the location of the building - it gives you the new hourly g values for all the beside types of glazing and for all the orientations.					
Results (cooling load)					
Length of the period: 30 days					
Month	Q _{cd} (kWh/m ²)	Q _L (kWh/m ²)	Q _G (kWh/m ²)		
JAN	0.00	0.00	0.00		
FEB	0.00	0.00	0.00		
MAR	0.00	0.00	0.00		
APR	0.00	0.00	0.00		
MAY	0.00	0.00	0.00		
JUN	24.31	-0.45	23.86		
JUL	27.32	-3.67	23.65		
AUG	28.18	-5.81	22.37		
SEP	0.00	0.00	0.00		
OCT	0.00	0.00	0.00		
NOV	0.00	0.00	0.00		
DEC	0.00	0.00	0.00		
Total	79.81	-9.93	69.88		

This is the main sheet of the software. All the required inputs and the results are part of the main sheet.

The required input data are:

- Ground temperature for summer and winter period
- Window type
- Frame percentage
- Window perimeter length
- Wall and floor area
- Thermal resistance of the opaque elements
- Solar absorptivity of opaque elements
- Ventilation rate and temperature of the fresh air
- The target temperatures
- Heating and cooling time period (length to be switched on)
- The sensible part of the internal gains

The outputs are:

- Annual and monthly heating and cooling demand
- Annual and monthly heat gains
- Annual and monthly heat losses
- Chart for heating showing the above given values
- Chart for cooling showing the above given values

In case of building changes, special attention shall be given to the site location or the thermal mass of the building.

New location

In case that a new location has been specified, the heat gain coefficient shall be recalculated as it is affected by the incident solar radiation. The new climatic data shall be imported from the sheet “climatic data”.

Changing the building thermal mass

As the density and the thermal capacity of the different construction materials are not required as inputs the thermal mass of the building is not calculated. The effect of the thermal mass to the heating and cooling demand is estimated using the following parameters.

Period length:

The length of the period shall be used in order to estimate the heat accumulated in the building as one period is released in the next period or vice versa.

Dimensionless parameter a_0 :

For seasonal calculation a_0 shall take the value of 0.80, while for monthly calculations it shall take 1.00.

Time constant:

The time constant takes values in the range of 8 hours to 1 week.

γ critical:

A typical value for this parameter is 0.1. Parameter γ critical is used when the amount of gains compared to the losses is small. In such a case the heating demand is calculated by a different equation.

Sensitivity analysis

To run the macro results:

1. Give the orientation of the window :
2. Push the "Results" button:
3. Save the results to an other sheet.

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Please don't rename "SCM97.xls" or any sheet of these file. Please don't rename "SCM97.xls" or any sheet of these file. Please don't rename "SCM97

cases to study					Qhd - heat demand (kwh/m²)							
type of window	window area	wall area	ventilation	internal gains	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
1	0.000 m²	6.000 m²	0.5 ACH	0.0 W/m²	15.13113	18.03896	9.930931	0.006972	0	0	0	0
			0.5 ACH	2.0 W/m²	13.69299	16.6007	8.529805	0.003649	0	0	0	0
			0.5 ACH	4.0 W/m²	12.25909	15.16554	7.174155	0.001992	0	0	0	0
			0.5 ACH	6.0 W/m²	10.83563	13.73716	5.894289	0.001129	0	0	0	0
			0.5 ACH	8.0 W/m²	9.434098	12.32204	4.72456	0.000662	0	0	0	0
			0.5 ACH	10.0 W/m²	8.07267	10.93027	3.695687	0.0004	0	0	0	0
			0.5 ACH	20.0 W/m²	2.755295	4.907749	0.836683	4.62E-05	0	0	0	0
			0.5 ACH	30.0 W/m²	0.671353	1.626255	0.173527	8.22E-06	0	0	0	0
			1.0 ACH	0.0 W/m²	18.59361	22.18632	13.07384	0.023027	0	0	0	0
			1.0 ACH	2.0 W/m²	17.15423	20.7469	11.64805	0.012307	0	0	0	0
			1.0 ACH	4.0 W/m²	15.7163	19.30853	10.24062	0.006824	0	0	0	0
			1.0 ACH	6.0 W/m²	14.2821	17.87255	8.866747	0.003915	0	0	0	0
			1.0 ACH	8.0 W/m²	12.85614	16.44142	7.547482	0.002318	0	0	0	0
			1.0 ACH	10.0 W/m²	11.44629	15.01927	6.308099	0.001412	0	0	0	0
			1.0 ACH	20.0 W/m²	5.194931	8.35294	1.989086	0.000167	0	0	0	0
			1.0 ACH	30.0 W/m²	1.67925	3.594049	0.503841	3.01E-05	0	0	0	0
			1.5 ACH	0.0 W/m²	22.05634	26.33401	16.22644	0.063168	0	0	0	0
			1.5 ACH	2.0 W/m²	20.61657	24.89423	14.79209	0.034642	0	0	0	0
			1.5 ACH	4.0 W/m²	19.17736	23.45485	13.36549	0.019582	0	0	0	0
			1.5 ACH	6.0 W/m²	17.7396	22.01639	11.9538	0.011402	0	0	0	0
			1.5 ACH	8.0 W/m²	16.30519	20.57987	10.56807	0.006828	0	0	0	0
			1.5 ACH	10.0 W/m²	14.87754	19.14702	9.223499	0.004198	0	0	0	0
			1.5 ACH	20.0 W/m²	8.142146	12.18999	3.776129	0.000511	0	0	0	0
			1.5 ACH	30.0 W/m²	3.34857	6.389088	1.181047	9.34E-05	0	0	0	0

The software calculates the monthly heating and cooling demand for a given building orientation and for all the combinations of the following parameters:

Parameters	Value range
Window types	All the combinations of the fenestration systems (8 types)
Window area	For A_w/A_f from 0% to the maximum value for the specific wall with step 10%
Ventilation	0.5, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0 ACH
Internal gains	0, 2, 4, 6, 8, 10, 20, 30 W/m ²

where A_w/A_f is the window to wall area ratio.