

Traditional small house in context of
the Finnish energy code 2012

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1 Essential inputs and results

1.1 Energy code compliance at year 2012

The aim of this work is to study if it is possible that traditional wooden single family house, which has natural ventilation system without heat recovery, could fulfill year 2012 energy code, which will come in force at 1st of July at 2012.

To show code compliance it has to fulfill annual primary energy requirement. All delivered energy carriers are multiplied by a primary energy factor and are all summed up. With natural ventilation system the fan energy would be saved but at the same time ventilation heating energy usage is higher due to missing heat recovery.

The total heat loss of the building has another requirement, which should be fulfilled as well. The reference level of the heat loss is set with each component level values. For ventilation heat recovery the reference level of the annual energy efficiency is 45 %, which could be compensated with envelopment conduction and the air infiltration heat losses.

The presented calculations are made according to given codes. **The assumption is that the requirements for the outdoor air flows and air quality will be fulfilled without fan usage, ie. air flows are the input values of the calculations.**

1.2 Primary energy simulations

The simulations are made with IDA-Indoor Climate and Energy 4.0. The created geometries on top of DWGs are shown at figures 1 and 2. In the primary energy simulations the all U-values and air tightness of building are the reference values given in building code.

The selected heating system is ground source heat pump with water borne under floor heating. COP of GSH is 3.0 to space heating and 2.3 for domestic hot water heating. The values are building code default values.

Due to the high efficiency heating system primary energy requirements are fulfilled without the heat recovery. For one floor house primary energy requirement is 199 kWh/m² and the simulated result is 163 kWh/m². And for two floors house primary energy requirement is 162 kWh/m² and the simulated result is 144 kWh/m².

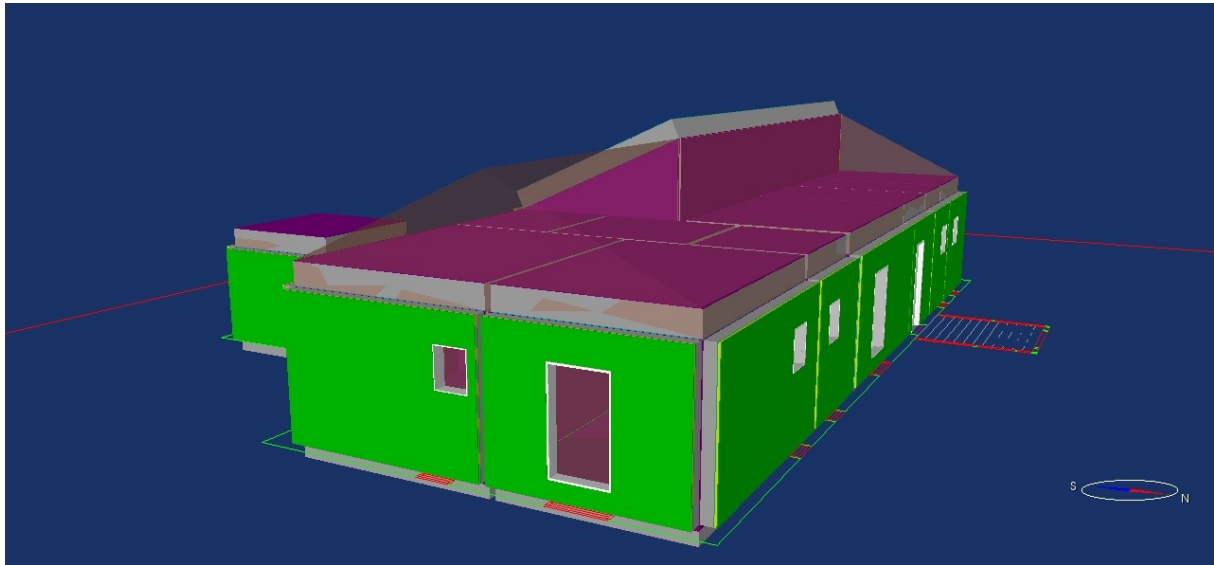


Figure 1. The IDA-ICE model for the one floor house.

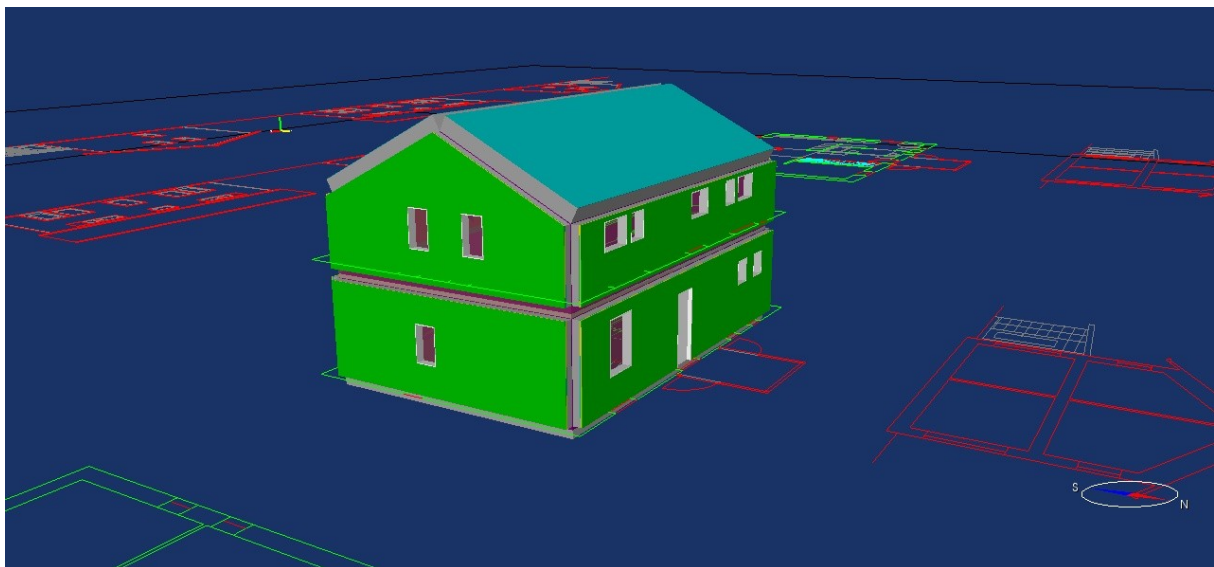



Figure 2 The IDA-ICE model for the two floors house.







1.3 Total heat loss calculation

Without ventilation heat recovery the total heat loss of building becomes the limiting requirement. The primary energy requirement could be fulfilled with the reference U-values and air tightness of the envelopment, but in the total heat loss compensation calculation the passive house level U-values are needed to compensate the 45 % annual efficiency of the ventilation recovery. An example per building is described in the separate documents.

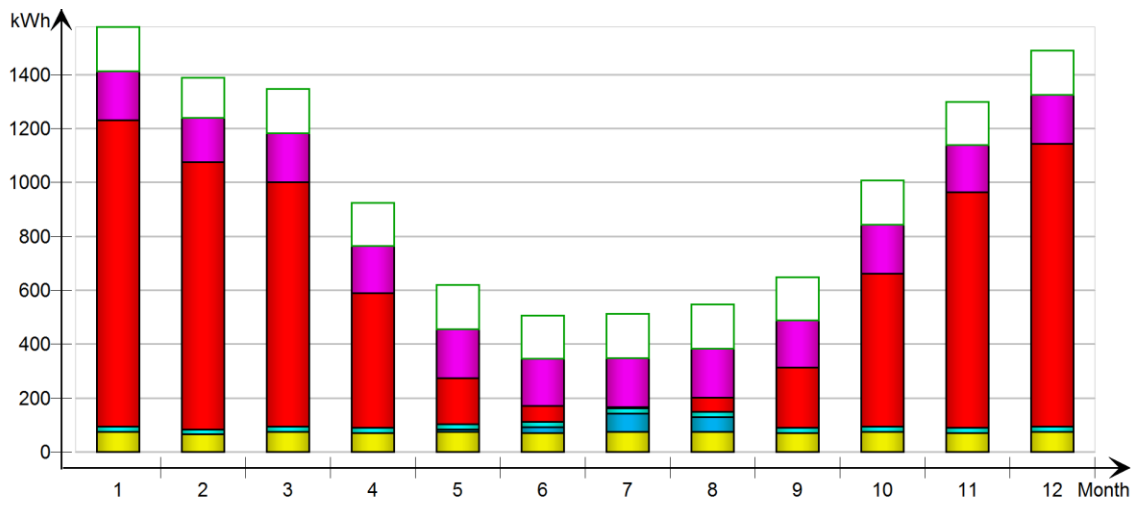
Appendix 1. Primary energy results for one floor house

		Delivered Energy Report	
Project		Building	
q50=2 COP lämmitys=3 COP lkv =2,3		Model floor area	123.4 m ²
Customer		Model volume	351.5 m ³
Created by	mvuolle	Model ground area	123.4 m ²
Location	Helsinki	Model envelope area	409.5 m ²
Climate file	Helsinki 2012	Window/Envelope	3.3 %
Case	efem	Average U-value	0.2787 W/(K·m ²)
Simulated	26.5.2011 17:28:32	Envelope area per Volume	1.165 m ² /m ³

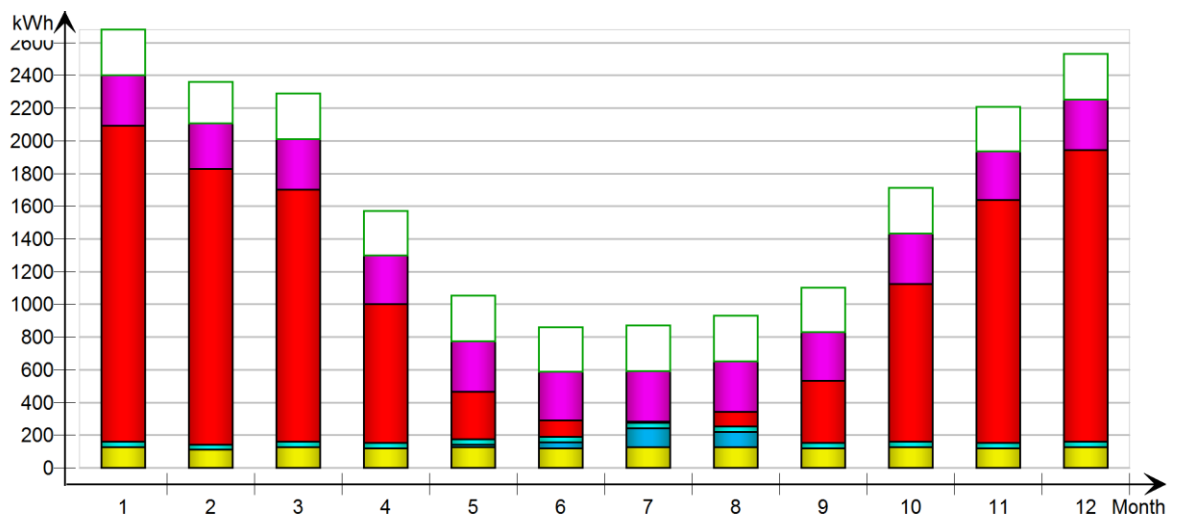
Delivered Energy Overview

		Delivered energy		Primary energy	
		kWh	kWh/m ²	kWh	kWh/m ²
	Lighting, facility	865	7.0	1470	11.9
	Cooling	155	1.3	263	2.1
	HVAC aux	239	1.9	407	3.3
	Heating	6534	53.0	11108	90.0
	Domestic hot water	2140	17.3	3639	29.5
	Total, Facility electric	9933	80.5	16887	136.8
	Total	9933	80.5	16887	136.8
	Equipment, tenant	1946	15.8	3308	26.8
	Total, Tenant electric	1946	15.8	3308	26.8
	Grand total	11879	96.3	20195	163.6


Monthly Delivered Energy



Monthly Primary Energy



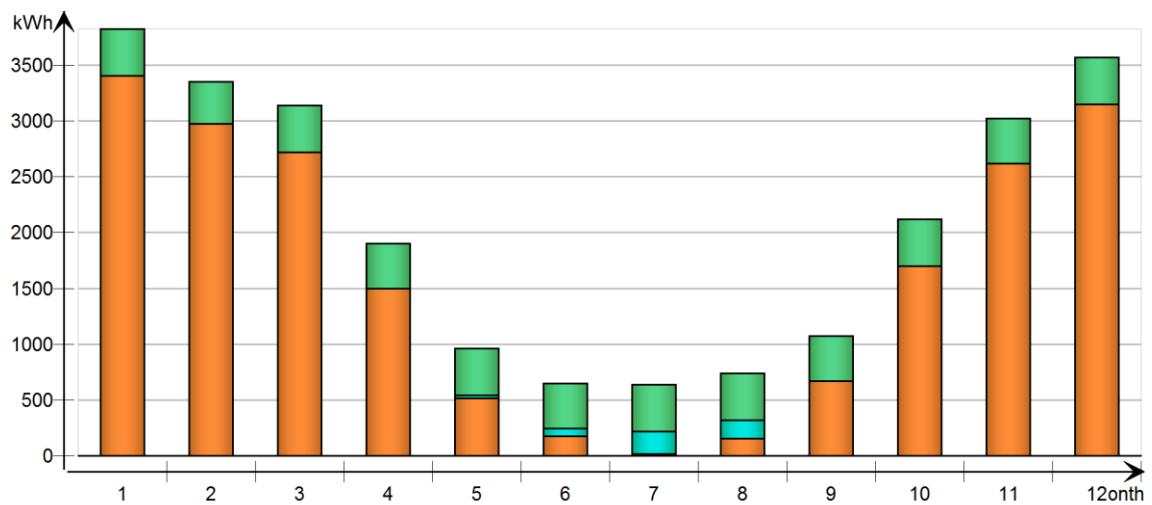
Month	Facility electric										Tenant electric	
	Lighting, facility		Cooling		HVAC aux		Heating		Domestic hot water		Equipment, tenant	
	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)
1	73.5	124.9	0.0	0.0	20.3	34.5	1136.0	1931.2	181.8	309.1	165.3	281.0
2	66.3	112.8	0.0	0.0	18.4	31.2	992.2	1686.7	164.2	279.1	149.3	253.8
3	73.5	124.9	0.0	0.0	20.3	34.5	906.0	1540.2	181.8	309.1	165.3	281.0
4	71.1	120.8	0.2	0.3	19.7	33.4	500.1	850.2	175.9	299.0	159.9	271.8
5	73.5	124.9	9.5	16.1	20.3	34.5	171.7	291.9	181.8	309.1	165.3	281.0
6	71.1	120.8	22.8	38.7	19.7	33.4	58.5	99.4	175.9	299.0	159.9	271.8
7	73.5	124.9	67.1	114.1	20.3	34.5	5.0	8.5	181.8	309.1	165.3	281.0
8	73.5	124.9	54.9	93.3	20.3	34.5	51.5	87.5	181.8	309.1	165.3	281.0
9	71.1	120.8	0.4	0.7	19.7	33.4	223.9	380.6	175.9	299.0	159.9	271.8
10	73.5	124.9	0.0	0.0	20.3	34.5	567.3	964.4	181.8	309.1	165.3	281.0
11	71.1	120.8	0.0	0.0	19.7	33.4	872.8	1483.8	175.9	299.0	159.9	271.8
12	73.5	124.9	0.0	0.0	20.3	34.5	1049.0	1783.3	181.8	309.1	165.3	281.0
Total	864.8	1470.2	154.8	263.2	239.3	406.8	6533.9	11107.6	2140.4	3638.7	1946.0	3308.2

		<h2 style="text-align: center;">Systems Energy</h2>	
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Customer		Model volume	351.5 m ³
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Location	Helsinki	Model envelope area	409.5 m ²
Climate file	Helsinki 2012	Window/Envelope	3.3 %
Case	efem	Average U-value	0.2787 W/(K·m ²)
Simulated	26.5.2011 17:28:32	Envelope area per Volume	1.165 m ² /m ³

Systems Energy

kWh (sensible and latent)

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	AHU heat recovery	AHU cold recovery	Humidification	Fans	Pumps	Dom. hot water
1	3406.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	418.0
2	2975.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	377.6
3	2717.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	418.0
4	1500.0	0.6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	404.6
5	514.8	28.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	418.0
6	175.3	68.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	404.6
7	15.0	201.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	418.0
8	154.3	164.6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	418.0
9	671.4	1.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	404.6
10	1701.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	418.0
11	2617.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	404.6
12	3147.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	418.0
Total	19593.8	464.5	0.0	0.0	0.6	0.0	0.0	1.4	0.0	4922.0




Distribution Losses
kWh







Month	Domestic hot water circuit	Heating	Cooling*	Air ducts*
1	52.3	511.1	0.0	0.0
2	47.3	446.5	0.0	0.0
3	52.3	407.7	0.0	0.0
4	50.6	225.0	0.0	0.0
5	52.3	77.3	0.0	0.0
6	50.6	26.3	0.0	0.0
7	52.3	2.2	0.0	0.0
8	52.3	23.2	0.0	0.0
9	50.6	100.8	0.0	0.0
10	52.3	255.3	0.0	0.0
11	50.6	392.7	0.0	0.0
12	52.3	472.2	0.0	0.0
Total	616.3	2940.3	0.0	0.0

*positive loss when conduit is cooler than building

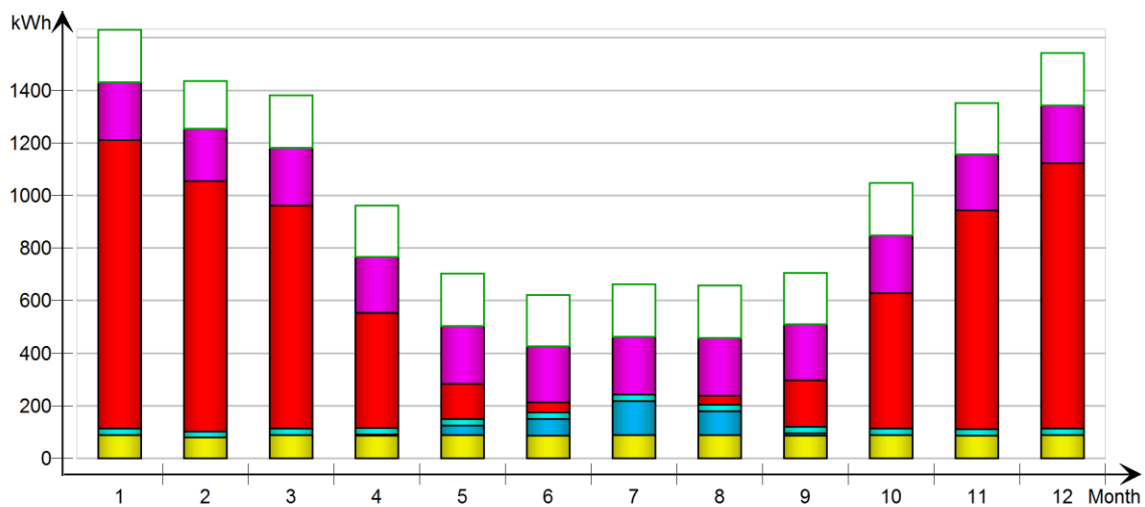
Appendix 2. Primary energy results for two floors house

		Delivered Energy Report	
Project		Building	
q50=2 COP lämmitys=3 COP lkv =2,3		Model floor area	149.6 m ²
Customer		Model volume	387.1 m ³
Created by	mvuolle	Model ground area	74.8 m ²
Location	Helsinki	Model envelope area	329.8 m ²
Climate file	Helsinki 2012	Window/Envelope	5.0 %
Case	efem2floors	Average U-value	0.2936 W/(K·m ²)
Simulated	29.5.2011 07:14:26	Envelope area per Volume	0.8518 m ² /m ³

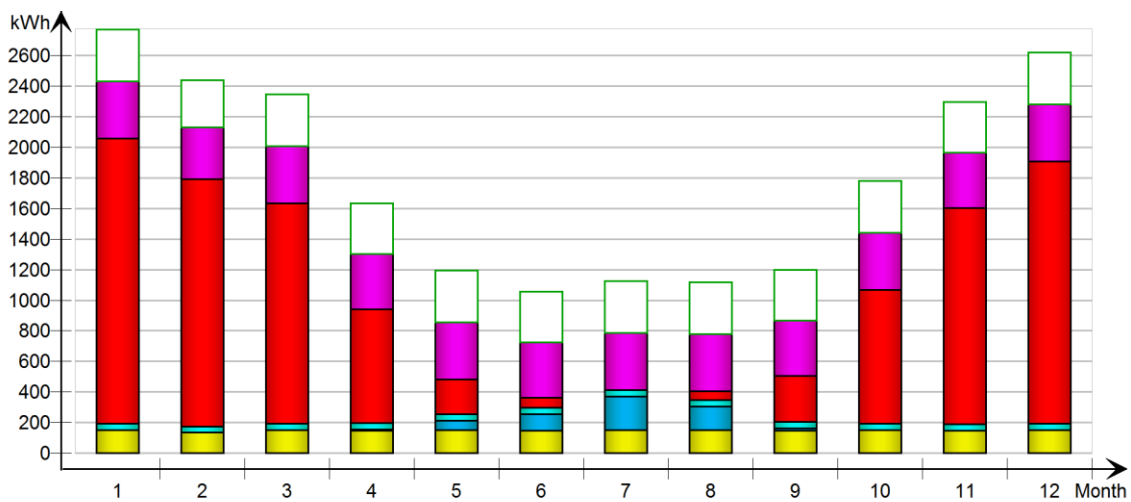
Delivered Energy Overview

		Delivered energy		Primary energy	
		kWh	kWh/m ²	kWh	kWh/m ²
	Lighting, facility	1049	7.0	1783	11.9
	Cooling	335	2.2	569	3.8
	HVAC aux	290	1.9	493	3.3
	Heating	6076	40.6	10330	69.0
	Domestic hot water	2595	17.3	4412	29.5
	Total, Facility electric	10345	69.1	17587	117.5
	Total	10345	69.1	17587	117.5
	Equipment, tenant	2360	15.8	4012	26.8
	Total, Tenant electric	2360	15.8	4012	26.8
	Grand total	12705	84.9	21599	144.4


Monthly Delivered Energy



Monthly Primary Energy



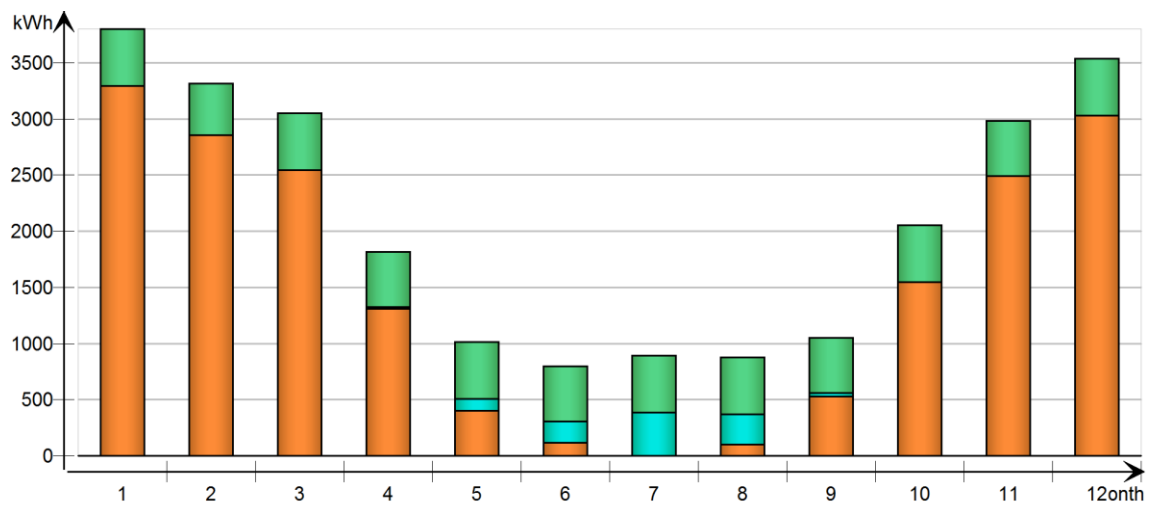
Month	Facility electric										Tenant electric	
	Lighting, facility		Cooling		HVAC aux		Heating		Domestic hot water		Equipment, tenant	
	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)	(kWh)	Prim. (kWh)
1	89.1	151.4	0.0	0.0	24.6	41.9	1098.0	1866.6	220.4	374.7	200.4	340.7
2	80.4	136.7	0.0	0.0	22.3	37.8	951.8	1618.1	199.1	338.5	181.0	307.7
3	89.1	151.4	0.0	0.0	24.6	41.9	848.8	1443.0	220.4	374.7	200.4	340.7
4	86.2	146.5	5.6	9.6	23.9	40.5	437.2	743.2	213.3	362.6	194.0	329.8
5	89.1	151.4	35.8	60.9	24.6	41.9	134.4	228.5	220.4	374.7	200.4	340.7
6	86.2	146.5	64.2	109.2	23.9	40.5	39.4	67.0	213.3	362.6	194.0	329.8
7	89.1	151.4	128.4	218.3	24.6	41.9	0.6	1.1	220.4	374.7	200.4	340.7
8	89.1	151.4	90.4	153.7	24.6	41.9	32.9	55.9	220.4	374.7	200.4	340.7
9	86.2	146.5	10.2	17.3	23.9	40.5	176.5	300.1	213.3	362.6	194.0	329.8
10	89.1	151.4	0.2	0.3	24.6	41.9	515.5	876.4	220.4	374.7	200.4	340.7
11	86.2	146.5	0.0	0.0	23.9	40.5	831.3	1413.2	213.3	362.6	194.0	329.8
12	89.1	151.4	0.0	0.0	24.6	41.9	1010.0	1717.0	220.4	374.7	200.4	340.7
Total	1048.6	1782.6	334.9	569.3	290.1	493.2	6076.5	10330.0	2595.1	4411.7	2359.8	4011.7

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Simulated	29.5.2011 07:14:26	Envelope area per Volume	0.8518 m ² /m ³

Systems Energy

kWh (sensible and latent)

Month	Zone heating	Zone cooling	AHU heating	AHU cooling	AHU heat recovery	AHU cold recovery	Humidification	Fans	Pumps	Dom. hot water
1	3294.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	506.9
2	2854.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	457.8
3	2545.0	-0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	506.9
4	1311.0	16.9	0.0	0.0	0.1	0.0	0.0	0.1	0.0	490.5
5	403.2	107.4	0.0	0.0	0.1	0.0	0.0	0.1	0.0	506.9
6	118.3	192.6	0.0	0.0	0.1	0.0	0.0	0.1	0.0	490.5
7	1.9	385.3	0.0	0.0	0.1	0.0	0.0	0.1	0.0	506.9
8	98.7	271.3	0.0	0.0	0.1	0.0	0.0	0.1	0.0	506.9
9	529.4	30.6	0.0	0.0	0.1	0.0	0.0	0.1	0.0	490.5
10	1546.0	0.6	0.0	0.0	0.1	0.0	0.0	0.1	0.0	506.9
11	2493.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	490.5
12	3030.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	506.9
Total	18224.5	1004.7	0.0	0.0	0.7	0.0	0.0	1.7	0.0	5968.1



Distribution Losses

kWh

Month	Domestic hot water circuit	Heating	Cooling*	Air ducts*
1	63.5	494.3	0.0	0.0
2	57.3	428.3	0.0	0.0
3	63.5	382.0	0.0	0.0
4	61.4	196.7	0.0	0.0
5	63.5	60.5	0.0	0.0
6	61.4	17.8	0.0	0.0
7	63.5	0.3	0.0	0.0
8	63.5	14.8	0.0	0.0
9	61.4	79.4	0.0	0.0
10	63.5	232.0	0.0	0.0
11	61.4	374.1	0.0	0.0
12	63.5	454.6	0.0	0.0
Total	747.1	2734.8	0.0	0.0

*positive loss when conduit is cooler than building