

SYSTEM PERFORMANCE OF HVAC IN A LOW ENERGY HOUSE IN THE COLD REGION OF JAPAN

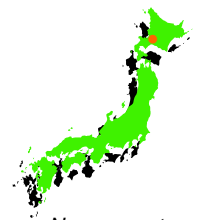


Sayaka Takeda – Kindaichi
Katsunori Nagano
Takao Katsura
Shogo Hori
Kazuo Shibata

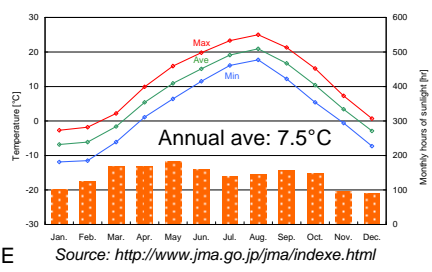
The University of Tokyo
Hokkaido University
Fujiwara Environmental Science Institute Ltd.
Hokkaido University
Nissin Techno Incorporated

General information about the low energy house

Location and climatic conditions



Naganuma town
Lat. 43°N, long. 141°E
40 km southeast from Sapporo



Source: <http://www.jma.go.jp/jma/indexe.html>

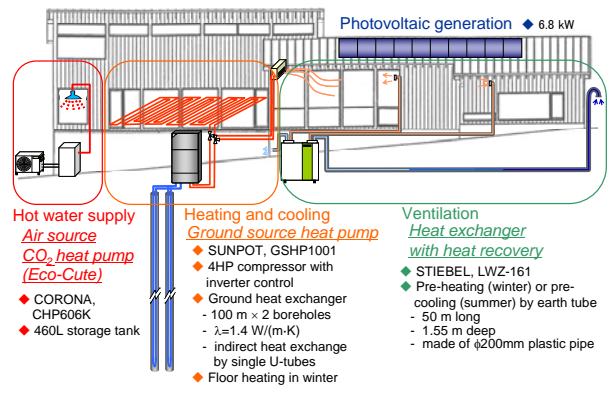
Physical properties of the building

	Insulation	Area [m ²]				
		E	W	S	N	Total
Ceiling	240 mm	132				
Outer walls	186 mm	E	W	S	N	Total
		47	38	55	94	234
Floor	50 mm (with concrete slab of 300 mm)	200 (Base: 23, First: 132, Second: 45)				
Windows	Low-E Triple filled with Argon gas (1.3 W/(m ² K))	E	W	S	N	Total
		6	9	53	14	82
Q value	0.96 W/(m ² K)					
C value	0.42 cm ² /m ²					



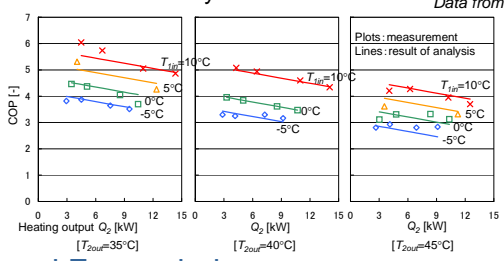
External appearance

System specification

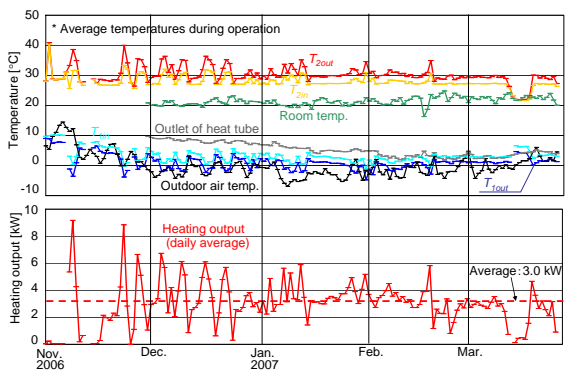


Partial load efficiency of GSHP1001

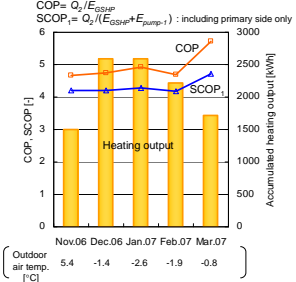
Data from Sunpot Co., Ltd.



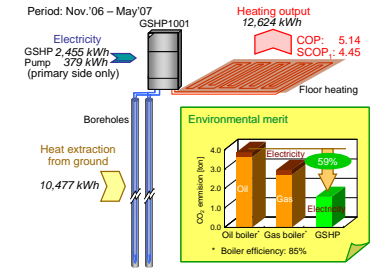
Performance of the GSHP system



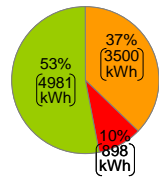
Monthly performance



Seasonal heat balance

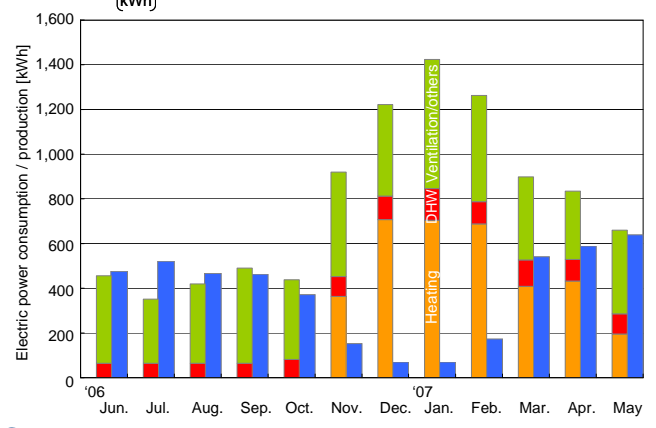


Annual Energy balance



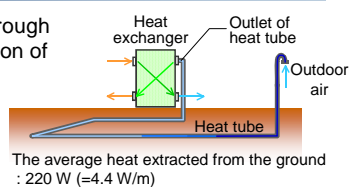
Consumption - Production = Real consumption
9,379 kWh - 4,534 kWh = 4,845 kWh (24 kWh/m²)

Energy self-sufficiency rate = Production / Consumption = 48%



Effect of heat tube

- Heat extraction from the ground through the heat tube results in 14% reduction of the heat load for ventilation.
- The use of the heat tube provides an advantage to avoid the defrost operation of the ventilation unit.



Conclusions

- Heat pump operation with low supply water temperatures about 30°C provides not only sufficient thermal environment but high efficiency of the heat pump by the partial load operation.
- Totally the seasonal average COP and SCOP of the heat pump system reach 5.14 and 4.45 respectively.
- The total electric power demand for all purposes is 9,379 kWh in a year. The real electric power consumption, that is, the difference between the demand and the power generation by the solar photovoltaic system, is calculated as 4,845 kWh. Totally almost half of energy demand can be covered by the solar system in the low energy house.