



# ProEcoPolyNet

## Best practice Sheet

### "MINERGIE® Gelterkinden"

#### RTD Project Identification

##### RTD Project:

Calculation method for the seasonal performance factor of heat pump compact units and validation

##### Programme:

Swiss Federal Office of Energy (SFOE), research programme ambient heat, refrigeration and heat pumping technologies

Contract No. 150332 (SFOE)

#### Description of technology

Low energy houses require a mechanical ventilation system with heat recovery (HR) to reduce the space heating (SH) demand. To further recover the energy of the exhaust air, a heat pump provides SH and domestic hot water (DHW). With regard to installation space and costs, ventilation compact units with exhaust air heat pump were introduced in the market, combining the three functions in one unit. These systems are very popular in German passive houses.

#### Operating principle

The monitored compact unit is designed for low energy residential houses in the range of 3-5 kW design heat load, e.g. according to the Swiss MINERGIE standard. Outdoor air serves besides of exhaust air as additional heat source for the heat pump evaporator. An electrical back-up heater covers peak loads. Furthermore, the unit includes an additional air preheater to prevent frosting of the ventilation heat recovery. The preheater uses the sub-cooling energy of the heat pump refrigerant cycle and reduces thereby the use of energy for defrosting.

The compact unit is designed for a floor heating system. The floor heating has been dimensioned to very low flow temperatures below 30°C in order to optimize the COP of the heat pump. The latter is achieved by the self regulation effect, which refers to a reduced heat flux in case of a low temperature difference between space and emission system, i.e. in case of increasing room temperatures the heat emission of the SH system is reduced by itself.

#### Technical characteristics of the installation

- ▶ Type: Multifunctional ventilation compact unit with heat recovery and heat pump using exhaust air/outdoor air. The unit provides the functions SH, DHW and ventilation.
- ▶ Thermal output capacity heat pump 4.2 kW (A2/W35)
- ▶ Additional direct electrical back-up heater 1.4 + 2.8 kW , 4.2 kW in total
- ▶ Electricity 1.3 kW (A2/W35), i.e. COP 3.2
- ▶ Noise emissions 49 dB(A)\*
- ▶ Weight: 223 kg (unit)/153 kg (storage w/o water)

\* at A2/W35, 170m<sup>3</sup>/h ventilation air at 50 Pa

#### Location and use

▶ The compact unit is installed in a private residential dwelling according to the Swiss MINERGIE® standard in Gelterkinden, canton Basel-Landscape, Switzerland.

#### Capital investment and maintenance costs

- ▶ Capital investment  
Cost of unit: 17.200 SFr. (~10440 €) \*
- Total Cost: 36.500 SFr. (~21850 €) \*\*
- ▶ Avoided capital investment  
Due to self regulation effect, thermostatic valves are avoided. However, the floor heating system has to be designed for lower flow temperatures, which may increase the costs, thus an avoided investment is difficult to evaluate.
- ▶ Avoided installation costs  
Compared to fuel systems no connection to the gas network and no costs and space for the fuel storage is required.
- ▶ Maintenance  
During the monitoring, no specific maintenance was needed. The air filters of the ventilation system were changed by the user.

\* catalogue price 2007 w/o VAT, exchange rate Sept. 2007

\*\* including ventilation compact unit, floor heating system, ventilation system, design and installation, excluding DHW distribution system

## State of Development/ Market implementation

▶ The compact unit is fabricated in serial production and is available on the market for several years with increasing market shares.

## Operational data

- ▶ hours of operation (h/a)
  - ▶ ventilation system: 8760 h/a (year round)
  - ▶ space heating:
    - ▶ activation: 5196 h/a
    - ▶ heat pump: 2496 h/a
  - ▶ domestic hot water (year-round):
    - ▶ heat pump 609 h/a
- ▶ heat supplied to the SH and DHW distribution systems
  - ▶ Heat pump: 12947 kWh<sub>th</sub>/a
  - ▶ Back-up heater: 199 kWh<sub>th</sub>/a
- ▶ Total electrical energy input 4434 kWh<sub>e</sub>/a
- ▶ Back-up energy 199 kWh<sub>e</sub>/a (5%)
- ▶ Auxiliary energy 898 kWh<sub>e</sub>/a (20 %)
- ▶ Generated heat output 13146 kWh<sub>th</sub>/a
- ▶ Used heat output 12073 kWh<sub>e</sub>/a
- ▶ Fraction of heat losses 8 % (DHW Storage)
- ▶ Overall Seasonal Performance Factors
  - ▶ Heat Pump\* 3.7
  - ▶ Generator\*\* 3.6
  - ▶ System\*\*\* 3.1

\* ratio of produced heat by heat pump to electrical energy input to heat pump compressor and fan

\*\* ratio of produced heat energy by heat pump and back-up heater to electrical energy input to heat pump compressor and fan, back-up heater and controls

\*\*\* ratio of heat energy delivered to the user (incl. the amount of recovered heat by ventilation system) to total electrical energy input to the compact unit for heat pump, back-up heater, ventilation fans and transformers, sink pump and control

## CO<sub>2</sub> and primary energy savings

Primary energy factor: 2.94 kWh/kWh<sub>el</sub> (M2)\*

Primary energy consumption: 13036 kWh/a

CO<sub>2</sub> emission factor electricity: 0.15 kg/kWh<sub>el</sub>\*

CO<sub>2</sub> emissions: 665.1 kg/a

\* based on

SIA Merkblatt 2031 Energieausweis für Gebäude, draft version for public enquiry, Swiss Engineers and Architects Association, Zürich, March 2007

## Benefits and obstacles

▶ Benefits of the self regulation are a higher COP for the heat pump operation due to the lower temperature lift to be provided by the heat pump and avoided installation costs, since no thermostatic valves are required

▶ Benefit of the compact unit is

- ▶ space saving due to the compact arrangement of all technical components in one casing
- ▶ cost savings by easier installation
- ▶ Easy setting of operation conditions for all building services

▶ Benefit of heat pumps: For the operation only electricity is needed, which is available in any dwelling, so no extra cost for connection of other grid-based energy carriers or storage installations for fuels are needed.

▶ Obstacle of heat pumps: maximum flow temperature is normally limited to about 55°C, so floor heating systems are the best choice for the space heating emission system and DHW temperature of 60°C may not be achievable.

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Final report at the link

<http://www.bfe.admin.ch/dokumentation/energieforschung/index.html?lang=de&publication=9170>

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