OCHSNER

CO_2 heat pipes – an option for vertical collectors

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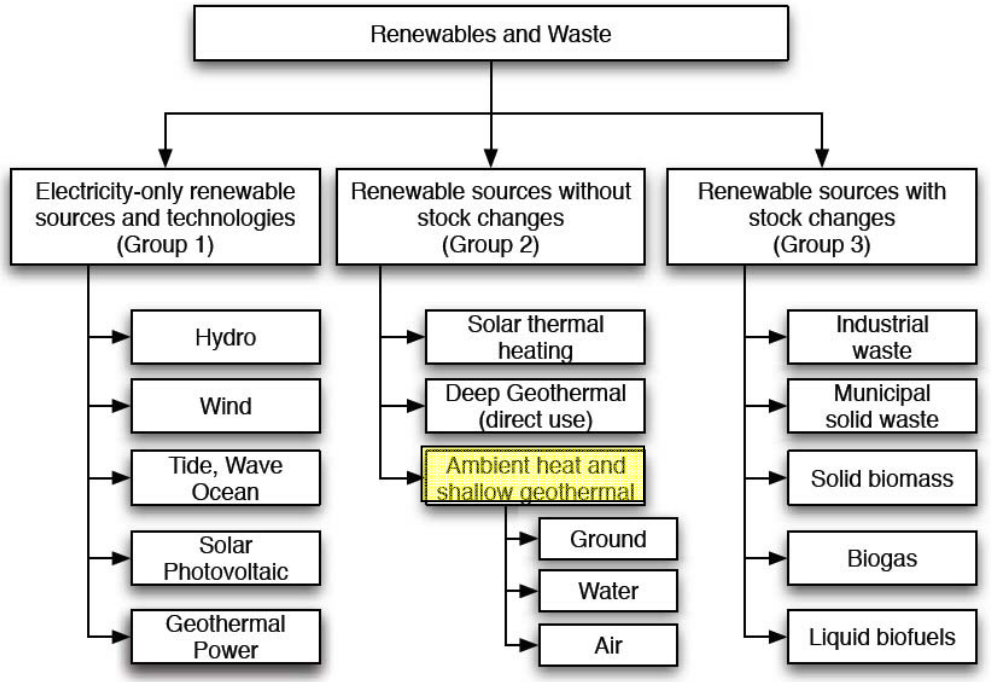
Content:

- Benefit of using CO_2 as heat transfer medium
- Function of a CO_2 – heat pipe
- Exemplary installation of a ground source Heat Pump with CO_2-heat pipe
- Classification of Renewable Energy Sources
- Heat Pumps a Renewable Energy Technology
- Heat Pump Development in Austria
- The various Heat Sources

Classification of Renewable Energy Sources



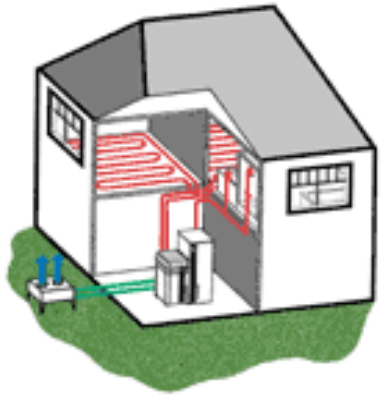
Source: EHPA (European Heat Pump Association) classification of ambient heat

Different alternatives for the energetic use of ambient heat

- **Air** as a heat source
- **Groundwater** as a heat source
- **Ground** with *Direct Expansion* and horizontal collectors
- **Ground** source with *convenional* collectors (wth antifreeze)
- **Ground** source with *Heat Pipes*

Air as heat source

- Air is led through the evaporator - thereby warmth is withdrawn
- Compact air/water heat pumps include evaporator and all other components
- Split-air/water HPs : Evaporator is located outdoors
- Ochsner Type GMLW heat pump COP A2 / W 35 =4
- SPF 3 to 3,5

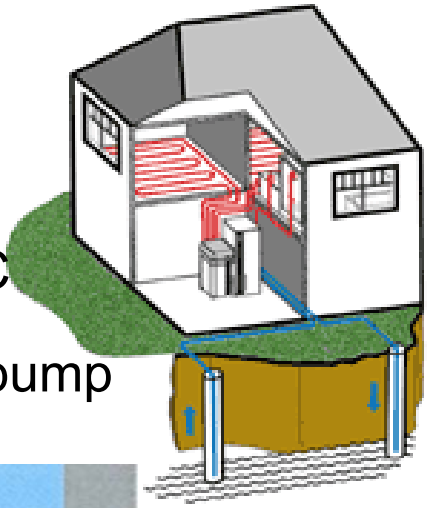


Souce: Ochsner

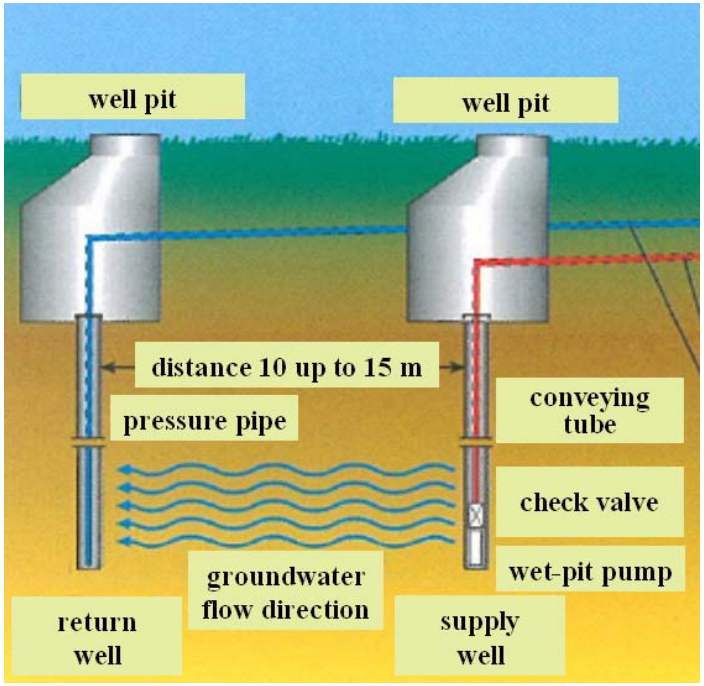
➢Groundwater as a heat source

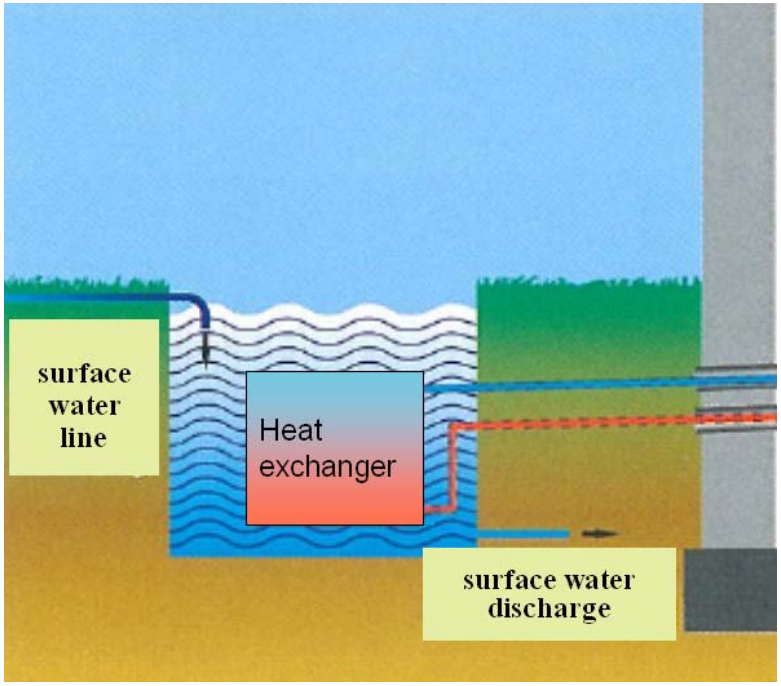
- ➢ Highest COP
- ➢ A constant temperature from normally + 8 °C to + 12 °C

Groundwater is pumped from the supply well to the heat pump and from there 15 meters to the return well.

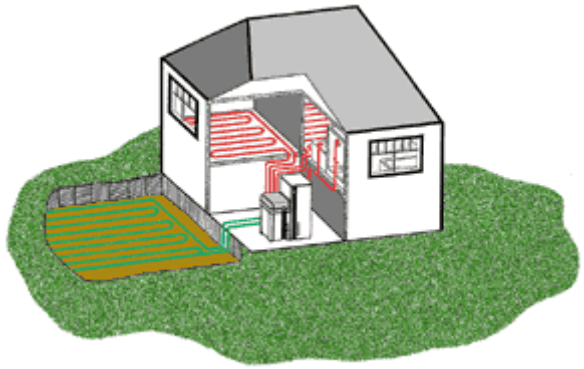


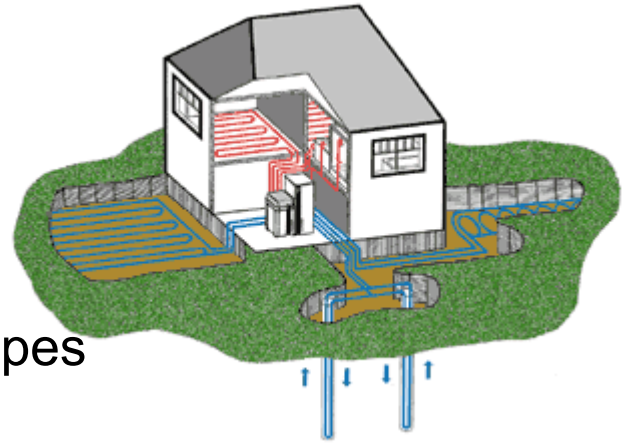
Souce: Ochsner





Types of ground source systems





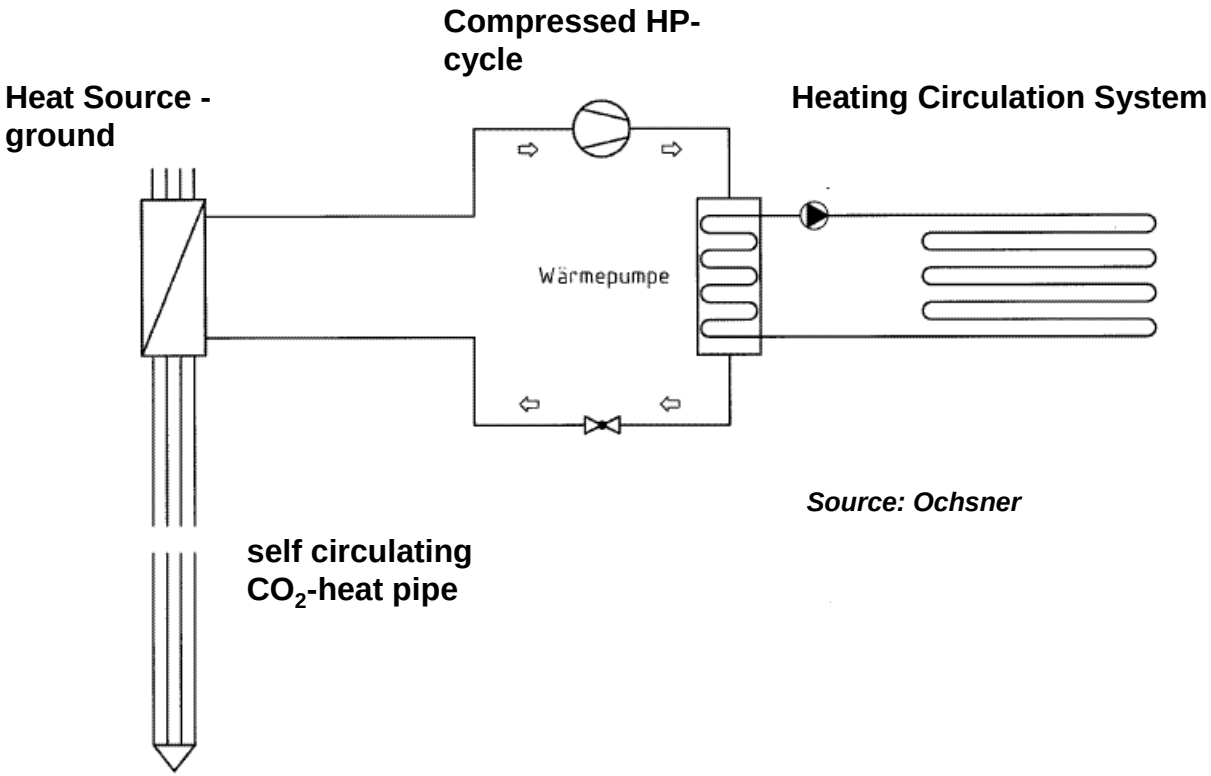
Souce: Ochsner

- With **Direct expansion system**
- refrigerant circulates and evaporates in coll.pipes
- no heat exchanger with heat source needed
- no brine circulating pump is needed

With the **brine system** brine circulates

- in horizontal collector pipes in parallel
- or in spiral form in trenches
- or in vertical collectors

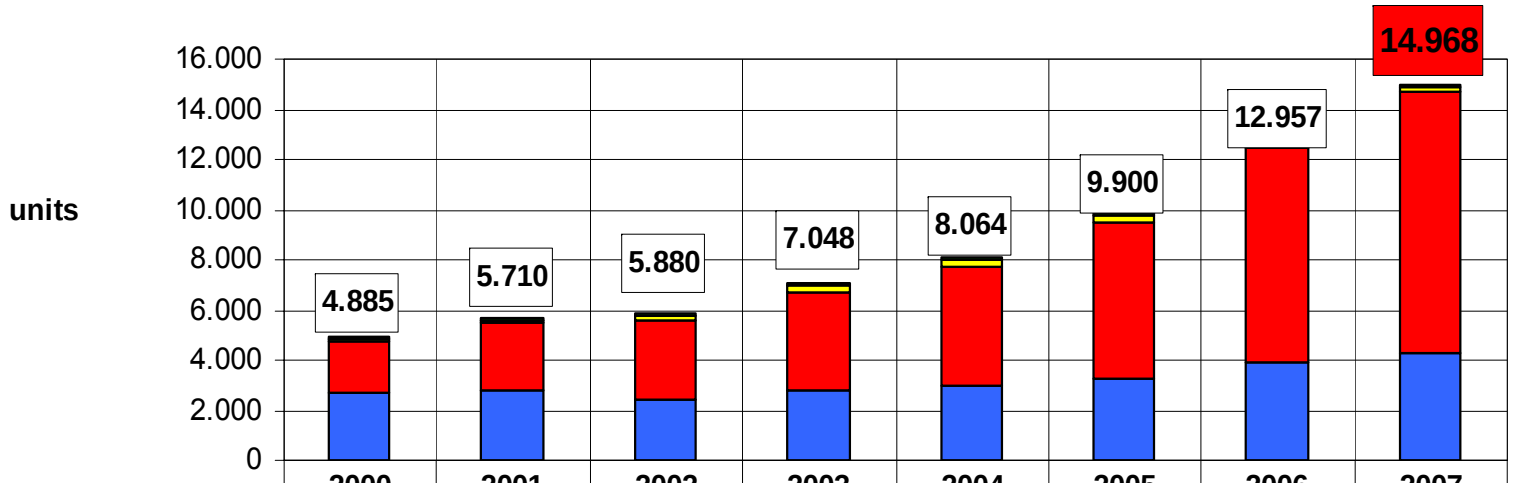
A special alternative: CO_2 heat pipes



Source: Ochsner

Market development heat pumps Austria 2007

Market growth 15 %

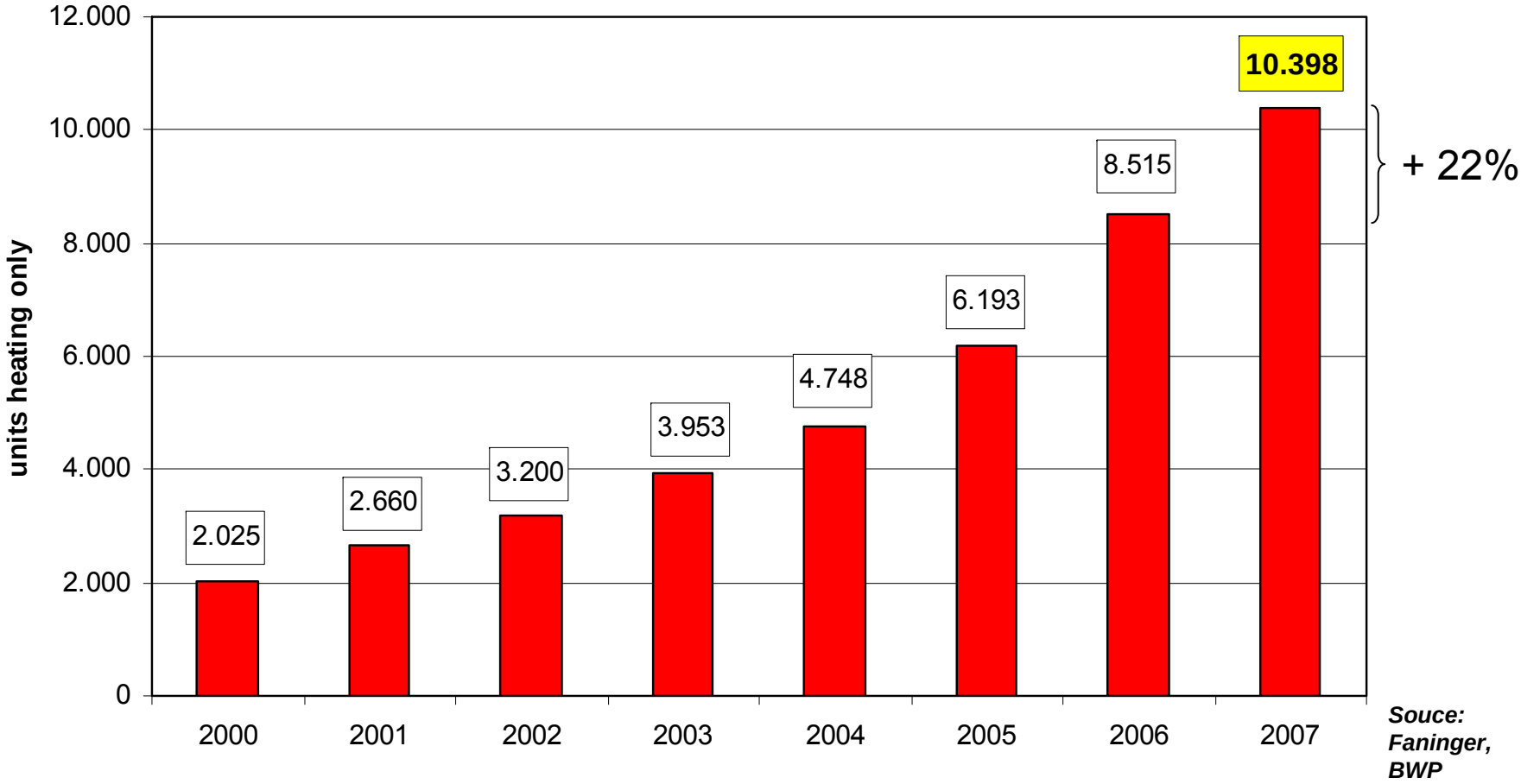


	2000	2001	2002	2003	2004	2005	2006	2007
swimmingpool dehumidification	90	120	100	113	96	105	79	93
air conditioning heat recovery	80	120	160	221	258	349	421	213
heating	2.025	2.660	3.200	3.953	4.748	6.193	8.515	10.398
hot water	2.690	2.810	2.420	2.761	2.962	3.253	3.942	4.264

Souce: Faninger, BWP

Installed heat pumps (only heating) Austria 2000-2007

Market growth 22 %



Souce: Faninger, BWP

Heat pumps: a renewable energy technology →i.g. renewable share in Austria

Heat Pump SPF: 4

share of renewable electricity: 70%

->total share of renewable: 92,5 %

Benefit of using CO_2-heat pipes

Benefit of CO_2 as a heat transfer medium:

- CO_2 is chemically neutral
- not flammable
- inexpensive
- no special regulations for its disposal
- **applicable also in water protection area**

Benefit of using CO_2-tubes

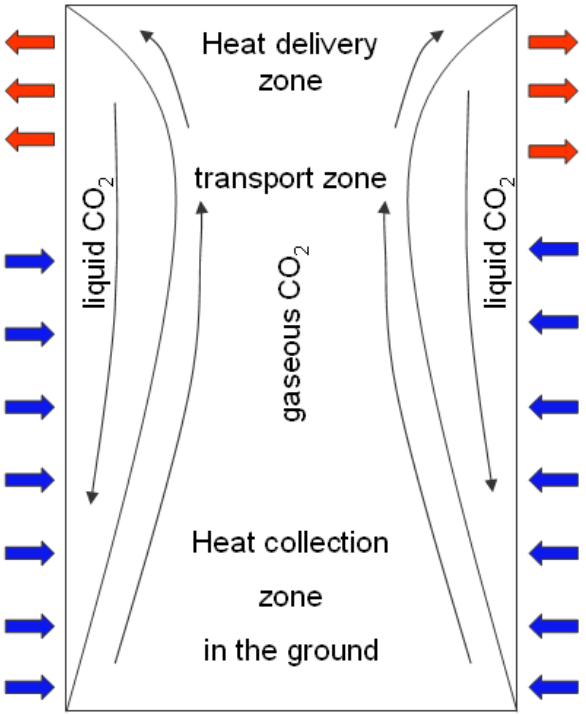
Evoiding disadvantages of conventional antifreeze ("brine")
(Prophylen,- or Ethylenglycol e.g.):

- Brine circulating pump needed (power ,wear, mixing)
- Precise definition of flow rate / velocity to ensure turbulent flow
- Avoiding addition of inhibitors might result in corrosions
- Precise definition of the concentration necessary

Function of CO_2- heat pipe

Principle of a heat pipe:

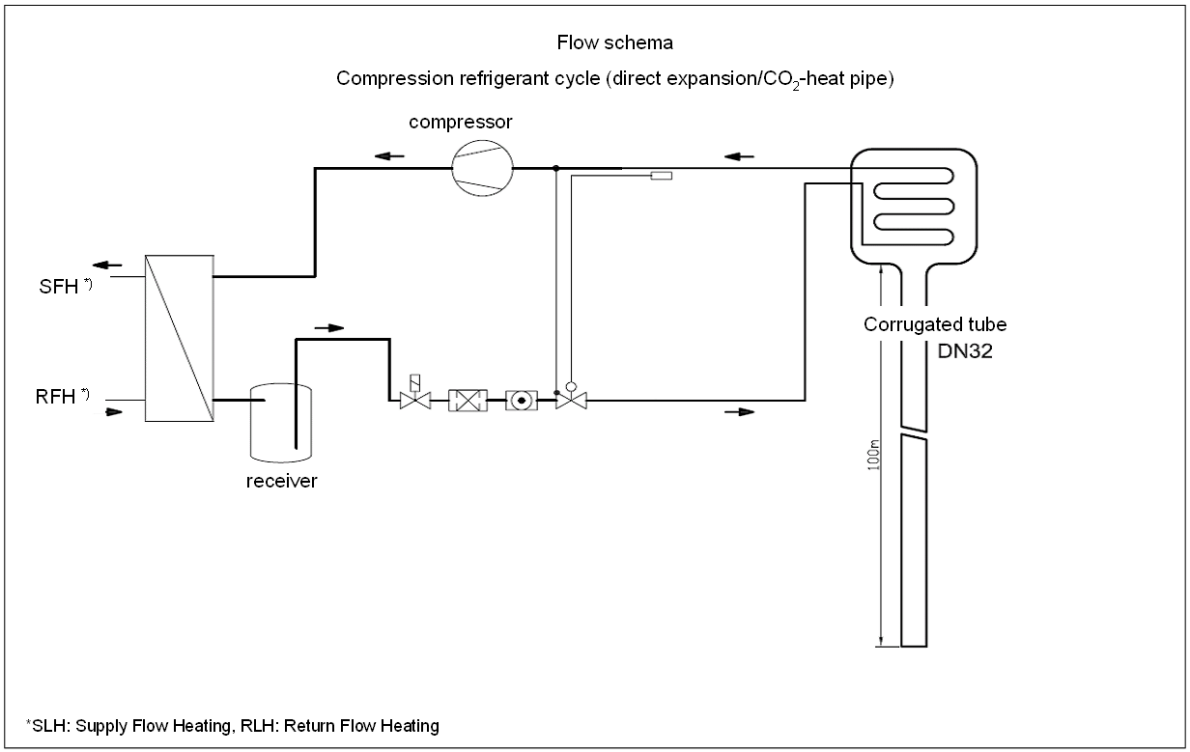
- Heat pipe transports warmth from heat source to heat pump
- Heat transfer medium is CO_2
- The heat transfer medium collects heat energy – by evaporating and delivers heat when condensing (Thermosyphon principle)
- Delivers the heat into the heat exchanger of the Heat Pump (evaporator) while condensing
- CO_2 descends as liquid



Source: Ochsner, Principle of a heat pipe

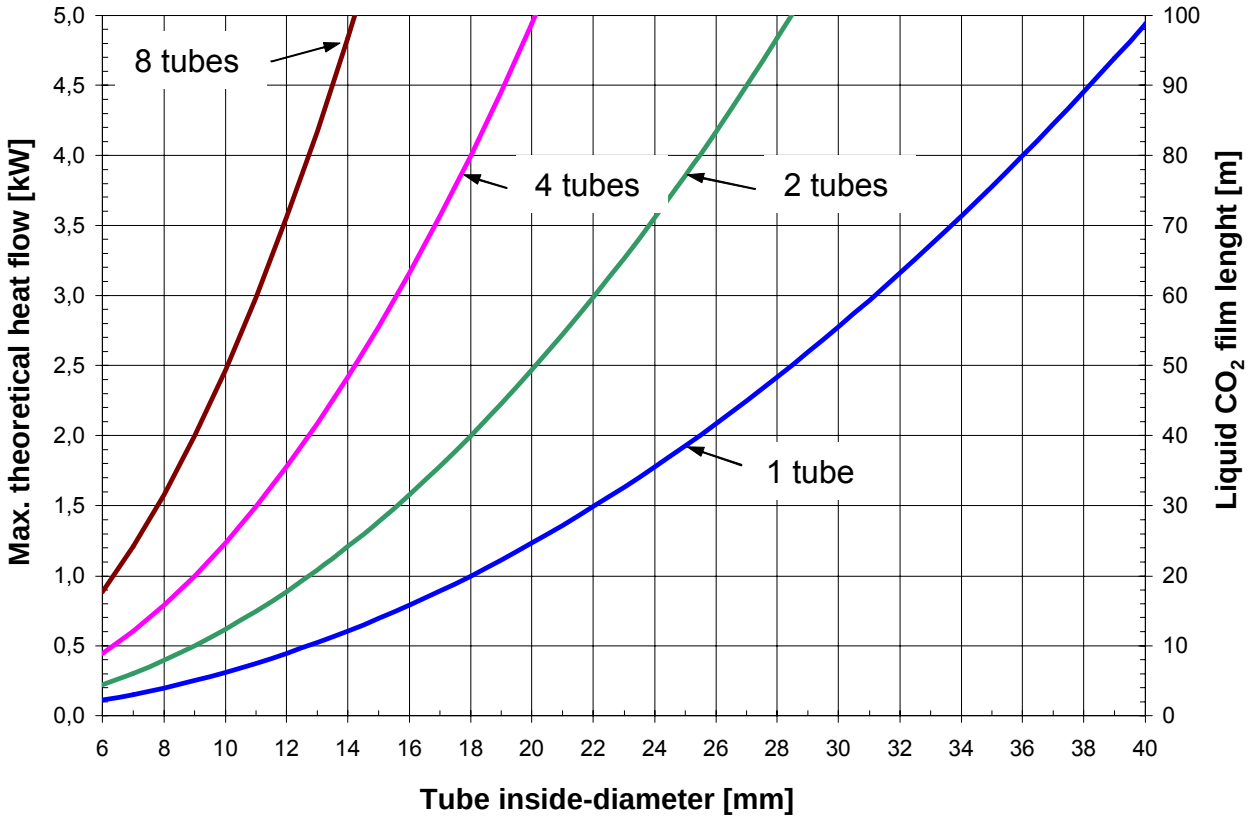
CO_2-heat pipe coupled with as direct expansion heat pump

- System Heat Exchanger acts as evaporator for Heat Pump compression cycle and as condenser for Heat Pipe
- High system COP / SPF as no brine circulating pump required



Compression refrigerant cycle: direct expansion/CO_2-heat pipe
Source: Ochsner

Heat Pipe with CO_2: Maximum heat capacity and length in function of diameter at 50 W/m



Source: FKW Hannover Prof.H. Kruse

Installation- example: object data

Object data	
Heated area	160 m²
Construction design	Low energy house
Heat demand	~ 33 W/m²
Number of persons	3

Family house Gaffal, Upper Austria

Object data and type of heating system
Source: Ochsner

Heating system

Heating system	
Heat pump	OCHSNER Golf GMDW 7
Heating capacity (E0/W35)	6.4 kW
Heat source	Ground source direct expansion, 1 CO_2-tube
Heating mode	monovalent
Distribution system	Floor – and wall heating system
Flow temperature	max. 35°
hydr. decoupling	300 Litre buffer tank
Hot water supply	OCHSNER Europa 303

Object data and type of heating system
Source: Ochsner

Drilling

- borehole with depth of 100 m

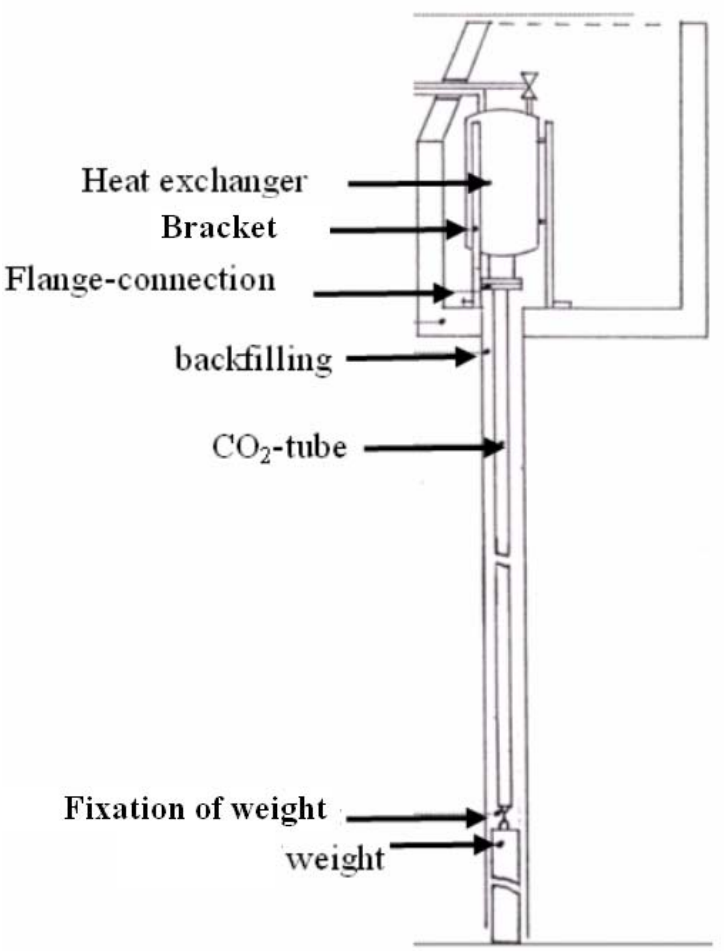
***Source**: Drilling of the borehole* (Ochsner GmbH)

Heat Pipe Tube

- 100 m length
- CO_2 pressure at 15°C: 50 bar
- flexible high-grade steel pipe

Source: CO_2-high-grade steel pipe (Ochsner GmbH)

CO_2-Heat Pipe – installation vault



***Source**:* Ochsner

Insertion of the tube

***Source**: Insertion of the CO_2-tube* (Ochsner GmbH)

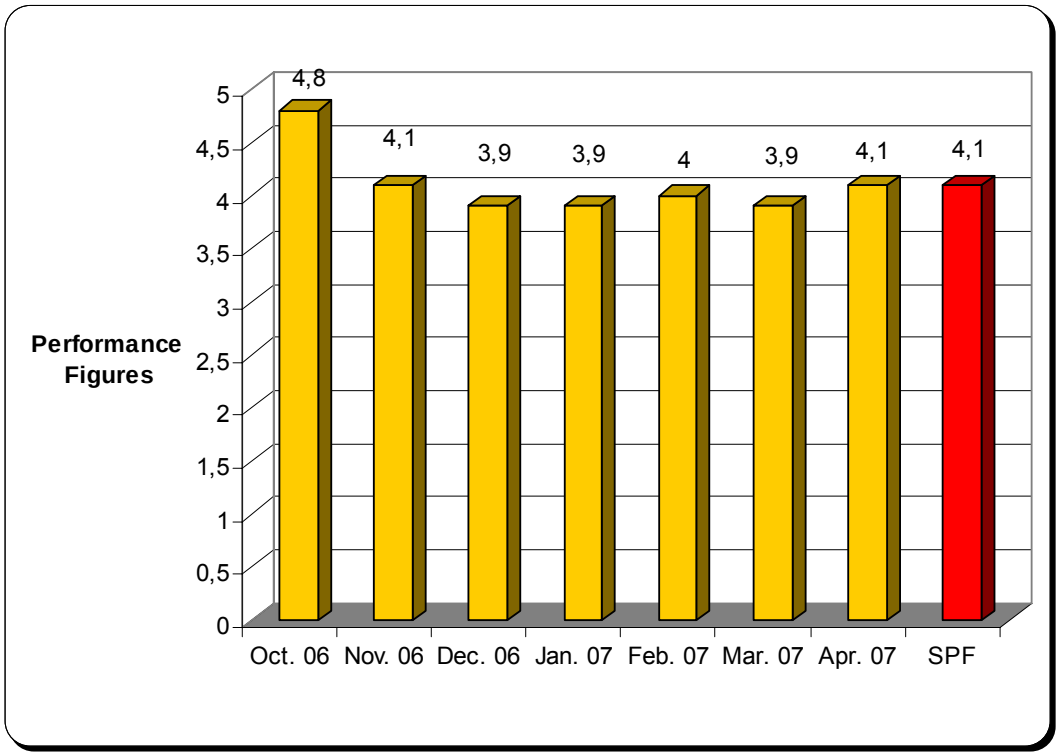
Connection of the CO_2-tube to Heat Pump Cycle

Distance CO_2-tube – heat pump not more than 25 meters.

Refrigerant containing pipes to be insolated

***Source**:* (Ochsner GmbH)

Seasonal Performance Figure



***Source**:* Monthly performance figure and seasonal performance for heating season 2006/2007 (Ochsner GmbH)

Advantages of the CO_2-Heat Pipe

- No brine circulating pump: higher SPF than conventional earth taps (conventional pumps for this typical size installation have a power requirement of approx. 200 W x 1800 h → 360 kWh results in approx. 10 % difference in SPF)
- Environmental friendliness and versatile use: Permissible at all locations including water protection area

Thank you for your attention!