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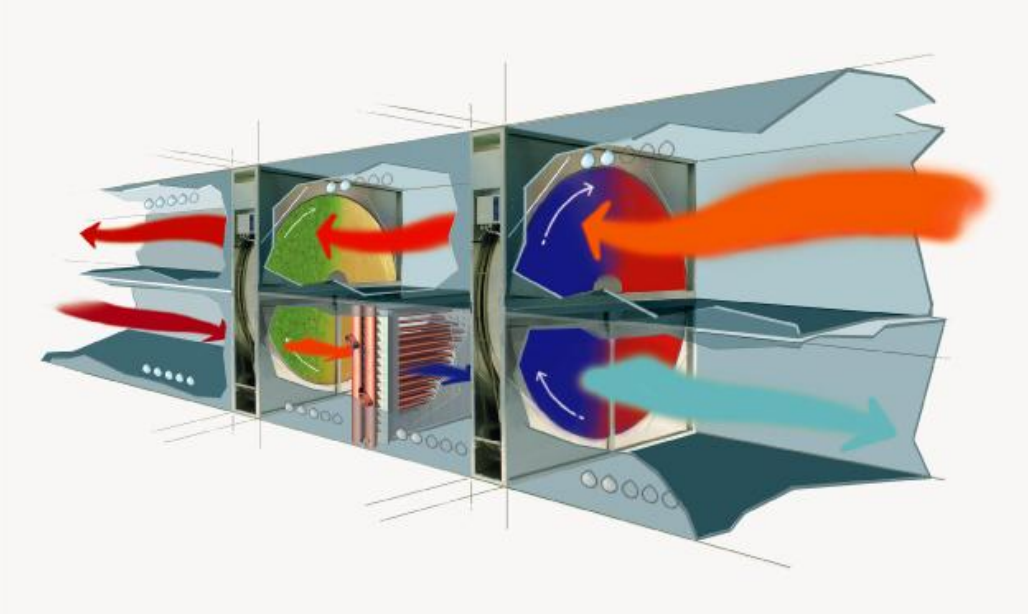
Efficient energy recovery in AHU

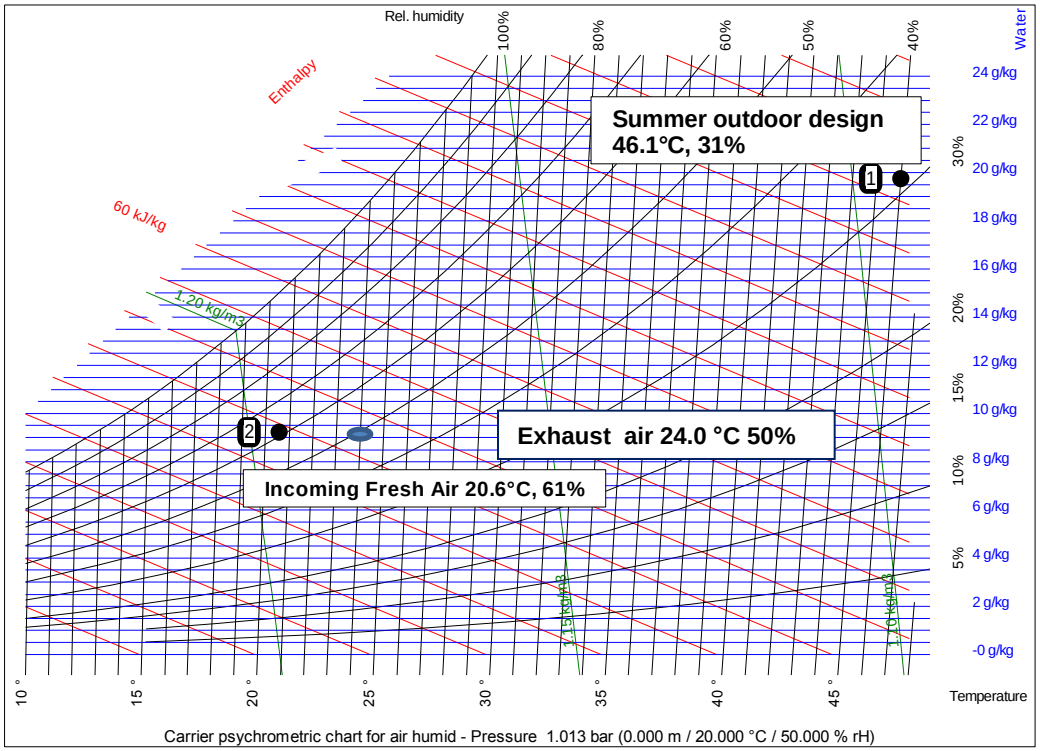


DOHA, Qatar 11.04.2010

Timo Schreck
Enventus AB, Sweden

Main principles for cooling and dehumidification process in AHU

1. With cooling coil and reheater
2. Energy recovery with sensible or sorption rotor
    1. With cooling coil and reheater
    2. + With horse shoe heat pipe
    3. <u>With double wheel system and cooling coil</u>



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CASE STUDY

- Location: Dubai / Doha
- Summer out door 46.1°C, Rh 31%, 19.9 g/kg
- Inlet fresh air 20.6°C, Rh 61%, 9.2 g/kg
- Exhaust air 24.0 °C Rh 50%, 9.2 g/kg

- Calculation done for 1m^3/s, 3600 m^3/h
- Temp / humidity efficiency of HR units 65-70%
- Exhaust air 90% of supply air

- COP of cooling units 3
- Cooling capacity cost 300-400 €/kW,
  300 €/kW used
- Electric capacity cost 800-1000 €/kW,
  800 €/kW used

(price of power plant, actual for peak load case)

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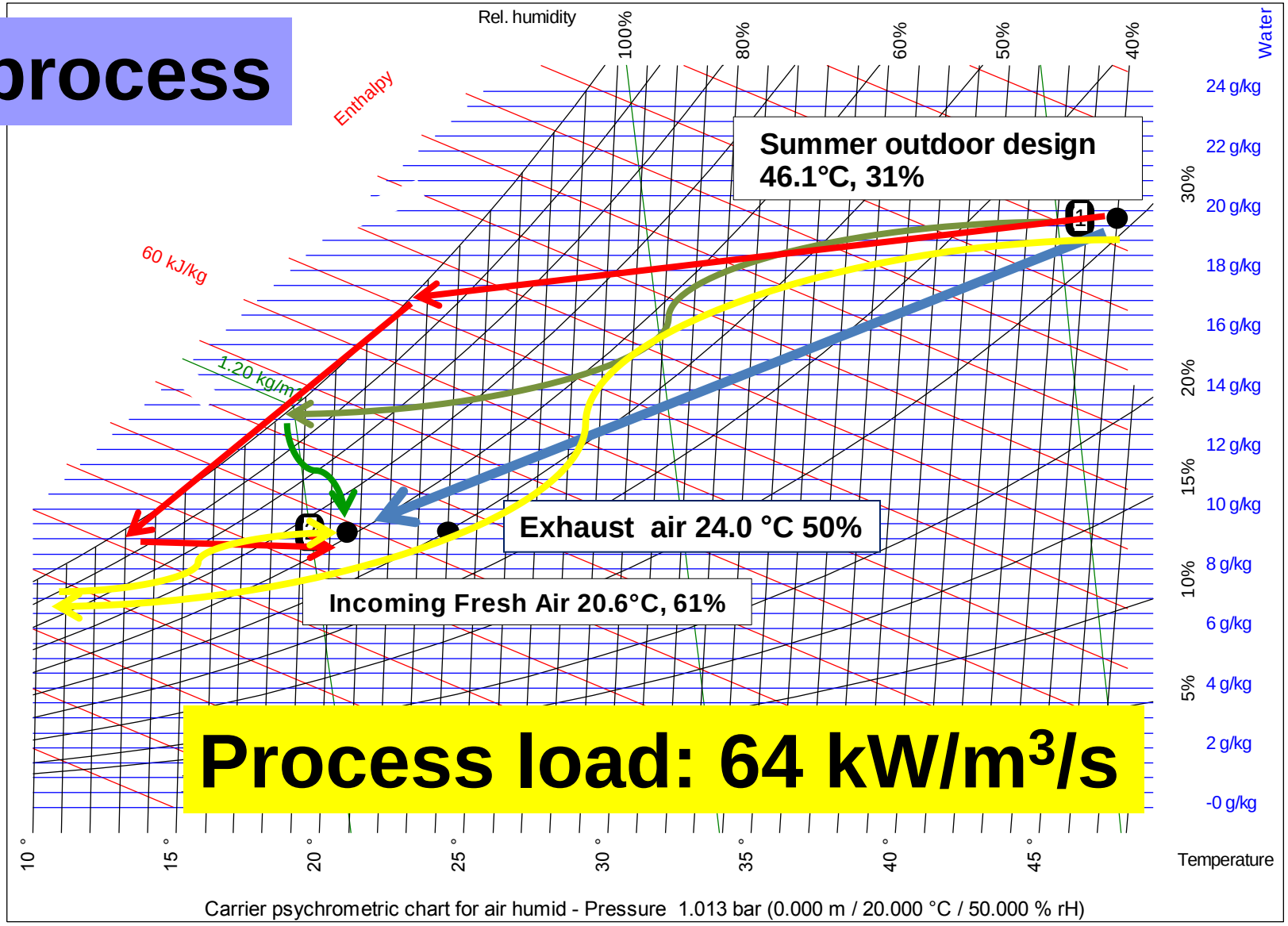
The process



Process load: 64 kW/m³/s

The challenge

Investor:

- Minimum investments
- Energy efficient solution

Society:

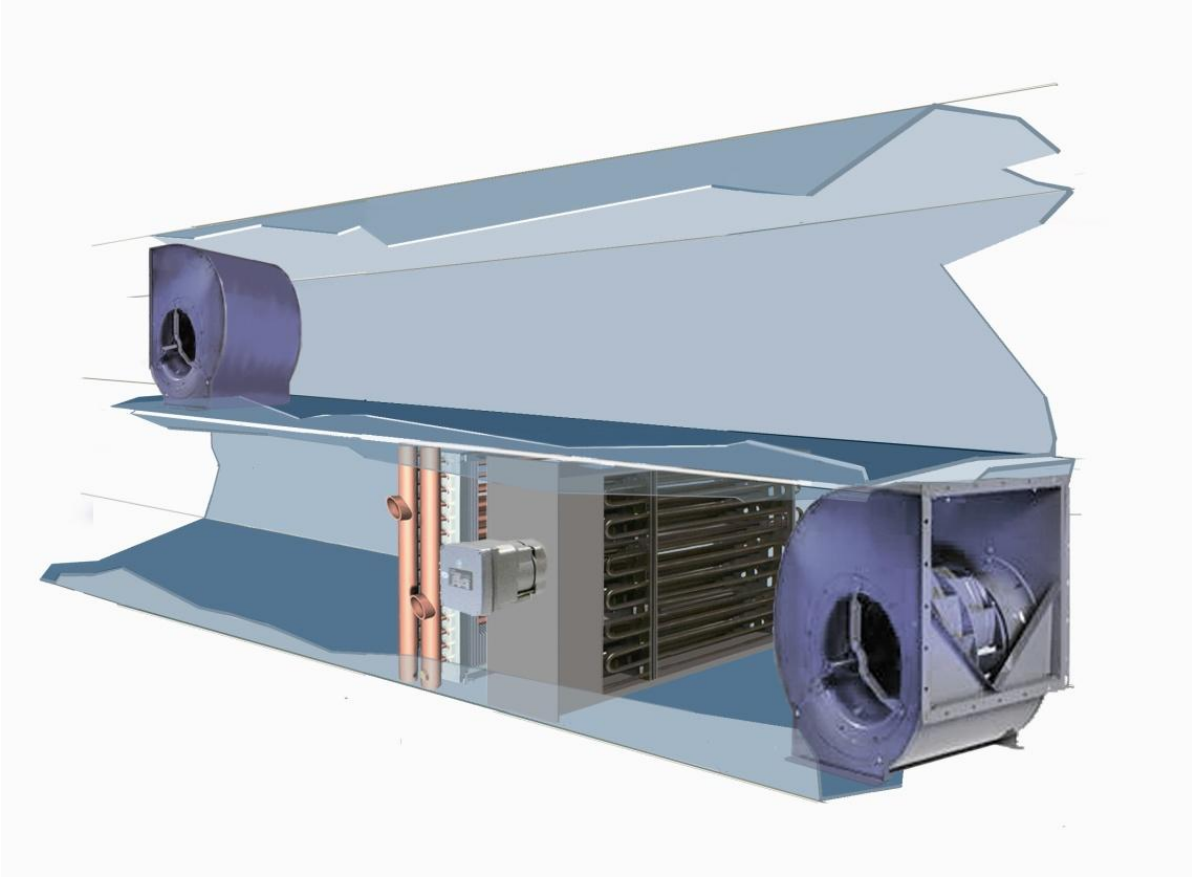
-Sustainable development

- Green building, LEEDS etc.
- Regulations

Engineer:

- Minimum service
- Minimum amount of partners
- No problems
- Fast to design
- Easy to commission
- Peace of mind
- Good engineering work

No energy recovery



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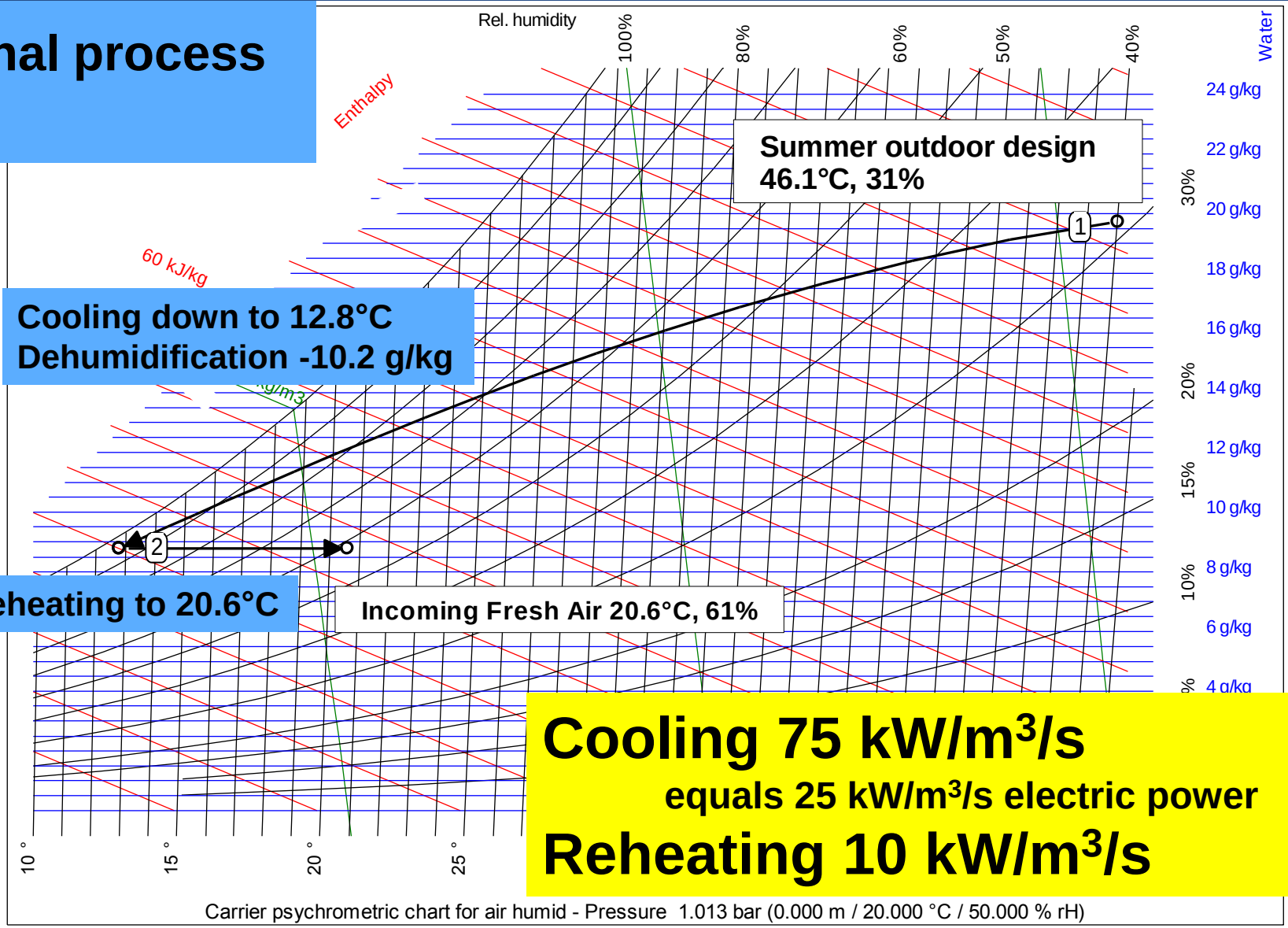
Basic traditional process w/o recovery

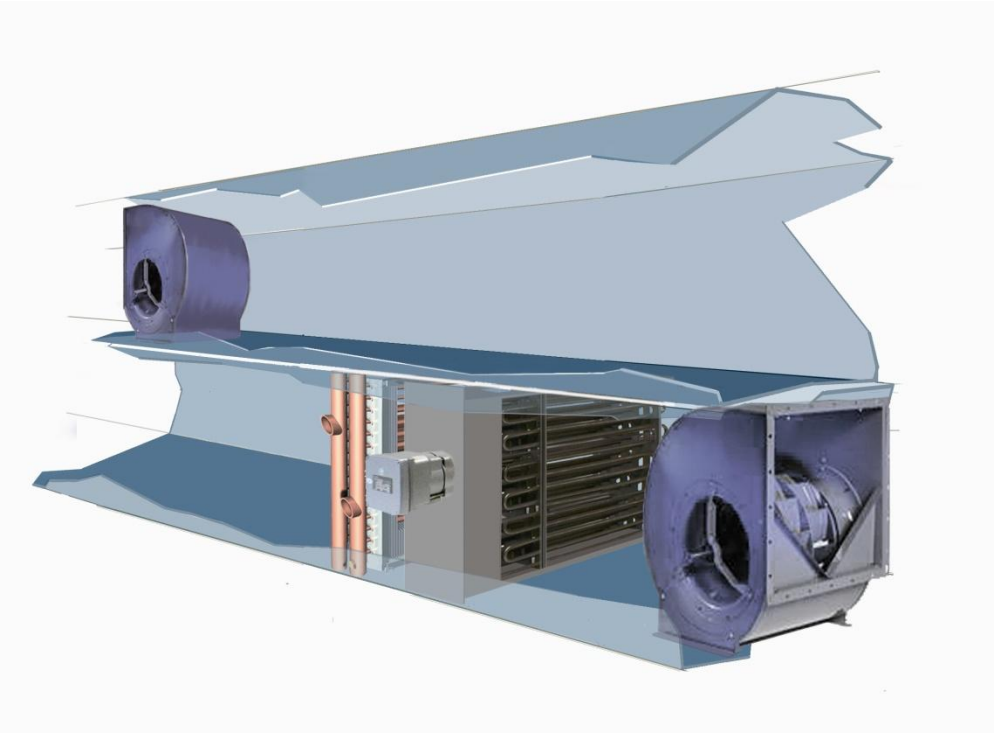


Cooling 75 kW/m³/s

equals 25 kW/m³/s electric power

Reheating 10 kW/m³/s

Without energy recovery



Pros

- Low initial cost in AHU

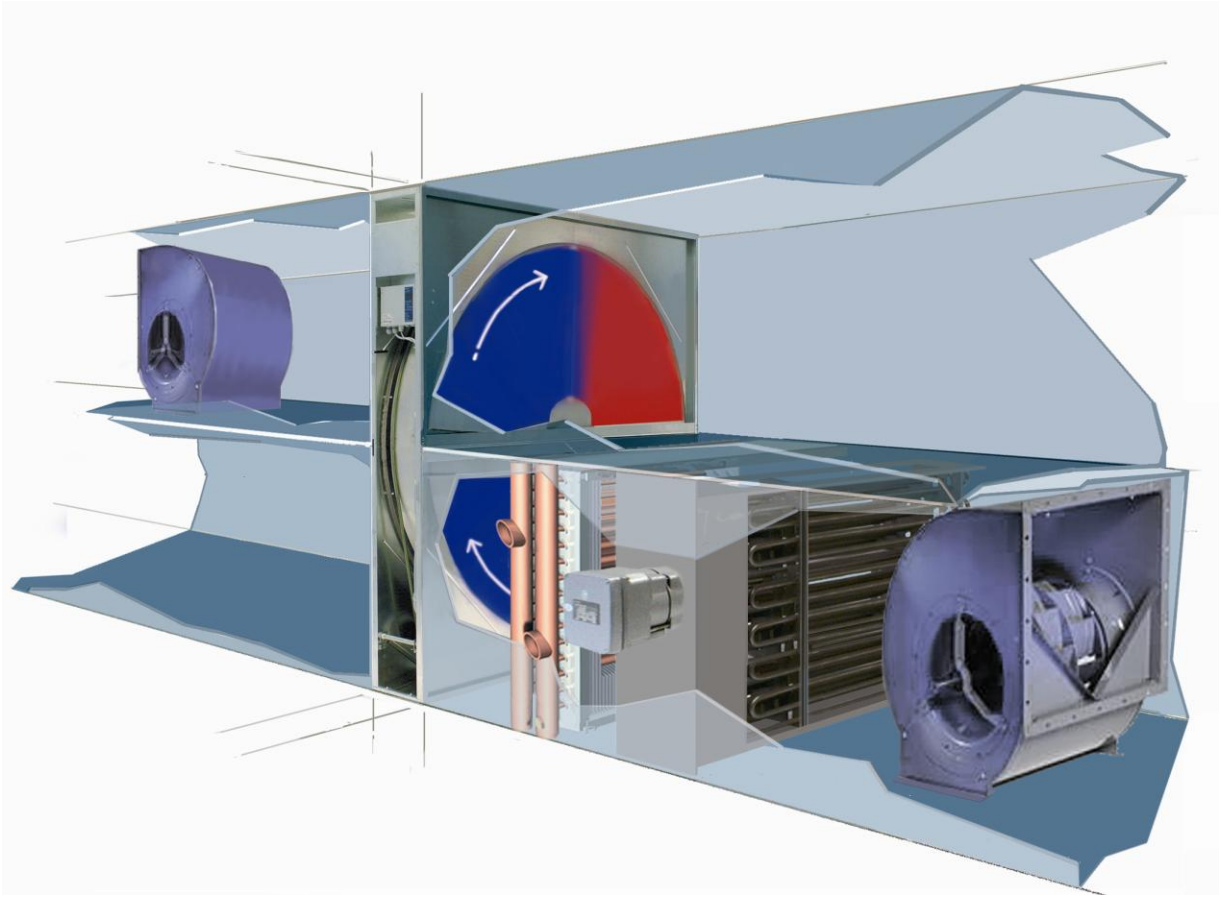
Cons

- Very high running cost
- Higher initial cost in cooling, electric installation etc.

Summary

- Should be avoided as total economically bad solution
- Not sustainable design

Energy recovery with sensible wheel



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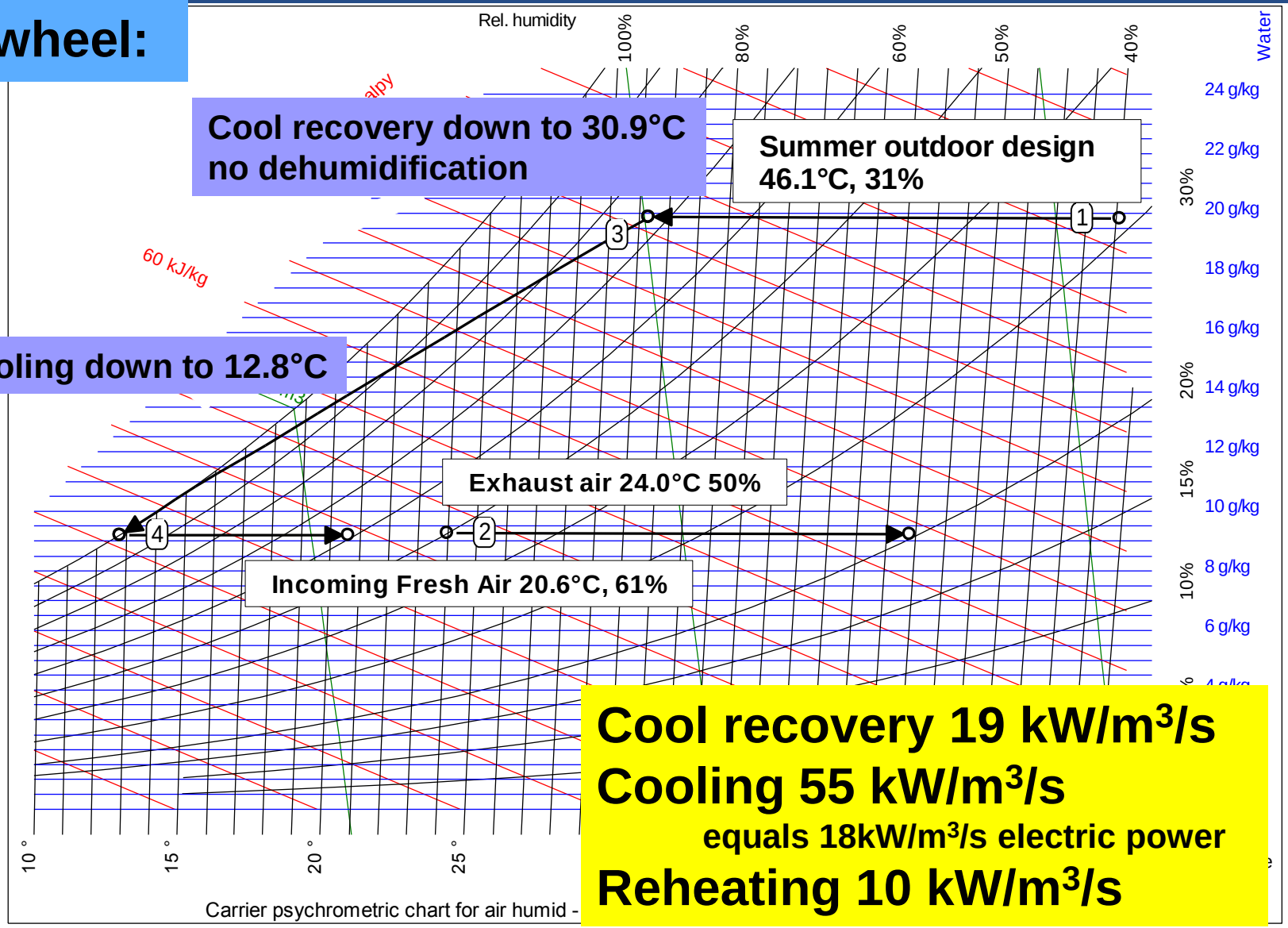
With sensible wheel:



Cool recovery 19 kW/m³/s
Cooling 55 kW/m³/s
equals 18kW/m³/s electric power
Reheating 10 kW/m³/s

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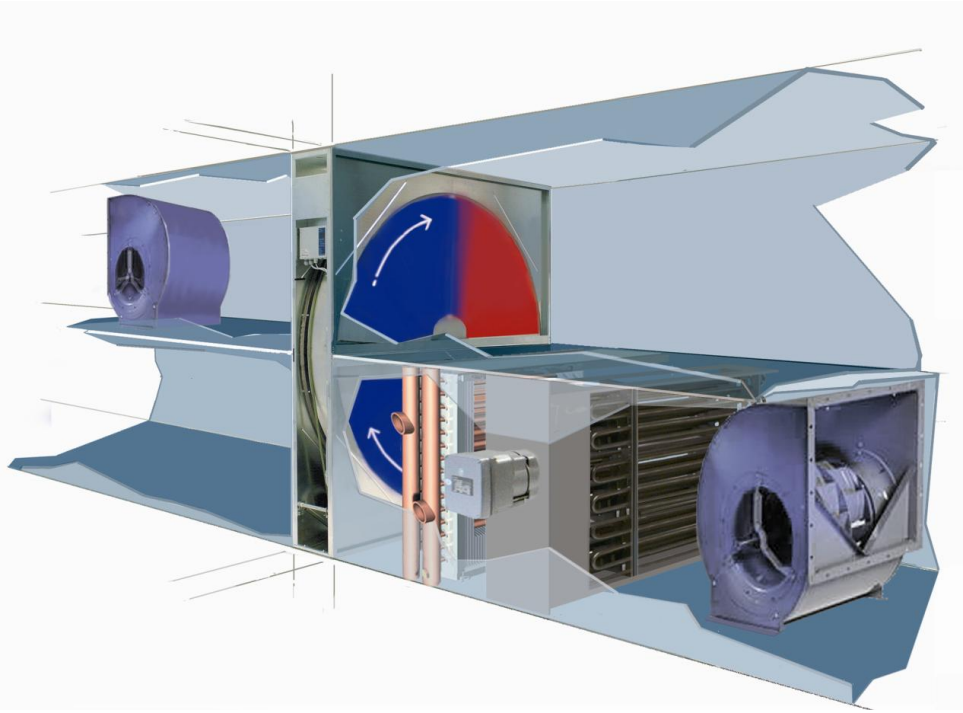
Sensible wheel



Pros

- 25% of cooling load is recovered
- Smaller cooling unit and cooling coil

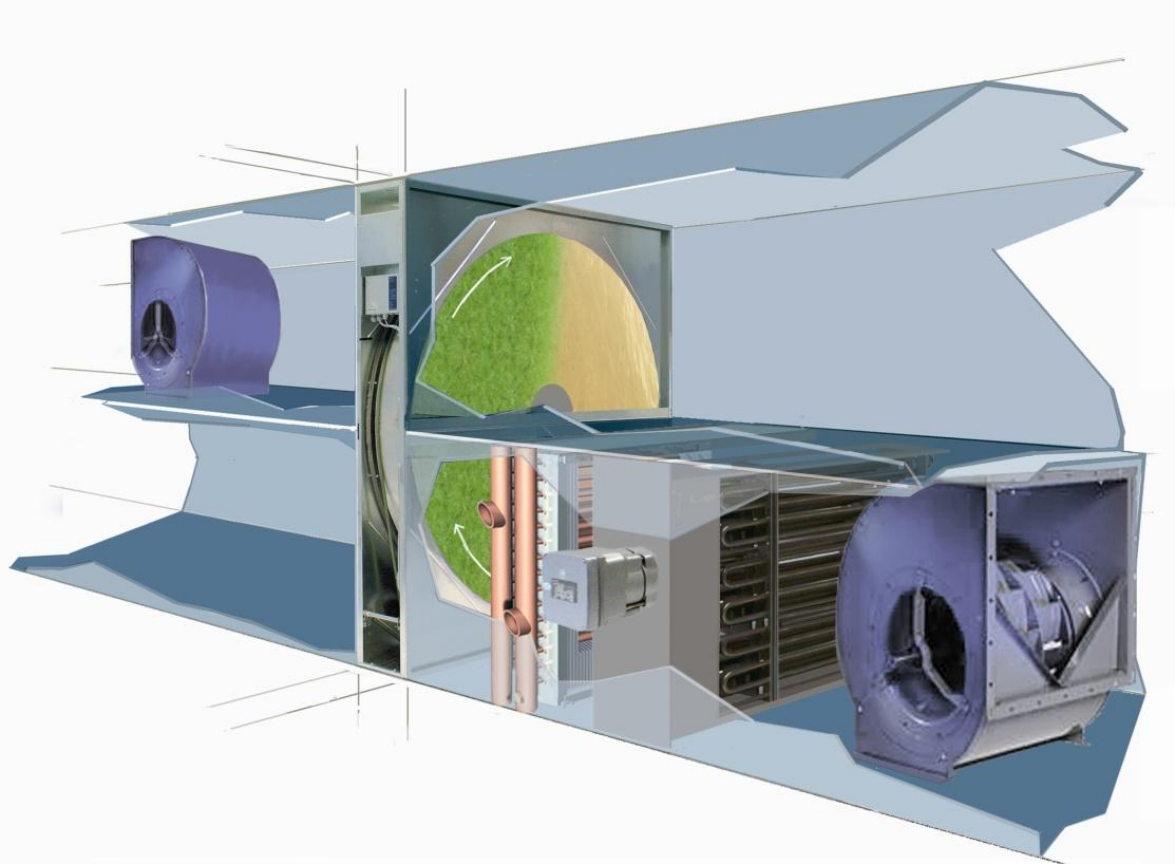
Cons

- No humidity recovered
- Electric heating still needed
- Could be much better with little extra investment

Summary

- Solution that should be avoided if dehumidification needed
- First step towards energy recovery

Sorption / Total Energy wheel



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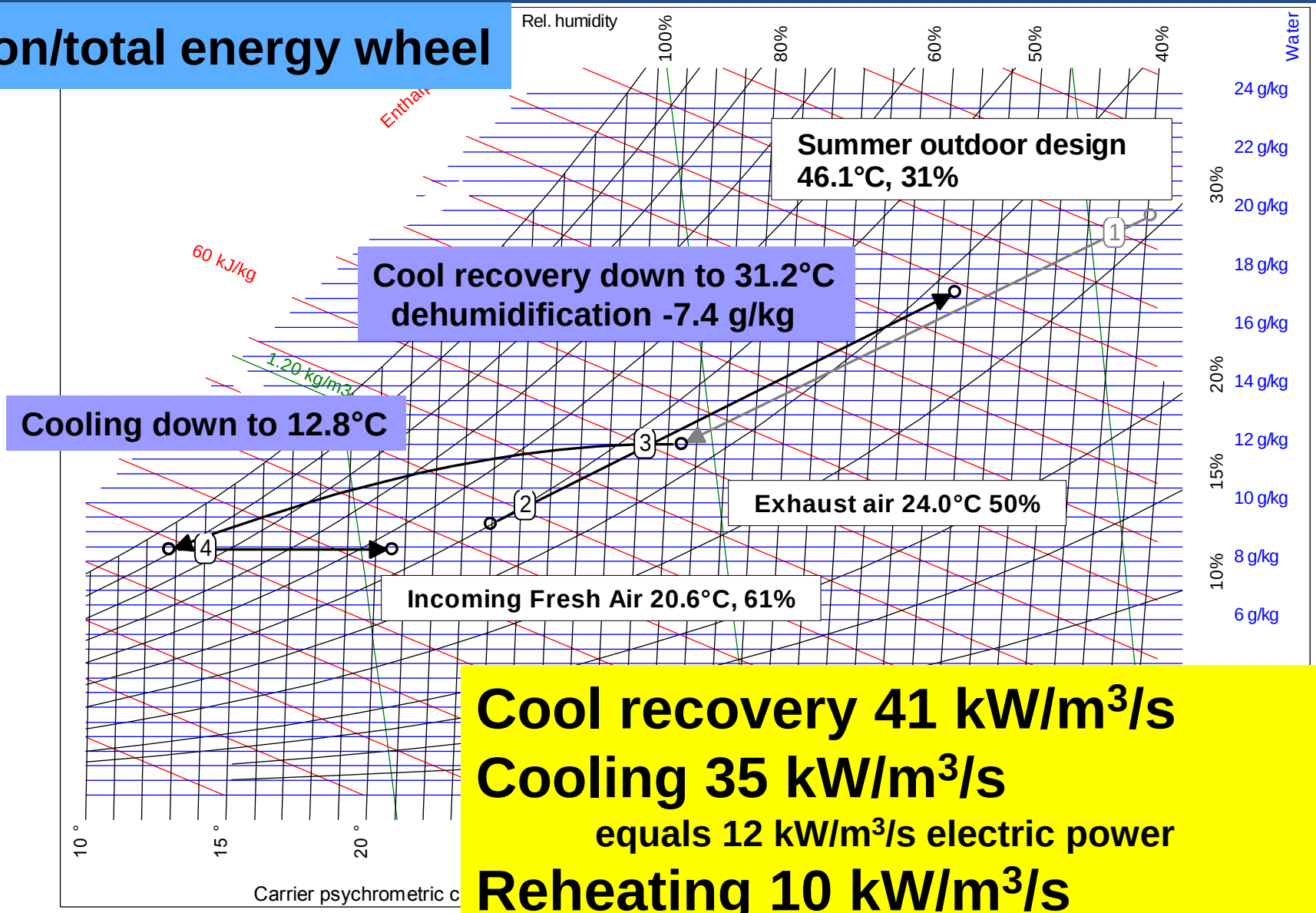
With sorption/total energy wheel



Cool recovery 41 kW/m³/s

Cooling 35 kW/m³/s

equals 12 kW/m³/s electric power

Reheating 10 kW/m³/s

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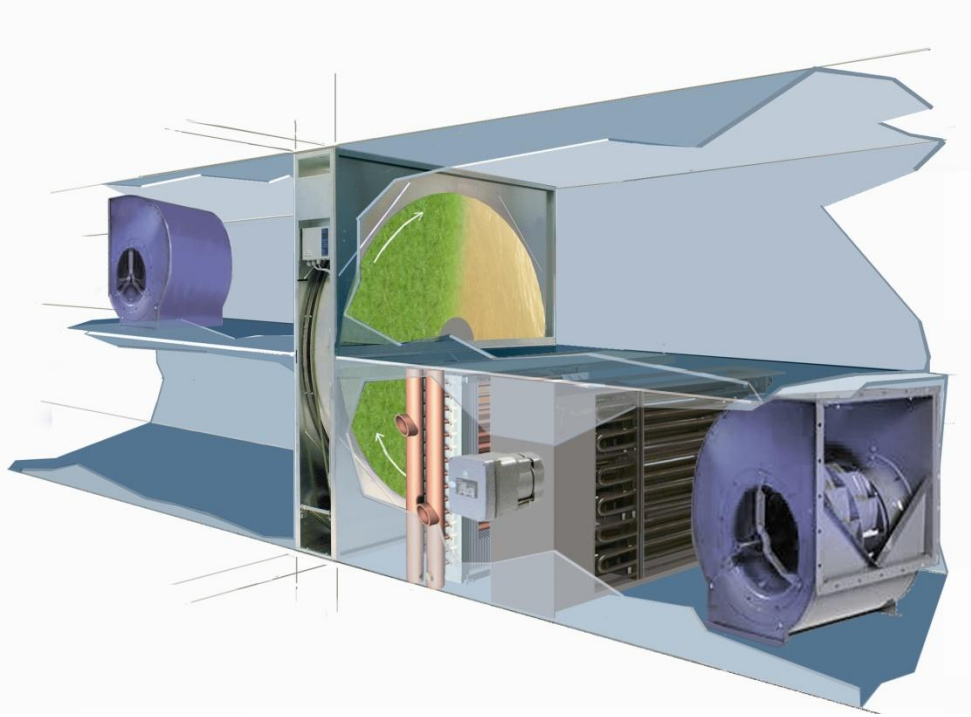
Sorption/total Energy wheel



Pros

- 55% of cooling load, 63% of latent load is recovered
- Smaller cooling coil

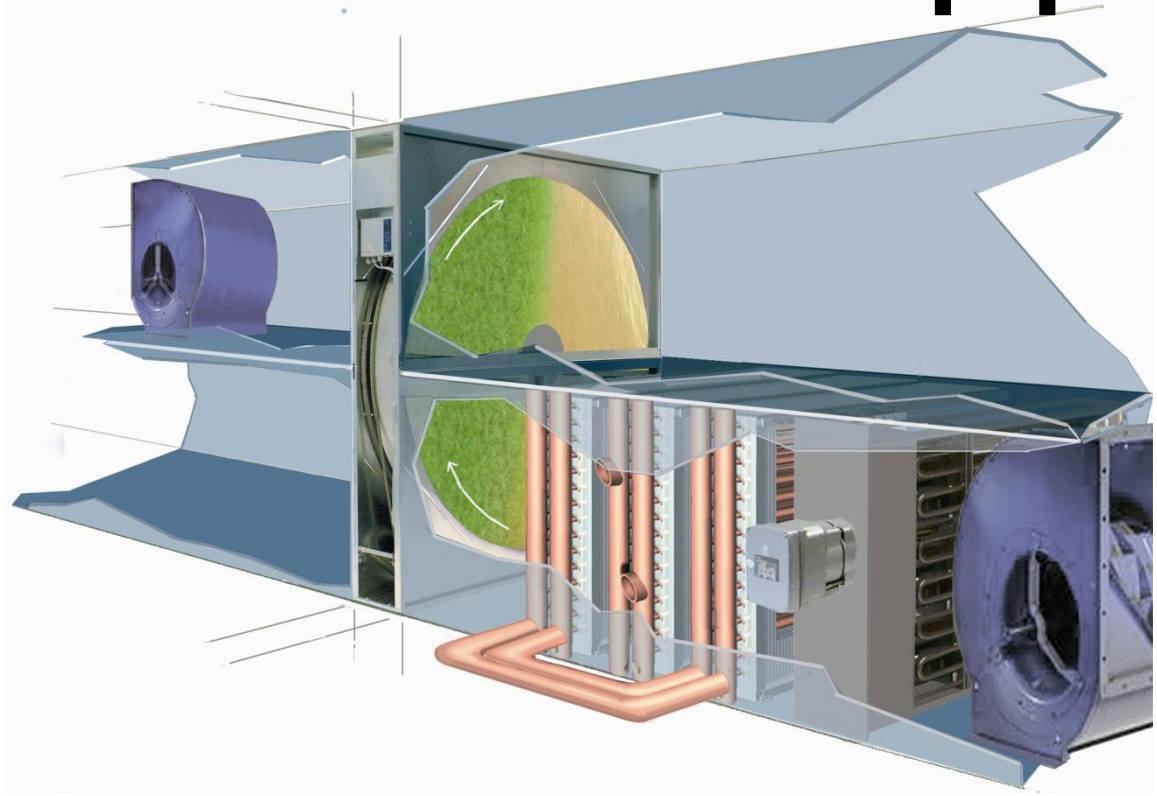
Cons

- Still more to recover
- Electric heating still needed 10 kW/m^3/s

Summary

- A good established solution towards good energy recovery

Sorption wheel + horse shoe heat pipe



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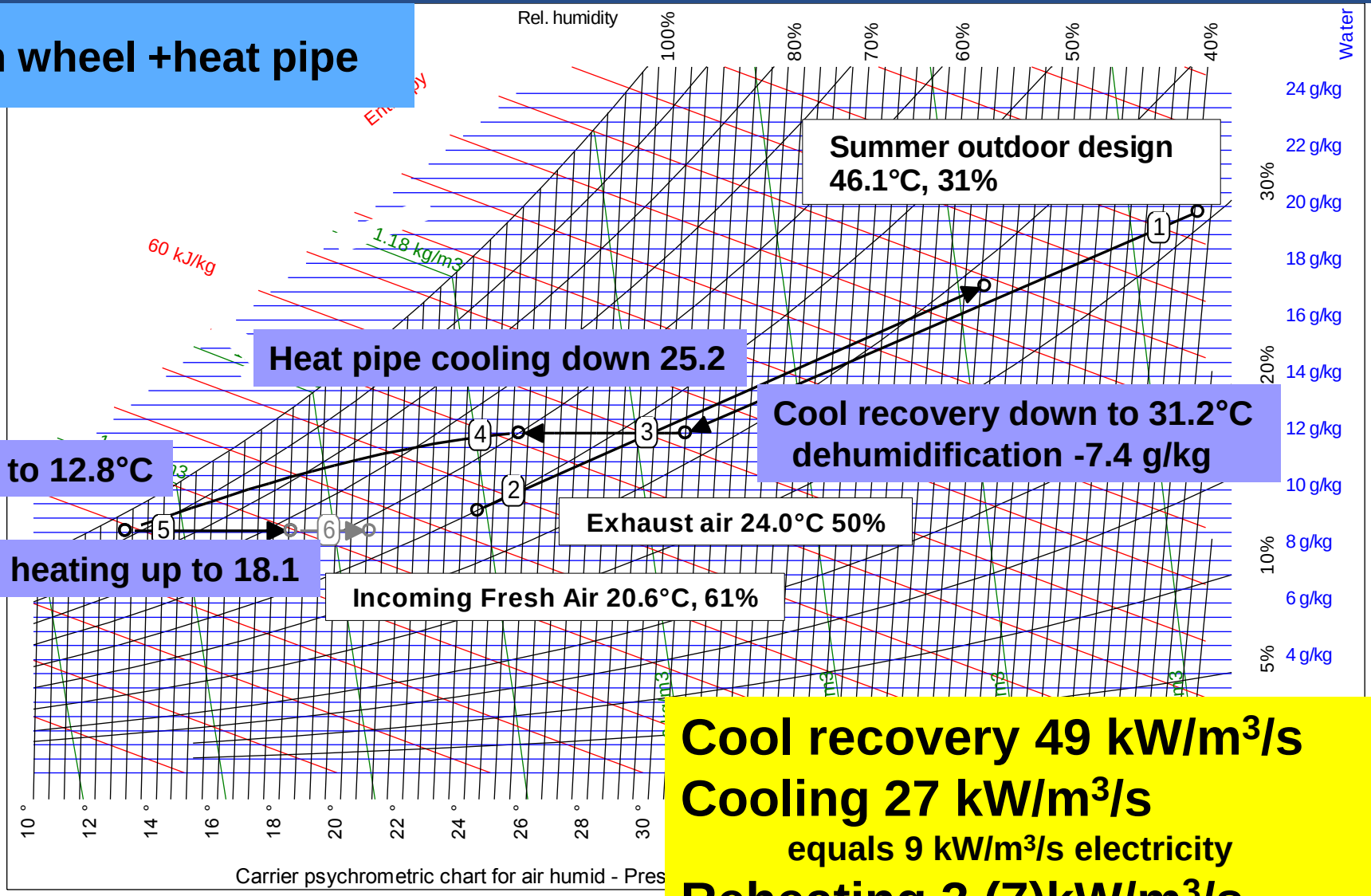
With Sorption wheel +heat pipe



Cool recovery 49 kW/m³/s
Cooling 27 kW/m³/s
equals 9 kW/m³/s electricity
Reheating 3 (7)kW/m³/s

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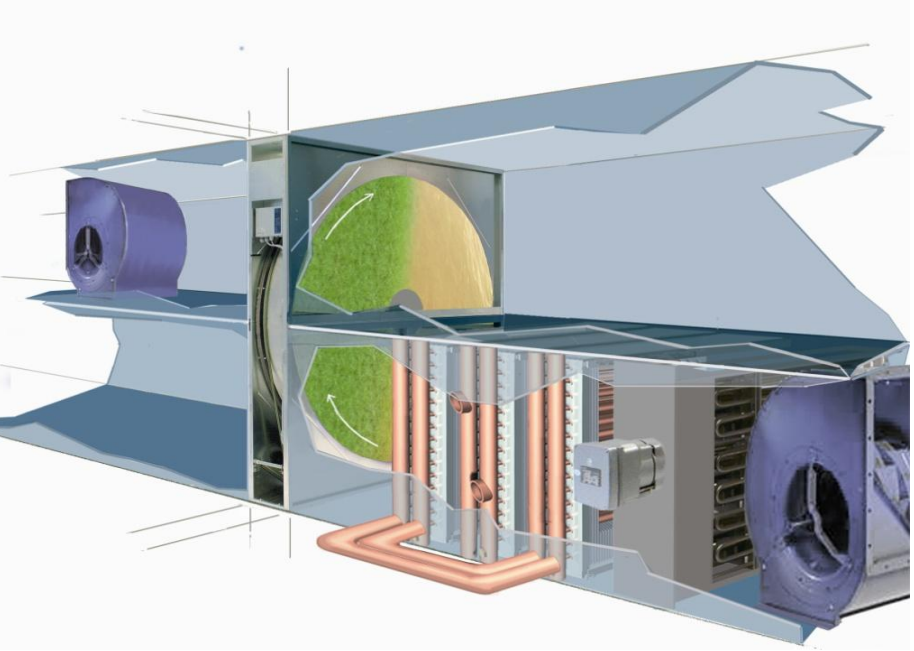
Sorption wheel + heat pipe



Pros

- 65% of cooling load, 63% latent load recovered.
- Reduced electric heating capacity
- Smaller cooling coil

Cons

- Still electric reheating needed, horse shoe heat pipe doesn´t heat in winter
- Freon installation with leakage risk
- What happens in long run?

Summary

- Good step into right direction
- Still electric heating needed in winter
- Freon coils are doubtful for green design

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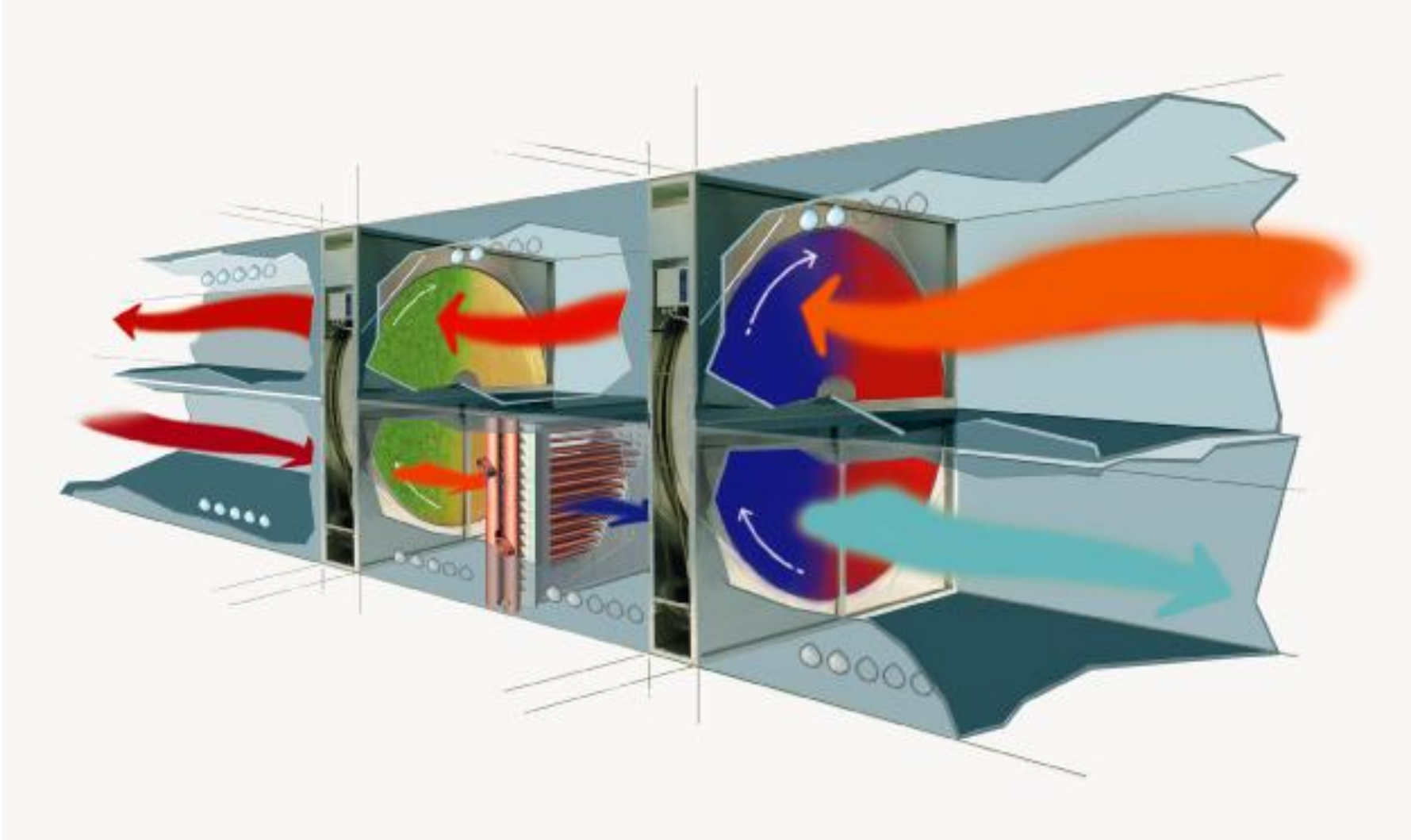
Double wheel concept



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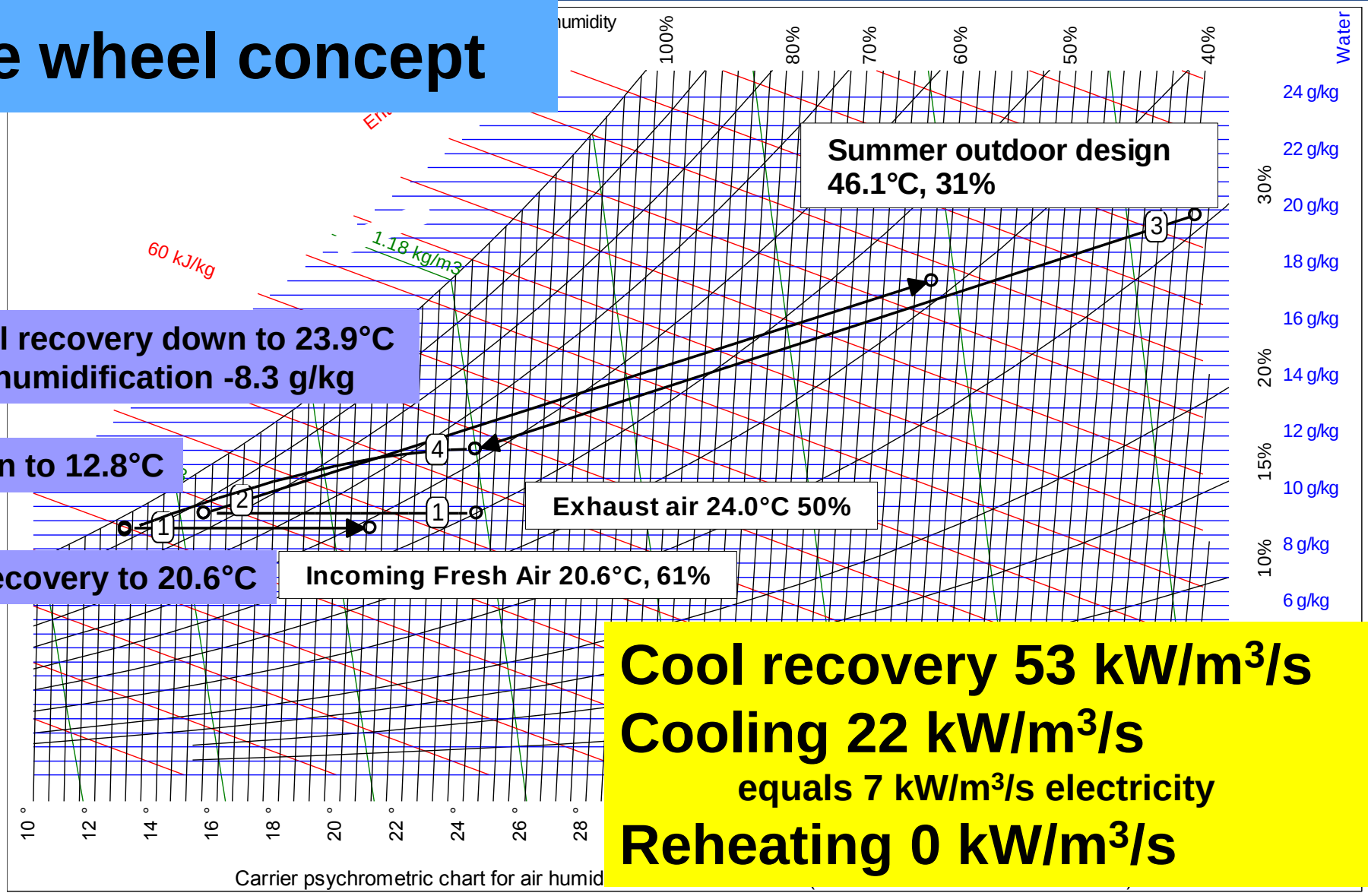
Double wheel concept



Cool recovery down to 23.9°C dehumidification -8.3 g/kg

Cooling down to 12.8°C

Reheat recovery to 20.6°C

Cool recovery 53 kW/m³/s

Cooling 22 kW/m³/s

equals 7 kW/m³/s electricity

Reheating 0 kW/m³/s

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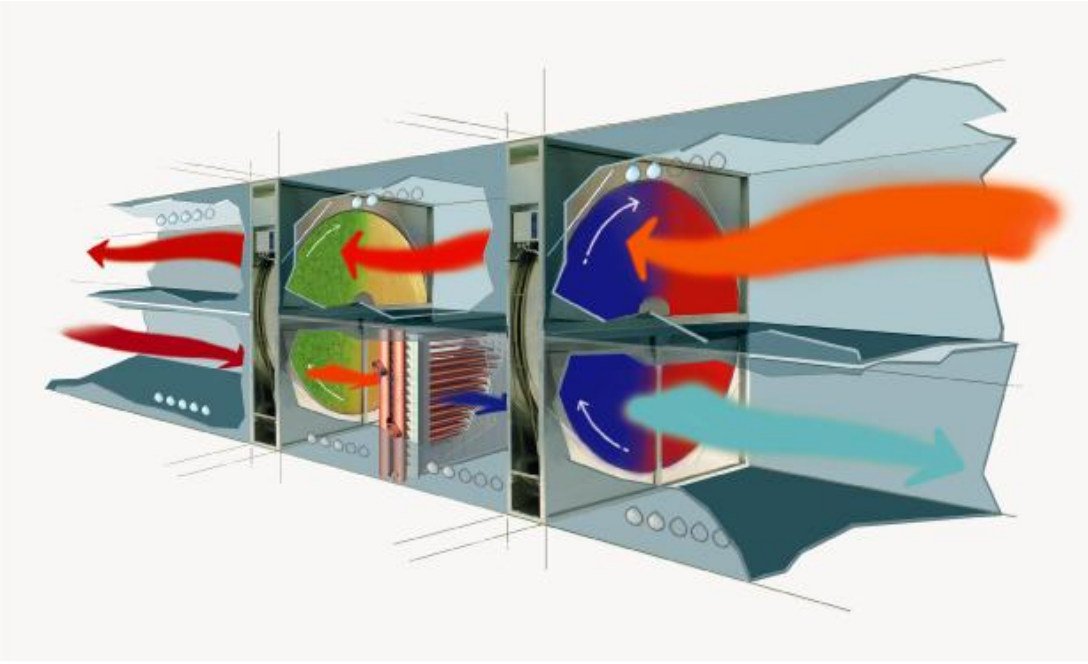
Double wheel concept



Pros

- 71% of cooling load, 77% latent load recovered
- No electric heating
- Even smaller cooling coil

Cons

- Some increase in AHU costs(in total installation cost savings)

Summary

- Perfect energy saving concept
- Should be used when reheating is needed due to dehumidification
- Heat and cool recovery in one

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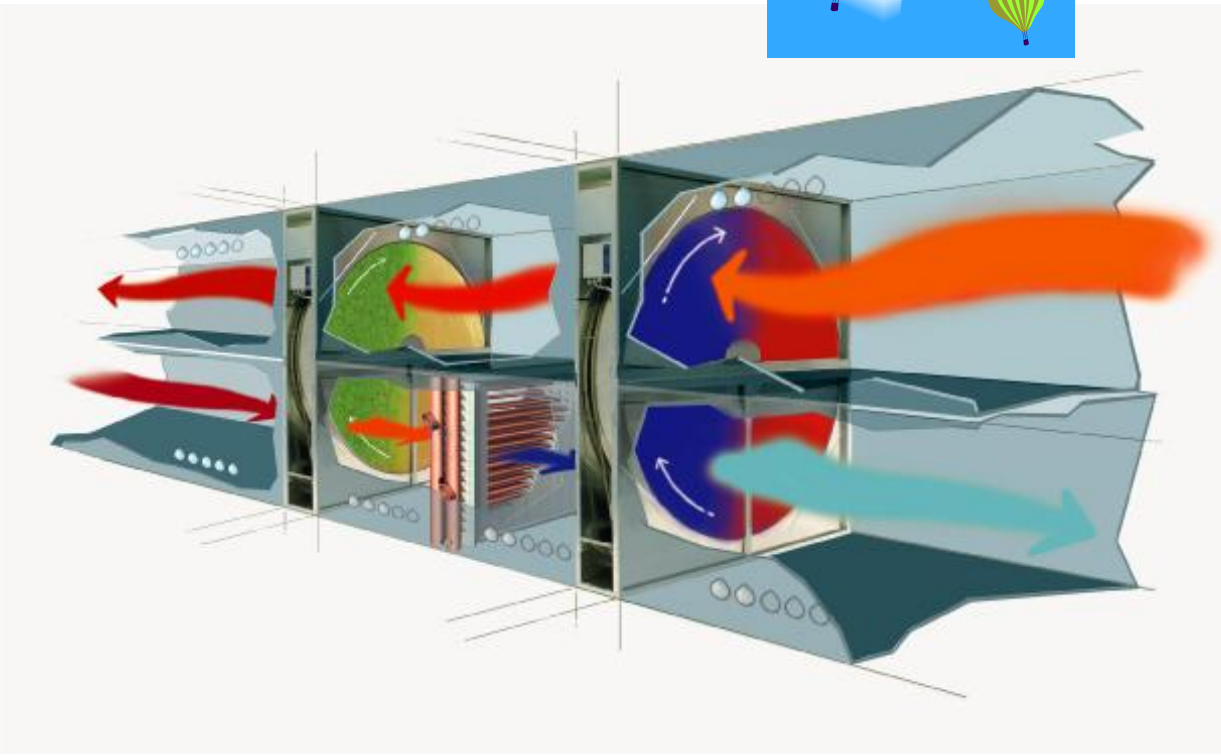
Comparison of different solutions per m^3/s

System	Cooling load $kW/m^3/s$	%	Heating load $kW/m^3/s$	Other extra power: additional fan, drive motor	Total electric power load $kW/m^3/s$ COP = 3	%	Total cost of the loads Electric 800 €/kW Cooling 300 €/kW	%
w/o energy recovery	75	0%	10	0	35	0%	50500	0%
Sensible wheel	55	-27%	10	0.2	29	-17%	39400	-22%
Sorption/total energy wheel	35	-53%	10	0.3	22	-37%	28100	-44%
Sorption wheel + heat pipe	27	-64%	3(7)	0.5	16	-54%	21300	-58%
Double wheel	22	-71%	0	0.5	8	-77%	12800	-75%

Summary of double wheel concept

- **Excellent concept from energy saving perspective**
  - Sustainable green design
- **Major savings in investments of**
  - Cooling capacity, chillers, cooling towers etc.
  - No electric heating
  - Electric installation no switches for electric hester
  - Electric capacity fees
  - Cooling piping installations.
- **Major Energy savigns**
  - In all conditions and seasons

    When reheating is required after dehumidification



Thank you for your interest!

Any Questions?

Design

Dimensioning:

1. **Sensible wheel**
    1. Exhaust air conditions
    2. Air after cooling coil
    3. Expected fresh air temperature
    4. About 70% temperature efficiency.
2. **Sorption / Total Wheel**
    1. Out door air
    2. Exhaust air after Sensible wheel
    3. Max capacity with 1.7 or 2.0 mm well height 70- 85% temperature and humidity efficiency
3. **Cooling coil**
    1. Supply air after Sorption /total wheel
    2. Supply air to expected dew point

Controls:

1. **Sensible rotor.**
    1. Max capacity or temperature controller rotation speed
2. **Sorption/ Total energy rotor**
    1. Max recovery capacity all the time. Can be constant speed.