A novel algorithm for demand-control of a single-room ventilation unit with a rotary heat exchanger

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Ventilation for renovated apartments

Centralized

- No space for ductwork
- Difficult to plan and install

Single-room ventilation

- Drilled installation
- Low fan power
- Local control of heat recovery

- Development with DTU: Rotary H.Ex. (Breathe 55) & Plate H.Ex. (Spiralflow)

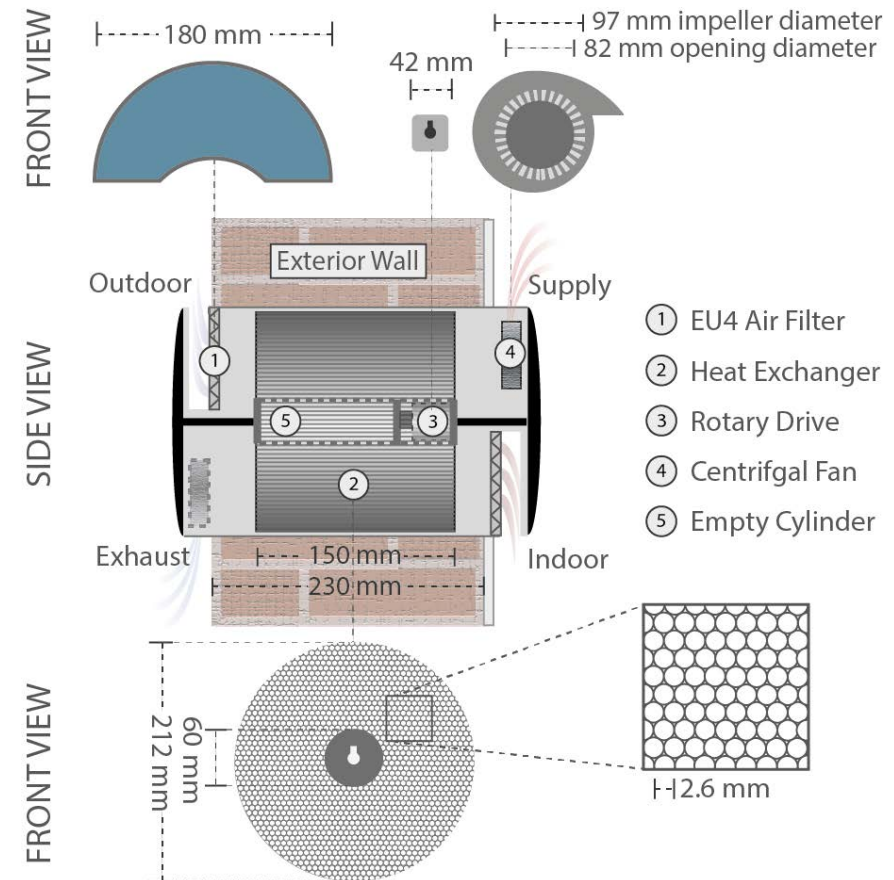# Single-room unit w/ Rotary Heat Exchanger

Variable-speed fans

Sensors
- Temperature, CO_2, RH in exhaust
- Temperature at all inlets/outlets
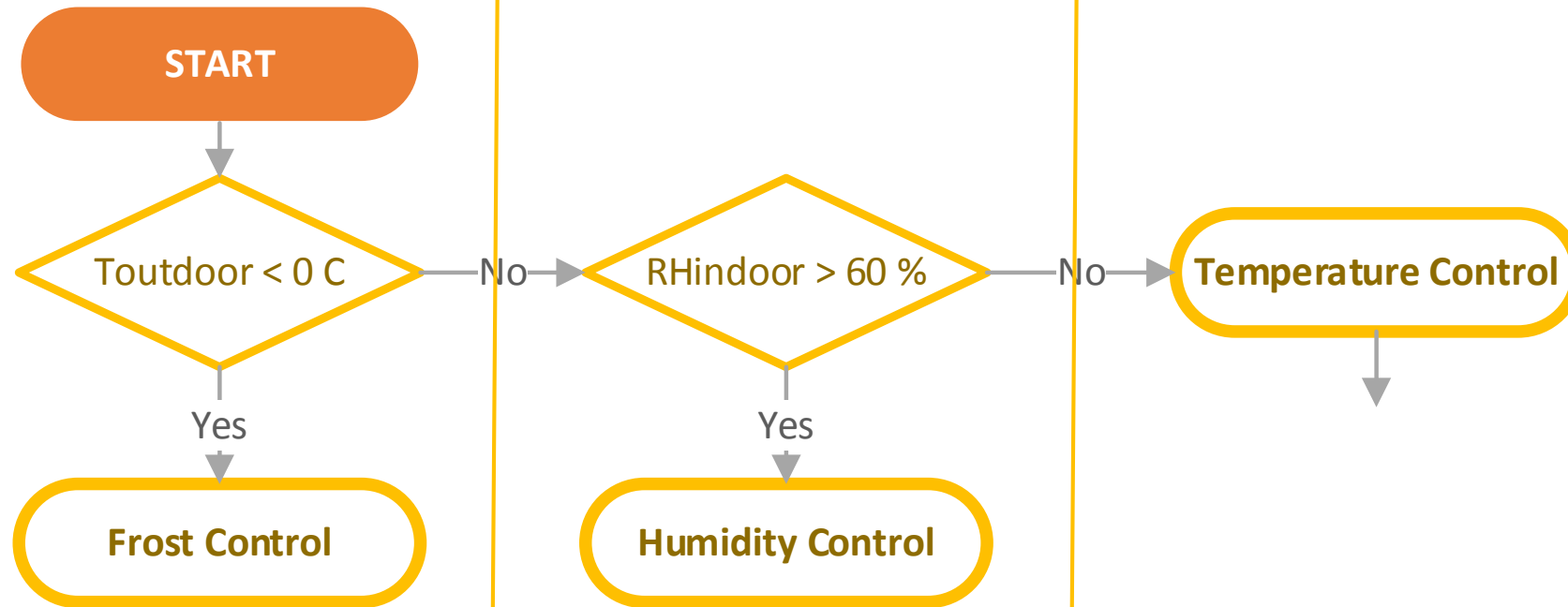
Plastic rotary heat exchanger
- > 80% eff. @ 8 L/s
- Variable-speed drive
- Recovers heat and condensation

- Intended for dry rooms

Not drawn to scale.

Three control modes (priority from L to R)

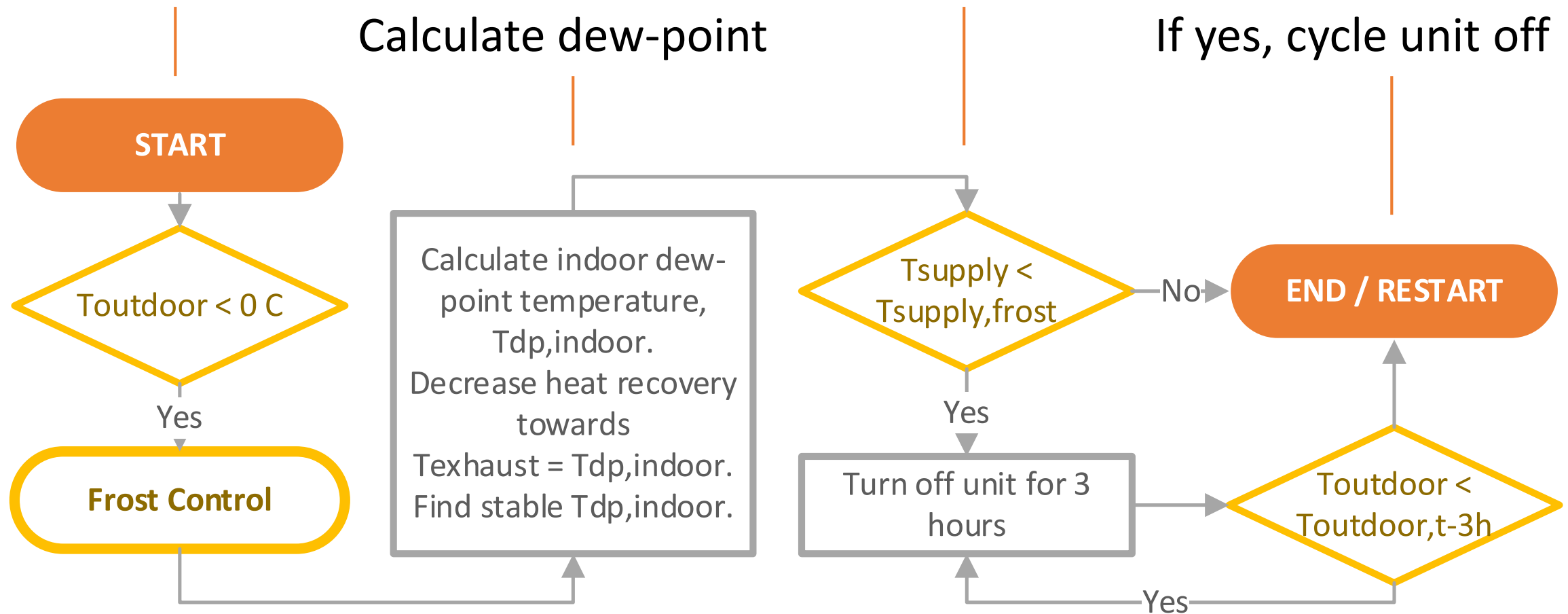Frost protection → Humidity control → Temperature control

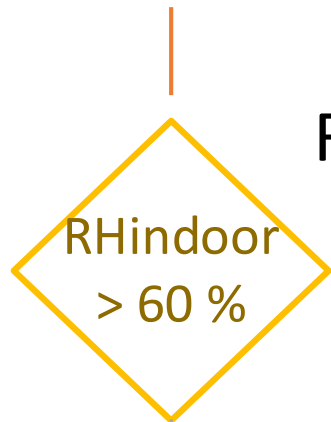# 1st priority: Frost control

Below 0°C outside?

Calculate dew-point

Is supply air too cold?

If yes, cycle unit off

START

Toutdoor < 0 C

Yes

Frost Control

Calculate indoor dew-point temperature, Tdp,indoor.
Decrease heat recovery towards
Texhaust = Tdp,indoor.
Find stable Tdp,indoor.

Tsupply < Tsupply,frost

No

Yes

Turn off unit for 3 hours

END / RESTART

Toutdoor < Toutdoor,t-3h

Yes

2nd priority: Moisture control

Humid indoors?

Still too humid?

STILL too humid?

RHindoor > 60 %

Reduce coupled heat + H_2O recovery

Use more ventilation
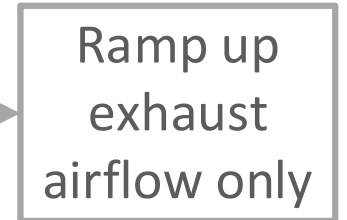
Probably a kitchen. Boost exhaust.

Yes

Humidity Control

While Tsupply > Tsupply,min Decrease heat recovery

RHindoor > 70 %

Yes

Ramp up ventilation rate

RHindoor > 85 %

Yes

Ramp up exhaust airflow only

No

No

END / RESTART

3rd priority: Temperature control

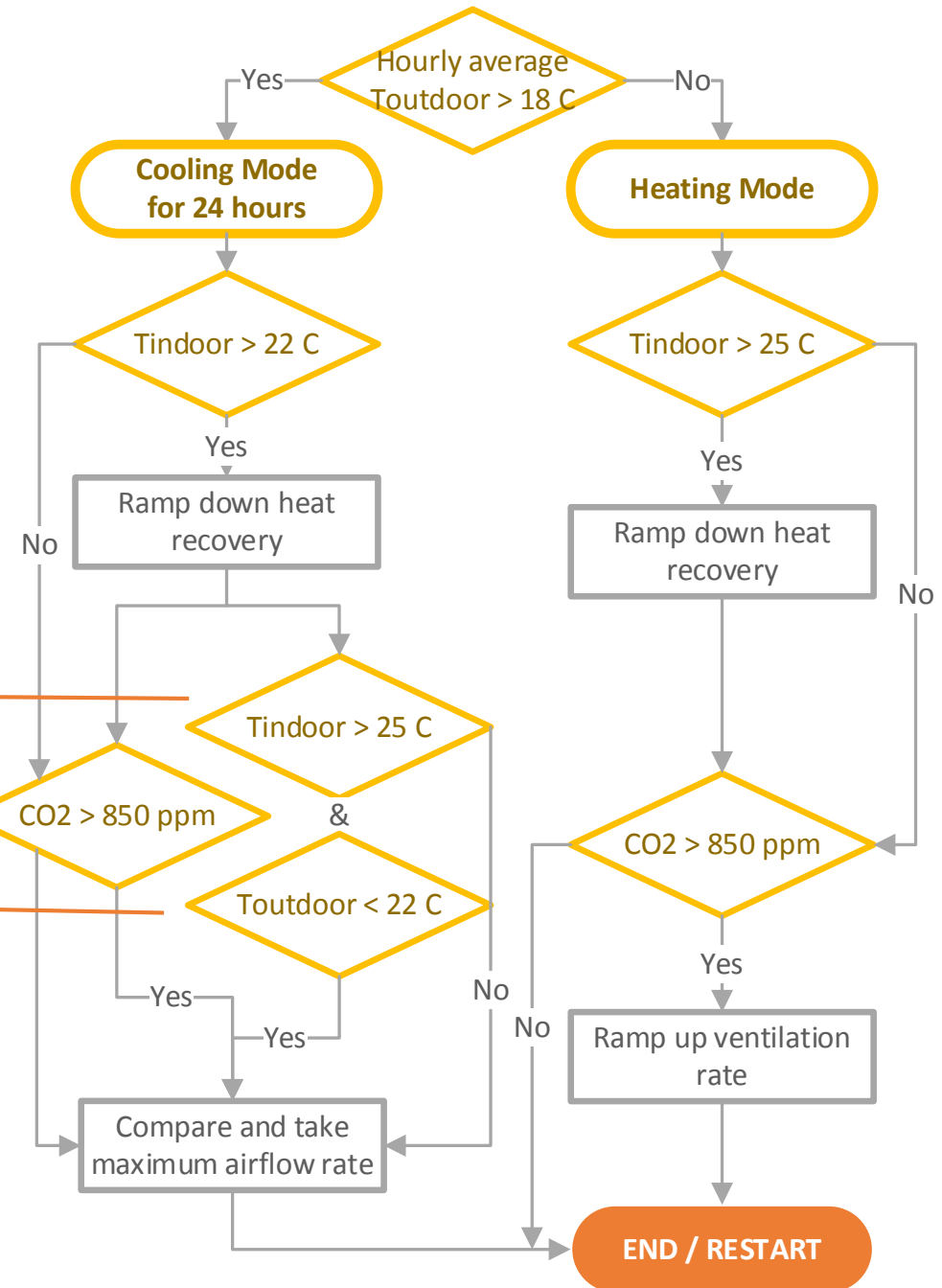Unknown set-point on room thermostat —

Too warm? Decrease heat recovery. —

Cooling mode: Too warm? More airflow. —

Poor IAQ, too-high CO_2? More airflow! —

Is there cooling potential? —

Take the highest demand for airflow —

Flowchart:

- Hourly average Toutdoor > 18 C
  - Yes → **Cooling Mode for 24 hours**
  - No → **Heating Mode**

Cooling Mode for 24 hours → Tindoor > 22 C
- No → CO2 > 850 ppm
- Yes → Ramp down heat recovery → Tindoor > 25 C & Toutdoor < 22 C
  - Tindoor > 25 C: No → Compare and take maximum airflow rate
  - Toutdoor < 22 C: Yes →
- CO2 > 850 ppm: Yes → Compare and take maximum airflow rate
- Compare and take maximum airflow rate → END / RESTART

Heating Mode → Tindoor > 25 C
- Yes → Ramp down heat recovery → CO2 > 850 ppm
- No → CO2 > 850 ppm
  - No → END / RESTART
  - Yes → Ramp up ventilation rate → END / RESTART

END / RESTART

Current activities & next steps

- Algorithm written in C code, installed in commercial units

- Simulating controls in IDA-ICE

- Experimental tests
  - Between chambers
  - Test offices at DTU

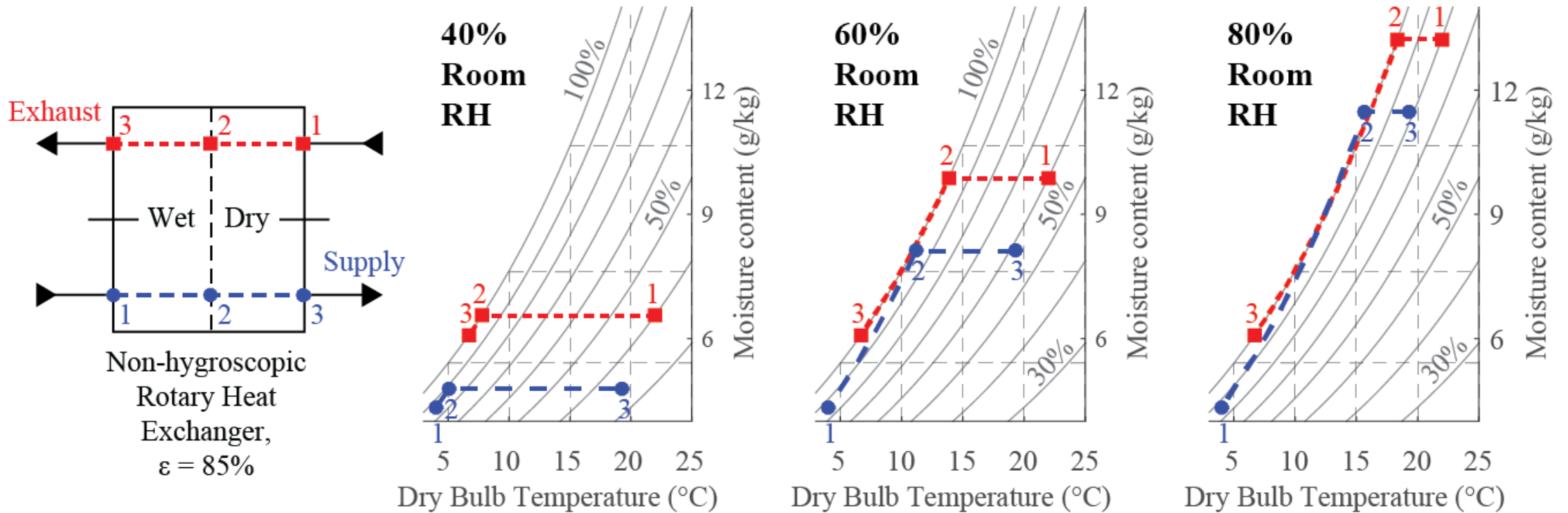# Thanks for your attention. Questions?

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Uncoated rotary heat ex. (a.k.a. Heat Wheel)
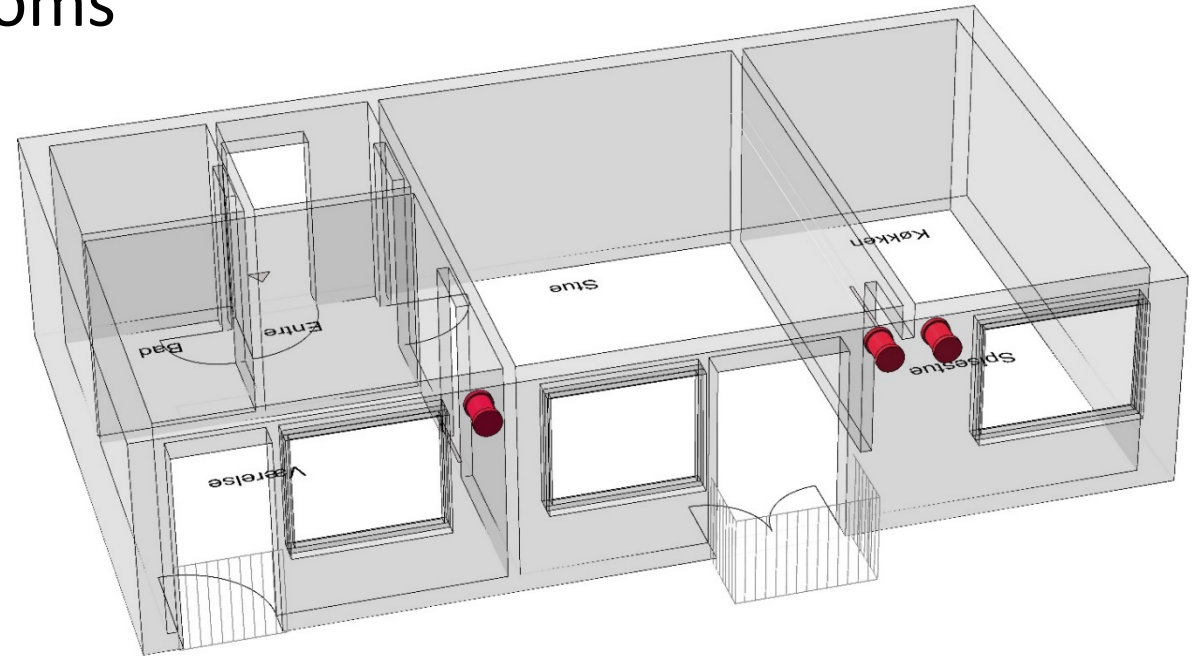

Drying capacity = 1.76 g H_2O per kg AIR

Concept for a demand-controlled system

Use existing direct exhaust from 'wet rooms'

- Central rooftop fan + local VAV dampers
- Bathroom
  - Adjusts according to RH
  - From fully-closed up to > 15 L/s
- Kitchen
  - Boosted by high humidity & temperature
  - From fully-closed up to > 20 L/s

Kitchen single-room rotary unit

- Background ventilation of 0.3 L/s/m2
- Increased airflow according to CO_2 + RH
- Temperature control on heat recovery

Source: http://www.sustainsolutions.dk/breathe-55-decentral-komfort/