FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF ARCHITECTURE AND URBAN PLANNING
BUILDING PHYSICS, CONSTRUCTION AND SERVICES RESEARCH GROUP

EFFECT OF INDOOR TEMPERATURE DIFFERENCES AND ZONING ON THE PERFORMANCE OF ENERGY EFFICIENT VENTILATION STRATEGIES FOR DOMESTIC BUILDINGS *(Josue Borrajo Bastero)*

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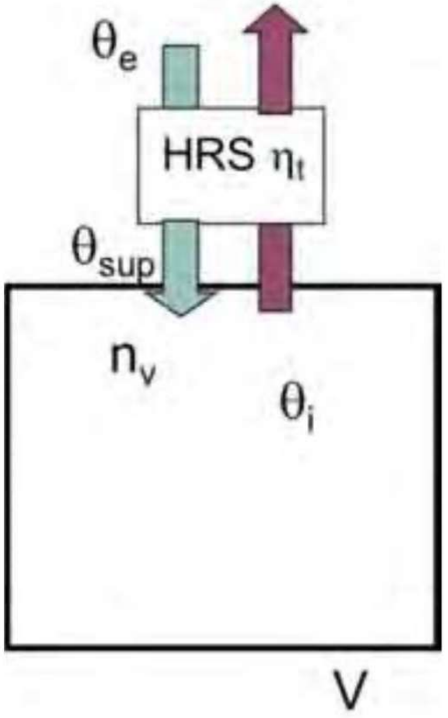
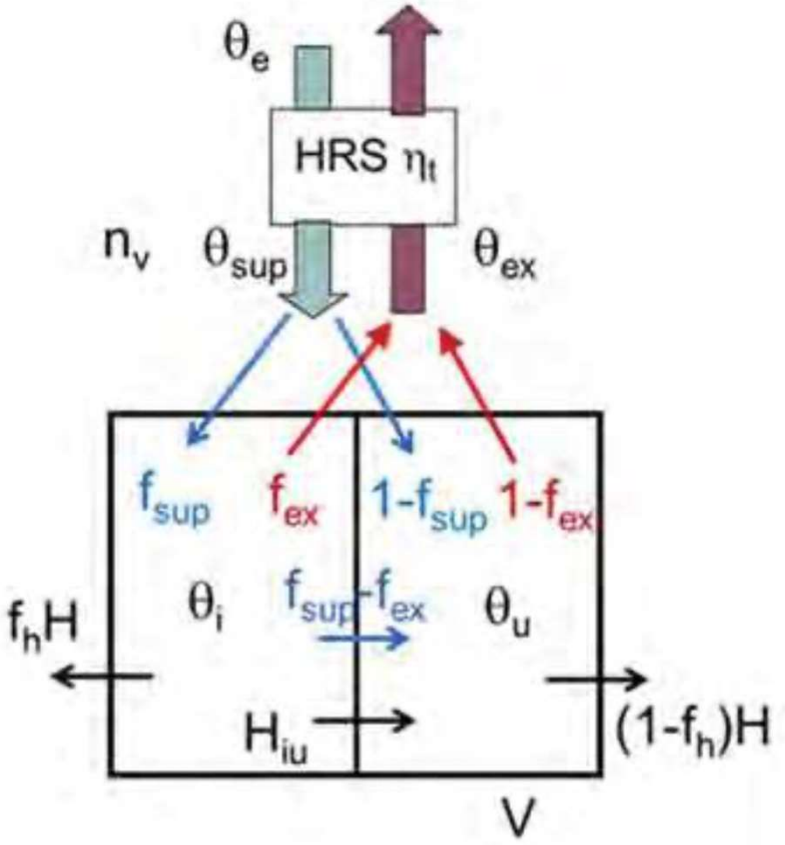
ZONING AND HRV





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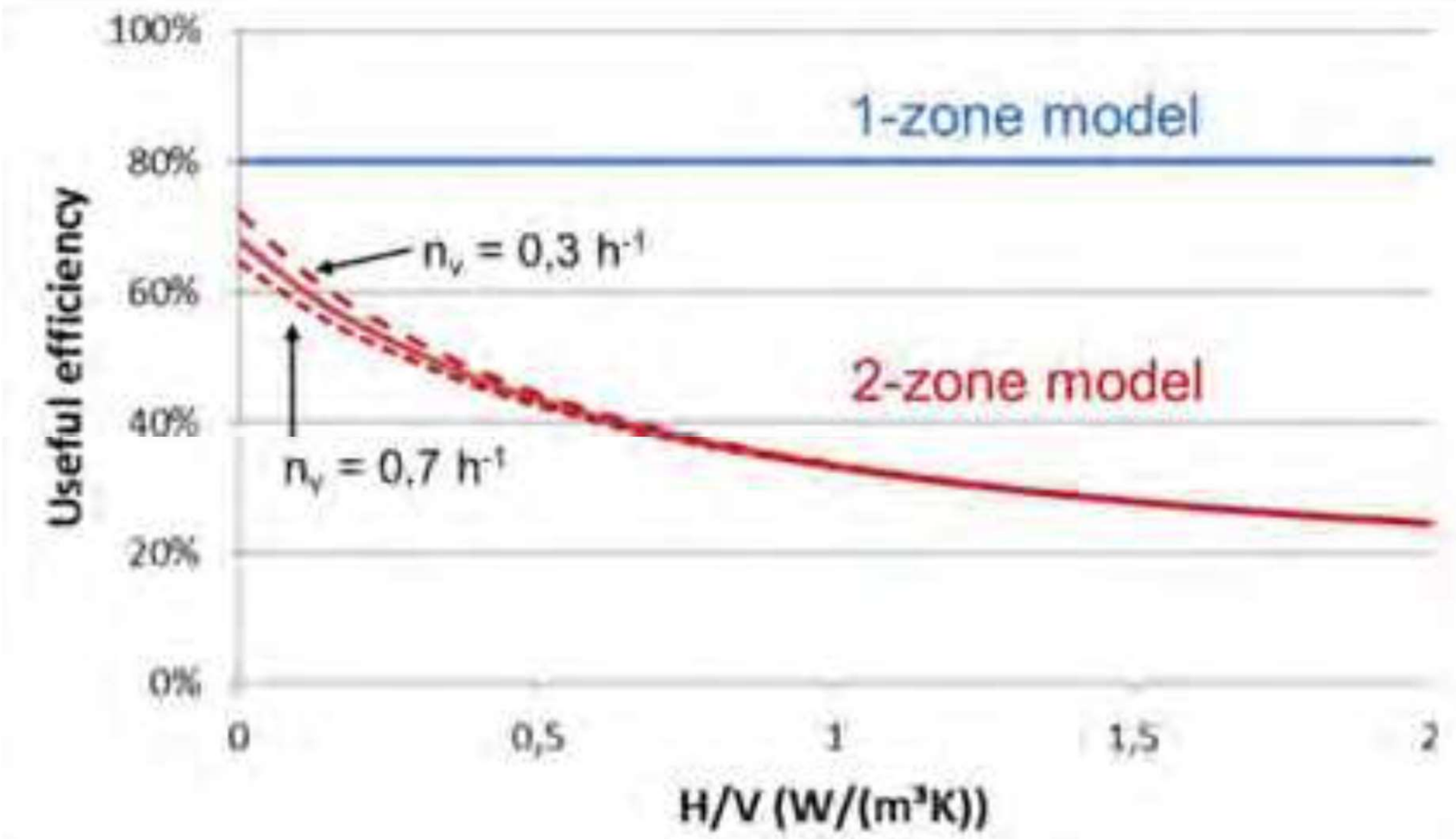
ZONING AND HRV: EXPECTED EFFECT



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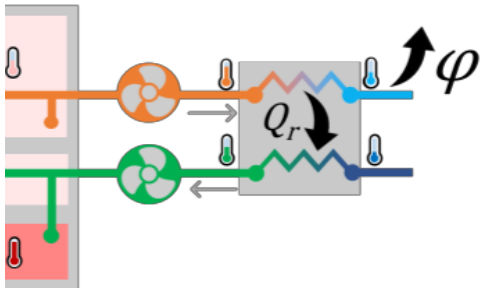
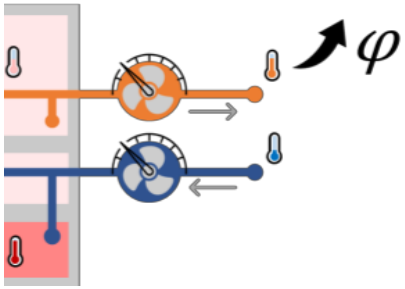
‘ENERGY EFFICIENT’ VENTILATION



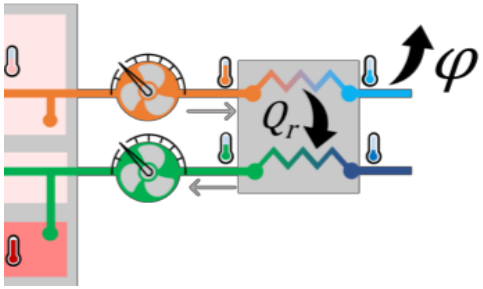
- **Heat exchanger(s)**

Part of the heat can be recovered.



- **Demand controlled ventilation**

Reduced aiflows -> Less conditioned air is released to the atmosphere



- **Demand controlled ventilation**
- **Heat exchanger(s)**

□□φ □ □□Q

Q = Annual heating demand
φ = Annual ventilation heat losses
Q_r = Recovered heat

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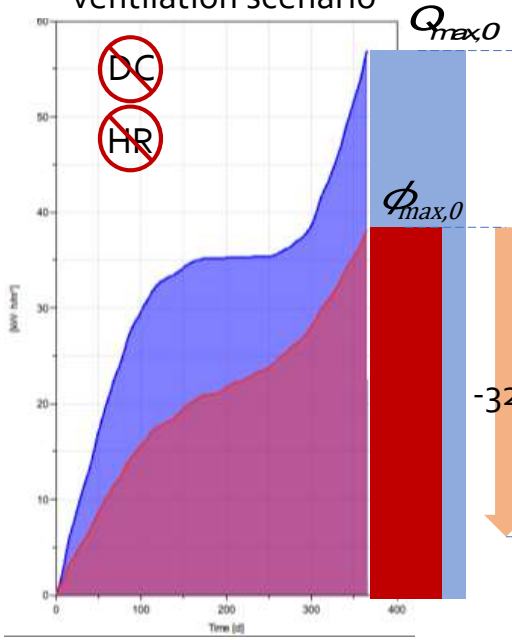
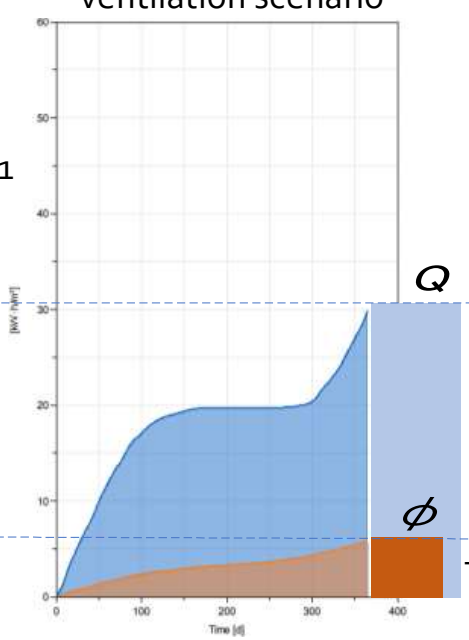
GENERIC ASSESSMENT METHOD

Maximum flowrates no HR ventilation scenario



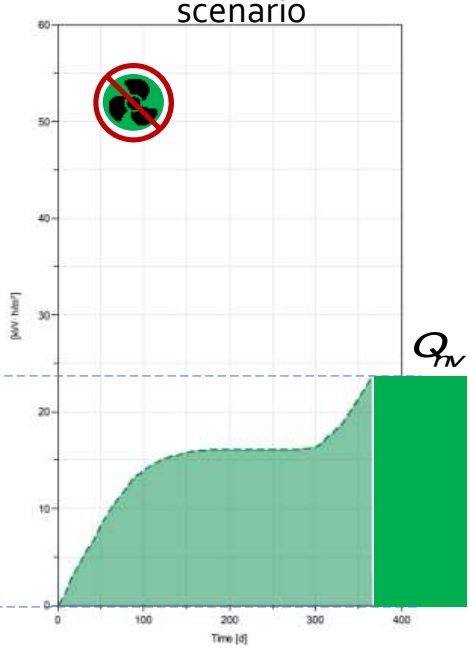
$Q_{max,0}$ = 56.9 kWh/m²/year
$\phi_{max,0}$ = 38.1 kWh/m²/year

Characteristic ventilation scenario



Q = 29.8 kWh/m²/year
ϕ = 5.8 kWh/m²/year

No ventilation scenario



Q_{nv} = 22.7 kWh/m²/year
ϕ_{nv} = 0 kWh/m²/year

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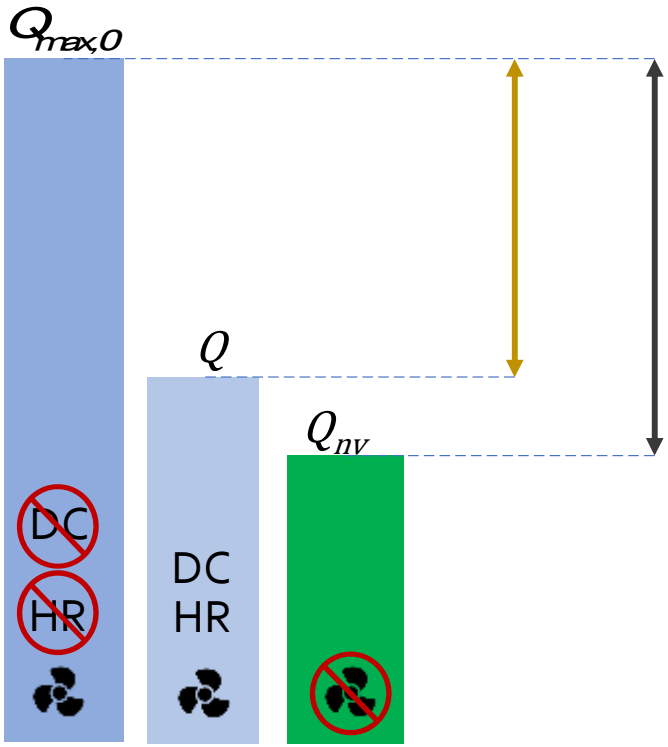
INDICATOR/METRIC



$$(Q_{max,0} - Q) / (Q_{max,0} - Q_{nv})$$

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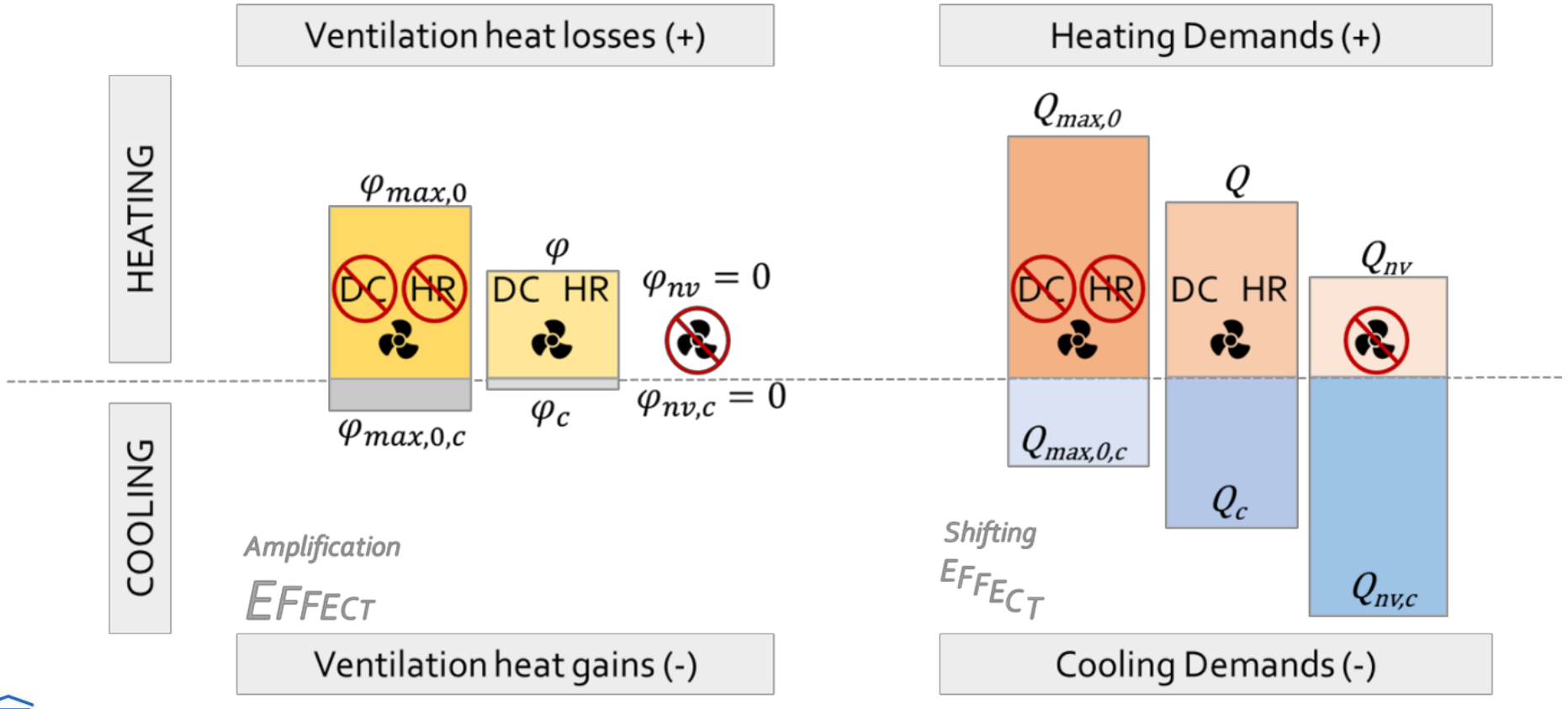
EFFECT COOLING



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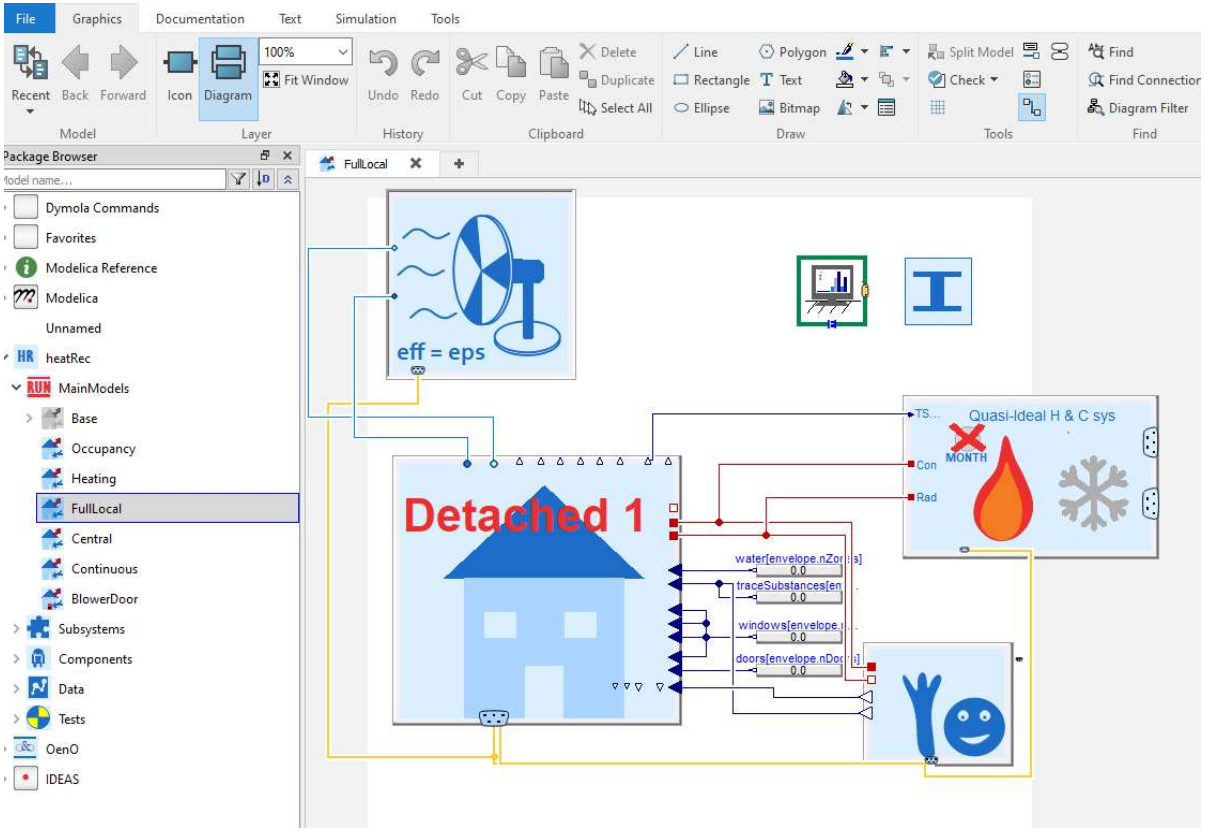
MODELING



Modelica: modelling language

Dymola: Commercial software

Libraries used:

- **MSL** 4.0.0
- **IDEAS** 2.1.0 (modified version)
- **OenO**: Library developed in a previous project

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VARIATIONS

Dwellings (6)


Detached house (BE)


Terraced house (NL)


Semi Detached house (IE)


Apartment (NL) 2 versions


Big detached house (IE)

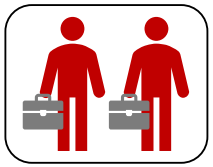
Insulation Level (2)

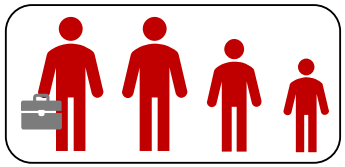

(U-values: ~0.35 W/m²/K) 2 ACH50 **New construction**


U-values: ~0.15 W/m²/K 0.6 ACH50 **Passive house**

Weather (4)

Occupation Profiles (2) *StROBe*


- 2 full time workers


- 1 full time worker
- 1 adult at home
- 1 teenager
- 1 kid

Total combinations:
6x2x2x4 = 96

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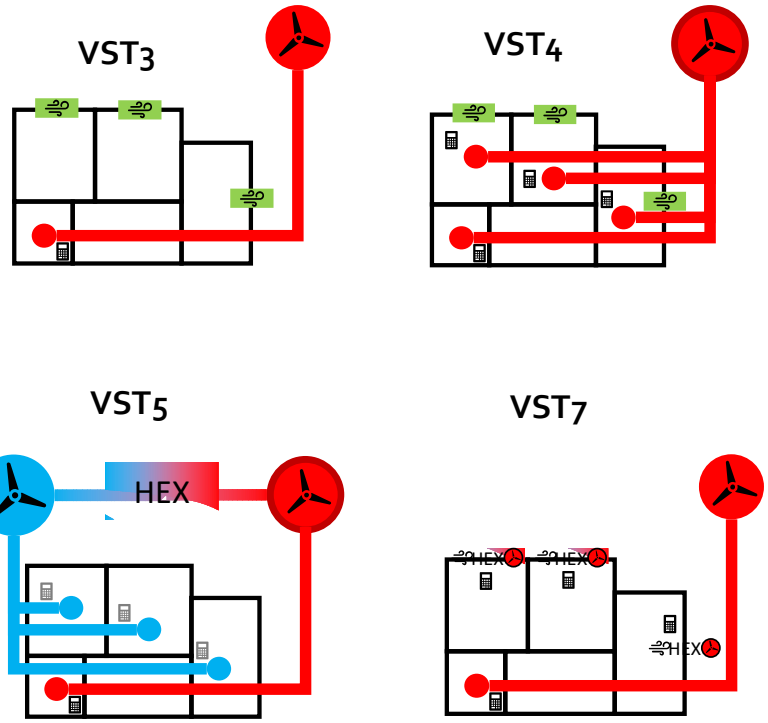
VENTILATION SYSTEMS

Ventilation systems (16)			
ID	VST	Heat recovery	DC/CAV
3a	*VST3*	✗	DC
3b	*VST3*	✗	DC
3c	*VST3*	✗	DC
3d	*VST3*	✗	DC
4a	*VST4*	✗	DC
5a_c	*VST5*	✓	CAV
5b_c	*VST5*	✓	CAV
5c_c	*VST5*	✓	CAV
5d	*VST5*	✓	DC
5e	*VST5*	✓	DC
5f	*VST5*	✓	DC
5g	*VST5*	✓	DC
7a_c	*VST7*	✓	CAV
7b_c	*VST7*	✓	CAV
7c_c	*VST7*	✓	CAV
7d	*VST7*	✓	DC

* DC = Demand Controlled ventilation
CAV = Constant Air Volume



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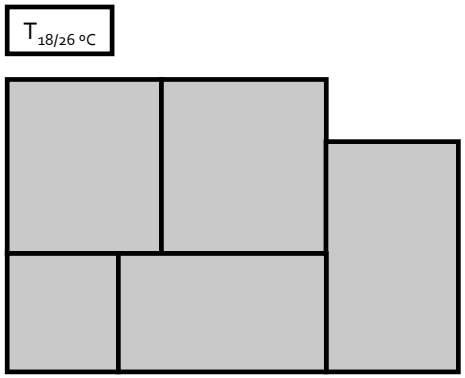
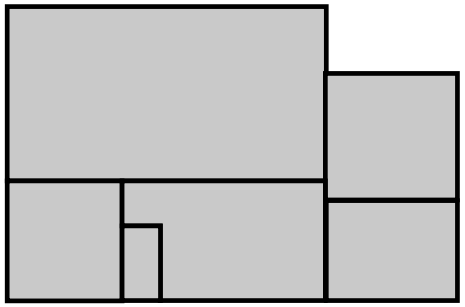
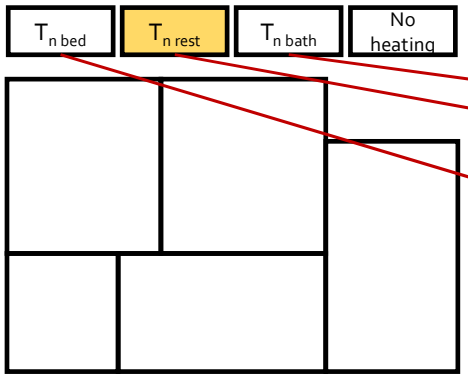
HEATING AND ZONING

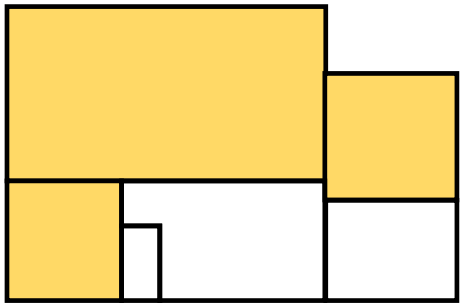
$T_{18/26\,°C}$ Always ON
All zones are heated

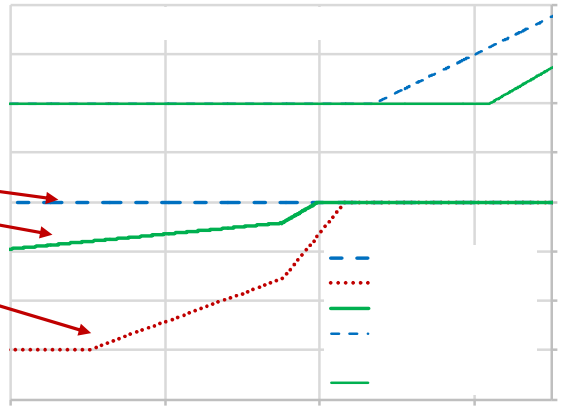


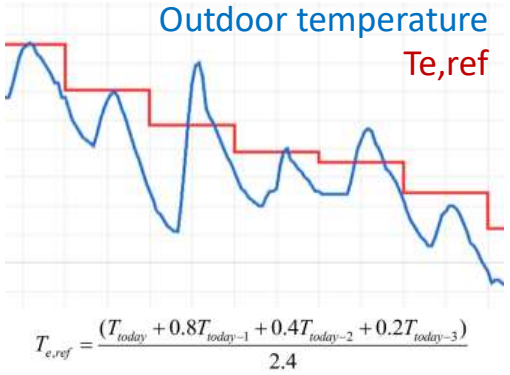


T_n Full local
on if someone is present in the zone









Total combinations: BC x vent. x heating modes x scenarios 6x2x2x4x16x2x(2+1/16) = 6336 simulations

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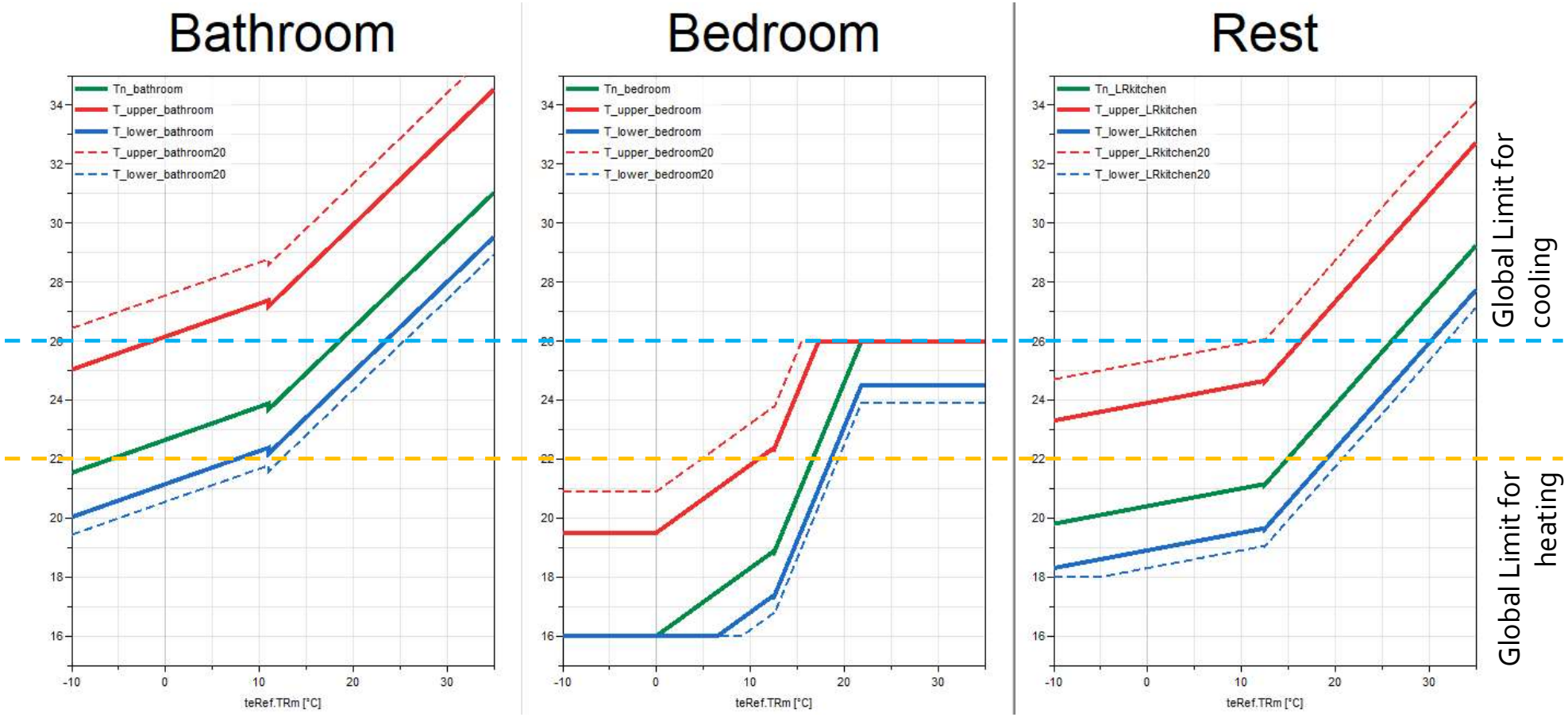
HEATING AND ZONING



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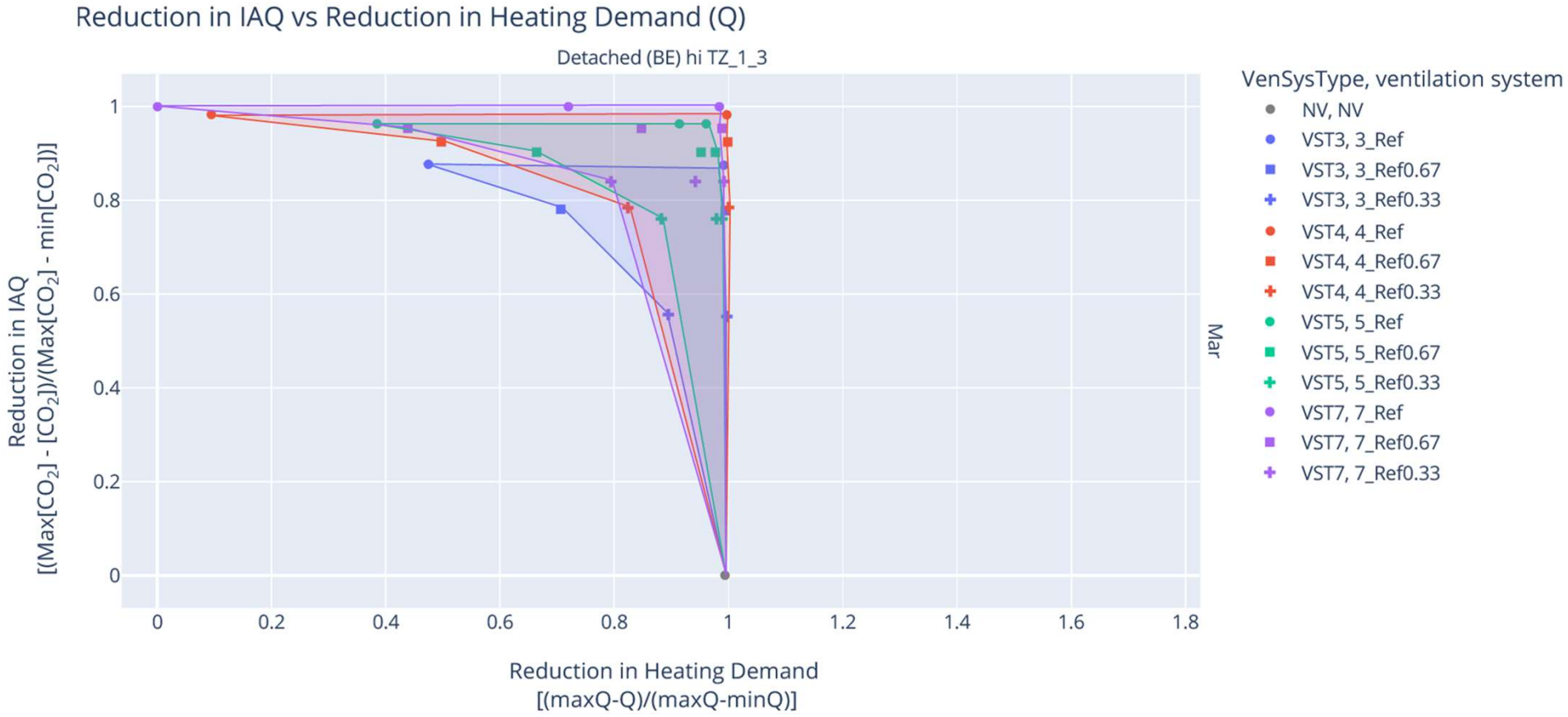
RESULTS



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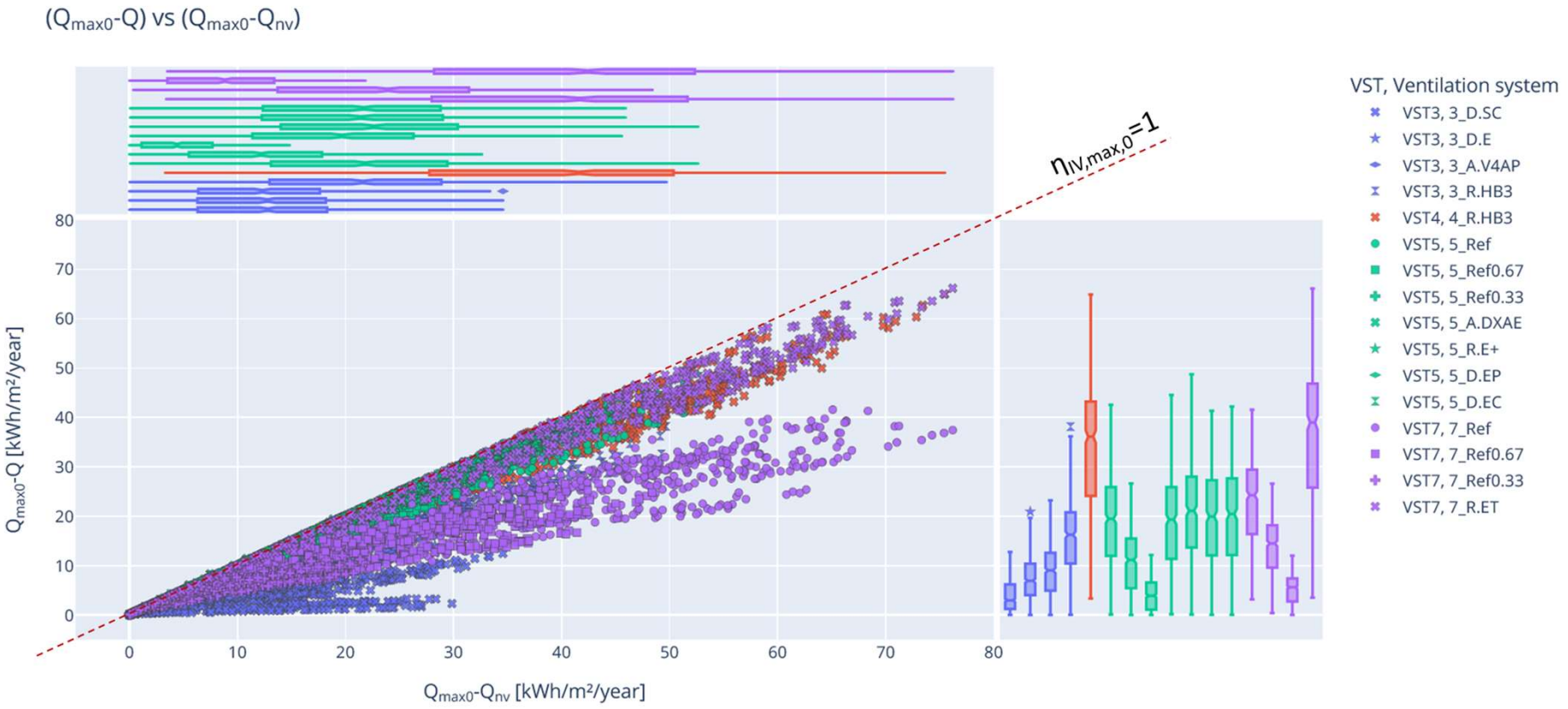
RESULTS



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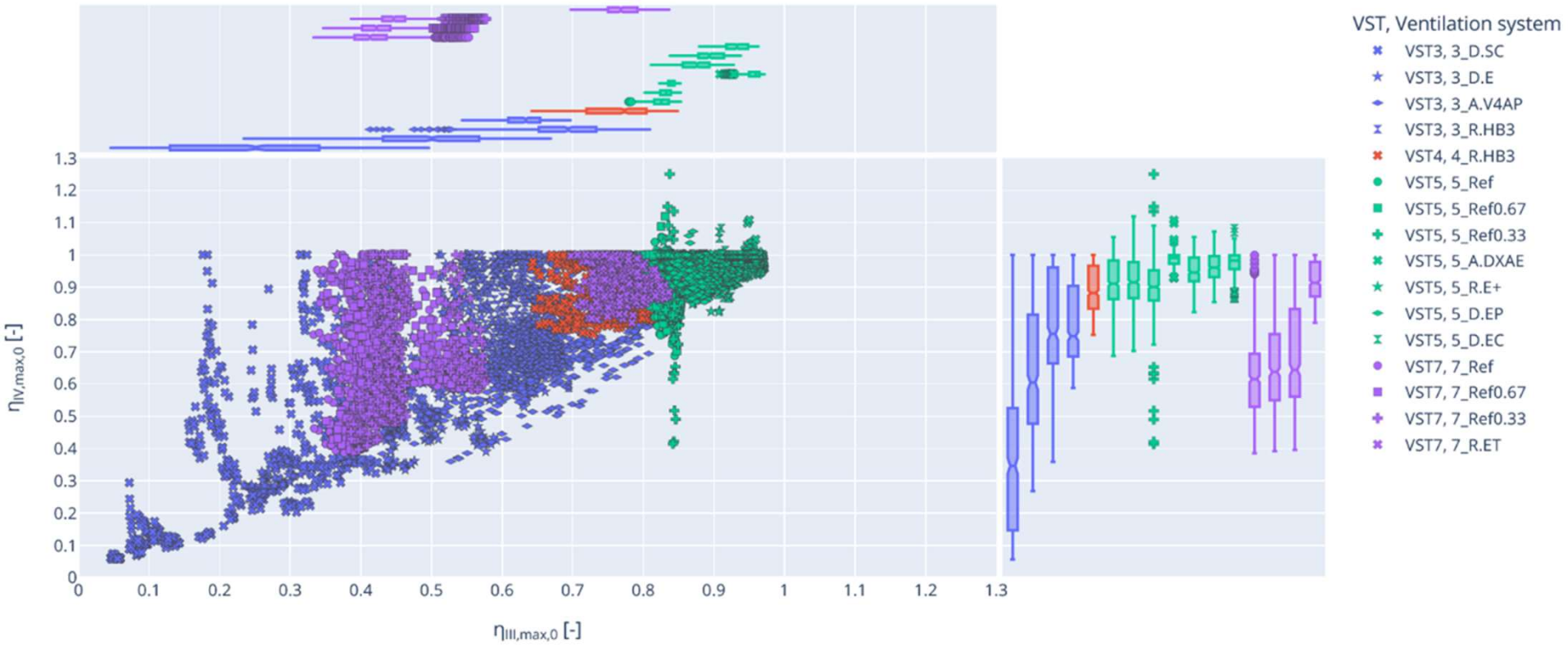
HEALTH VS ENERGY



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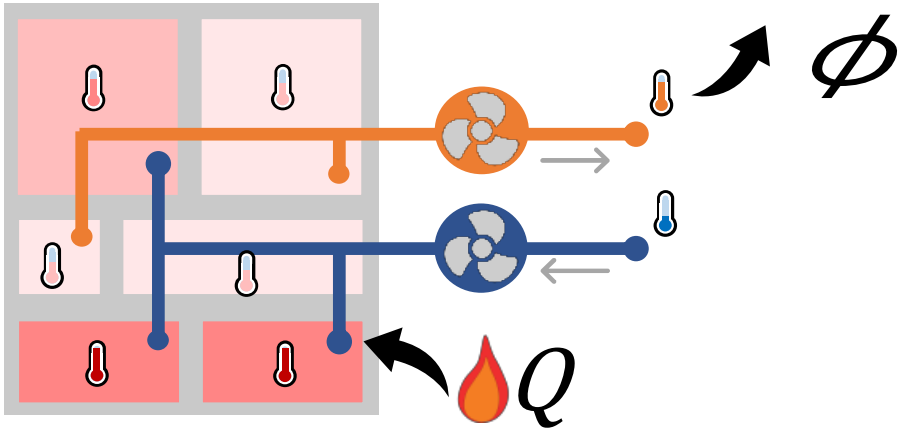
EFFECT OF ASSUMING UNIFORM T

Non uniform Temperature

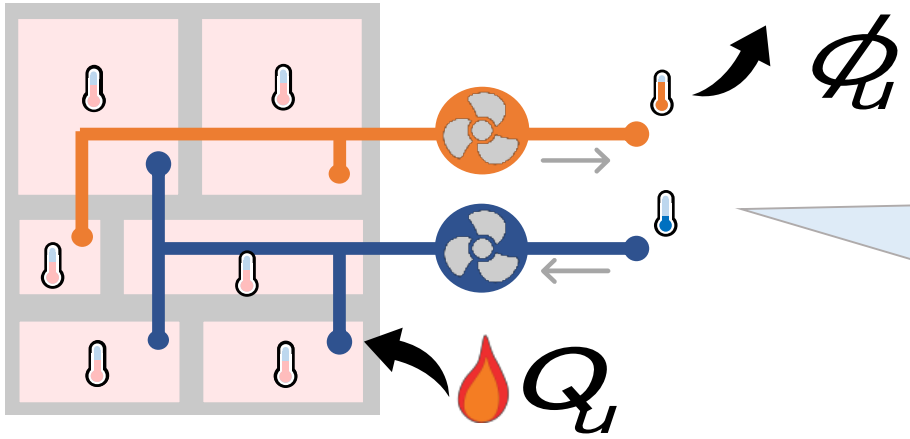


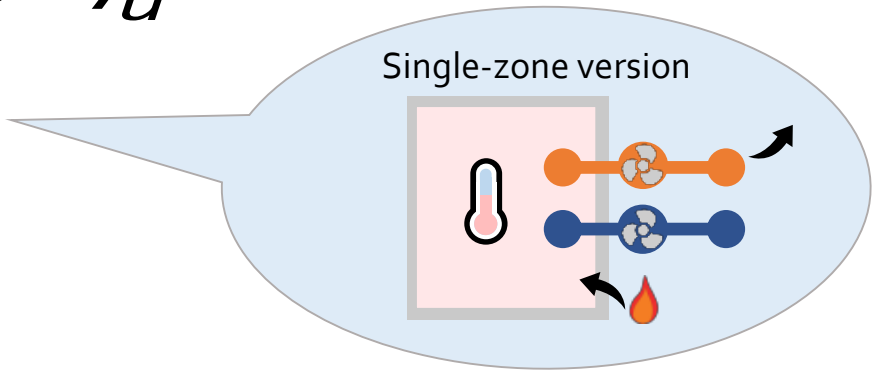
Q, Q_u = Annual heating demand
ϕ ϕ_u = Annual ventilation heat losses

$\phi = \phi_u$?

$Q = Q_u$?

Uniform Temperature





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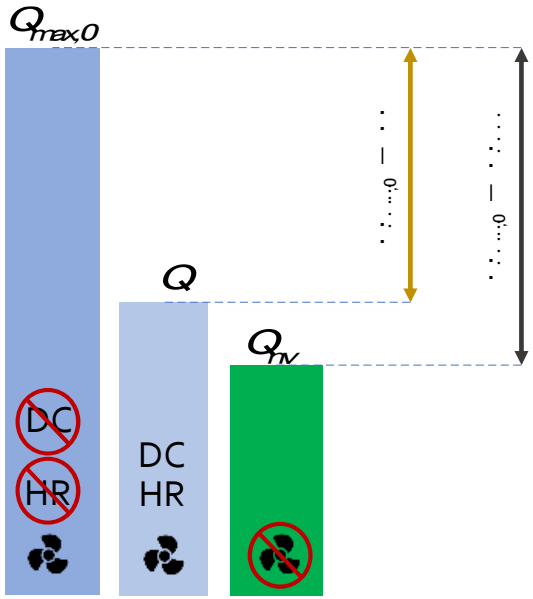
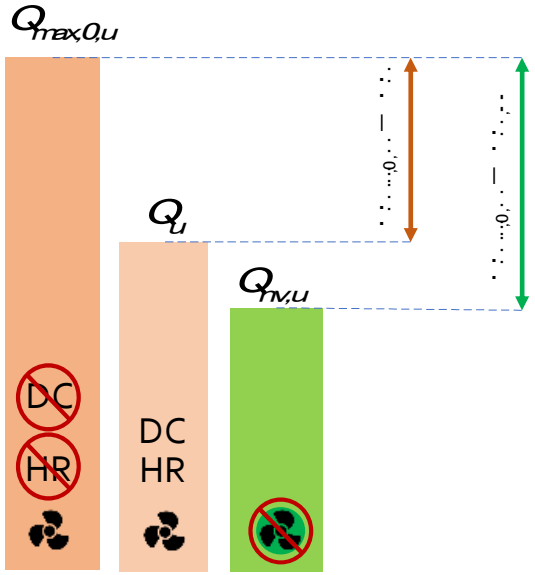
EFFECT OF ASSUMING UNIFORM T





$$\frac{\eta_{IV,max,0}}{\eta_{IV,max,0,u}} = \frac{x\,Q_{max,0} - Q}{x\,Q_{max,0} - Q_{nv}} \Big/ \frac{x\,Q_{max,0,u} - Q_u}{x\,Q_{max,0,u} - Q_{nv,u}}$$

> 1 → The non-uniform temperatures scenario has a better energy performance.

< 1 → The uniform temperatures scenario has a better energy performance.

→ 6 simulations involved

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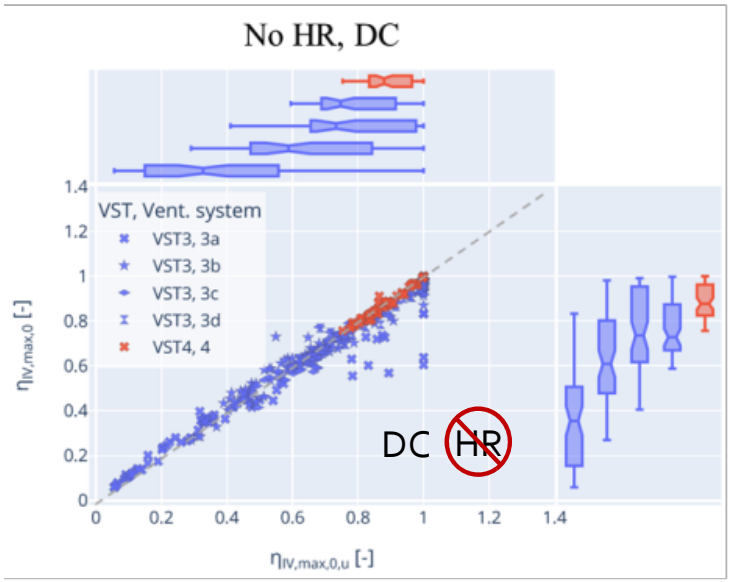
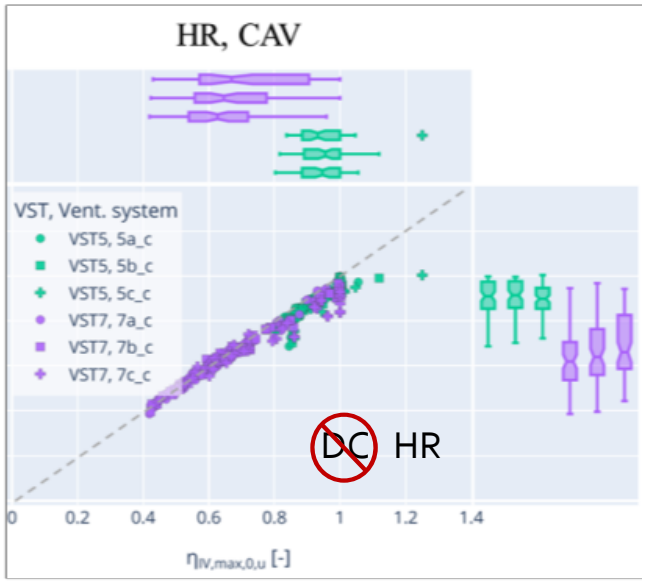
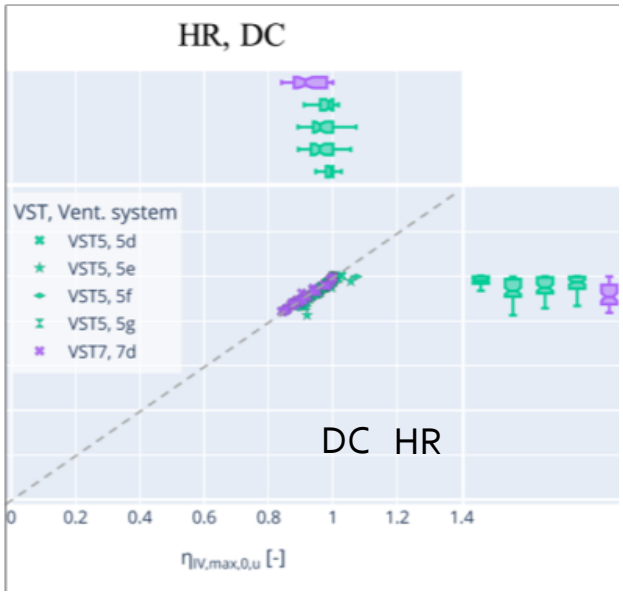
EFFECT OF ASSUMING UNIFORM T







- The energy performances are similar, but uniform temperatures show a slightly better energy performance (differences in performance around 5 %).
- VST3 have the lowest energy performance.

Non-uniform temp has a better energy perfomance

Uniform temp has a better energy perfomance

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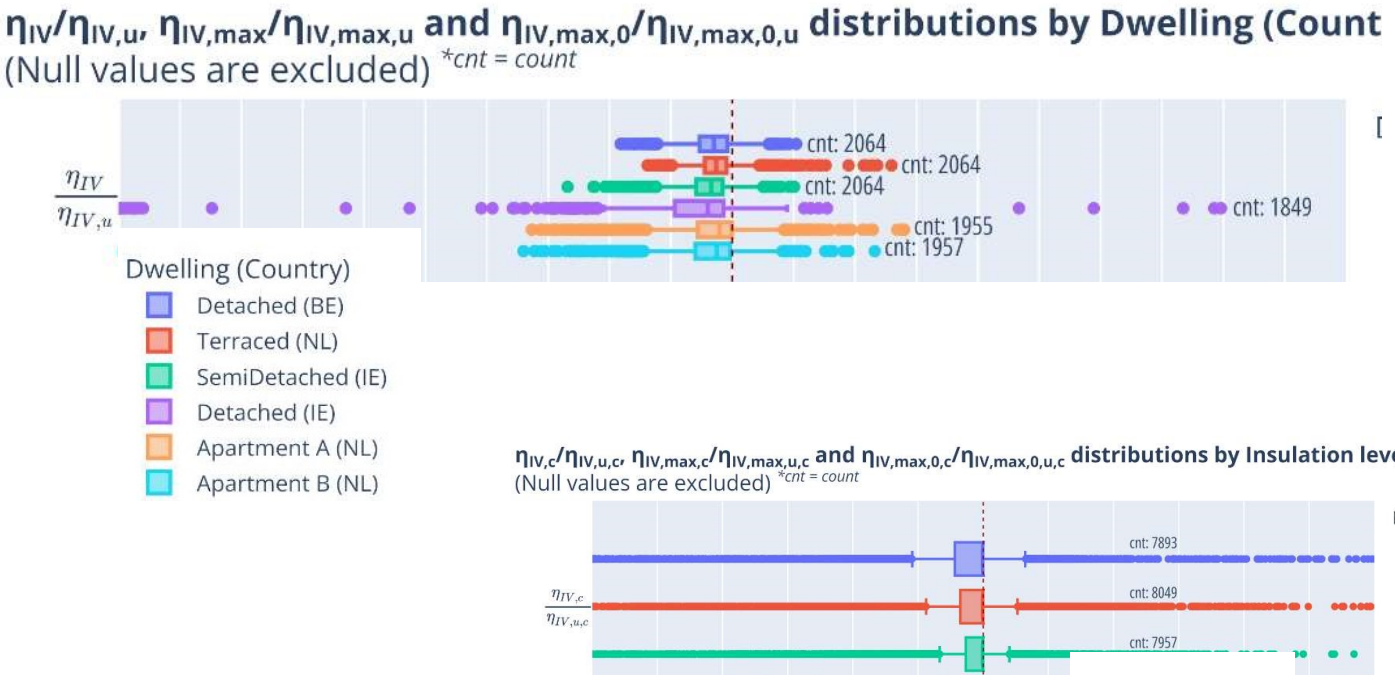

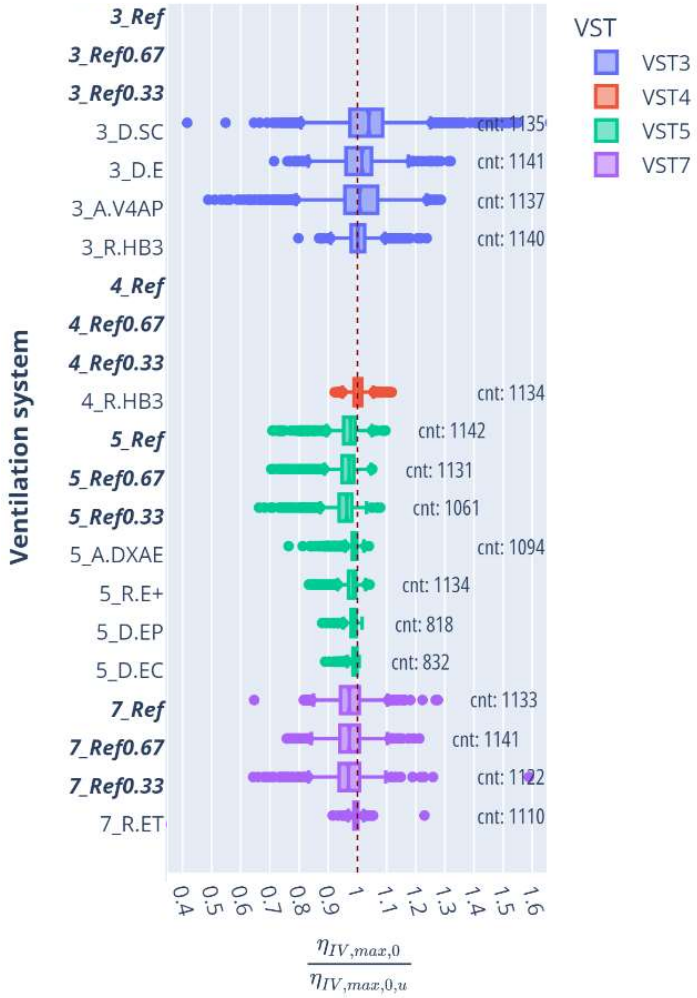

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