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Earth to Air Heat Exchangers (ETAHE)

Mark Murphy

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Introduction

- What is an earth to air heat exchanger?
- What do they look like?

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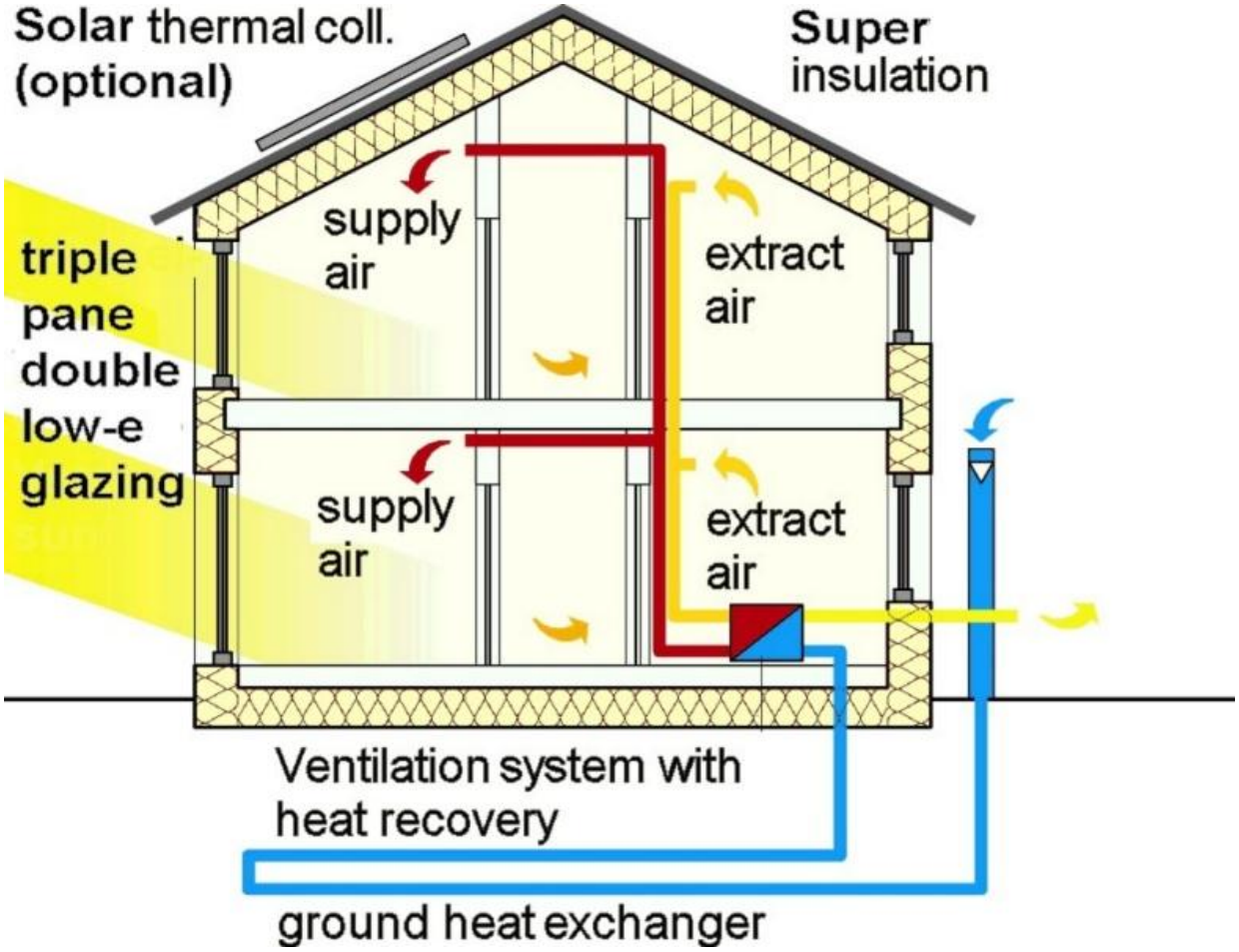
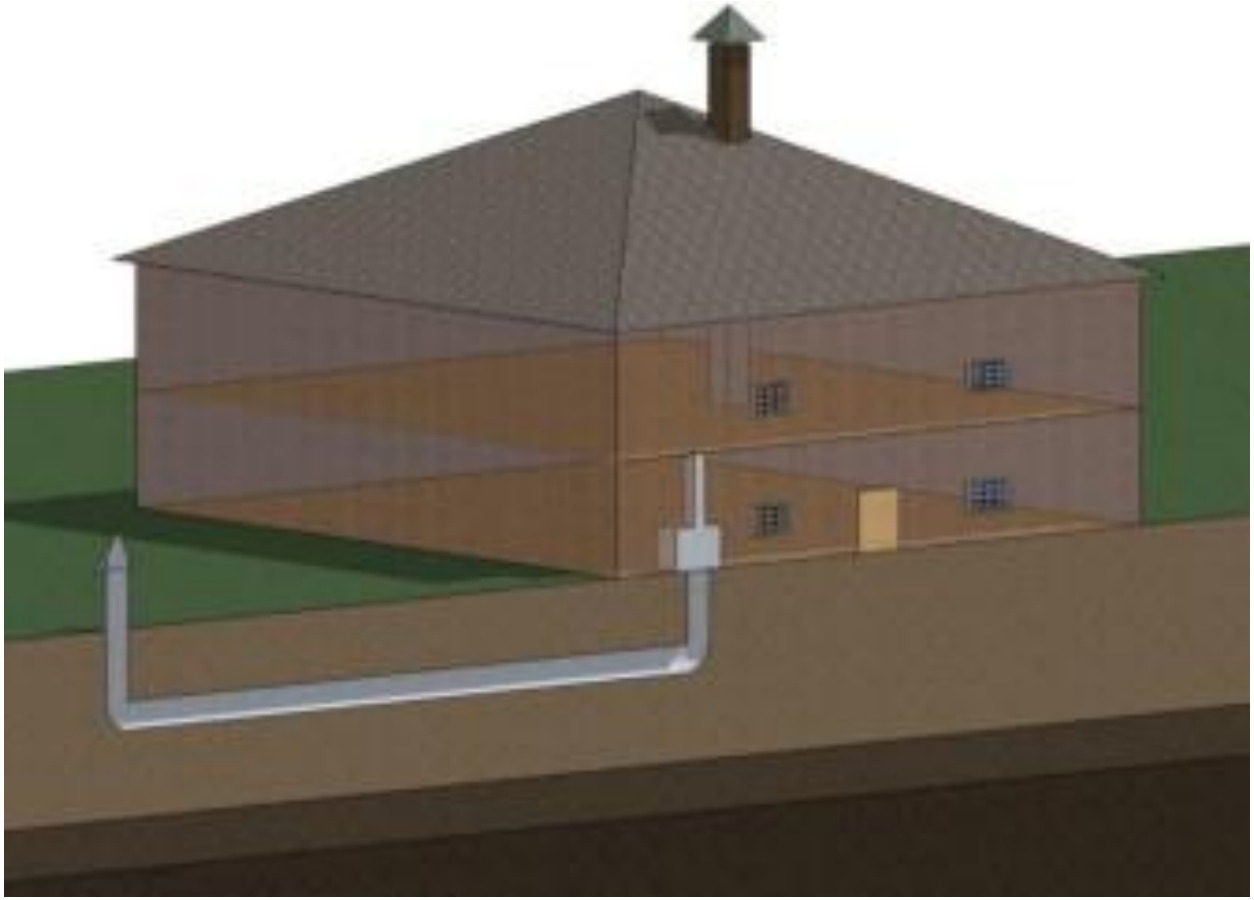
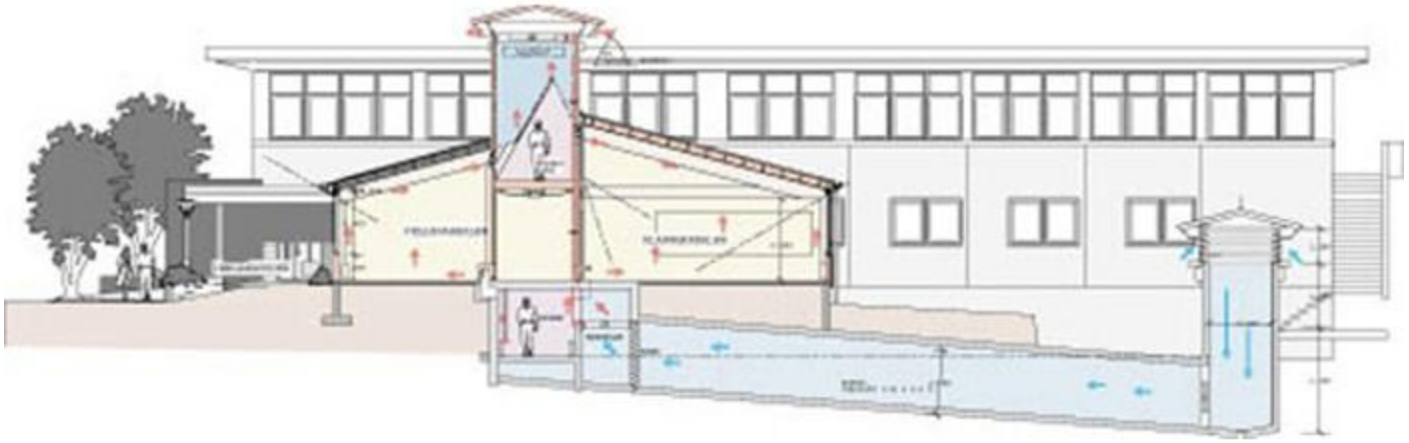
Wikipedia



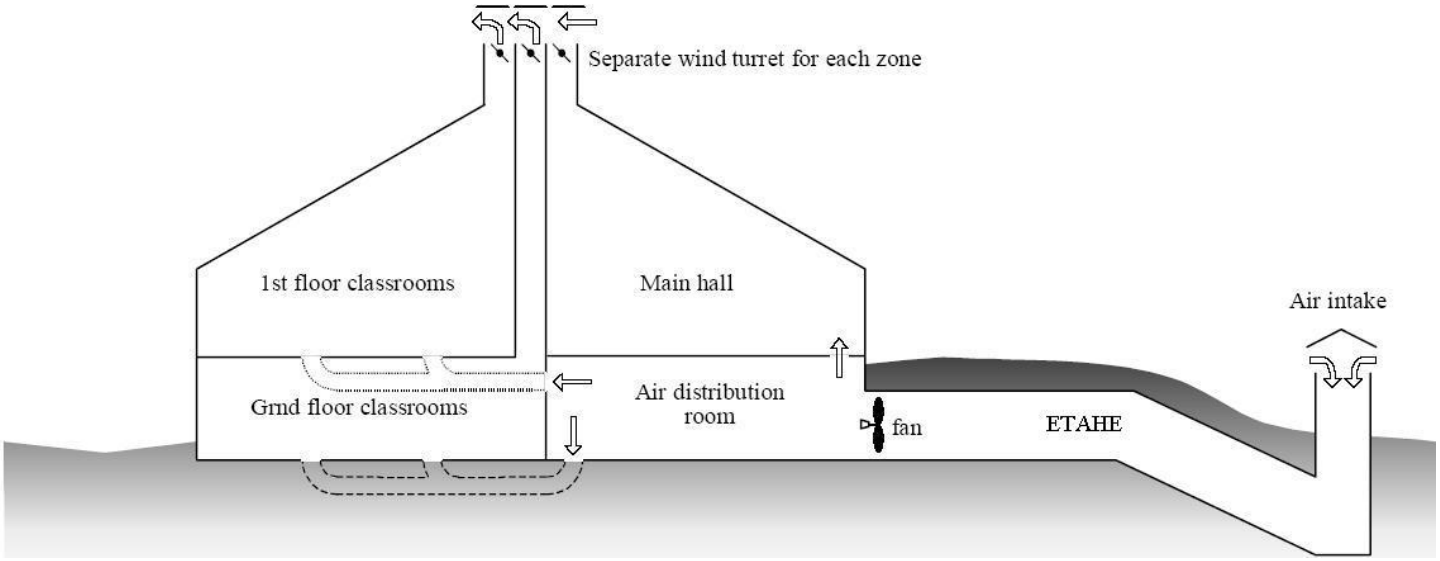
Zhang (2009)



Mediå Skole - Grong, Norge



Jaer Skole


Separate wind turret for each zone
1st floor classrooms
Main hall
Air intake
Grnd floor classrooms
Air distribution room
fan
ETAHE

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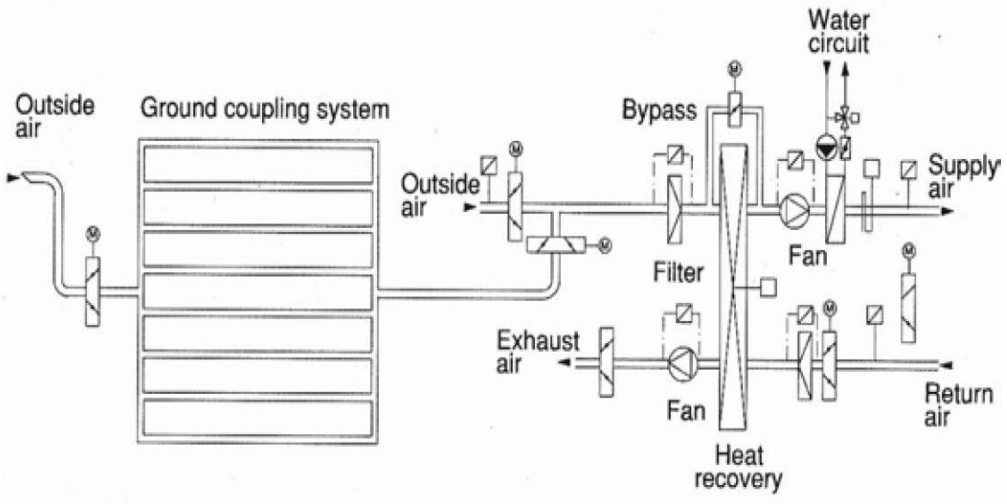
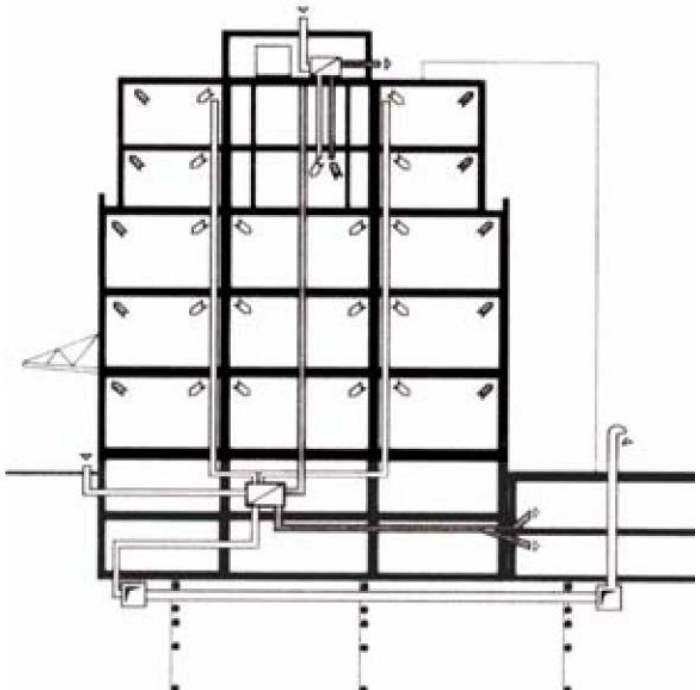
Rehau

Schwerzenbacherhof Building
Zurich, Switzerland





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Rehau

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Simulating an ETAHE

- What needs to be taken into consideration?
- What has been done before?

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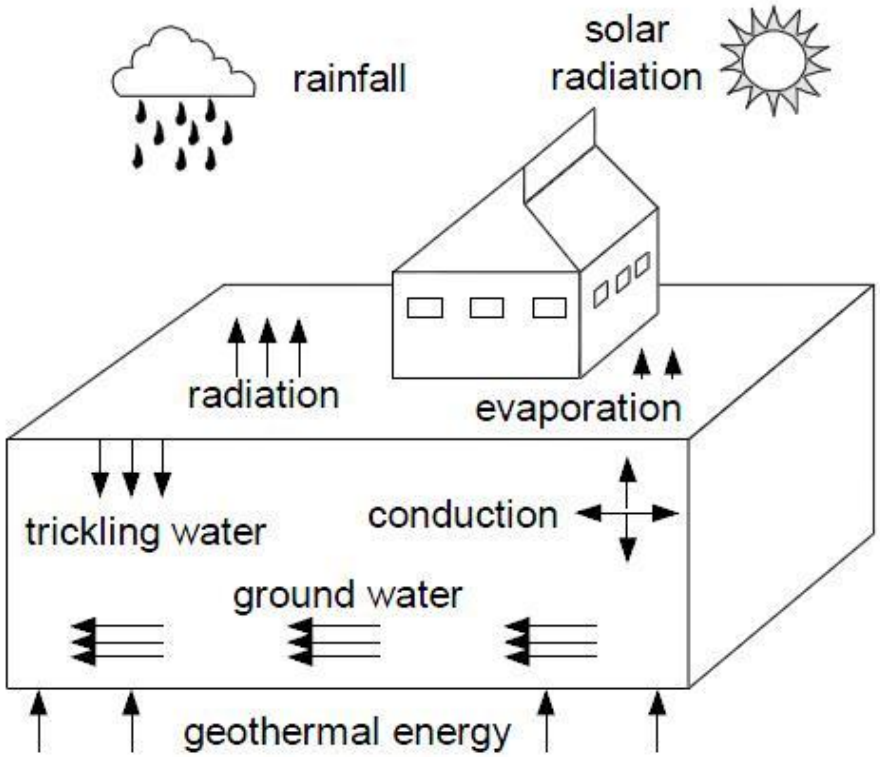
Wagner et al. 2000



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Ground Temperature Simulation

- Simplified correlations with untouched temperature distribution in the background or fixed boundary conditions
- CFD close, but still contains approximations
  - Ground water, surface water, heterogenous soil, vegetation on the surface

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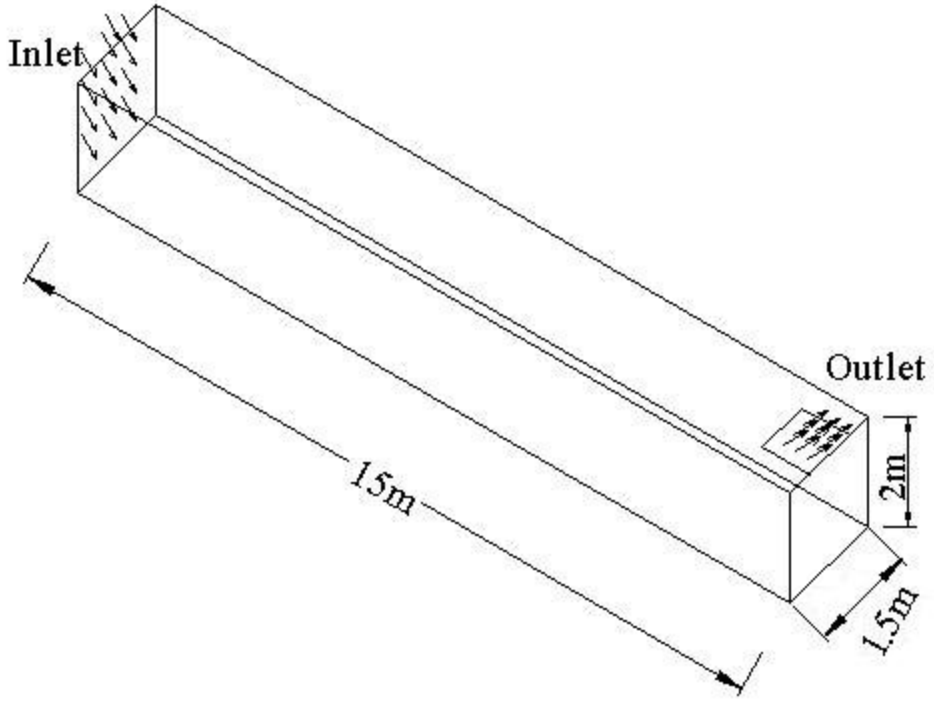
Available Simulation Tools

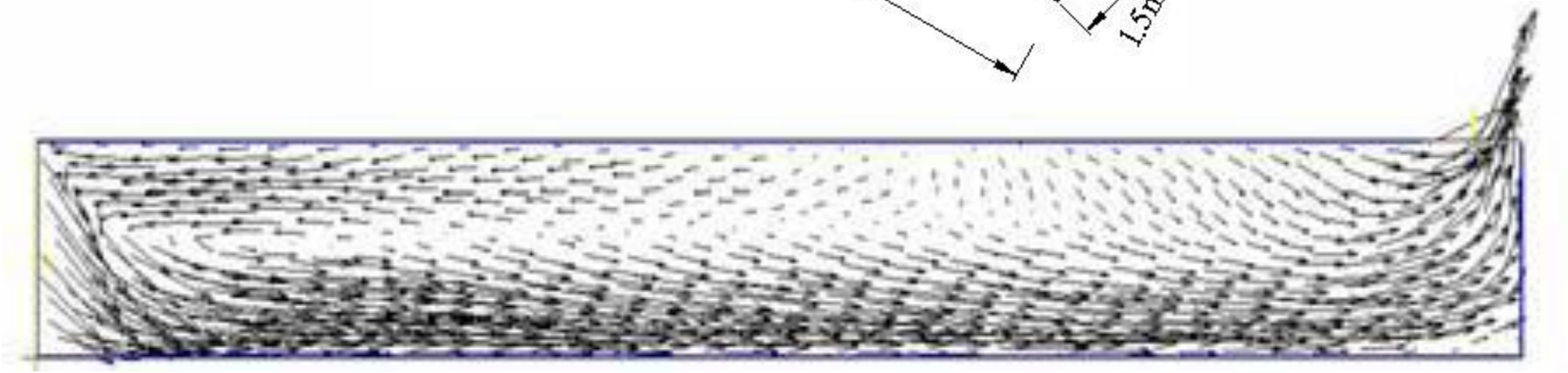
- Energy +
- TRNSYS
- WTK2 + other specially developed tools
- CFD – ANSYS/COMSOL

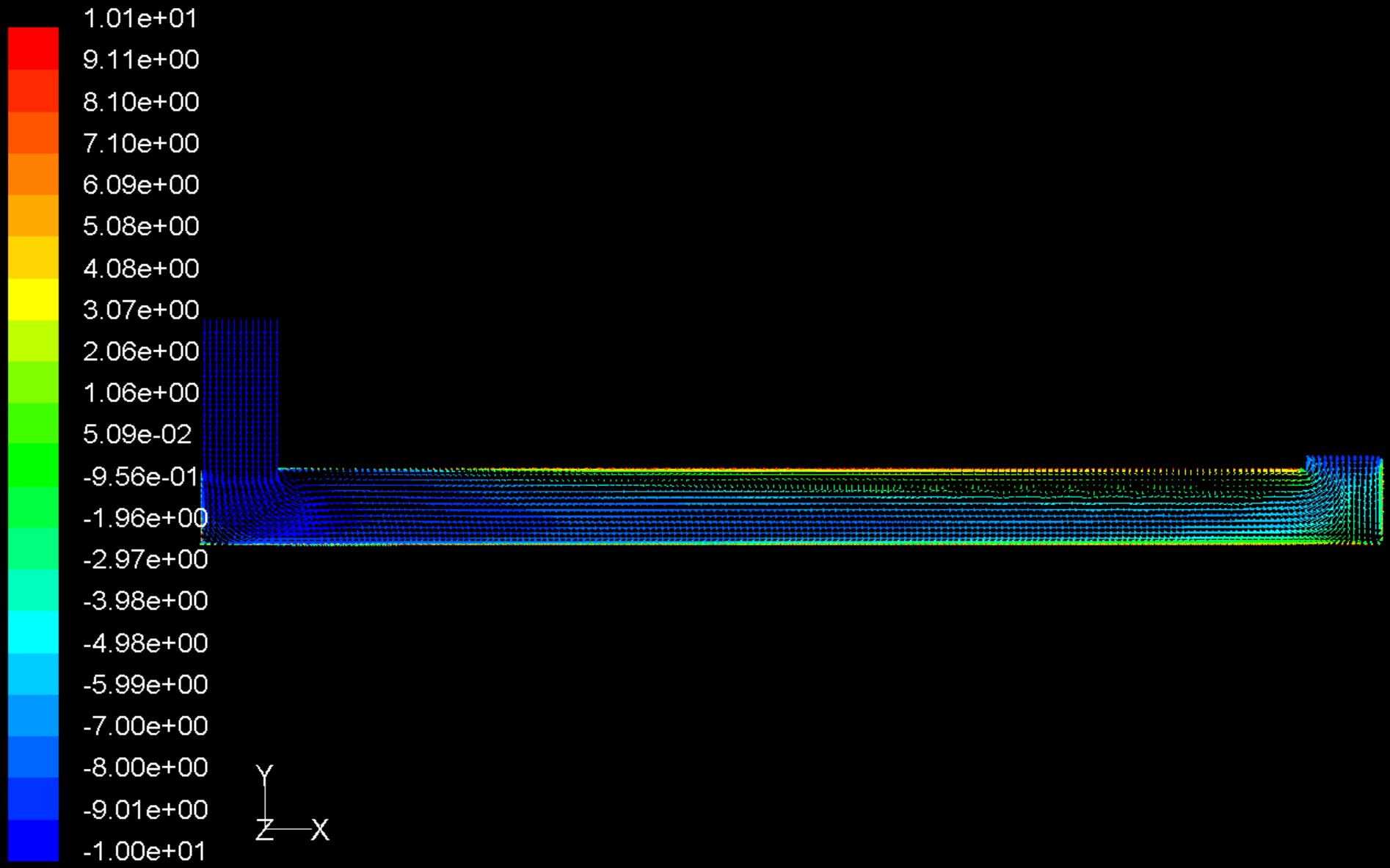
CFD

- Results from Canada

J. Zhang, F. Haghighat (2005)







Velocity Vectors Colored By Static Temperature (c)

Aug 08, 2006
FLUENT 6.1 (3d, segregated, ske)

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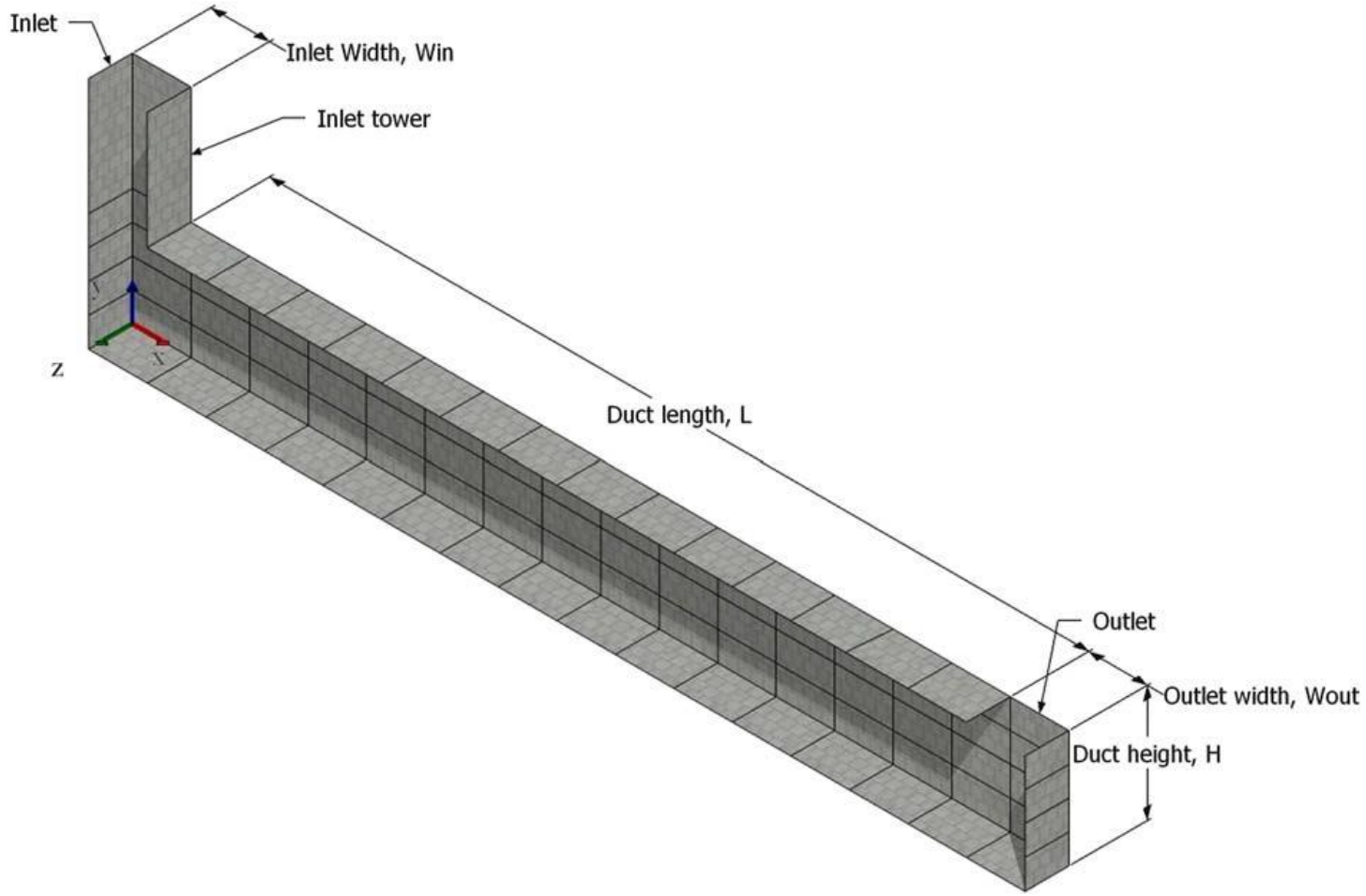
J. Zhang, F. Haghighat (2009)



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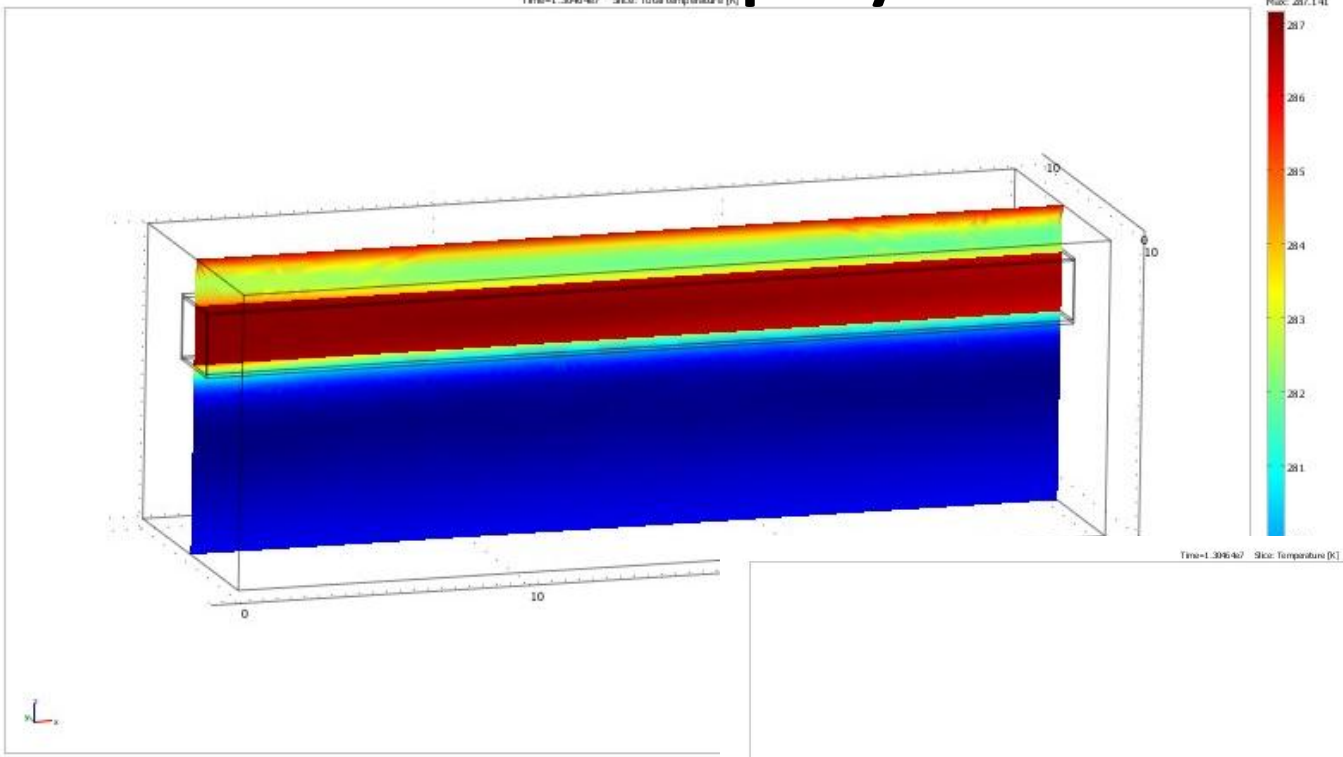
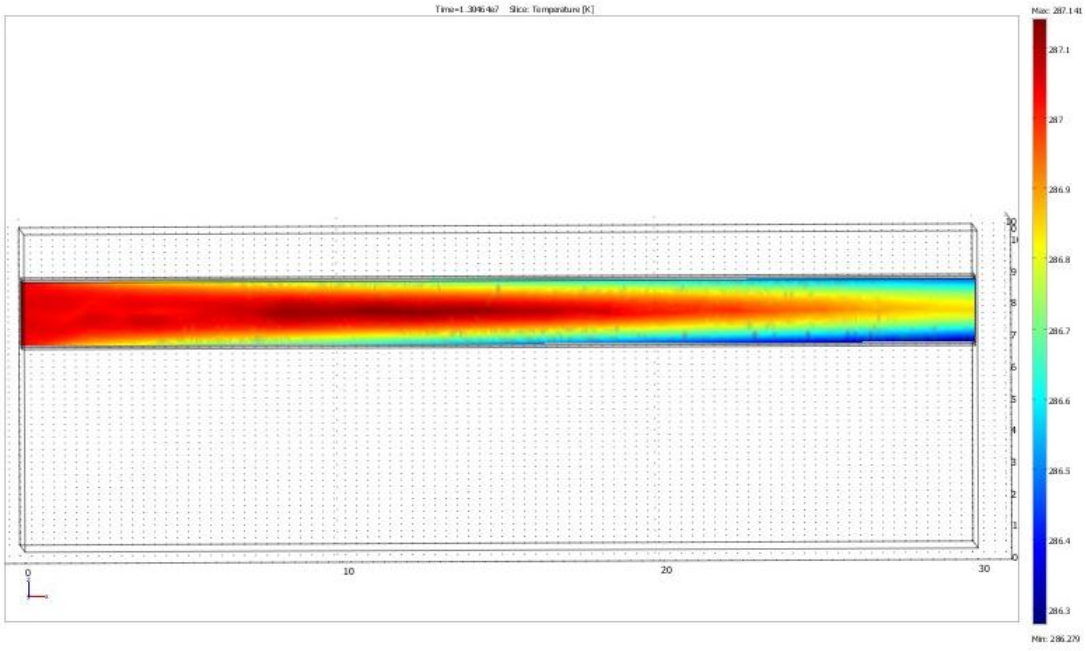
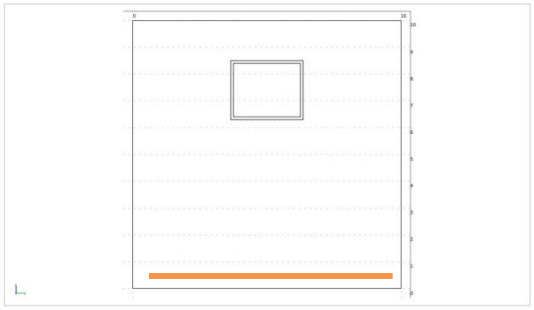
CFD

- My Preliminary Results

Comsol Multiphysics Simulations







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Simulating without CFD

- Requires assumptions
- Fully Developed Turbulent flow

  $\Rightarrow$Heat Transfer Correlations

  $\Rightarrow$Mechanically ventilated ETAHEs

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Assumption

- Fully Developed Turbulent flow

  => Heat Transfer Correlations

- These models are then useful – the size is generally speaking small and used for mechanical ventilation

Simulated System

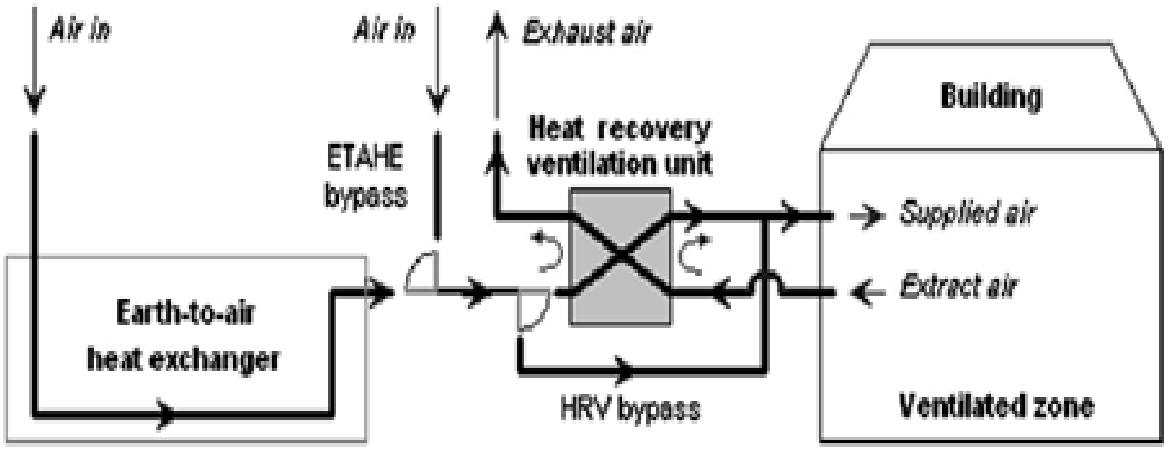

Figure from Thiers and Peuportier (2008)

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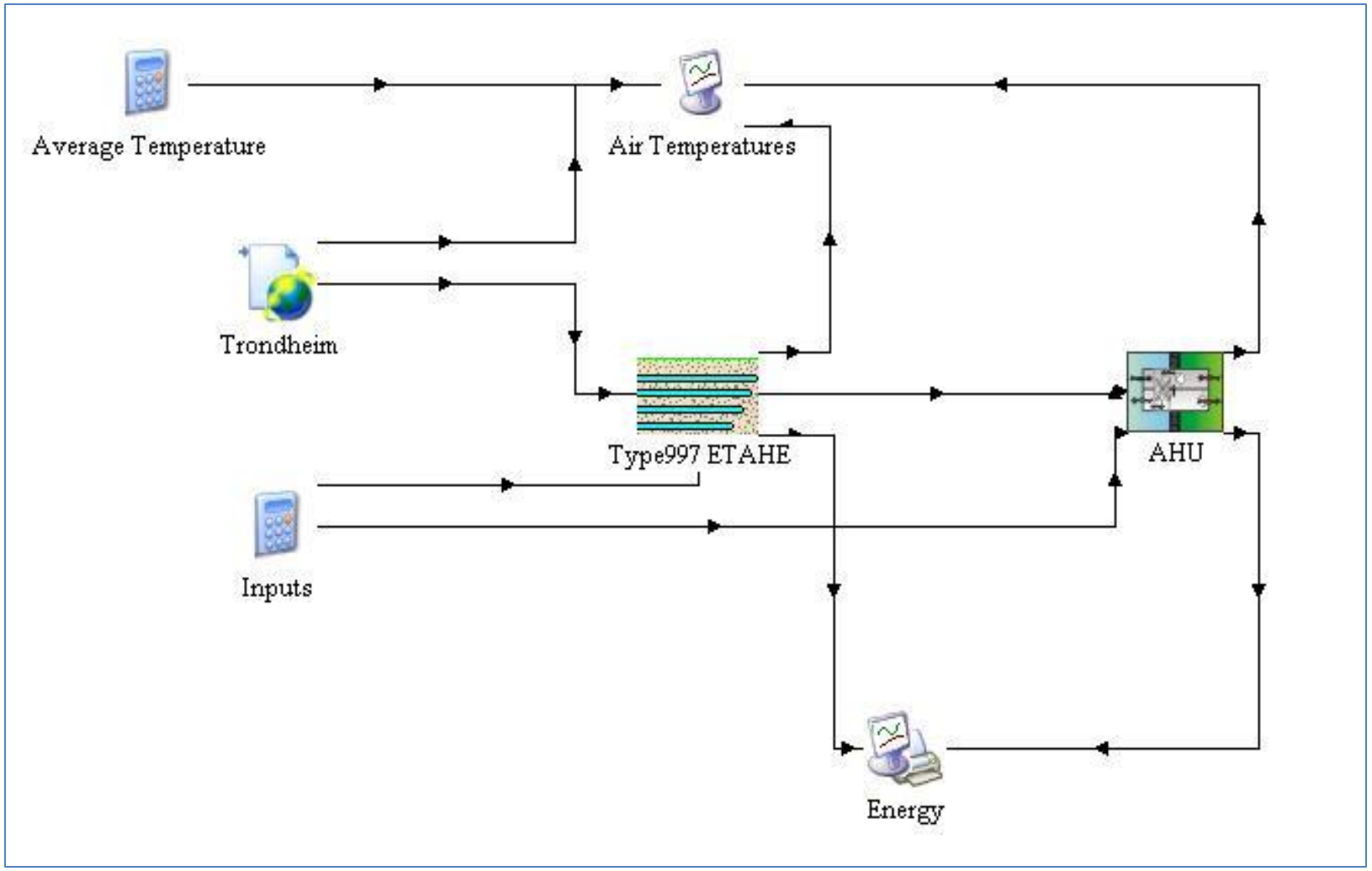
Trnsys Model



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Simulated Bypass

$$(T_{avg} + x) < T_{outdoors} < T_{supply}$$

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Simulated Structures

- Small Houses
- Row Houses
- Small Office – single pipe
- Small Office – multiple parallel pipes

Results – Small House Trondheim

	Trondheim		
	[kWh]		Hours
	Heating	Cooling	Defrosting
Without ETAHE	1149.6	-21.1	1165
With ETAHE	716.4	0	55
Bypass starts at	------	-	--
Tavg	**686.6**	0	55
Tavg-1	693.9	0	55
Tavg+1	681.9	0	55
Tavg+2	680.0	0	55
Tavg+3	**679.4**	0	55
Tavg+4	681.4	0	55
Tavg+5	685.8	0	55

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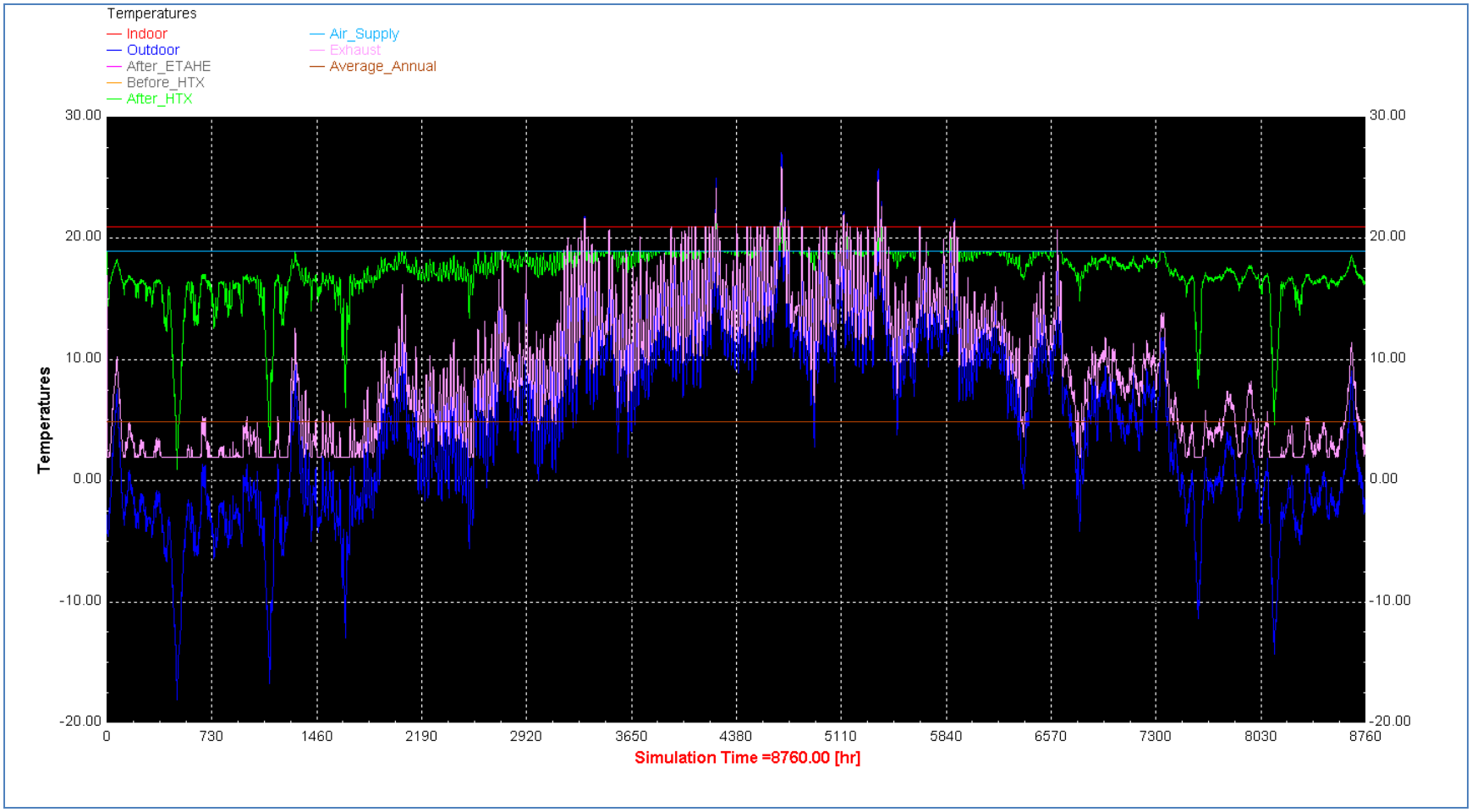
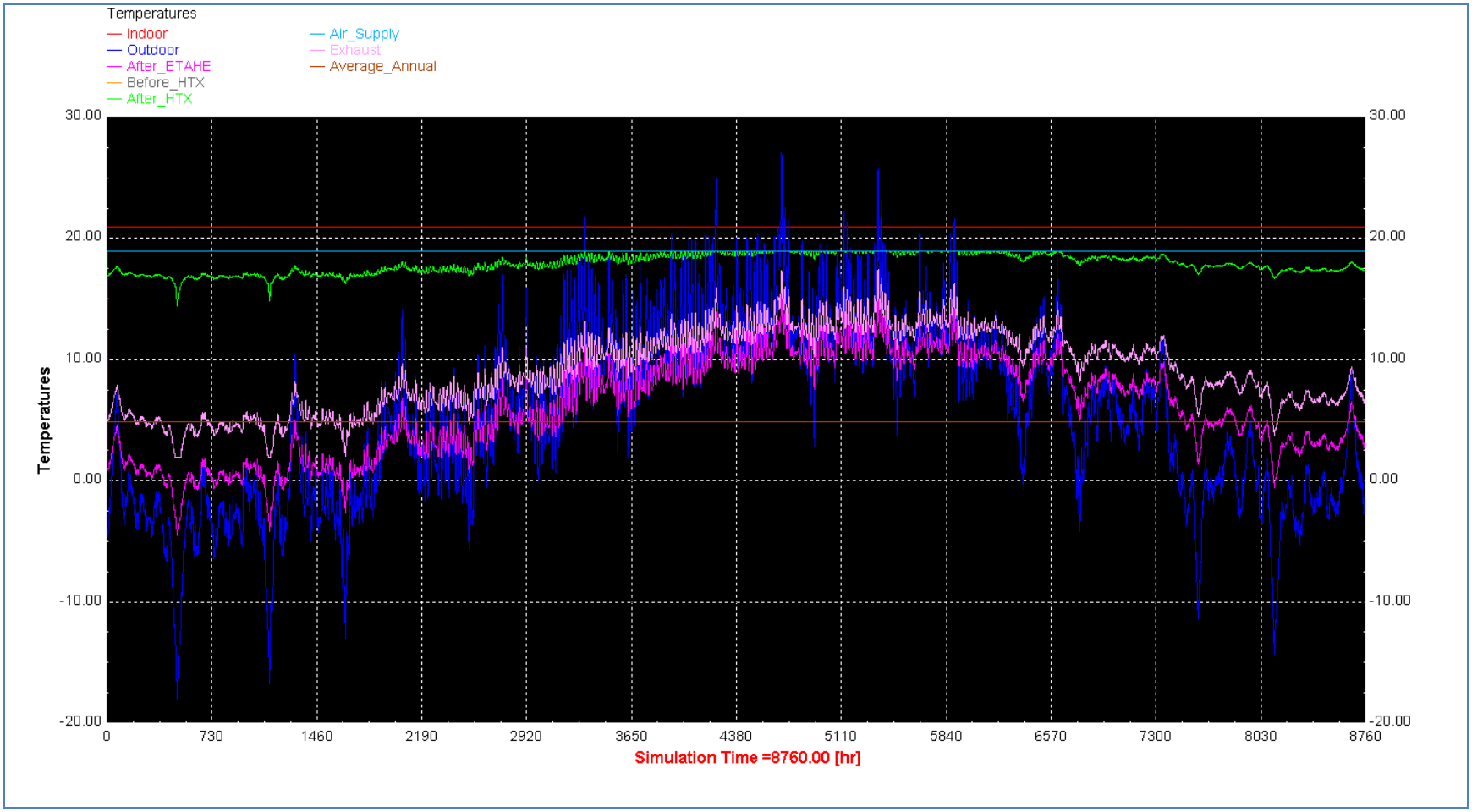
Energy Savings Potential within Parallel Piped ETAHEs

Air Exchange Rate [h^{-1}]	1	2	3	4
Number of Pipes	5	10	15	20
Energy Savings Potential [kWh/m^2]	2.1	4.1	6.0	8.0

Extra Slides

- Small House Example
  - Graphical Output from TRNSYS


Temperatures
Indoor
Outdoor
After_ETAHE
Before_HTX
After_HTX
Air_Supply
Exhaust
Average_Annual
30.00
20.00
10.00
0.00
-10.00
-20.00
Temperatures
0
730
1460
2190
2920
3650
4380
5110
5840
6570
7300
8030
8760
Simulation Time =8760.00 [hr]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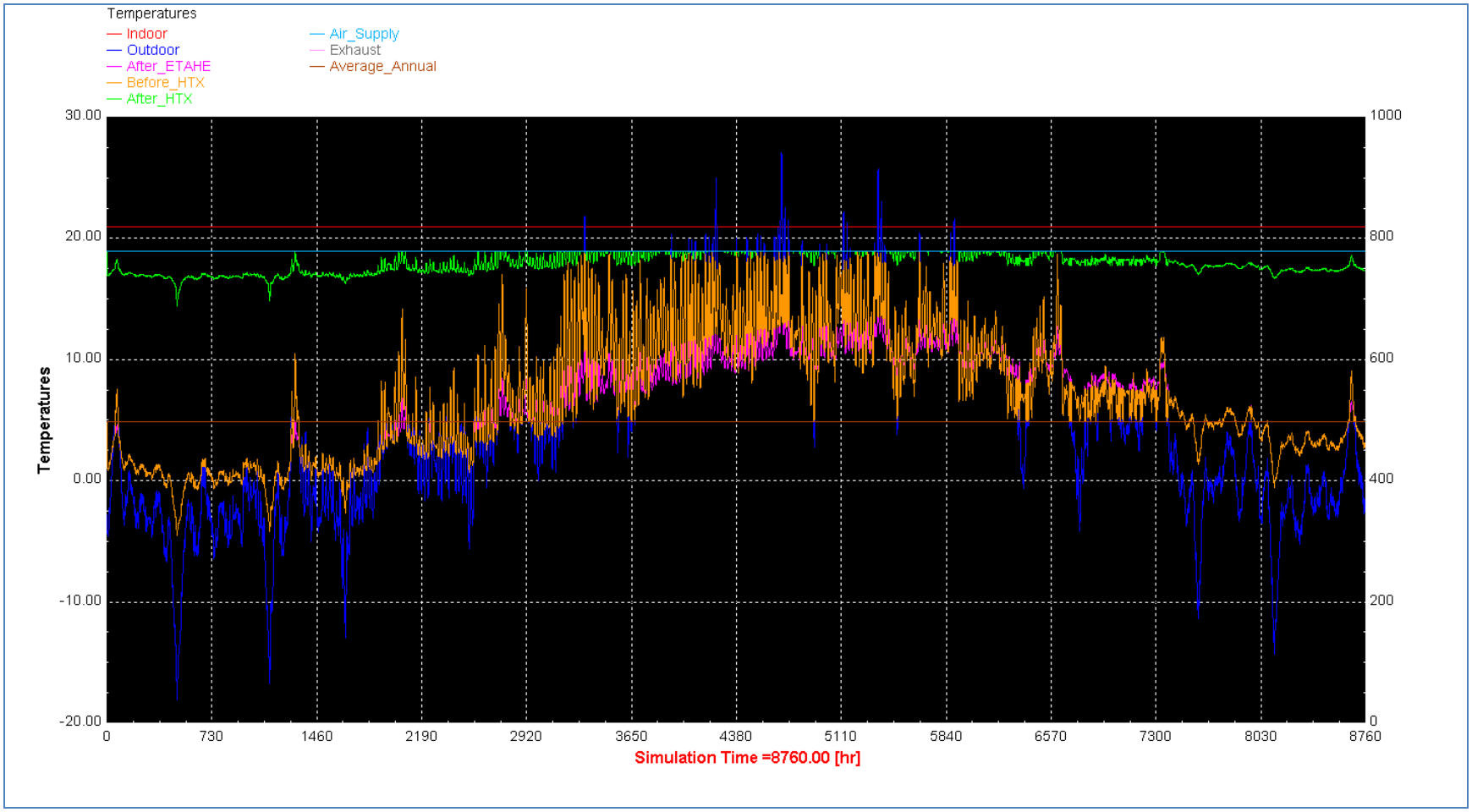
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1000
800
600
400
200
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