W23 - Commercial Scale Passive House Ventilation and Modulating Airflow to Meet the Needs

February 12 • 12:30am–1:30am • B to Z Learning Hub

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Presented by

PASSIVEHOUSE CANADA

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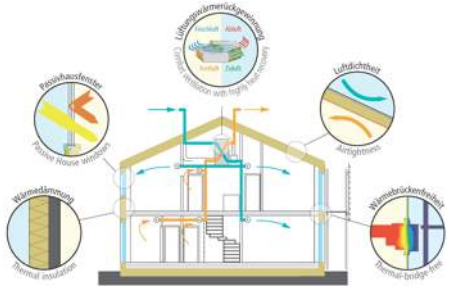
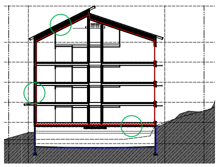
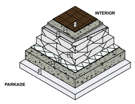
OUTLINE

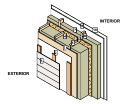
- Integrating Mechanical Systems with the Architectural Design
- Mechanical System Specifics
- Recap
- Q/A



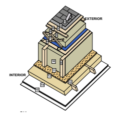




FLOOR ASSEMBLY
R20 (5") Monoglass
R48 (12") EPS Type 2
R-nominal: R-68
R-effective: R-70.75
U-value: 0.080 W/m2



WALL ASSEMBLY
R38 (9 1/4") Cellulose
R14 (3 1/2") Fiberglass Batt
R-nominal: R-52
R-effective: R-45.64
U-value: 0.124 W/m2



ROOF ASSEMBLY
R22 (5 1/2") Mineral Wool Batt
R79 (19") Cellulose
R22 (5 1/2") Fiberglass Batt
R-nominal: R-116
R-effective: R-97.72
U-value: 0.058 W/m2

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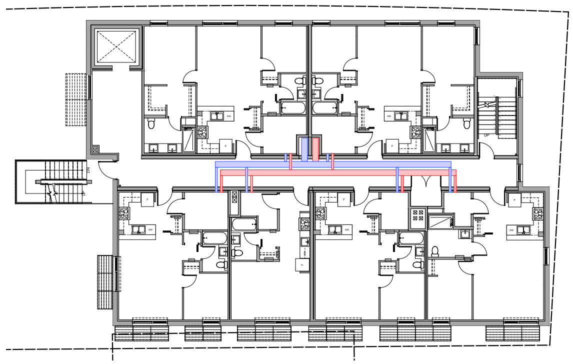

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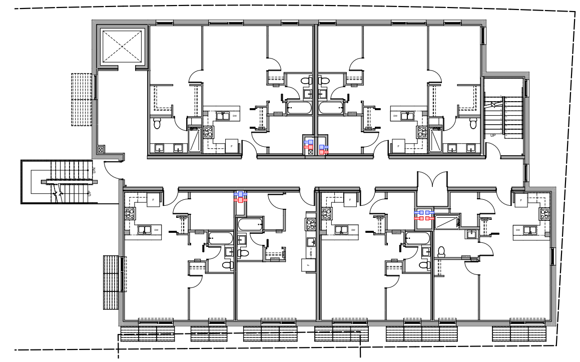

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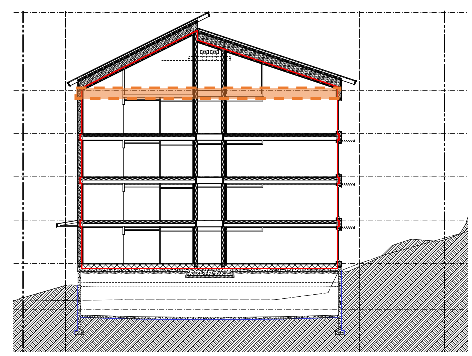

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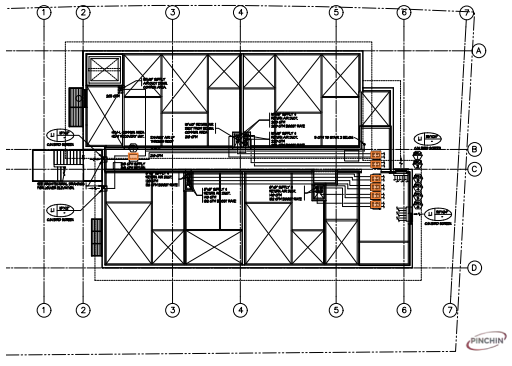

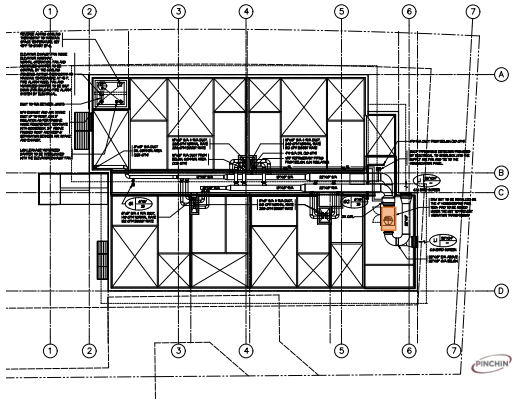

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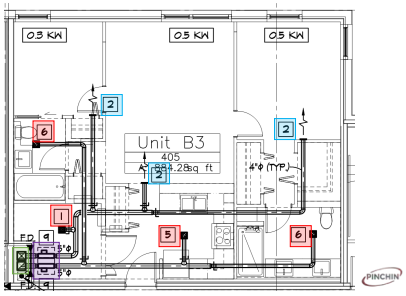

Type	Boost/ normal mode
Studio	40 / 30 cfm
1 bedroom	46 / 35 cfm
2 bedroom	72 / 55 cfm

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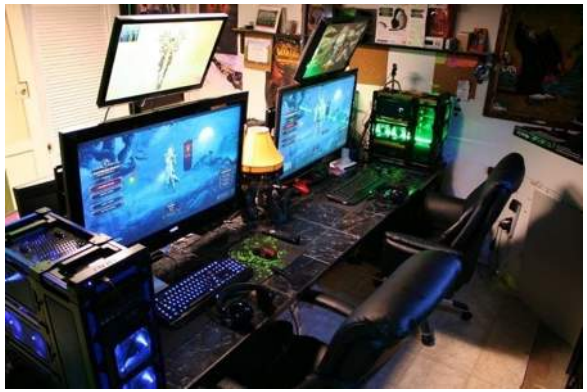

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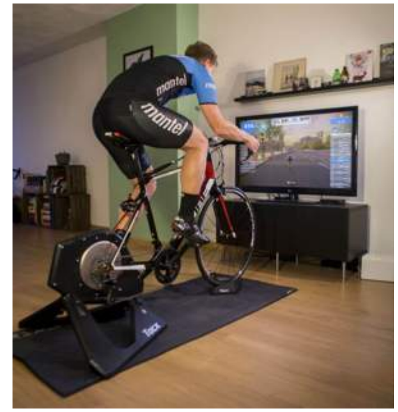

Multiple Mid-sized HRVs

- More energy efficient
- Smaller units were easier to fit
- Less computers

One Large ERV

- Moisture recovery
- Individual suite controls
- Integrated cooling

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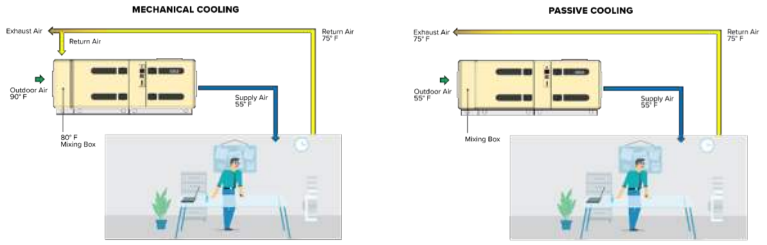
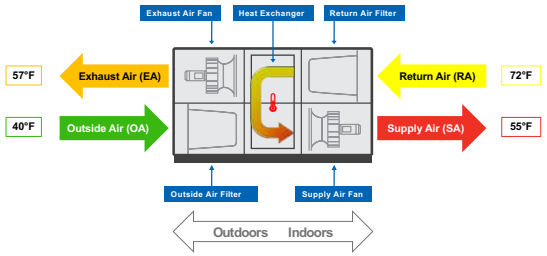
What is Passive (Free Cooling)?

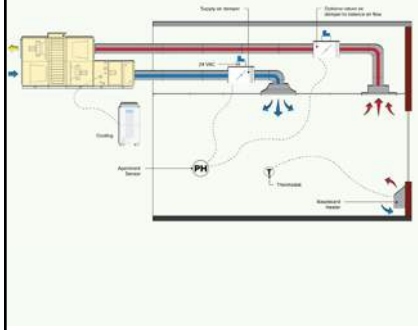
PASSIVE COOLING: ECONOMIZER CONCEPT



PASSIVE COOLING: SUPPLY AIR TEMPERATURE CONTROL



Energy recovery device uses free heat from building to warm outdoor air to required setpoint



PASSIVE COOLING IN PASSIVE HOUSE

- Need the right climate zone
  - Miami – Not good!
  - Canada (zones 4 to 8) support passive cooling
- Passive House projects are typically decentralized systems
  - VRF, WHSP, Fancoil, etc.
  - All air systems are rare
- Passive House projects have ventilation systems

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Leveraging the Ventilation System

PASSIVE HOUSE MURBs

- Volume to surface ratio much higher than single family dwellings
  - More internal heat
- Compared to Commercial spaces, MURBs have internal heat gains
- Each apartment is treated as a single HVAC control zone
  - Separate heating and AC controls
  - Tends to promote decentralized HVAC systems like VRF, WSHPs, fancoils etc
- There is some form of ventilation unit
  - Decentralized (one per apartment)
  - Centralized (several apartments using common ventilation unit)

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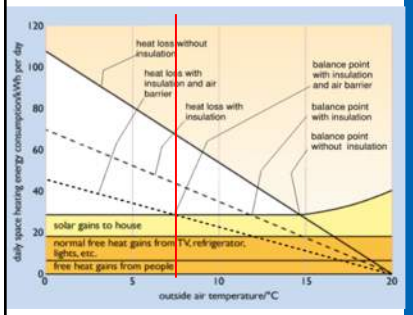

Dan Nall, Syska Hennessy

LOW BALANCE POINT

- Passive House is very well insulated with very low leakage rates
- Leads to a very low "Balance Point"
  - The ambient temperature when the building swings from needing heat to needing cooling
- Passive House balance points are around 0 °C
- Building will need cooling when it is cold outside
- An automatic air conditioning system will try and operate
  - Can be hard on the equipment
- Balance point will be reached on south side first
  - Going to have some zones in heating mode and others in cooling mode
  - Passive shading may not work (too early)

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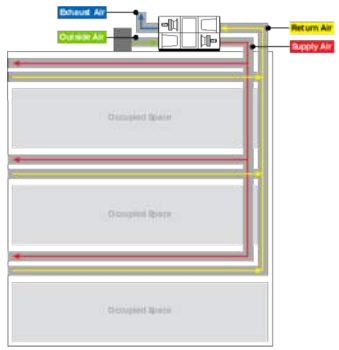

VENTILATION SYSTEM

- Ventilation airflow rates usually selected for
  - Meeting Indoor Air Quality (IAQ) goals
  - Providing air balance in building
- Passive House requirements in MURBS
  - Setback (~ 20% less)
  - Normal
  - Boost mode (~20% more)
- Opportunity to increase design airflow rate to deliver more passive cooling
- Reset airflow rate based on
  - Outdoor air temperature
  - Return air temperature
  - "Average" zone temperature

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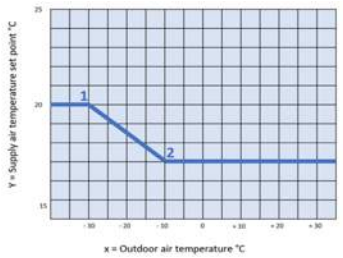

VENTILATION AIR TEMPERATURE RESET

- Can reset supply air temperature based on outdoor air temperature
- 72 °F (22°C) in winter
- Reset closer to 55 °F (12.8 °C) in shoulder weather
- Could reset supply air temperature based on return air temperature
  - Hotter return air temperature means more cooling is required
  - Not recommended
  - Return air is a "blend" of multiple zones
  - Not a good proxy for building load

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LEVERAGING THE VENTILATION SYSTEM
POTENTIAL COOLING CAPACITY FROM VENTLATION AIR

Space Temperature (°F)	Supply Air Temperature (°F)	Airflow Rate (cfm)	Sensible Cooling Capacity (Btu/h-ft²)
75	55	0.11	**2.4**
75	55	0.165	**3.6**
75	50	0.11	**3.0**
75	50	0.165	**4.5**
75	45	0.11	**3.6**
75	45	0.165	**5.4**
78	55	0.11	**2.7**
78	55	0.165	**4.1**
78	50	0.11	**3.3**
78	50	0.165	**5.0**
78	45	0.11	**3.9**
78	**45**	**0.165**	**5.9**

Realistically get between 4 and 5 Btu/h-ft² Passive cooling

3

Zone Control

ZONE CONTROL

- Main issue with using ventilation system for passive cooling it will treat all apartments the same
- All apartments will experience any adjustments to supply air temperature or supply airflow amount
  - North side and south side

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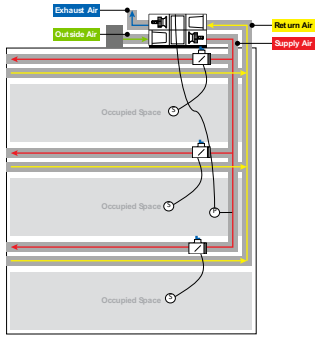

ZONE CONTROL

- Ventilation unit has variable flow fans
  - Typically controlled by supply duct pressure
- Each zone (apartment) has independent control zone damper that can vary the ventilation airflow based on apartment needs
- Can vary airflow based on;
  - Ventilation requirement (Setback – Normal – Boost or DCV (CO_2))
  - Temperature (passive cooling)
  - Humidity (dry space in winter)

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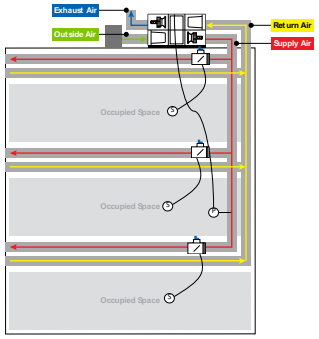

ZONE CONTROL

- Temperature Sensor - Winter
  - Normal ventilation airflow
  - Control heat source for supplemental heating (i.e. EBB)
- Temperature Sensor – Summer
  - Increase ventilation rate for passive cooling
  - Control cooling source (if available)

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CONTROL DAMPERS

- Independent Dampers
  - Measure airflow and adjust damper position to deliver required airflow regardless of upstream pressure
- Actuator
  - 24V
- Controller
  - Necessary control sequences
  - Requires a Zone sensor (Temperature, Humidity, CO_2 etc.)
- Standalone or Digital communications
  - BACnet, Lonworks, Modbus etc.

5" Damper Performance	
Min. Airflow	19 cfm
Max. Airflow	190 cfm
APD	0.12 in. w.c.

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Real World Lessons Learned

STILL EARLY DAYS

- Hundreds of projects in design , construction and commissioning
  - Not Many with more than years worth of operational data
- Design concepts being adjusted based on lessons learned from commissioning and initial operation

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MECHANICAL COOLING IN APARTMENTS

- New York often has mechanical cooling
- Several projects built with ventilation rates at "boost" level
  - More passive cooling
- Cooling is coming on sooner than expected
- Betances V under construction
  - Zone Control

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PASSIVE COOLING WITH SUPPLEMENTAL COOLING AT VENTILATION UNIT

- No zone control
- Resetting supply air temperature on
  - Return air temperature (poor results)
  - Outdoor air
- Additional mechanical cooling for summer
  - Occupant dissatisfaction - too hot
  - Mechanical cooling issues took a while to resolve

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PASSIVE COOLING

- Ventilation Air distributed by façade
  - Airflow control in the shafts
- Mechanical cooling at ventilation unit

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CONTROL DAMPERS

- Western BC
- Variable airflow ventilation unit
  - VRF supplemental heating and cooling
- Has Setback – Normal - Boost Control
- Electric BB heating
- VAV Cooling via ventilation airflow

- Ventilation unit uses supply air temperature reset
  - Passive cooling
  - Mechanical cooling (VRF)

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SUMMARY

Passive House has low Balance Point

Low Balance point causes a need for cooling during cool weather that can be met with passive cooling

Ventilation Systems Can be Used For Passive Cooling

The Ventilation system can be enlarged to deliver 4-5 Btu/h-ft² of passive cooling

Controlling Passive Cooling is Challenging

Single zone cooling control is proving to be problematic

Zone control should resolve issues but adds complexity

TWO FUTURE PASSIVE HOUSE TOWERS THERE