

Design of the PH heating/ventilation system

26 March 2010



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Regional PassiveHaus Northwest Gathering
2010



Summary, Mechanical Systems in Passive

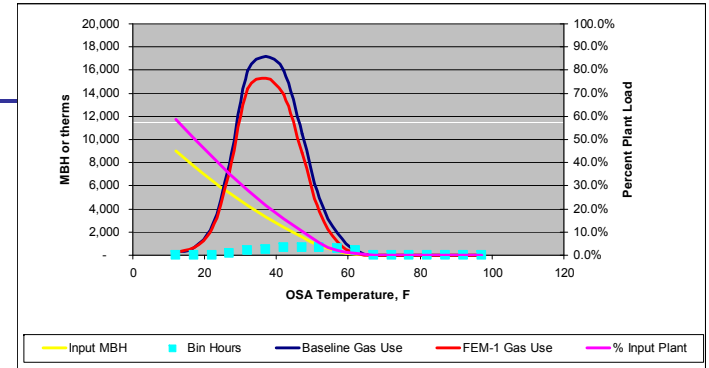
Houses
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- Glossary for the non-engineer
- Unique aspects of PH mechanical systems
- System options / variations (esp. for NW climate)
- Interaction between mech system and other uses (hot water, dryer, lights)
- Ducts / diffusers (locations, layout, products)
- Controls (how and why)
- Integration of Renewables
- Basics of equipment sizing

Glossary for the non-engineer

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- Ventilation
- Peak heating/cooling load
- Load vs. consumption
- Supply-, return-, outside-, exhaust-air
- OA economizer
- Types of heating Equipment



Unique aspects of PH mechanical systems

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- Low air flow rates
- Variable speed fans
- Low supply air speeds into space
- Little/no temperature stratification in bldg.
- 100% outside air system
- Ultra-low flow-resistance ductwork



System Options in moderate Pacific Northwest

Climate
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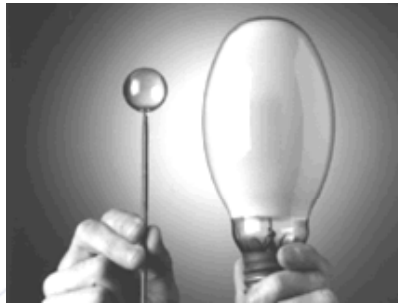
- Heat or energy recovery ventilator
- Heating options:
 - Electric resistance (air / hydronic)
 - (Air-Source) Heat pump (S.S.)
 - Wood / Natural Gas (hydronic)
 - Solar (air / hydronic)
- Cooling options:
 - Prevention³ + passive cooling (+ waste “coolth”)
 - Earth tube
 - (Hydronic Coil)
 - (Air-Source) heat pump



Interaction w/ other systems

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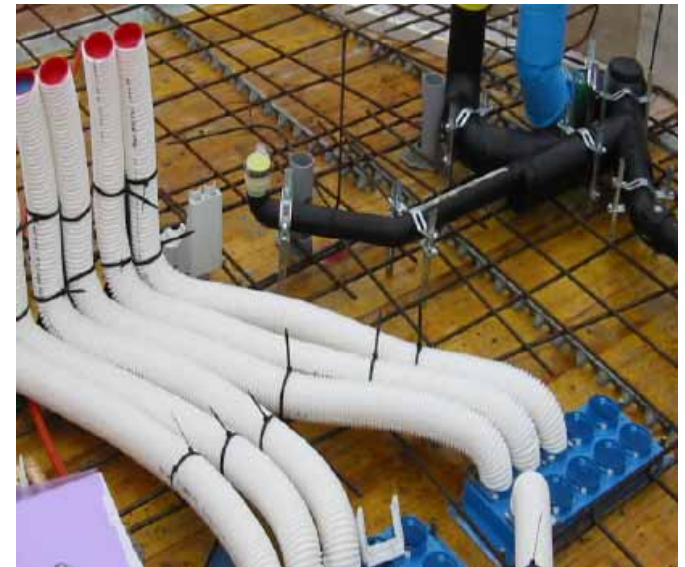
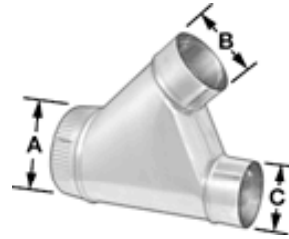
- Domestic hot water
- Stove / Hood
- Dryer
- Lights
- Fridge
- Other appliances, gadgets



Air transport and delivery

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- Ducts
- Diffusers, Return grilles
- Transfers
- Silencers
- T&B



Controls

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- KISS
- Temperature
- Supply Air flow rate
- (Outside Air flow rate)



Test	Inlet Water <i>F</i>	Water Flow <i>GPM</i>	Air Flow <i>CFM</i>	Inlet Air <i>F</i>	Outlet Water <i>F</i>	Outlet Air <i>F</i>	DP Fan <i>in. wg.</i>	Capacity <i>Btu/hr</i>
Options For Post Heat (Space Conditioning)								
1	160	2.5	200	55	152.8	95.7	0.02	8777
2	160	2.5	200	65	153.5	102.0	0.02	7,972
3	160	5.0	200	65	156.6	103.9	0.02	8,393
4	160	2.0	100	65	153.7	123.5	0.01	6,220
5	120	2.0	200	65	115.5	85.9	0.03	4,452
6	120	5.0	200	65	118.1	87.2	0.02	4,783
7	120	2.5	100	65	117.1	98.8	0.01	3,585

Integration of Renewables

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- **Electric systems**
 - Photovoltaics
 - Micro-Hydro
 - Micro-Wind
- **Solar Thermal**
 - Hot Water
 - Air collectors



Equipment sizing, basics

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ECM Description and Energy Use									
General: This ECM proposes to reduce operation of heating water loop pumps via implementation of new controls that will turn off pumps during unoccupied period.									
Calculative: Hours of operation and correct load calculation. kWh = kW x hours/yr. Load and hours of operation are derived from short term datalogging. kWh = volts x amps x (phase) x 60000									
Baseline									
Equipment	amp	volt	phase	kt. assumed	kwh_cac	kwh/yr	kwh/yr	kwh/yr	kwh/yr
Pump 2 (50)	22.97	480	3	0.75	13.20	8760	120,221		
Pump 3 (100)	26.72	480	3	0.75	15.97	8760	139,893		
ECM									
Equipment Operation schedule									
Average Week					Annual Variation				
Day	Start	Stop	Run hours	Percent of year non-typical	10%				
1 Sunday	00:00	00:00	0	100%					
2 Monday	00:00	17:00	12:00	100%					
3 Tuesday	00:00	17:00	12:00	100%					
4 Wednesday	00:00	17:00	12:00	100%					
5 Thursday	00:00	17:00	12:00	100%					
6 Friday	00:00	17:00	12:00	100%					
7 Saturday	00:00	00:00	0	100%					
8 One shift			60:00		4000.4				
Savings									
Equipment	amp	volt	phase	kt. assumed	kwh_cac	kwh/yr	kwh/yr	kwh/yr	kwh/yr
Pump 2 (50)	22.97	480	3	0.75	13.72	2,090	28,668		
Pump 3 (100)	26.72	480	3	0.75	15.97	2,090	33,300		
Baseline energy use: 260,103 kWh/yr									
ECM energy use: 62,869 kWh/yr									
Energy savings: 197,235 kWh/yr									

- Ventilation (V in cfm)
 - PHPP, “Ventilation“ tab or ASHRAE 62
- Heating (Q in Btu/hr)
 - PHPP, “Heat Load“ tab, Q84 (+ ?? %)
- Equipment sizing
 - Coils: rated capacity in Btu/h or Watts
 - Air: $Q = 1.085 \times V \text{ (cfm)} \times \Delta T \text{ (}^\circ\text{F)}$
 - Hydronic: $Q = 500 \times \text{GPM} \times \Delta T \text{ (}^\circ\text{F)}$

Questions...

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The End (or the beginning?)

