NEHERS Webinar

Modeling Mechanicals Consistently

NEHERS
NORTHEAST HOME ENERGY RATING SYSTEM ALLIANCE

THE BER
BUILDING EFFICIENCY RESOURCES

September 20, 2017

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Agenda

- Mechanical efficiency impact on HERS Index
- Space Heating
- Space Cooling
- Heat Pumps
- Water Heating

Mechanical Efficiency

- Important terms
  - End use load (EUL)
    - The items that cause energy to be used
      - Example: envelope features, window solar gain, infiltration, pipe heat loss, etc
    - Separated for heating, cooling, water heating
  - Coefficient of Performance (COP)
    - The ratio of energy output to energy input
      - Example: 95% AFUE Furnace = 0.95 COP
      - Example: 9 HSPF ASHP = 9/3.412 = 2.64 COP

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Mechanical Efficiency

The Energy Consumption equation:

EC = EUL/COP

Mechanical Equipment Properties Summary

#	Type	Htg Eff
1	92AFUE Gas Furn 93k***********	92.0 AFUE
2	14SEER A/C 5 ton***	
3	Demand-Propane0.96EF******	

Annual Loads (MMBtu/yr)	
Heating	146.5
Cooling	5.0
Water Heating	14.1
WH w/out Ta...	14.1
Annual Consumption (MM...	
Heating	162.1

146.5/0.92 = 159.2 MMBtu/yr

Eae = 889 *3.412/1000 = 3 MMBtu/yr

159.2+3 = 162.1 MMBtu/yr

(Slight reduction due to modified Eae)

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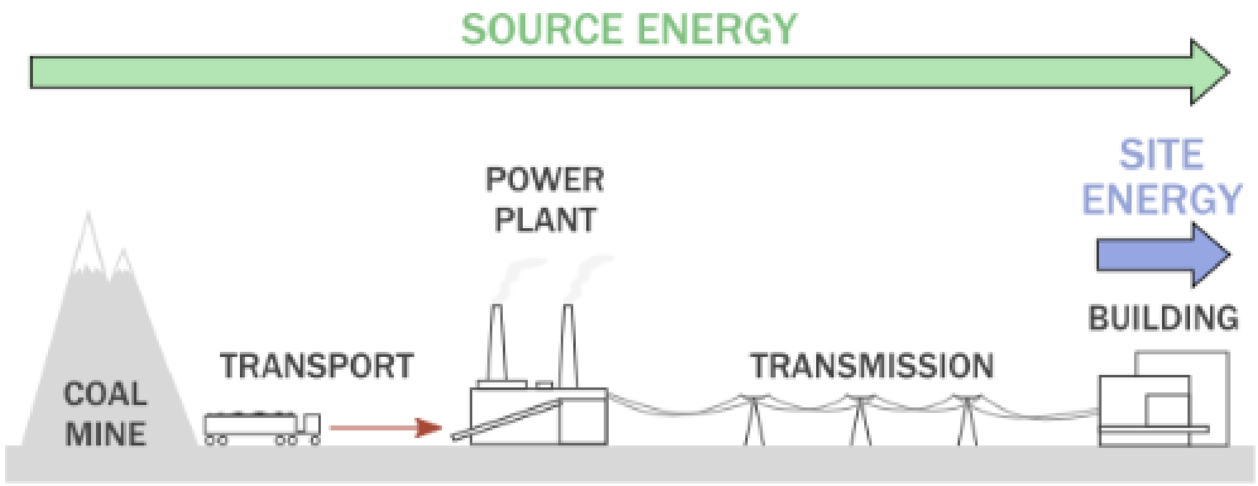
Brief History of HERS

- "Original" Method – Jul '95- Jan '96
  - 100 point scale;
    - 100 = zero energy home
    - 1993 MEC = 80 Score
    - Point score = 100 - 20 * (ER / EC)
  - Product of Rated vs Reference <u>energy consumption</u>
  - Problem
    - Not fuel neutral; electric systems have inherently higher COP
    - Electric vs gas different "source energy" considerations

Site Energy vs. Source Energy



- For electricity, the source energy burden for production is relatively large, yielding a site-to-source energy multiplier of about 3.16 for electricity
- For fossil fuels, the source energy burden for production is relatively small, yielding a site-to-source energy multiplier of about 1.09 for natural gas.

FSEC

Electric vs Gas

- Home design load 50 kBtu/h
- 30k Electric Furnace - COP = 1.0
  - Output capacity = 30 x 3.412 = 102.4 kbtu/h
  - 50/ 102.4 kbtu/h = 0.49 kbtu /3.412 = 0.14 kwh
  - Source energy: 0.14 x 3.16 = 0.44 kwh
- 100k 95% Gas Furnace - COP = 0.95
  - 50/ 95 kbtu/h = 0.53 kbtu /.95 = 0.55 kbtu
  - 0.55/3.412 = 0.16 kwh
  - Source energy: 0.16 x 1.09 = 0.17 kwh

  - 0.44/0.17 = 2.6 less source energy used in gas

Brief History of HERS

- "Modified End Use Load" (MEUL) method - Aug '96- Sept '99.
  - Modifies consumption so that it is comparable to the Reference EUL $MEUL = REUL*(EC_{Act}/EC_{Ref})$
  - Basing rating off of loads, instead of consumption, attempted to resolve issues
    - Fuel neutral - ie, gas system in Rated Home compared against gas system in Reference
    - Site vs source neutral; loads aren't consumption, they cause consumption.

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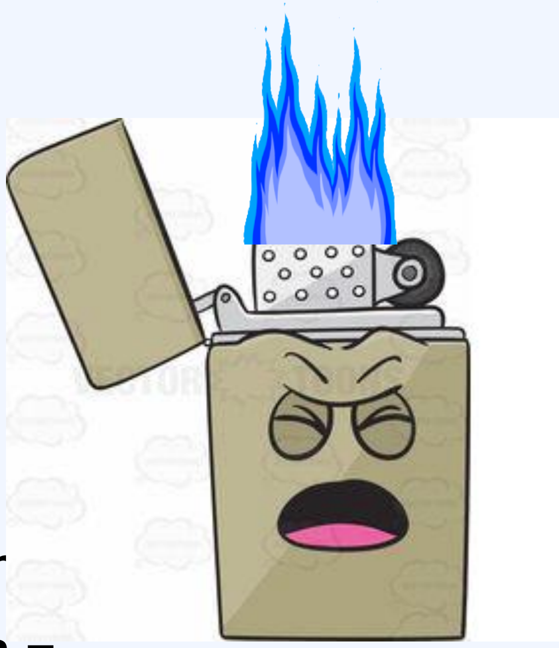
Brief History of HERS

- MEUL “Problems”
  - Gas producers still cry “foul”
    - Electric grid still dirtier; efficiency should be “handicapped”
  - Gas systems have limits on efficiency potential
    - Best gas furnace = 98.7 AFUE; Fed. Min =78 AFUE
      - 98.7/78 = 127% potential efficiency gain
    - Best electric heat ~ 5 COP; Fed. Min = 7.7 HSPF (2.3 COP)
      - 5/2.3 = 217% potential efficiency gain



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Brief History of HERS

- "Normalized Modified End Use Loads" (nMEUL) method – Sept '99-current

4.1.2. Calculating the Energy Rating Index. The Energy Rating Index shall be determined in accordance with Equation 4.1-2:

$$\textbf{Energy Rating Index} = \textbf{PEfrac} * (\textbf{TnML} / \textbf{TRL}) * \textbf{100} \qquad \textbf{(Eq 4.1-2)}$$

$$TnML = nMEUL_{HEAT} + nMEUL_{COOL} + nMEUL_{HW} + EUL_{LA}\ (MBtu/y).$$
$$TRL = REUL_{HEAT} + REUL_{COOL} + REUL_{HW} + REUL_{LA}\ (MBtu/y).$$

  - 2006: MINHERS changed from "HERS Score" to "HERS Index"
  - 2017: ANSI/RESNET 301-2014 changed HERS Reference from 2004 IECC to 2006 IECC

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Brief History of HERS

- nMEUL method
  - Uses coefficients to "normalize" efficiency potential of gas and electric systems

4.1.1. Calculating End Use Loads. The normalized Modified End Use Loads (nMEUL)
for space heating anc
accordance with Equ

nMEUL = REU

where:
nMEUL = norma
comp
REUL = Refer
comp
nEC_x = norma
including Auxiliary Electric Consumption, cooling or hot water) as computed
using an Approved Software Rating Tool.

where:

EC_x = estimated Energy Consumption for the Rated Home's end uses (for heating, including Auxiliary Electric Consumption, cooling or hot water) as computed using an Approved Software Rating Tool.

EEC_x = Equipment Efficiency Coefficient for the Rated Home's equipment, such that EEC_x equals the energy consumption per unit load in like units as the load, and as derived from the Manufacturer's Equipment Performance Rating (MEPR) such that EEC_x equals 1.0 / MEPR for AFUE, COP or EF ratings, or such that EEC_x equals 3.413 / MEPR for HSPF, EER or SEER ratings.

EC_r = estimated Energy Consumption
heating, including Auxiliary Ele
computed using an Approved S

and where:

nEC_x = (a* EEC_x – b)*(EC_x * EC_r *

Table 4.2.1(1) Coefficients 'a' and 'b'

Fuel type and End Use	a	b
Electric space heating	2.2561	0
Fossil fuel* space heating	1.0943	0.4030
Biomass space heating	0.8850	0.4047
Electric air conditioning	3.8090	0
Electric water heating	0.9200	0
Fossil fuel* water heating	1.1877	1.0130

*Such as natural gas, liquid propane gas, fuel oil

Brief History of HERS

- **Summary**
  - HERS Index primarily product of EULs, <u>modified</u> to equalize fuel source to consider site vs source energy, <u>normalized</u> for relative efficiency potential of electric vs gas mechanicals
  - Getting system efficiency correct crucial for fair comparison!
    - Especially for cold-climate electric heating!

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Mechanical COP and Code

- Prescriptive (including UA Tradeoff)
  - Code is equipment neutral
  - No gain or penalty for mechanical system efficiency (must meet Fed Min)
- Performance (R405 Simulated Performance)
  - Reference and Design Homes have same equipment efficiency
    - Must meet Fed Min, or Design Home penalized
    - Electric resistance in Design Home compared to Fed Min ASHP

Space Heating

- Air distribution systems
  - Furnaces
  - “Hydro-air”
- Hydronic distribution systems
  - Boilers
  - DHWs as space heat
- Unit/radiant heaters
  - Electric resistance
  - PTACs
  - Masonry heaters/wood stoves

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Space Heating

- Air Distribution Systems
  - Any system that has air ducts
    - Must model areas, floor area served, % duct locations, R-values,and test them for leakage!
    - Affects Distribution System Efficiency (DSE)
    - Can be any fuel (gas, propane, electric, etc.)
  - Furnaces
    - Fuel : Consult AHRI for AFUE and Capacity
    - Electric : 100 %EFF or 1.0 COP, capacity based on manf. Listed electric coil capacity
    - Coal/wood/pellet furnaces: consult EPA BurnWise or manf for efficiency/capacity

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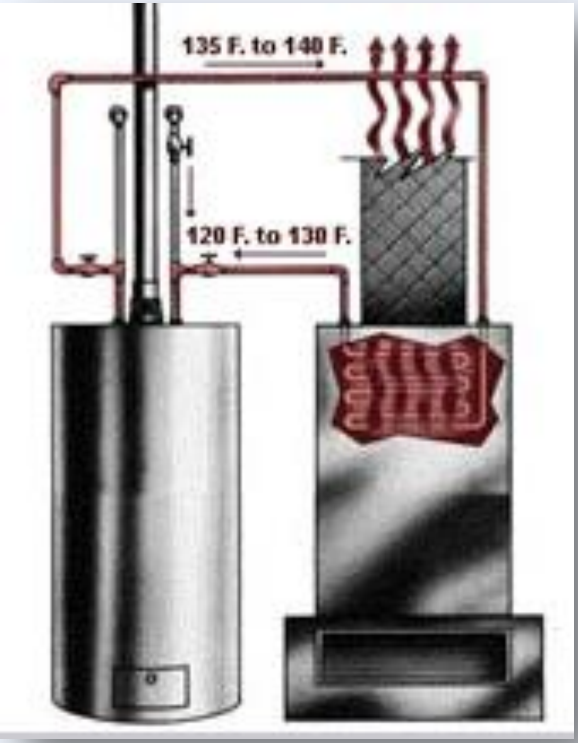
Space Heating

- **Air Distribution Systems**
  - Hydro-air systems
    - Separate appliance provides hot water, run through a coil in the AHU (typically a boiler)
    - Model "air distribution" system, not "hydronic"
      - Must attach system to ducts!
      - Efficiency = efficiency of hot water producing appliance
      - Capacity = based on hot water coil data



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Space Heating

- Hydro-air systems
  - Nuances
    - Use Recovery Efficiency (RE) where DHW provides hot water
    - Where water heating producing appliance feeds indirect-fired storage tank prior to hot water coil, use efficiency x 0.92 or commercial EF calculator
    - Oversized systems with high return water temps may not achieve true efficiency for condensing units

Space Heating

- Hydronic Distribution Systems
  - Uses pipes to distribute hot water, either in-floor or to baseboard radiators
    - Can be any fuel (gas, propane, electric, etc.)
  - Boilers
    - Fuel boilers: AFUE, Capacity from AHRI
    - Electric boilers: 100 %EFF or 1.0 COP, capacity based on electric coil capacity
    - Coal/wood/pellet boilers: consult EPA BurnWise or manf for efficiency/capacity

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Space Heating

- Hydronic systems
  - Nuances
    - DHW used for hydronic distribution model RE as %EFF
    - HPWH as hydronic distribution, use EF as COP
    - GSHP hydronic
      - Can be modeled in both REM and Ekotrope.
      - Desuperheater can be modeled in REM; tricky in

Space Heating

- Unit/radiant heater
  - Could be radiant, thru-wall PTAC, fan coil unit (FCU), wood stove, etc.
  - Can be any fuel (gas, propane, electric, etc.)
    - Fuel-fired unit heaters: AFUE, Capacity from AHRI (Direct Heating Equipment), manf. data
    - Electric baseboard/radiant: 100 %EFF or 1.0 COP, capacity based on electric coil capacity
    - Coal/wood/pellet stoves: consult EPA BurnWise or manf for efficiency/capacity

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Space Heating

- Auxiliary Electric consumption
  - Fans, pumps, igniters, burners, etc.
  - Fuel-fired furnace EAE is AHRI rated annual auxiliary electric in kWh/yr
    - Product of motor size and type (ECM vs PSC)
    - REM adjusts for furnace based on actual system runtime.
  - Hydronic pumps, hydro-air AHUs, PTAC/unit heater blower fans, etc. should be modeled with manf. rated watts

Space Cooling

- Typical system
  - Electric direct expansion (DX)
    - Use vapor compression of refrigerants and outdoor air to dissipate heat to achieve cooling and COP > 1.0
  - Split/packaged air distribution systems
    - Efficiency (SEER) and capacity per AHRI, or manf. data
      - AHRI match may include indoor / outdoor coils + furnace
    - Must be attached to ducts
    - SHF – ratio of sensible to total capacity. Default 0.70
      - Could be modified per expanded system performance tables
  - PTACs / window units
    - Rated in EER; capacity per manf data
    - No ducts

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Space Cooling

- Other systems
  - Absorption chillers
    - Natural gas fired; very rare
  - Evaporative coolers
    - Cool by blowing dry air over moist pad; provide evaporative cooling
    - Most appropriate in very dry climates
  - Whole-House Fans
    - Rated in “ventilation” page of REM (not available in Ekotrope)
    - Used for “night flush” cooling
    - Very effective in dry climates with high diurnal swings
    - Must move a lot of air (5 ACH) to be rated

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Heat Pumps

- Air-Source Heat Pumps (ASHP)
  - Conventional air-to-air systems
  - Inverter/Variable Refrigerant Flow (VRF)
  - Dual-fuel heat pumps
  - Air-to-water systems

- Ground-Source Heat Pumps (GSHP)
  - Water-to-air vs water-to-water systems
  - GLHP vs GWHP vs WLHP
    - Open vs Closed loop

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Heat Pumps

- Air-Source Heat Pumps
  - Electric DX refrigerant systems that can run in reverse to produce heat
  - Conventional air-to-air systems
    - AHRI rating for efficiency (HSPF), capacity at 47°/17°
      - Rating at CFR Climate Region IV
    - COP, capacity drops significantly with colder temps
      - FSEC "Climate Impacts" study
    - Typically has electric resistance strip heat as back-up for cold weather capacity
      - REM: add the backup kwh
      - Ekotrope: software automatically assumes electric resistance once system capacity can no longer meet load

Heat Pumps

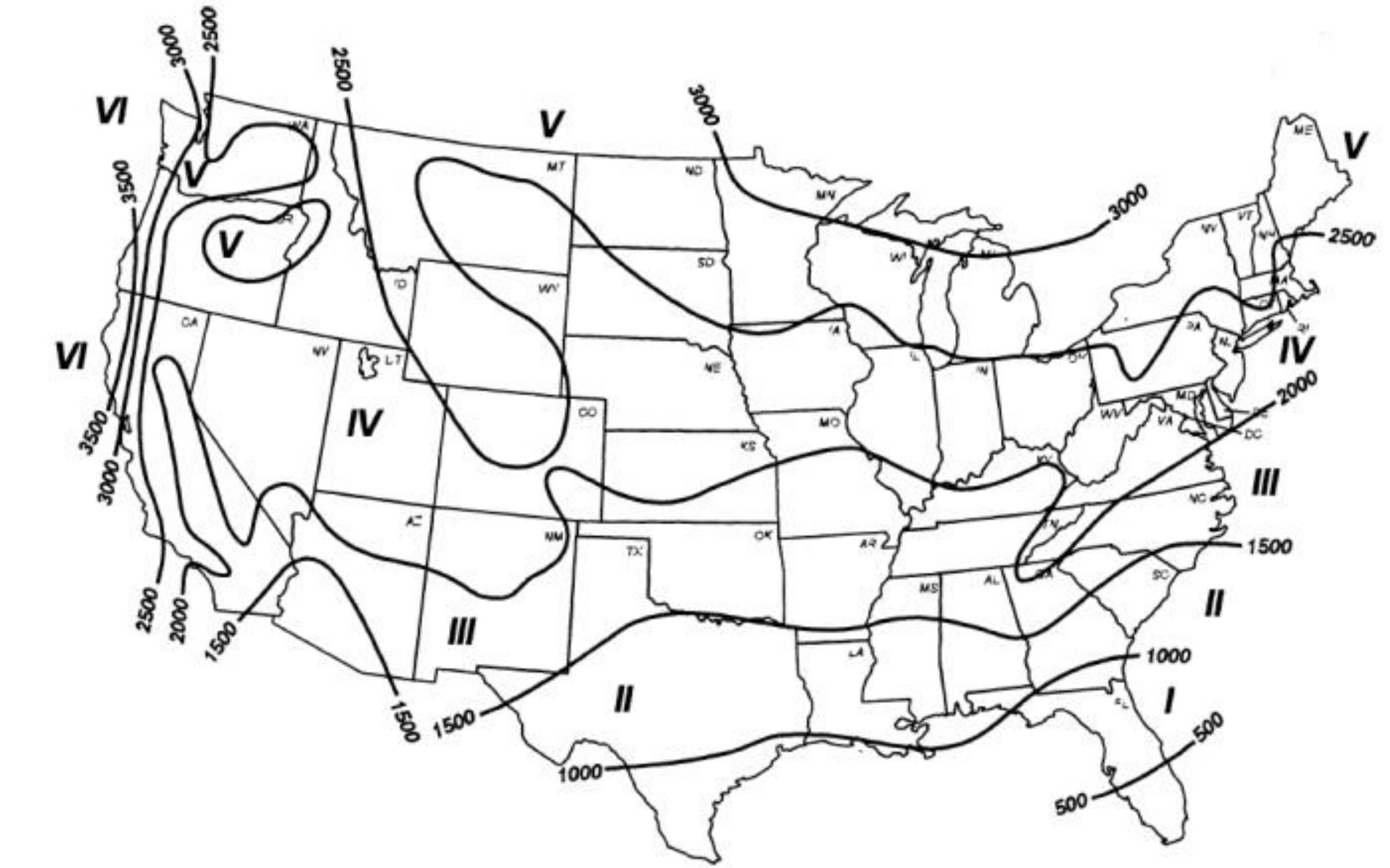
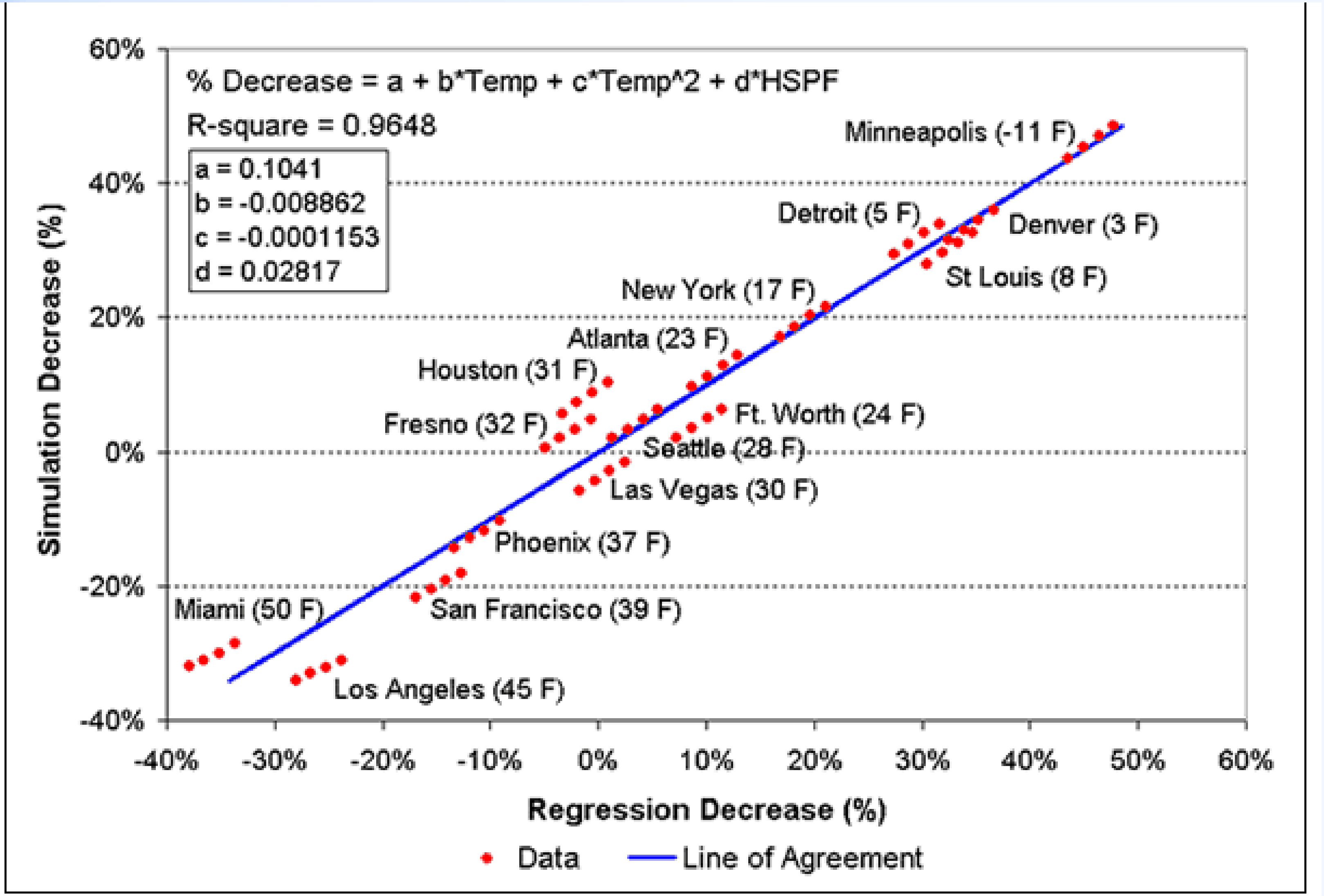


Figure 2 Heating Load Hours (HLH_A) for the United States

Heat Pumps



% Decrease = a + b*Temp + c*Temp^2 + d*HSPF
R-square = 0.9648
a = 0.1041
b = -0.008862
c = -0.0001153
d = 0.02817
Minneapolis (-11 F)
Detroit (5 F)
Denver (3 F)
St Louis (8 F)
New York (17 F)
Atlanta (23 F)
Houston (31 F)
Fresno (32 F)
Ft. Worth (24 F)
Seattle (28 F)
Las Vegas (30 F)
Phoenix (37 F)
Miami (50 F)
San Francisco (39 F)
Los Angeles (45 F)
60%
40%
20%
0%
-20%
-40%
Simulation Decrease (%)
-40%
-30%
-20%
-10%
0%
10%
20%
30%
40%
50%
60%
Regression Decrease (%)
Data
Line of Agreement

Heat Pumps

- Air-Source Heat Pumps
  - Inverter/VRF systems
    - Computers control variable-speed compressors and terminal units to produce higher efficiency, greater capacity at cold temps
    - AHRI rating for efficiency (HSPF), capacity at 47°/17°
    - Most people think of wall-mounted "mini-splits", but also come in ducted versions
    - Greatest efficiency with ductless units
      - Minimal drag on interior head, small fan motors

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Heat Pumps

- Air-Source Heat Pumps
  - Modeling Inverter/VRF systems
    - NORESCO
      - Model inverter heat pumps in Space Heating library, GSHP system type
      - Eliminates climate reduction factor; wells face 55º
      - For cooling, IEER as SEER
      - Don't model resistance backup (unless its installed; rare)
    - Ekotrope and Philip Fairey
      - Don't model ASHPs as GSHPs
      - Even if climate reduction factor is moderated, it is not eliminated
      - Ekotrope uses climate derating on GSPHS; a bug
    - RESNET Standards mum

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Heat Pumps

- Air-Source Heat Pumps
  - Modeling Inverter/VRF systems
    - Conservative approach: model in ASHP library; climate adjustment will reduce system COP
      - HSPF already attempts to take into account seasonal performance over range of temperatures
    - Integrative approaches:
      - PHIUS approach: estimate seasonal performance based on average monthly temps and COPs at a min of 2 temps
        - » If average COP can be derived, modeling as "GSHP" would be appropriate
      - Use hourly simulation-based modeling tool that can estimate performance of variable speed compressor

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Heat Pumps

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Instructions:**													
2	1) Copy and "Paste Special-->Values" your average ambient temperature from the CLIMATE sheet into row 8													
3	2) Copy and "Paste Special-->Values" the monthly heating demand from the MONTHLY sheet (cells T31 through AE31) into row 9													
4	3) Get the heating performance data from the heat pump manufacturer (see example) for 47F and 17F outdoor temperatures. Enter it in cells b17													
5	4) The result in cell B13 is an estimate for the annual heating COP for this equipment, for this house and in this climate location													
6														
7	**Month**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
8	**Average ambient temperature (F)**	16.5	21.2	27.0	46.8	57.0	62.6	69.4	67.3	59.9	47.1	33.4	23.2	
9	**Heating demand from Monthly Sheet (kBtu/ft2)**	1.15	0.62	0.44	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.65	1.22	**4.11**
10	**Monthly average COP (W/W)**	3.00	3.23	3.51	4.49	4.99	5.27	5.61	5.50	5.14	4.51	3.83	3.33	
11	**Monthly weighted COP*heat demand**	3.46	1.99	1.53	0.06	-	-	-	-	-	-	2.47	4.05	**13.57**
12														
13	**Average annual COP**	**3.30**												
14														
15														
16	**Manufacturer's data:**	**Rated COP**	**Ambient Temperature (F)**											
17	Mitsubishi MSZ/MUZ-FE09	4.50	47											
18		3.02	17											
19	Slope per F	0.05												
20	Intercept	2.18												
21														

- **PHIUS approach: site specific COP**
- **Average demand/temps, manf COP rating at 2 temps creates average COP**

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Heat Pumps

Brian,

Thanks for the reply.

I think some people were concerned that by using the GSHP library and not facing a climate reduction factor for heat pump performance in cold climate whatsoever, we may be overstating the

Hi Chris,

Until I've had the chance later this year to do the research and thinking about ASHP systems that I mentioned earlier, I don't have an opinion on your concern or suggested interim approach.

I will say that there are wide disagreements between the ASHP results for all 6 HERS software tools that have been engaged in the RESNET Software Consistency Task Group, so it is fair to say there is as yet no consensus on what the consumption results should be -- for ANY air source hp systems, let alone the inverter driven models.

- Split it 50/50 ; 50% ASHP and 50
  - Take some, but not full credit for
  - Industry still split/undecided on h

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Heat Pumps

- Air-Source Heat Pumps
  - Dual-fuel heat pump
    - Uses ASHP at mild temps; switches to fuel-fired furnace when cold
      - Maintains higher COP of ASHP
    - AHRI: combo rating of indoor, outdoor and furnace
      - HSPF, capacity, SEER, capacity
      - Search for furnace efficiency/capacity @47° separately

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Heat Pumps

- Air-Source Heat Pumps
  - Dual-fuel heat pump
    - Modeling
      - REM: Dual-Fuel Heat Pump library
        - » Ask HVAC contractor for switch over temp
      - Ekotrope: no clean way to model.
        - » Need to model both and estimate a % load served
        - » Need to model 2 duct systems

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Heat Pumps

- Air-Source Heat Pumps
  - Air-to-water heat pump (aka hydronic HP)
    - Similar to inverter ASHPs, but create heated/chilled water
    - No AHRI rating. Use manf efficiency/capacity data
    - Modeling
      - Where used w/ air handler
        - » If manf COP rating includes fan watts, no adjustment. If not, either must include adjustment or model fan watts additionally
      - Where hydronic/radiant
        - » If manf COP rating includes pumps, no adjustment. If not, either must include adjustment or model pump watts additionally

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Heat Pumps

- Ground-Source Heat Pumps
  - Electric systems that use the ground or bodies of water as a heat exchange source
    - Use water or glycol mixture, pumped through ground or body of water, into a heat exchanger
      - Both the earth and deep bodies of water maintain fairly consistent ~55° year round temps
      - No or minor climate adjustment factors to COP
  - Water-to-air vs water-to-water systems
    - W2A pump exchanged fluid into forced air system
    - W2W pump exchanged fluid into hydronic system

Heat Pumps

- Ground-Source Heat Pumps
  - GLHP vs GWHP vs WLHP
    - Ground Loop Heat Pump (GLHP)
      - Typical inland system; closed-loop
      - Use vertical or horizontal wells/trenches with closed piped loops ran through ground or body of water
    - Ground Water Heat Pump (GWHP)
      - Open loop system connected to ground water source
      - Pumps fluid directly to heat exchanger
    - Water Loop Heat Pump (WLHP)
      - Open loop system connected to body of water
      - Pumps fluid directly to heat exchanger

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WLHP (Water-Loop Heat Pumps)	Full Load	Part Load
Cooling Capacity(Btuh)	26000 / 26000	18800 / 18800
Cooling EER Rating(Btuh/watt)	16.00 / 16.00	17.50 / 17.50
Cooling Fluid Flow Rate(gpm)	6.00 / 6.00	6.00 / 6.00
Heating Capacity(Btuh)	30000 / 30000	20500 / 20500
Heating COP(watt/watt)	5.00 / 5.00	5.10 / 5.10
Heating Fluid Flow Rate(gpm)	6.00 / 6.00	6.00 / 6.00
GWHP (Ground-Water Heat Pumps)		
Cooling Capacity(Btuh)	29000 / 29000	21000 / 21000
Cooling EER Rating(Btuh/watt)	24.00 / 24.00	30.00 / 30.00
Cooling Fluid Flow Rate(gpm)	6.00 / 6.00	6.00 / 6.00
Heating Capacity(Btuh)	25000 / 25000	18000 / 18000
Heating COP(watt/watt)	4.60 / 4.60	4.60 / 4.60
Heating Fluid Flow Rate(gpm)	6.00 / 6.00	6.00 / 6.00
GLHP (Ground-Loop Heat Pumps)		
Cooling Capacity(Btuh)	27500 / 27500	20000 / 20000
Cooling EER Rating(Btuh/watt)	18.70 / 18.70	24.50 / 24.50
Cooling Fluid Flow Rate(gpm)	6.00 / 6.00	6.00 / 6.00
Heating Capacity(Btuh)	19000 / 19000	15500 / 15500
Heating COP(watt/watt)	3.80 / 3.80	4.00 / 4.00
Heating Fluid Flow Rate(gpm)	6.00 / 6.00	6.00 / 6.00

- **Typical residential systems are closed-loop, GLHPs**
  - **Use this data above**
- **Heating efficiency = COP**
- **Cooling efficiency = EER**

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Heat Pumps

- Ground-Source Heat Pumps
  - Modeling
    - Systems w/ full & part load efficiency/capacity
      - Conservative approach: use Full Load data only
      - Integrative approach: model two systems, one with Part Load data and one with Full Load data
        - » Will require modeling two separate duct systems for W2A systems

Heat Pumps

- Ground-Source Heat Pumps
  - Modeling auxiliary electric of GSHP

$$\text{GSHP Auxiliary Electric Consumption (kWh/y)} = GSHP_{pump} - GSHP_{intp} + GSHP_{fanESP}$$

- Fan and pump power <u>must</u> be modeled!
  - AHRI COP/EER ratings do not include pump energy
  - Fan energy is at 0” ESP! additional fan watts to overcome static must be considered
  - If W2W, pump energy shall include both well pumps and hydronic distribution pump energy
  - If modeling “integrative approach”, fan/pump energy estimates should be at individual full/part load rates

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Heat Pumps

- Ground-Source Heat Pumps
  - Modeling loop characterizes
    - REM: ability to model ground-transfer characteristics of wells for closed systems
      - # Wells
      - Well depth
      - Loop flow (GPM)
    - Ekotrope: simplified method; no ground modeling
  - Using engineer/GSHP designer COP estimates
    - Unless you or your Provider are technically capable of interpreting and analyzing validity of estimates, don’t use. Use AHRI rated data

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Water Heating

- Water Heating
  - System Types
    - Domestic Water Heating (DHW)
      - Tank
      - Tankless
      - Indirect fired
      - Solar/despurheater
    - Central water heating (multifamily)
  - Distribution features
    - Pipe length/insulation/fixture volume
    - Recirculation
    - Drain water heat recovery

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Water Heating

- Domestic Water Heating (DHW)
  - Electric, natural gas, propane, oil
  - Conventional storage tank systems produce hot water and store it
    - Efficiency product of combustion % and standby loss
  - Tankless systems produce hot water on-demand
    - Efficiency product of combustion % and cycling
    - RESNET software auto-derates EF by 0.92
  - Both rated by AHRI for capacity and Uniform Energy Factor (UEF)

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Water Heating

- UEF: New DOE metric
  - HERS Ratings still require old Energy Factor (EF)
    - Using UEF from AHRI in ratings not correct
      - Most changes modest 0.01-0.03
    - RESNET calcs subcommittee creating conversions
  - If EF ratings needed now, use California Energy Commission Appliance Database
    - BER maintains database of legacy EF ratings

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Water Heating

AHRI Certified Reference Number: 6583231 Date: 1

Product: Residential Water Heaters
Model Number: PROG50-40N RU67 PDV
Manufacturer: RHEEM SALES COMPANY, INC.
Trade/Brand name: RUUD

Rated as follows in accordance with Depa
the latest edition of the Code of Federal R
accuracy by AHRI-sponsored, independen

Old Rating

Energy Factor:	
First Hour Rating:	

AHRI Certified Reference Number: 6583231 Date: 9/

Product: Residential Water Heaters
Model Number: PROG50-40N RU67 PDV
Manufacturer: RHEEM SALES COMPANY, INC.
Trade/Brand name: RUUD

Rated as follows in accordance with Department of Energy (DOE)
the latest edition of the Code of Federal Regulations, 10 CFR Part
accuracy by AHRI-sponsored, independent, third party testing:

New Rating

Uniform Energy Factor:	0.70
First Hour Rating:	89.0 Gallons per hour

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Fuel and Type	Usage Bin in UED Test		
	Low	Medium	High
Electric, Storage	UEF Lower	UEF Lower	UEF Higher
Gas, Storage		UEF Lower	UEF Higher
Oil Storage		UEF Lower	UEF Higher
Electric, Instantaneous	UEF Lower	UEF Lower	
Gas, Instantaneous			
Electric, Heat Pump			
Electric, Table Top	UEF Lo		
Electric, Grid Enabled			

BIN	BIN Daily Usage (Gallons)	First Hour Rating (Tank-Type Water Heaters)	Max GPM (Tankless Water Heaters)
Very Small	10	Less than 18 gallons	Less than 1.7
Low	38	18 to 51 gallons	1.7 to 2.8
Medium	55	51 to 75 gallons	2.8 to 4
High	84	75 gallons or larger	4 or more

Select Appliance Type

Select Category: Water Heater Products

Select Appliance: Small Gas & Oil Water Ht

Select Appliance Status: Approved

Select Fields to Display

- [ ] Select/Deselect All
- [x] Manufacturer
- [x] Brand
- [x] Model Number
- [x] Energy Source
- [ ] Pilot Light? (T/F)
- [ ] Heattraps
- [ ] Insulation Type
- [ ] Mobile Home?
- [ ] Rated Volume
- [ ] First Hour Rating
- [ ] Maximum GPM
- [ ] Input BTUH
- [ ] Recovery Efficiency
- [ ] Annual Energy Consumption KBTU
- [x] Energy Factor
- [ ] Energy Factor Std
- [ ] Pilot Light BTUH
- [ ] Tested Uniform Energy Factor (T/F)
- [ ] Regulatory Status
- [ ] Uniform Energy Factor
- [ ] Uniform Energy Factor Std
- [ ] Calculated: InputBTUH/RatedVolume
- [x] Add Date

Filters

Search | Clear

Search Results 12597 record(s) found

Export To: Excel | CSV

		Manufacturer	Brand	Model Number	Energy Source	Energy Factor	Add Date
Select		Vesta DS Inc	VESTA DS INC	VRS-199	Natural Gas	0.92	08/24/2017
Select		Vesta DS Inc	VESTA DS INC	VRS-199	LPG	0.92	08/24/2017
Select		Vesta DS Inc	VESTA DS INC	VRP-199	Natural Gas	0.92	08/24/2017
Select		Vesta DS Inc	VESTA DS INC	VRP-199	LPG	0.92	08/24/2017
Select		Vesta DS Inc	VESTA DS INC	VRP-150	Natural Gas	0.91	08/24/2017

Water Heating

- Commercial-rated storage tanks
  - Typically larger volume units 75 gal+
  - Rated by AHRI fo
    Thermal Efficien
    Standby loss
  - Use EF Calculator
    estimate
    - Recovery efficie
      thermal efficienc

AHRI Certified Reference Number: 7057287

Product: Commercial Water Heaters
Model Number: BL 100 100
Manufacturer: A.O. SMITH WATER PRODUCTS CO.
Trade/Brand name: A.O. SMITH

This certificate serves as verification that the model has testing methods and verified by AHRI as capable of achi tested within prescribed tolerances. The certificate and model and are non-transferable to alternate models or c

Energy Factor Calculator for Commercial DHW Tanks

Developed by David R. Roberts, P.E.
Architectural Energy Corporation
Last updated April 2, 2004
Modified for multifamily by Bruce Harley 2/7/08
Modified to use standby loss in BTU/hr by Brian Stanfill and Kevin Felt 10/12/10
Enter tank size, thermal efficiency and standby loss from GAMA directory
For a single family home, enter 1 in the # dwellings, and the # of bedrooms
For mulitfamily residence, enter the # of apartments and total # of bedrooms served by the hot water heater

Tank size	98
Thermal Efficiency (%)	81
Standby Loss (Btu/hr)	1150
# dwellings	1
# bedrooms	4
Energy in daily draw (Btu)	41243
Standby loss (Btu)	27600
Equivalent Energy Factor	**0.49**

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Water Heating

- Water Heating
  - Indirect Fired DHW
    - "Side-arm" insulated tank fed by hot water producing appliance (typically boiler)
    - EF can be estimated using AFUE of boiler x 0.92
      - Use commercial EF calculator where standby loss known.
      - AHRI rates (some) indirect WHs for standby loss
      - Recovery efficiency boiler AFUE
    - Don't use REM "Integrated heat/DHW" library!
      - Been outdated for years!
      - Disabled in REM v15.41+

AHRI Certified Ref #	Model Status	Trade/Brand Name	Manufacturer	Model Number	Heater Type	Potable Volume (gal)	Heat Source Volume (gal)	Standby Loss (°F/hr)
7180736	Active	BOSCH; BUDERUS	BOSCH THERMOTECHNOLOGY CORP	LT160/1*	Storage	42.6	1.7	0.6

- **Indirect Fired DHW**
  - **Boiler (86 AFUE) x 0.92 = 0.79 EF**
  - **Commercial EF calculator method**
    - **BTU/hr loss**
      - **Estimated using gallon capacity x 8.3 lbs/gallon x deg loss/hr**
      - **42.6 x 8.3 x 0.6 = 212 btu/hr**
    - **% per hr loss**
      - **Estimated using deg loss/hr divided by 70deg dT**
      - **0.6 / 70 = 0.86%**

INDIRECT FIRED DHW

Tank size	42.6
Thermal Efficiency (%)	86
Standby Loss (Btu/hr)	212
# dwellings	1
# bedrooms	4
Energy in daily draw (Btu)	41243
Standby loss (Btu)	5088
Equivalent Energy Factor	0.77

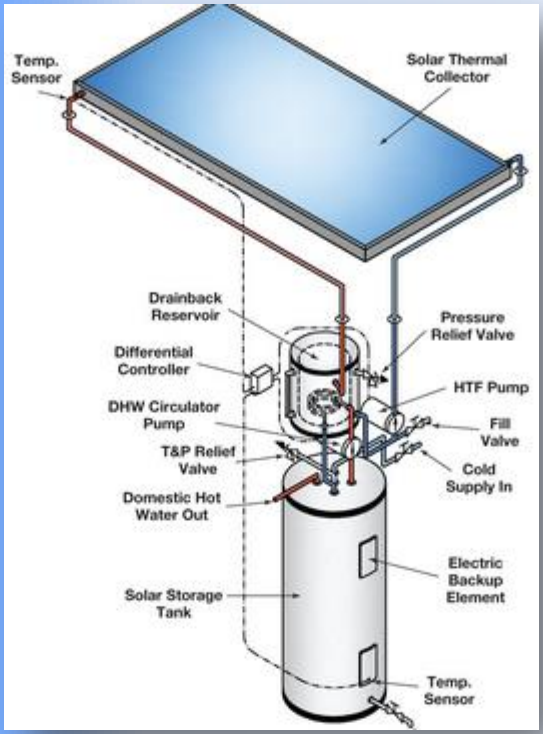
BTU/hr method

Tank size	42.6
Thermal Efficiency (%)	86
Standby Loss (%)	0.857
# dwellings	1
# bedrooms	4
Energy in daily draw (Btu)	41243
Standby loss (Btu)	4927
Equivalent Energy Factor	0.77

%/hr method

Water Heating

- Solar DHW
  - REM
    - Model system in Active Solar section
    - Still must model indirect fired tank in Mechanicals
      - Typically back-up electric resistance element in storage tank
      - Use EF Calculator
      - 1.0 COP; tank standby loss from manf.
  - Ekotrope
    - Get estimate DHW load covered by solar from designer



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Water Heating

- Desuperheater
  - Add-on for GSHP
  - "Free" hot water by capturing waste heat
  - REM
    - Check the checkbox in GSHP library
    - Software makes assumptions of "free" production
  - Ekotrope
    - No desuperheater functionality
    - Estimate COP effect and model as GSHP DHW, or
    - Estimate savings and model solar DHW

Water Heating

- MF Central Hot Water
  - Typically either large commercial tanks or indirect fired
    - Use EF Calculator to estimate EF
    - Use 40 gallons for capacity
    - Use WH or boiler efficiency for RE

Tank size	400
Thermal Efficiency (%)	96
Standby Loss (Btu/hr)	3200
# dwellings	50
# bedrooms	75
Energy in daily draw (Btu)	1443173
Standby loss (Btu)	76800
Equivalent Energy Factor	0.91

Equivalent to 0.99 EF tankless!

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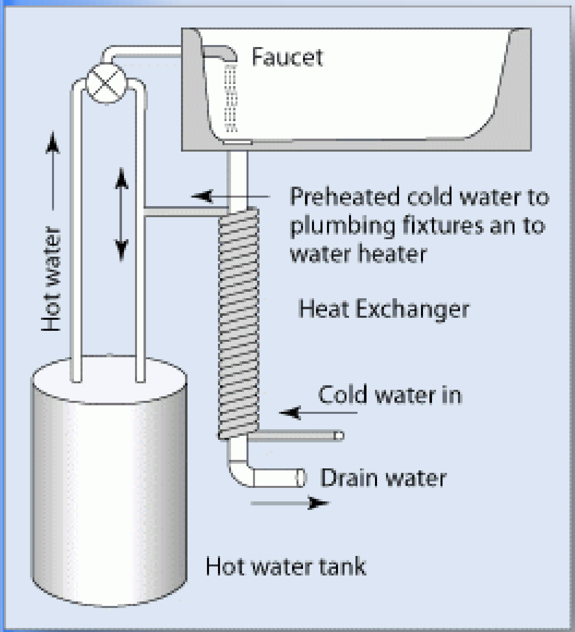
Central Systems

- Other central MF system modeling
  - Defer to RESNET MF Guidelines
  - RESNET 305 soon to become standard

Water Heating

- Distribution efficiency
  - Piping/fixtures
    - Pipe length matters – reduces heat loss
      - RESNET Default very conservative
      - Apportion central loop ft for MF dwelling units
    - Pipe insulation also matters
    - Fixture volume reduces hot water demand
  - Recirculation: Demand-based best
      - Time/temperature/continuous less good
      - Apportion pump watts for MF dwelling units
  - Drain Water Heat Recovery (DWHR)
    - Exchanges heat from shower water pipe, puts it back in tank



Summary

- System efficiency matters
  - Influencer in nMEUL calcs; HERS Index
- Electric systems have to work harder
  - "Handicapped" by fuel wars, source energy
    - COP ~ 3.0 to achieve HERS parity with best gas system
  - Electric system potential efficiency still greater
- Estimating ASHP efficiency challenging
  - Standard climate degradation factors may not be appropriate for inverter-based systems, but…
    - Modeling as GSHP may be too generous…

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Thinking Beyond nMEUL

- nMEUL coefficients based on 2006 equipment
  - Electric mechanicals have higher efficiency ceiling
    - "Next Gen" refrigerants; advanced motors/pumps
    - Gas needs "cogeneration" to compete
  - Will 'n' coefficients need to be updated again?
- Better grids and battery storage
  - Cleaner / more efficient electric production / distribution reduces value of "modification"
  - Battery storage allows off-peak consumption

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Building Efficiency Resources