

***Not Your Uncle's Old Mobe . . . But  
Maybe Your New One? News from  
the Factory Floor***

*Data Not Dogma 2014*

# The High Performance Manufactured Home

Component	NEEM (Base)	HPMH
Ceiling	R-40	R-45 (insulated to R-49 target)
Floor	R-33	R-38 (U=0.028 as per NEEM specs.)
Wall	R-21	R-26 (R-21 plus R-5 foam sheathing)
Window	U=0.35	U=0.22
Door	R-5	R-5
Duct Leakage	6% of Supply	No ducts
Target U <sub>o</sub>	0.054	0.040
Heating System	Electric Forced Air Furnace	DHP/ Elec. Res. Hybrid Zonal
Lighting	1.4 W/ft <sup>2</sup>	0.7 W/ft <sup>2</sup> (most all is CFL or LED)
Infiltration	0.25 ACH (natural)	0.25 ACH (natural)
Ventilation	Whole House Fan, 32 W continuous (0.1 ACH added)	Whole House Fan, 32 W continuous (0.1 ACH added)
DHW (EF)	EF =0.93	EF=2.0 Heat Pump Water Heater
Appliances and Misc.	Standard refrigerator, Energy Star dishwasher	Energy Star refrigerator and dishwasher / Low-flow showerheads and faucet aerators

# 1<sup>st</sup> Four Prototype HPMHs



# No Ducts=Fully Insulated Floor



# Stuffed Full



# Walls With R-5 Foam Sheathing



# Well-Flashed U-.22 Windows

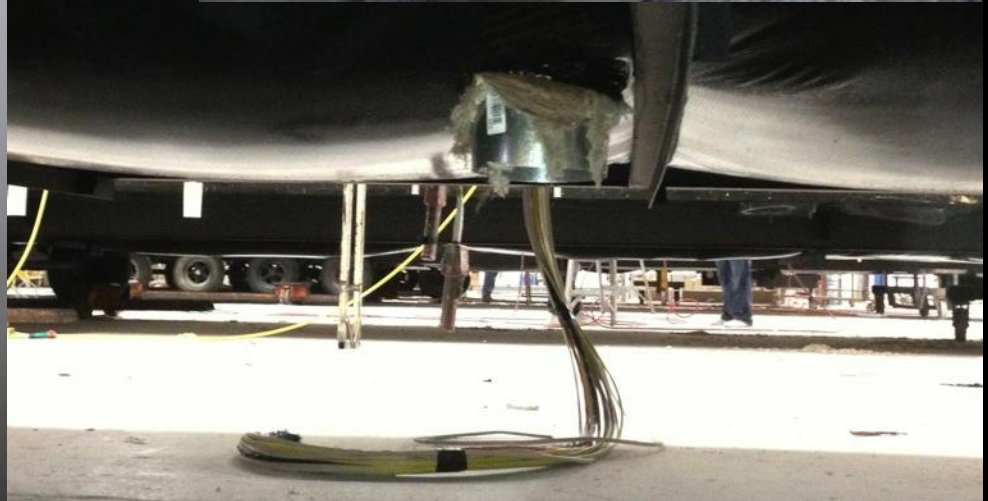


# R-49 Attic With Attention to Eaves





# Dual-Vented HPWH De-coupled from Home Interior—Draws from Crawlspace



# DHP Hybrid Zonal Space Conditioning



Figure 2. Function test of successful fa

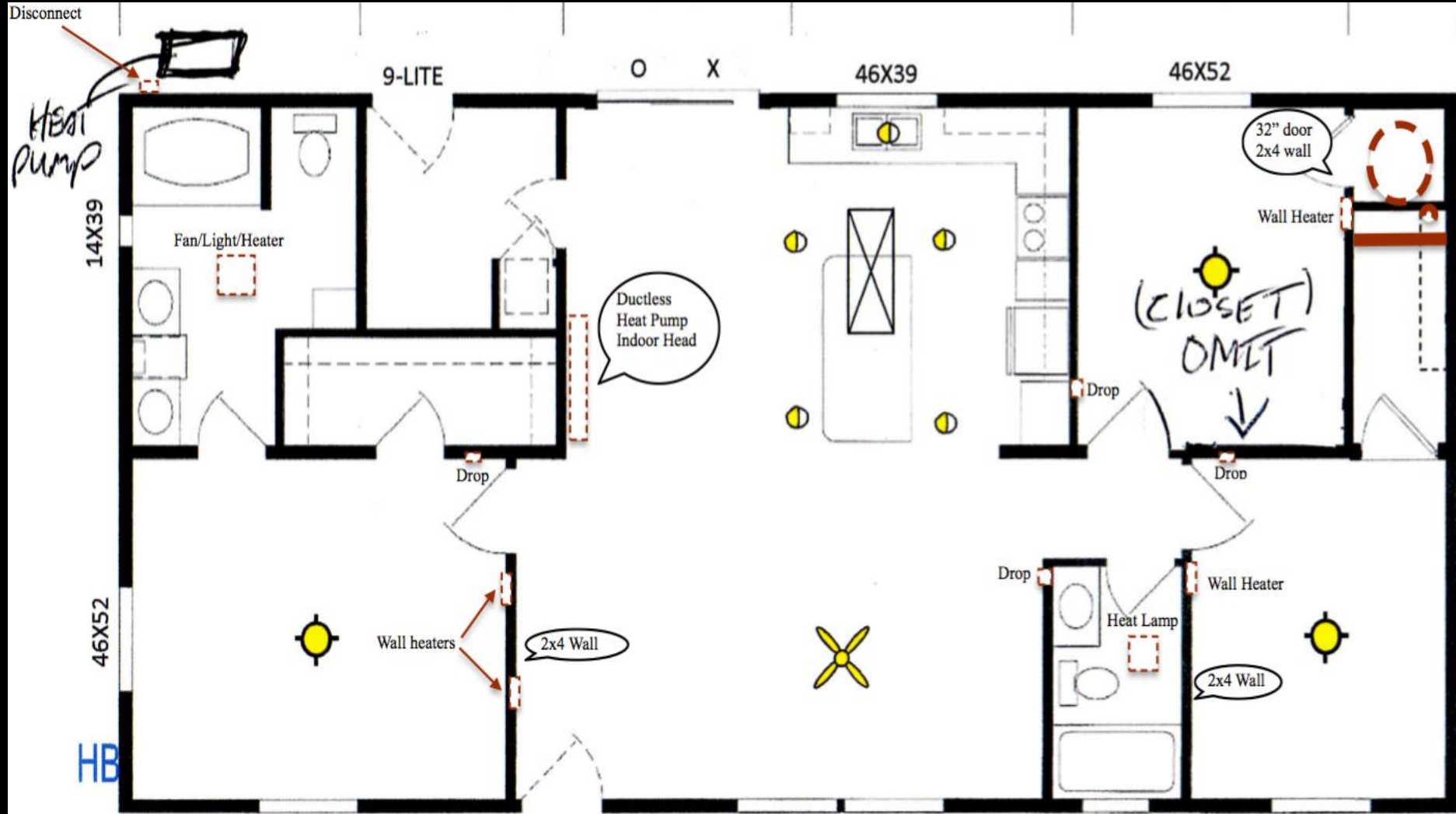
# DHP Hybrid Zonal Space Conditioning



# The Secondary Heating Component



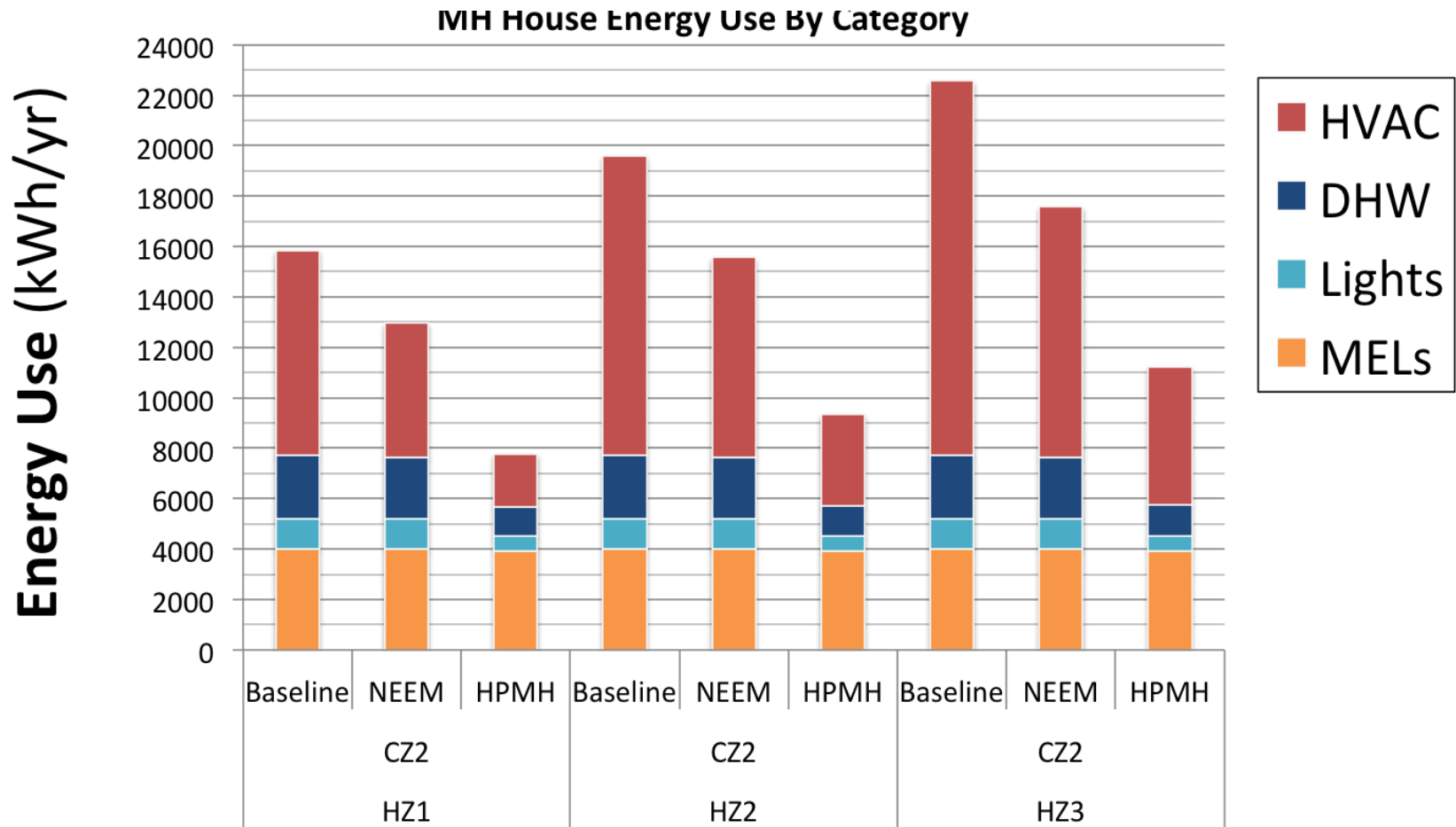
# The "Hybrid-Zonal" Approach



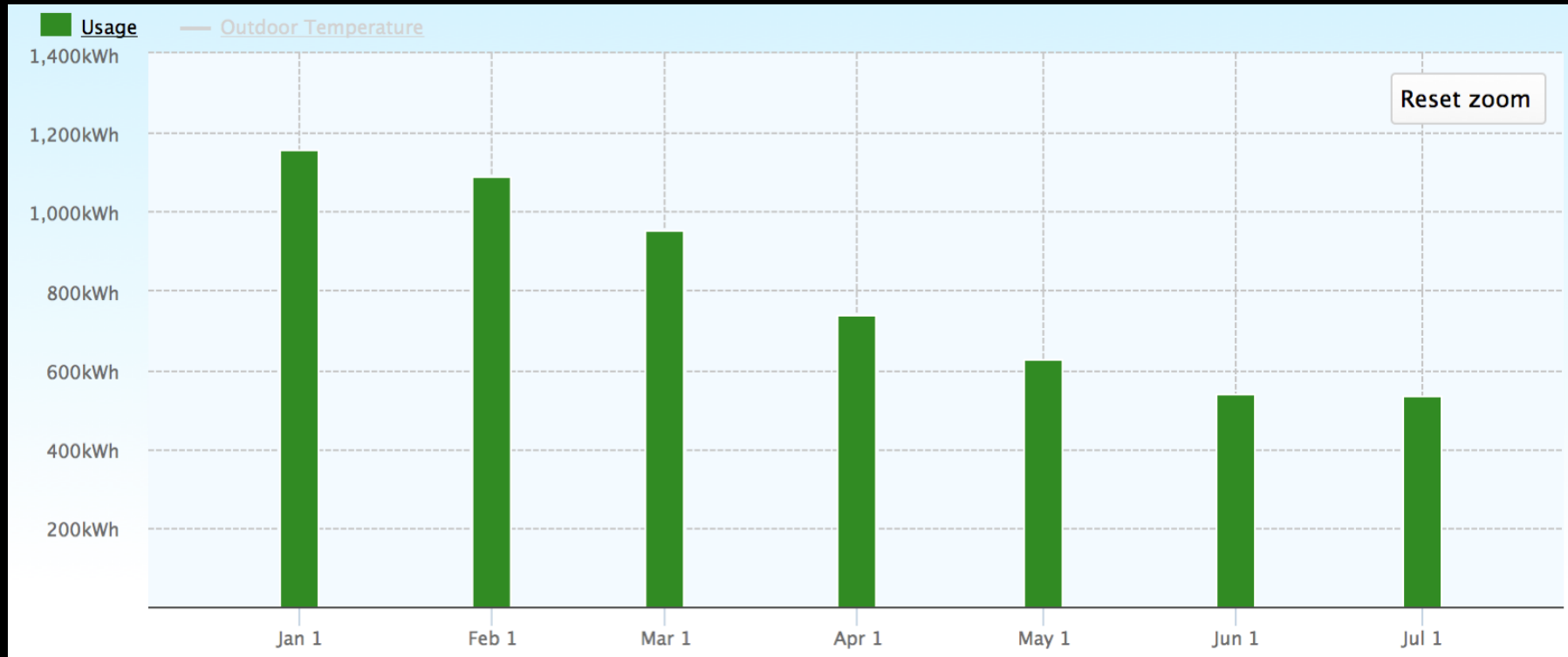
# Measuring the Results



# How's it Working? SEEM predicts . . .



# HPMH #1 Monthly Usage

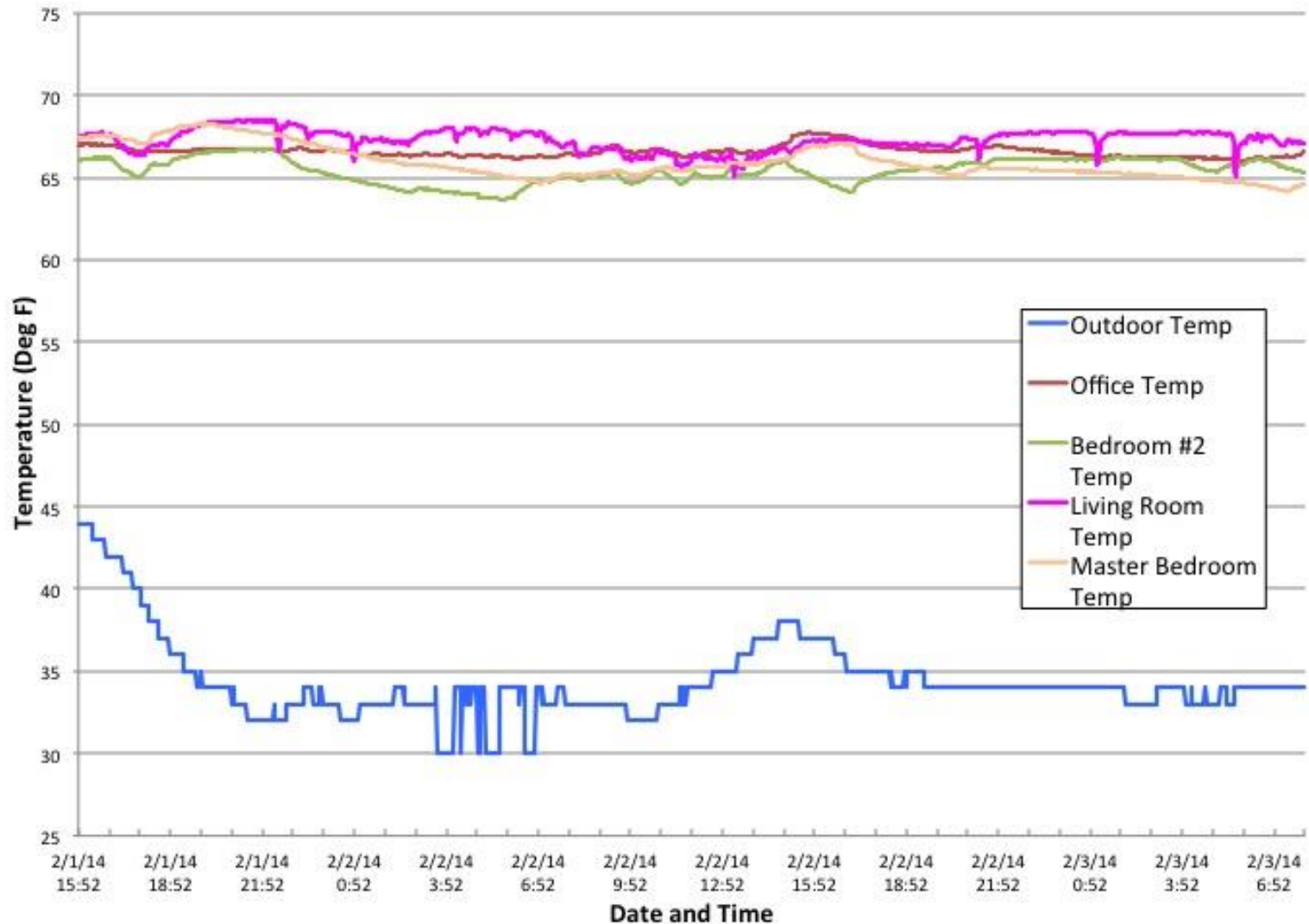


1<sup>st</sup> 7 months = 5,700 kWh ~ 9,800 kWh annual use



# Is it Comfortable?

Room Temperatures with a Single DHP Providing over 95 Percent of the Heating During Typical Western Washington or Oregon Winter Weather



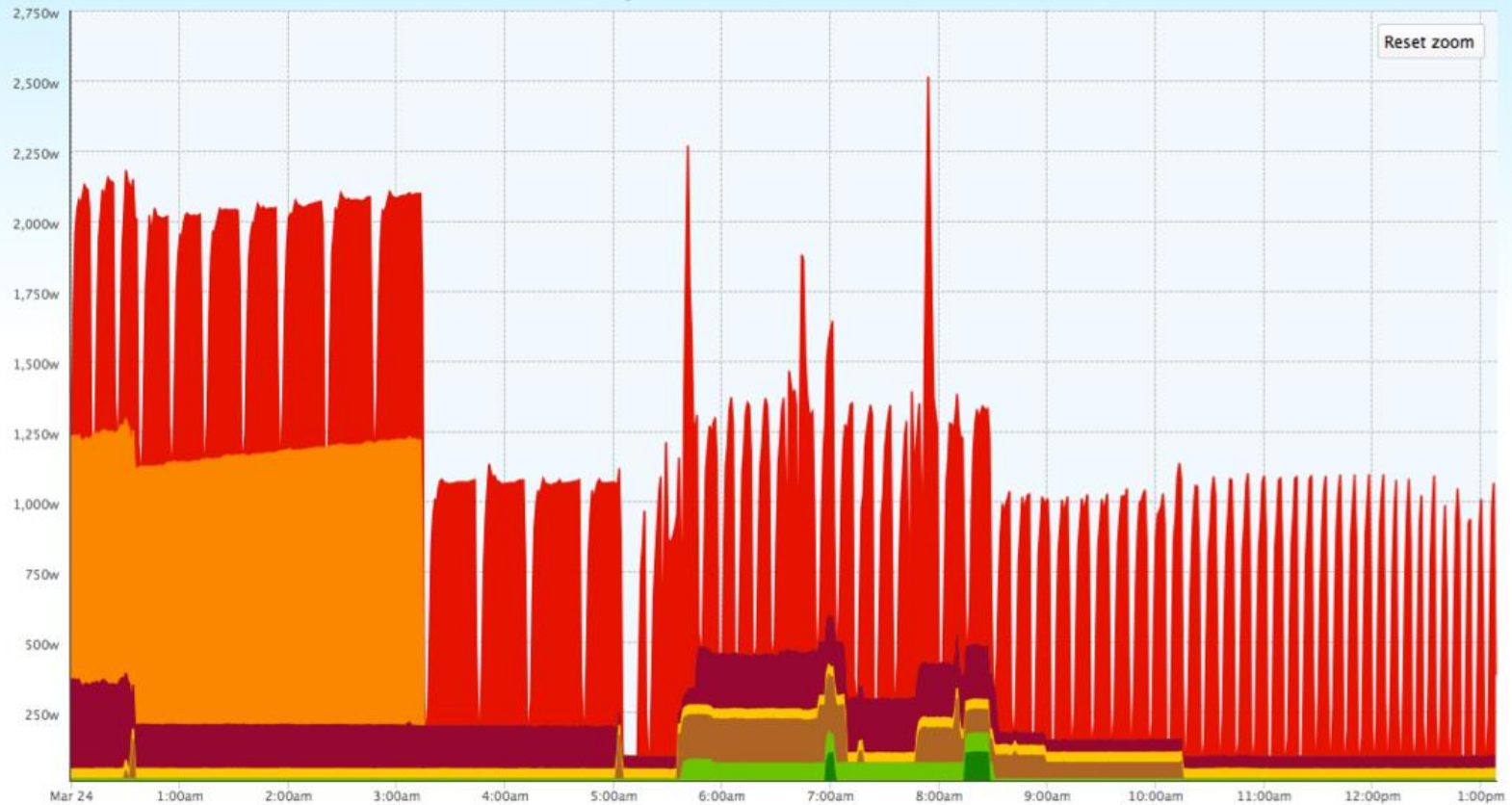
# How is the Heating System Being Used?

Outdoor Temp	Ave Watts/ Deg. (F) Delta-T	Ave DHP Pwr (W)	Ave Zone Heat Bdrm 2(W)	Ave Zone Heat Mstr Bdrm (W)	Ave Zone Heat Mstr Bath (W)	Ave Indoor Temp (F)	No. Hours	Total Heating kWh	ER kWh
18	38	1660	0	0	0	65.0	1.2	2.0	0.0
19	35	1529	0	0	0	65.1	1.6	2.4	0.0
20	25	1036	0	48	0	65.2	3.1	3.4	0.2
21	27	1071	0	56	0	65.3	3.1	3.5	0.2
22	28	1088	0	56	0	64.9	3.6	4.1	0.2
23	30	1057	0	74	1	64.4	6.4	7.3	0.5
24	33	1312	0	5	2	64.8	14.7	19.3	0.1
25	30	1113	0	0	3	64.4	4.2	4.7	0.0
26	29	1037	0	0	8	64.5	4.4	4.5	0.0
27	27	967	0	0	0	65.5	5.1	4.9	0.0
28	31	1109	0	0	0	65.7	9.2	10.2	0.0
29	31	1066	2	12	0	65.9	11.3	12.2	0.2
30	31	1055	0	19	2	66.3	32.7	35.1	0.7
32	34	901	0	130	16	66.0	19.4	20.3	2.8
33	37	960	0	107	62	66.1	31.2	35.2	5.3
34	33	915	0	33	55	66.6	27.1	27.1	2.4
35	28	796	0	7	30	66.8	13.3	11.1	0.5
36	28	768	0	0	21	66.8	7.6	6.0	0.2
37	31	754	0	0	100	66.8	4.7	4.0	0.5
38	33	816	0	0	37	66.6	14.9	12.7	0.6
39	31	769	0	0	4	66.9	9.9	7.6	0.0
40	30	767	0	0	13	67.4	20.9	16.3	0.3
41	32	783	0	0	13	67.4	12.6	10.0	0.2
42	28	702	0	0	2	68.4	17.8	12.5	0.0
43	30	715	0	0	2	68.0	12.3	8.8	0.0
44	32	699	0	0	0	67.6	8.4	5.9	0.0
45	31	661	0	0	11	68.0	9.8	6.6	0.1
46	36	657	0	0	84	67.8	7.6	5.7	0.6
47	30	616	0	0	0	67.9	5.1	3.1	0.0
48	30	582	0	0	0	67.4	5.5	3.2	0.0
49	30	563	0	0	0	67.7	2.1	1.2	0.0
50	30	535	0	0	0	68.0	1.9	1.0	0.0
51	31	519	0	0	0	68.1	1.3	0.6	0.0
<b>Grand Total</b>	<b>32</b>	<b>891</b>	<b>0</b>	<b>26</b>	<b>20</b>	<b>66.6</b>	<b>333.8</b>	<b>312.8</b>	<b>15.4</b>

# Room for Improvement?

Top 20 Circuits and Appliances, Last 24 Hours  
Click and drag to zoom

- Circuit**  
*(Click label to hide or show)*
- DHP
  - HPWH
  - Lights
  - Lights & Whl Hse Fan
  - Zone Heat Bath #2
  - Lights (w/smoke alarm)
  - Zone Heat Master Bath
  - Washer
  - Zone Heat Bedroom #2
  - Zone Heat Master Bdrn
  - Zone Heat Office



# Can I Buy One? The Path to Market

- Hard costs are running \$11k to \$14k per home to upgrade from Energy Star
- Assuming some level of savings from establishing purchase contracts, retail probably will be a \$20k+ price adder
- Opportunities for value engineering yet to be tested—window trade-off, different wall assemblies, newly arriving HPWH equipment?