



ATMO
sphere

Adventures in Water Heating

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Sanden International (USA)



CO₂ Heat Pump Water Heater

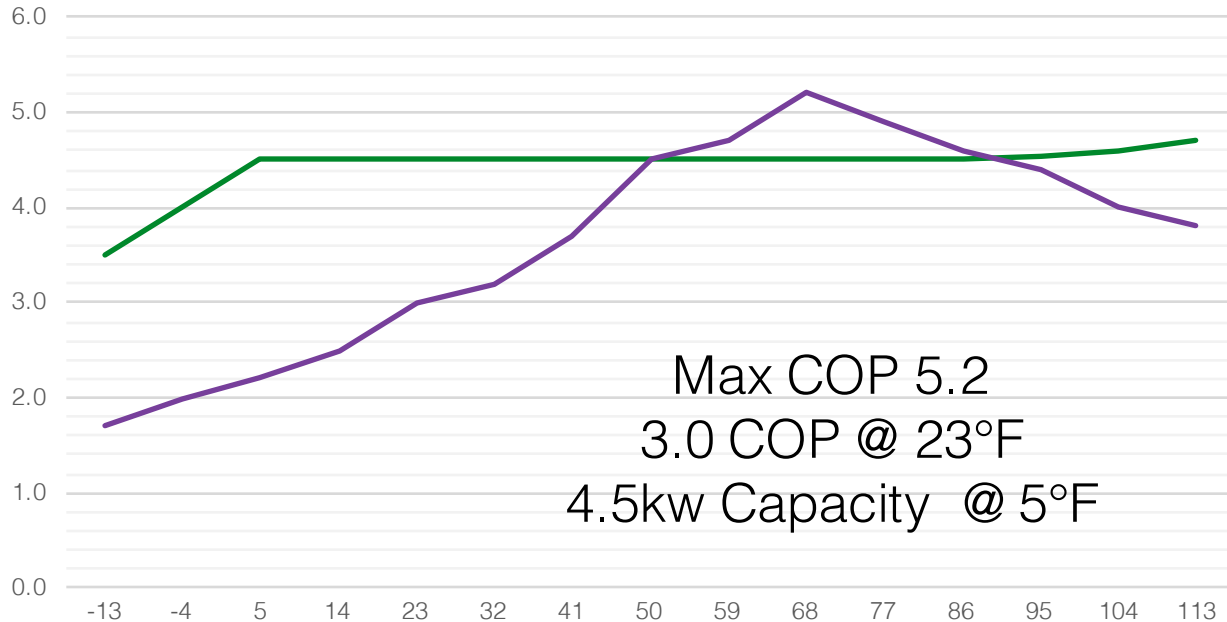
- Split system HPWH, based on the Japanese Eco Cute CO₂ Water Heaters BUT ETL & ETLc approved
- 2 Part system, either a 43 or 83 Gallon Stainless Steel storage tank coupled with a 4.5kw (15,400 Btu/h) capacity Inverter Compressor Outdoor unit
- #1 in Efficiency for ALL Water Heaters
- # 1 in Performance for ALL Electric Storage Water Heaters



CO₂ Efficiency & Performance

- Energy Factor is used to describe Water Heater Efficiency – DOE mandated testing, same process for all Water Heaters; Gas, Electric, Propane, Oil, Heat Pumps

G3 CAPACITY & COP @ 140°F Delivered Water



Typical Energy Factors

Gas Storage : 0.67

Electric Storage : 0.95

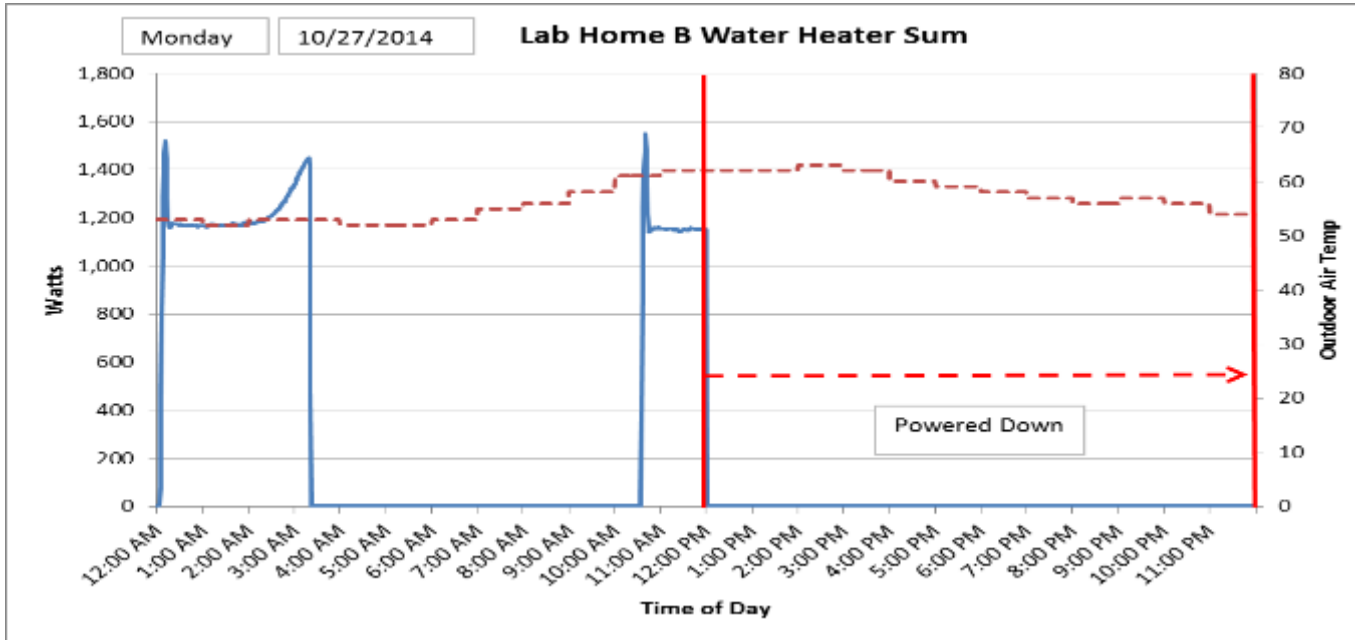
Gas Tankless : 0.95

HFC Heat Pump : 3.0

Sanden SANCO₂ : 3.84

CO₂ Utility Demand Response

- Tested in DOE Lab Home - Provide 140 Gallons in a 24 hour period, but including the effect of a 12 hour shutdown to simulate operation controlled by a Utility Demand Response program – Unit ran for approximately 6 hours



HP consumed 5.6kw for 140 Gallons
 At average \$0.124/kwh Total cost is \$0.69

Electric Water Heaters would use
 30.8kw at a cost of \$3.82

Demand Response also increases unit efficiency as the HP sees colder water

Multi Family/Commercial – DHW

- Using multiple Tank and Heat Pump combinations to provide DHW to apartment blocks and large commercial multi user systems
- Units operate well and provide hot water but care must be used in the piping arrangements, control system and most importantly for Multi Family the recirculation hot water line design and operation



Units shown in a Rooftop of a 93 unit low income apartment building in San Francisco
11 x Heat Pump's replaced a 726k Btu/h Gas Boiler system

Combi System Applications

- Because of the High Performance/Low Operation cycle/High Water Temperatures delivered we then looked to use the system to provide both DHW and Space Heating to Low Load Homes (Passive/Net Zero Homes)



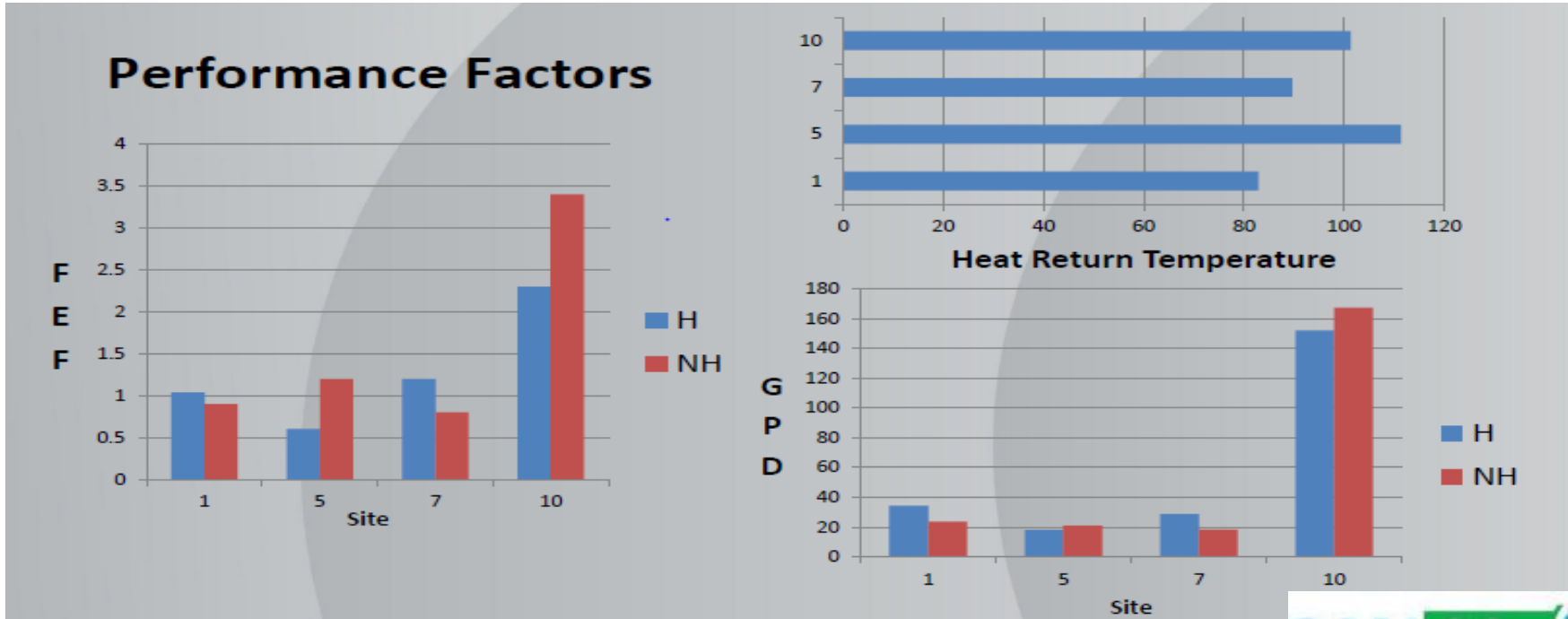
System was set up both in the DOE Lab Homes and also in 10 field sites Across the NW (ID, WA, OR) & monitored by WSU

Heating was provided by either Radiant, Fan Coil or Low Temp Radiators

Taco X Blocks were used to provide separation between Potable and Non Potable Water

Combi System Applications

- Performance in the field is significantly impacted by the use OR non use of DHW – Sites with low DHW use showed much worse efficiency – WHY??????



Eco Runo Space Heating

- Sanden Eco Runo (28,000 Btu/h) CO₂ Space Heating unit will be combined with a Fan Coil or Radiant Heating System plus an Indirect DHW Tank to provide Heating and DHW in 10 field test homes across the US
- Installations started in the late Winter, Early Spring of 2016/2017 after lab testing proved that the concept was viable

Current anecdotal test results

- Units working well
- Some minor installation issues



Hot water, *naturally.*

***Creating Hot Water using Outside
Air, a Natural refrigerant &
Heat Pump technology!***

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John.miles@sanden.com



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Thank you very much!

