Heat Pump Water Heaters
On-the-Ground Perspective

John Neal: Senior Project Manager
Danny discussed the “why…”

Now, “how?”

Challenges and lessons learned:

• Unitary (single family & apartment installs)

• Central system installs
Unitary

Electrical

– All heat pump water heaters require a 220v circuit
  • Tank type models typically require 30amp 220v
  • Stiebel Eltron and Rheem tank type and Sanden split system have 15amp 220v options
Electrical Challenges

My very own, very vintage, 30 amp service!
Electrical Challenges

• Sufficient service capacity?
  – Equipment from 1970’s or older could trigger service or panel upgrades
  – 100amp panels usually OK for some added load
  – Where capacity is at a premium, 15 amp 220v systems add the least load
Electrical Challenges

• Wiring
  – Breaker space in panel?
  – Access to run wiring to the new water heater without lots of demo?
    • Usually easy in single family homes with attics or crawl spaces
    • Can be difficult (more holes to fish wire) in multistory apt bldgs.
Electrical Opportunities

• Consider future electrification!
  – Heat Pump HVAC
  – Electric car charger
  – Induction stove, etc.

• If owner has existing air conditioning consider freeing up load through whole building approach...

...a brief digression...
• If replacing existing AC, opportunity to drop load through equipment and envelope improvements (example project went from 50 to 30 amp equipment disconnect)
  – “Traditional” scroll equipment might require electric resistance strip backup
  – Inverter equipment likely will not
• Lots of flavors, including traditional (high static) air handlers
Back to heat pump water heating...
Condensate Drain

- Equipment requires a condensate drain
- Can drain by gravity or with condensate pump
- Different jurisdictions treat condensate differently, usually the following work:
  - Exterior planter
  - Washing machine drain
  - Share with AC drain
  - Connect to sewer
Locating the water heater

- Tank type units draw heat from and reject cold air to their surroundings
- Most tank models can duct exhaust and/or intake
- Sanden system uses outdoor compressor location (requires piping between compressor and tank)
Locating the water heater

Review clearance & space volume requirements

– Different requirements depending on brand
– Water heater closets can be small
– Sufficient room volume required when not vented (garage)
– Filter/compressor access
Locating the water heater

• **Interior closet**
  – Cold air would be a nuisance in winter and adds load to HVAC.
  – Check clearances
  – Recommend to duct intake/exhaust

• **Exterior closet**
  – Check clearances
  – Duct exhaust, use fully louvered door for intake
Locating the water heater

• **Garage or Basement**
  – Well ventilated space may be sufficient
  – Both locations could get very cold in winter
  – Safer to duct exhaust & ensure sufficient makeup air for intake
Apartment Location Exercise
Two + story projects with interior water heaters require routing solutions
Apartment Location Exercise

- Venting
- Electrical
- Condensate
- Clearance?

Soffit?

Up?

Two + story projects with interior water heaters require routing solutions
Additional Considerations

• Distribution
  – If home has a domestic hot water recirculation pump install a demand control on pump

• Contractor options
  – Depends on electrical scope
  – If upgrading panel will need electrician
  – Running new wire only, providing exhaust/intake ducts - mechanical contractor
  – Knowledgeable plumber (electrical, ducting?)
Central Systems

Let’s start with pretty pictures
Central Systems

Pre-Install
Sanden System Mid-Install
Colmac System (Santa Rosa, CA)

photo from Colmac
Sanden Systems – Cold air baffle strategy
Lessons Learned - Advantages

• Pairing with PV attractive to owners
  – Solar thermal can have building limitations and is not price competitive with PV
  – Potential for load shifting can work well with Time-of-Use electric tariffs

• With or without PV, electric water heating can act as a cheap battery for bldg. or grid

• Much higher GHG reduction potential compared to gas equipment
Lessons Learned - Sizing

• **Traditional** ASHRAE sizing approach based on 1 to 3 hour draw periods.
  - Gas equipment might have some of first hour load covered by storage, rest by equipment recovery. This results in lots of heat pumps and less storage.

• **Need alt. sizing approach for a 12-24 hour draw period** for HPWH
  - Load shifting opportunity – increase storage, reduce heat pumps.
  - Cover peak load w/ storage, shift when HPWH operate
  - Reduce vulnerability to demand charges, allows for grid storage
Lessons Learned - Challenges

• Larger storage, location for heat pumps - **space constraints** for retrofits in some bldgs
• Contractor knowledge – **pricing**
• Owner knowledge – **hesitancy**
• IOU utilities limited in ability to **incentivize** fuel switching. Non IOU programs are stepping in to help move the market (see last slide)
Lessons Learned – Utility Tariffs

• Potential for a usage profile that can increase energy costs without education and/or controls (demand charges and TOU)

• Problem becomes solution - with the right rates and demand response controls, HPWH systems are another grid storage, load shifting strategy
Lessons Learned – Energy Code

Unitary Installs (1 per home)

- Retrofit: Unitary installs complies
- New construction: complies but T-24 credit is limited in 2016 code, better for 2019 code

Central

- No prescriptive compliance approach
- Performance approach is broken or provides no credit (depending on high rise or low rise)
- They’re working on fixes for 2019, may adopt sooner
Flow Monitoring to Verify Sizing
Central Heat Pump Chillers

- Simultaneous heating, cooling, DHW production
- Circulates hot and chilled water to building
- Designed to take the place of boiler (heating & DHW) + chiller
- Internal Heat Recovery
Efficiency

EER: 9.2
COP: 3.05
TER (Total Efficiency Ratio): 6.4
Heat recovery on condenser loop yields highly efficient operation while in simultaneous modes:

In this example (referring to unit size NRP 1250A) the total energy ratio is:

\[
TER = \frac{353 + 261}{97} = 6.3 (*)
\]
Oversized internal pumps

Heating pump oversized for DHW only service

Control sequence based on temp, not optimal

Undersized Hx

Tank location not optimized for thermal storage capacity

3-way fan coil valves prevent pressure modulating pumping

No secondary CW pump

Very little guidance on control setup or SOO
Change Order Schematic: Project #1
CEC Research Project

**Meter and logging:**
- Heating energy production & consumption (kW, kWh, Btu)
- Cooling energy production & consumption (kW, kWh, Btu)
- DHW energy production & consumption (kW, kWh, Btu)
- Indoor Temperature Set-points (from visual inspection)
- Indoor Temperatures (°F)
- Pumping energy (kW, kWh)
- Distribution losses (Btu)
- Tank losses (standby) (Btu)
- Domestic hot water usage (gal, gal/person/day)
- Total (cold + hot) water usage (gal)

How does DHW production efficiency compare to the GeoSpring and Sanden projects?
How much benefit are we getting from the heat recovery process?
Can system be used effectively for thermal storage?
CEC research project - What Have We Discovered So Far

- Not plug-and-play out of the box
- Many technical challenges (design & install)
- Still relatively new technology in US
- Issues with first 2 installs, unhappy residents, owners, management
Installation Challenges

- Complexity
- Noise levels
- Troubleshooting
- 2 compressors failed in a first year
- 1 year warranty!
- Parts availability
- Start-up
- Service
Incentives – Fuel Switching

• **Palo Alto** - up to $1500 for HPWH
• **Silicon Valley Power** - $500 for HPWH
• **Marin Clean Energy LIFT program** – Multifamily Electrification Pilot for Affordable Properties – *pays up to 100% of costs to switch from gas water heating and space heating to heat pump*
• **East Bay Energy Watch** – HPWH Program
• **Low Income Weatherization Program** – CA Cap and Trade program for affordable multifamily – whole building program including fuel switching, PV. Robust incentives.
• **BayREN** and Silicon Valley Power – starting to coordinate to bring both of their respective multifamily programs to bear on projects. Potential kicker for affordable multifamily properties. Fuel switching TBD
Incentives – Whole Building

Fuel switching measures are excluded from incentive

- **PG&E or BayREN** single family EUC program
- **BayREN multifamily** – 9 bay area counties
- **Marin Clean Energy** – Multifamily Program
- **PG&E** - Multifamily Program
Thank You!

John Neal: jneal@aea.us.org
510-431-1794