



Standing Technical Committee Water Heating



**Residential Energy Efficiency Stakeholder's Meeting
February 29, 2012 - Austin, Texas**



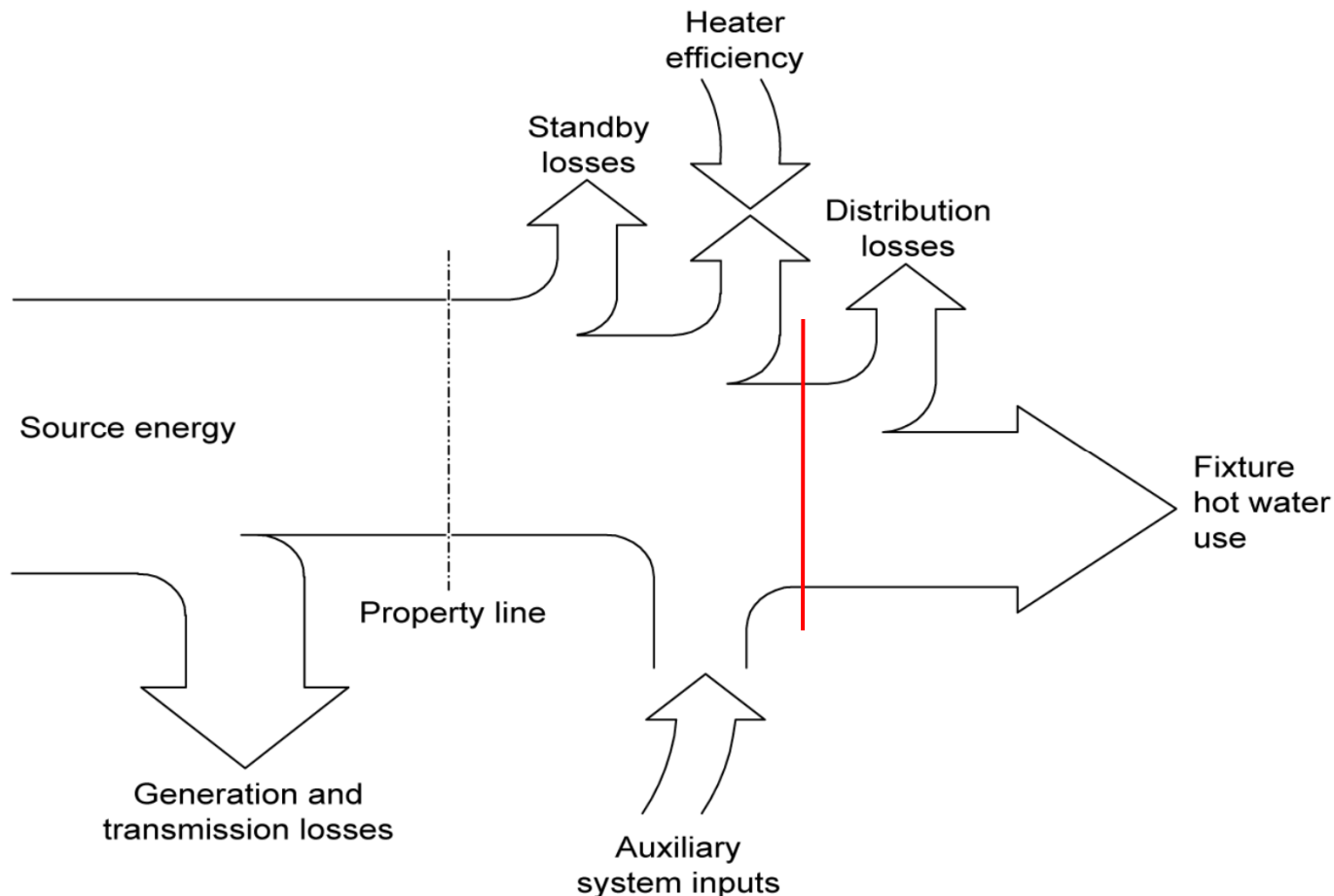
STC Chairman Responsibilities

- To maintain the Water Heating Strategic Plan (living document)
- To work with stakeholders to identify research activities that resolve gaps & barriers towards achieving Water Heating Strategic Goals
- To work with stakeholders to prioritize gaps leading to future BA research efforts
- To serve as a collection point for BA research activities and outside research
- To facilitate collaboration among BA researchers and the marketplace



Water Heating as a Significant End Use

According to DOE RECS data, residential water heating represents 20% of the energy delivered to U.S. households.





Water Heating Strategic Goals

Recent Building America directive that each STC develop broad strategic goals that support overall Building America program goals.

Draft goals will be included in the Strategic Plan available at:

http://www1.eere.energy.gov/buildings/building_america/strategic_plan.html



Draft Strategic Goals

1. To provide conclusive laboratory and field performance data to manufacturers, the building industry, and code bodies to enable the delivery of efficient, cost effective (or lower cost) water heating solutions to the marketplace. This effort should focus both on currently available technology solutions, as well as advanced configurations promising greater savings.



Draft Strategic Goals

2. To develop validated simulation tools to facilitate the evaluation and comparison of alternative water heating system designs for new and existing, single and multi-family buildings. The validated tools, and accurate inputs to drive the models, are needed to accurately understand the transient nature of hot water system performance.



Draft Strategic Goals

3. To develop industry design guides that convey optimal water heating system design practice for new buildings and preferred retrofit strategies for existing buildings, taking into account loads, climate, and utility rates.



Draft Strategic Goals

4. To identify the performance, maintenance, reliability, and customer acceptance characteristics of high efficiency water heating technologies in different applications, and to determine key factors that affect performance of these technologies relative to mainstream “conventional” technologies.



Current STC Prioritization

Rank	Description	Priority
1	High efficiency combined hydronic system performance & cost impacts	High
2	HPWH performance (isolate behavior impacts on performance)	High
3	Collect a broad, uniform set of hot water usage data & associated demographic data	High
4	Track maintenance/reliability/customer acceptance issues on emerging technologies (gas tankless, HPWH, hybrid systems, demand recirc, etc.)	High
5	Pre and Post field testing on distribution system improvements	High
6	Validate HPWH, tankless, condensing storage, hybrid models with lab/field data	High
6b	Integrate detailed modeling tools (Note: interrelated with "6")	High
7	Develop application specific retrofit decision tool	Medium
8	Characterize tankless and high efficiency gas water heater performance	Medium
10	Support plumbing code update (lab testing of right-sized plumbing systems)	Low
11	Develop industry friendly best practice design guides based on real world performance	Low
12	Low-cost solar hot water system (not necessarily roof-mounted)	Low
13	Existing Stock - Water quality impact on high efficiency water heating systems	Low
14	Validate distribution system models	Low



Combined Hydronic System Issues

- What are the cost and performance tradeoffs vs conventional high efficiency systems and how do they vary with climate and load?
- Can we reliably maintain condensing efficiencies and maintain comfort?
- What delivery options are best for different load and climate configurations?
- Does the appropriate equipment exist for low load combi applications?
- Need for system performance ratings
- Need for industry design guide



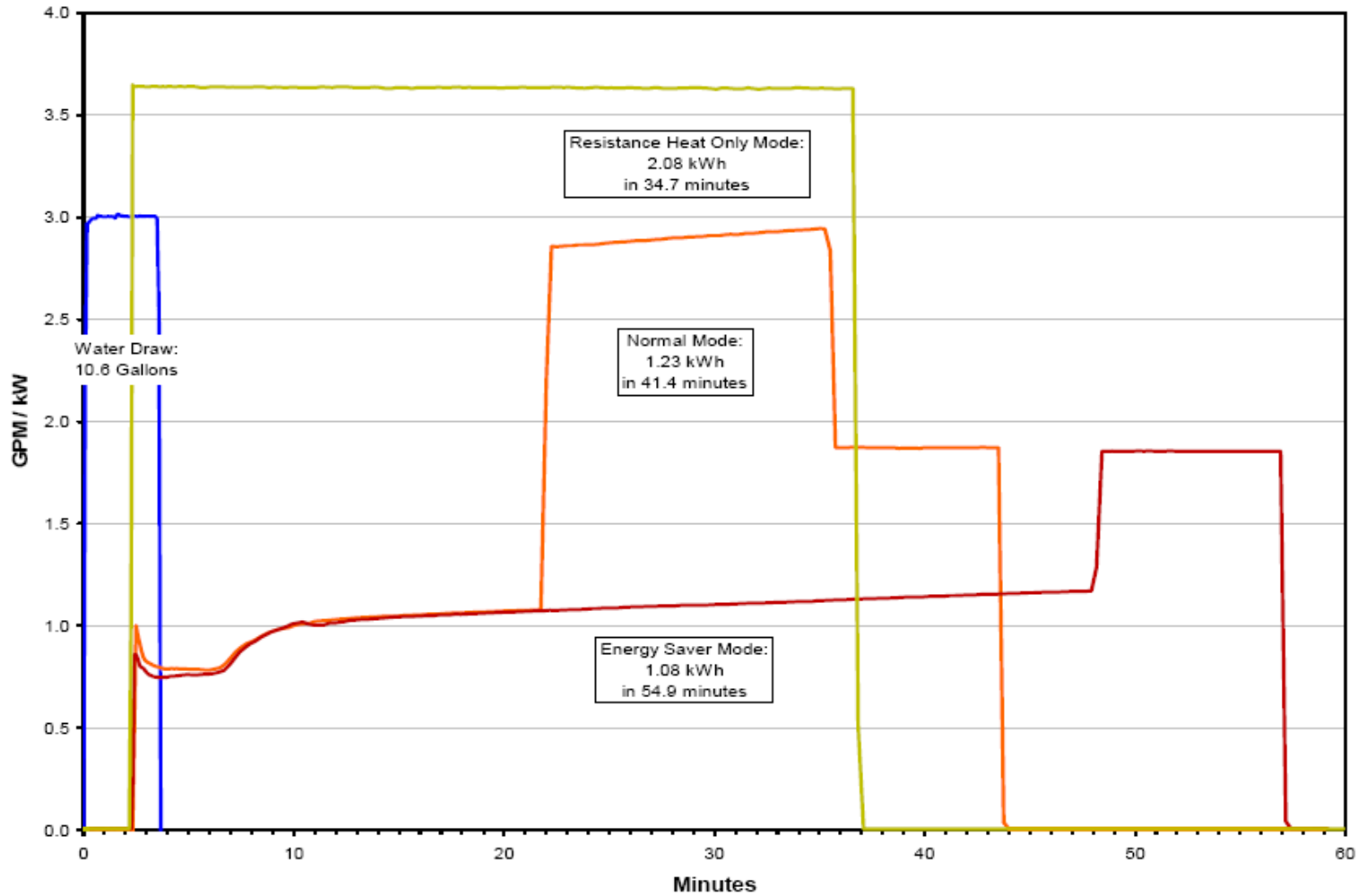
Heat Pump Water Heater Issues

- Reliability, durability, customer satisfaction
- Cost effectiveness relative to utility rates (gas, electric, and propane)
- Recovery capacity (0.5 to 1 ton compressors)
- Performance factors: gpd, gph, gpm, delta T, Tenv
- Energy savings relative to control settings
- Service infrastructure (plumber?, HVAC tech?)
- Long term maintenance costs
- Cooling & dehumidification potential



PG&E HPWH Lab Tests

Energy Impacts of Different Operating Modes



Ref: PG&E 2010



Tankless Water Heater Issues

- Longer waiting times (more water waste)
- Does “endless hot water” affect hot water usage?
- Gas line upsizing – retrofit barrier
- Venting requirements – retrofit barrier
- Rated vs. Actual EF’s
- Customer acceptance issues
 - Cold water sandwich, minimum flow rate, start up delay
- ~~Non-compliance with NOX requirements in some AQMD’s (SCAQMD standard set for 2012)~~
- Service infrastructure, long term reliability, and maintenance
- Need for water treatment in some areas

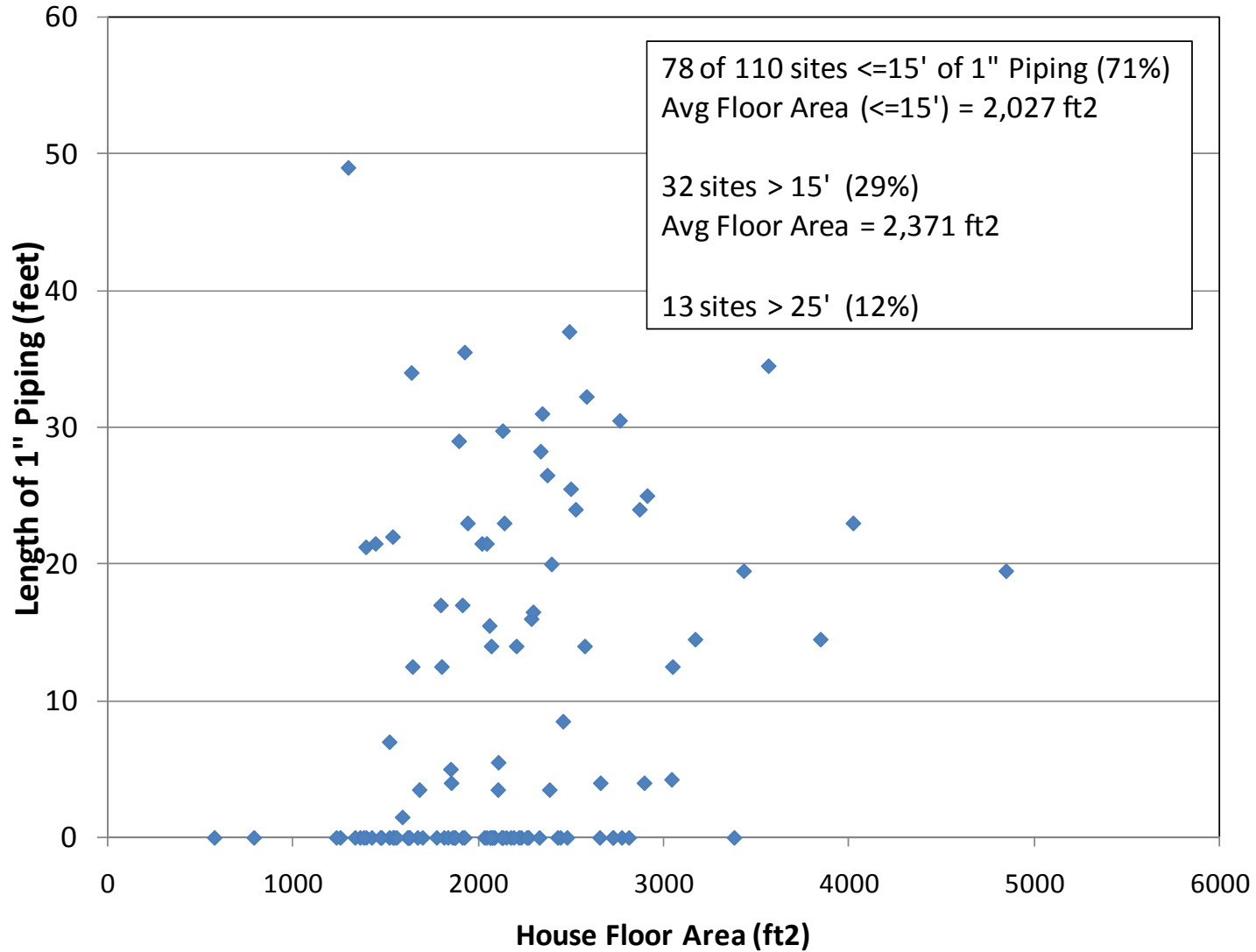


Hot Water Distribution Issues

- In single family homes, lack of plumbing design often leads to poorly performing “oversized” systems, especially with PEX.
- Lack of definitive data on how distribution systems perform and how different system types compare.
- Availability of accurate, high resolution software tools AND good input data limit the ability to compare and evaluate performance tradeoffs
 - When does distribution system type “X” make sense?



Oversized Piping: 1" Pipe in New CA Homes





Codes and Standards Issues

- Current Energy Factor test procedure does not equitably assess performance of different system types, nor recognize impact of lower or higher loads
- Revised test procedures must accommodate emerging technologies
- Fixture unit sizing tables not designed for low-flow fixtures and smooth pipe; difficult to use 3/8" tubing
- Codes need to facilitate future replacements with advanced technologies (gas line, venting, 240V) and renewable system options



Software Development and Validation

- Improved tools are needed to model the complexities of short duration hot water draw events
 - Validation needed
 - How best to integrate with existing hourly tools?
 - Input data to drive the models is critical (gal/day, use patterns, environment temperatures, installed pipe configuration, usage behaviors)
- Validated tools and field data can be used to develop design guides and contribute to codes and standards activities



Retrofit Challenges

- Economics of high efficiency system installations
- Ability to affect overall system performance, not just a water heater upgrade.
- Need for on-bill financing



Solar and Heat Recovery Opportunities

- Need for further solar thermal system installed cost reductions
 - Future single family water heating loads will likely be lower, leading to reduced savings potential
- Drain heat recovery and desuperheaters
- Greywater heat recovery systems



2011 BA Water Heating Deliverables

- **ARBI**
 - Water Heater Selection Criteria (Measure Guideline)
 - Hot Water Distribution System Model Enhancements (Tech Report)
- **BA-PIRC**
 - Hot Water Systems Lab: 2010 – 2011 evaluation (Tech report)
 - Gas Fired Tankless and Storage Water Heater Approaches to Combo Space and Water Heating (Tech Report)
- **BSC**
 - Combination Space and Water Heating Systems (Measure Guideline)
 - Recommendations For Applying Water Heaters In Combination Space and Domestic Water Heating Systems (Experts Meeting)



2011 BA Water Heating Deliverables

- **CARB**
 - HPWHs in New and Existing Homes (Measure Guideline)
 - Cost, Design, & Performance of Solar Hot Water in Cold-Climate Homes
- **IBACOS**
 - Transitioning to a Tankless Water Heater (Measure Guideline)
 - Residential Ground Source Heat Pumps with Integrated Domestic Hot Water Generation: Performance Results from Long-Term Monitoring (Technical Report)
- **NREL**
 - Laboratory Performance Evaluation of Residential Integrated HPWHs
 - An Analysis Model for Domestic Hot Water Distribution Systems
 - Add On Heat Pump Water Heater Field Evaluation
 - Condensing Hybrid Water Heater Monitoring Field Evaluation



2012 BA Water Heating Research

- **ARBI**

- Central HPWH monitoring at UC Davis student housing (12 apts)
 - Develop performance map; assess alternative control scenarios
- Validate TRNSYS (and HWSIM) distribution models vs. lab and field data (SolarRow);
 - Working with NREL
- Data mining on California 18 home detailed DHW field data project
 - Assess pre and post usage in homes converted to tankless (pattern change?)
 - Assess seasonality effects (hot water usage characteristics)
 - Look at hot water load intensities (useful for HPWH evaluations)

- **ARIES**

- Complete pre and post monitoring effort in 3-5 existing low income homes (water heater and dist system retrofits); base case monitoring to begin spring 2012



2012 BA Water Heating Research

- **BA-PIRC**
 - Lab Testing: HPWH, add-on HPWH with solar preheat, condensing TWH
 - Survey multi-family property managers on customer satisfaction with large scale HPWH implementation
- **CARB**
 - HPWH data evaluation to assess RH use as a function of load patterns
 - Monitor indoor HPWH (one site)
 - Boiler & indirect tank and boiler with DHW coil monitoring
- **IBACOS**
 - Validate desuperheater model with field data
 - Field test of combined hydronic/ASHP vs furnace/ASHP systems



2012 BA Water Heating Research

- **NAHB/Southface**
 - Monitor 4-5 HPWHs (with ducting kit) installed in affordable housing units; monitoring to begin 4th quarter 2012
- **NorthernStar**
 - Completing ~ 300 combi system retrofits in Minneapolis area. Looking for savings impact, overall economics, contractor learning curve, customer satisfaction.
 - Will monitor ~ 20 homes in detail
 - Pre-monitoring complete
 - Most of the combi retrofits completed
 - Monitoring into summer 2012

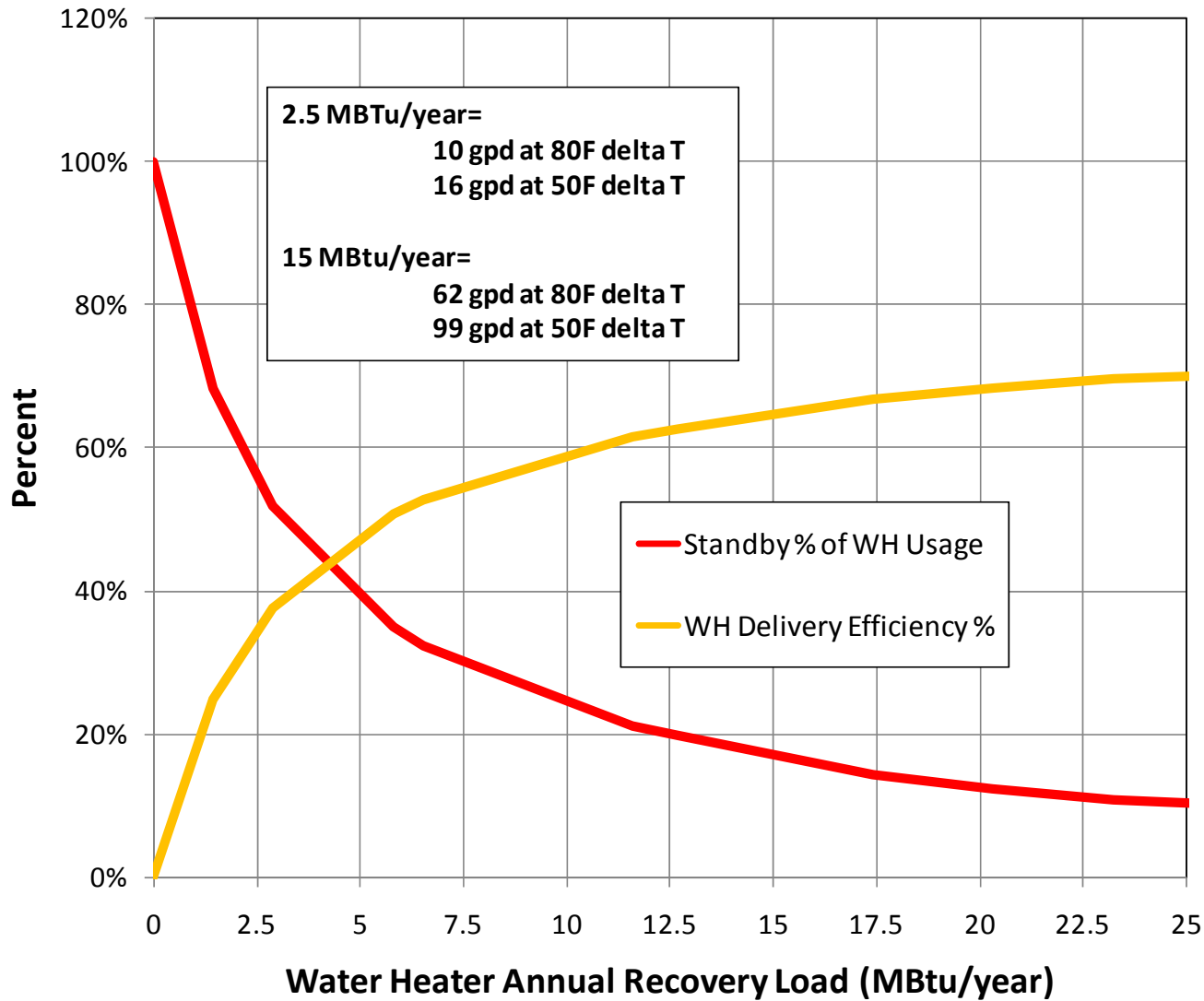


Other Water Heating Research

- **GTI/DEG CEC PIER Advanced Gas Water Heater Project: (2009 - 2012)**
 - Pre & post-replacement testing of gas water heaters in 18 California homes (report completed December 2011)
 - Lab testing of advanced water heaters
 - HWSIM distribution system model enhancements
 - Advanced water heater model development
 - Hot water behavioral study (On line survey of 400+ respondents)
 - New home hot water distribution takeoffs on 100 California production homes
 - Hot water design guide
 - Support 118.2 activities
 - Title 24 recommendations
 - Outreach and training



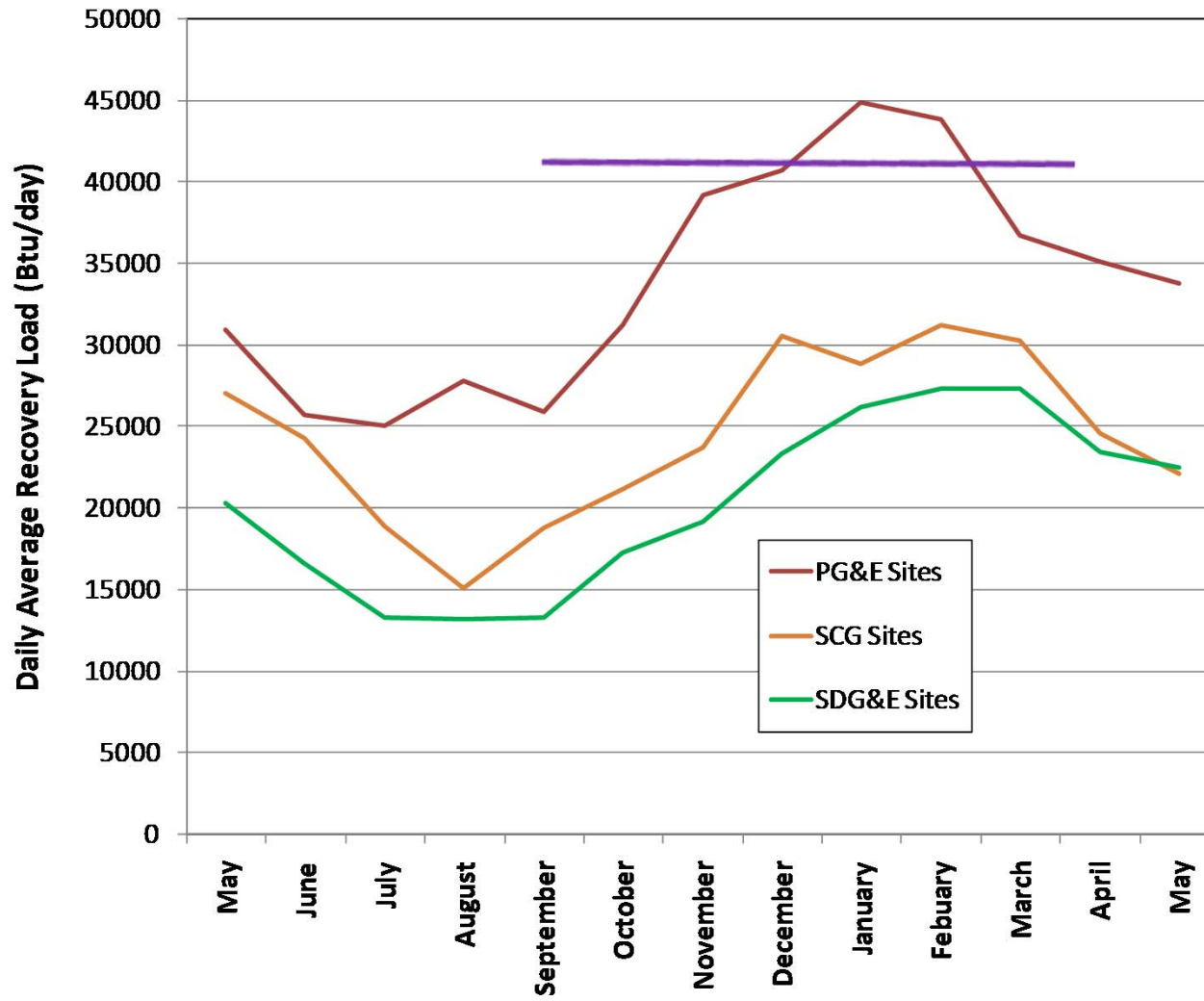
Gas Storage WH Performance with Load





DEG/GTI Water Heating Research

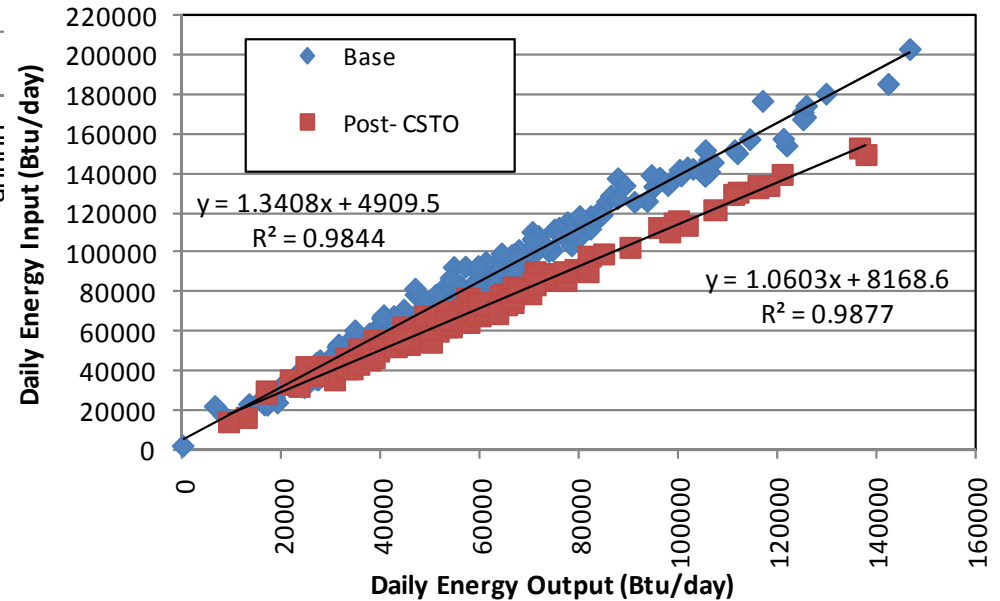
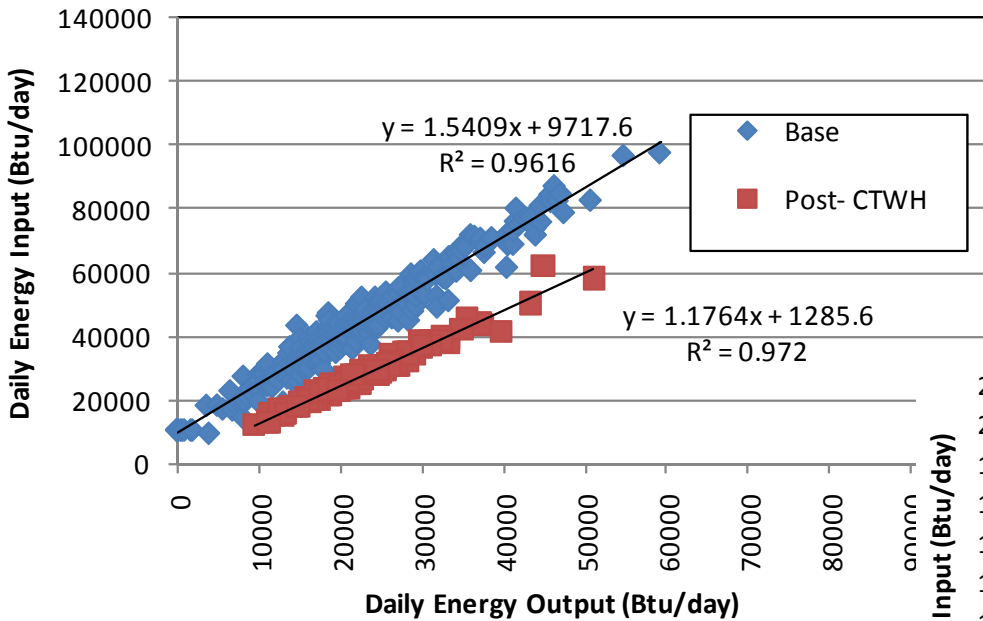
CA Monthly Water Heater Recovery Loads





DEG/GTI Water Heating Research

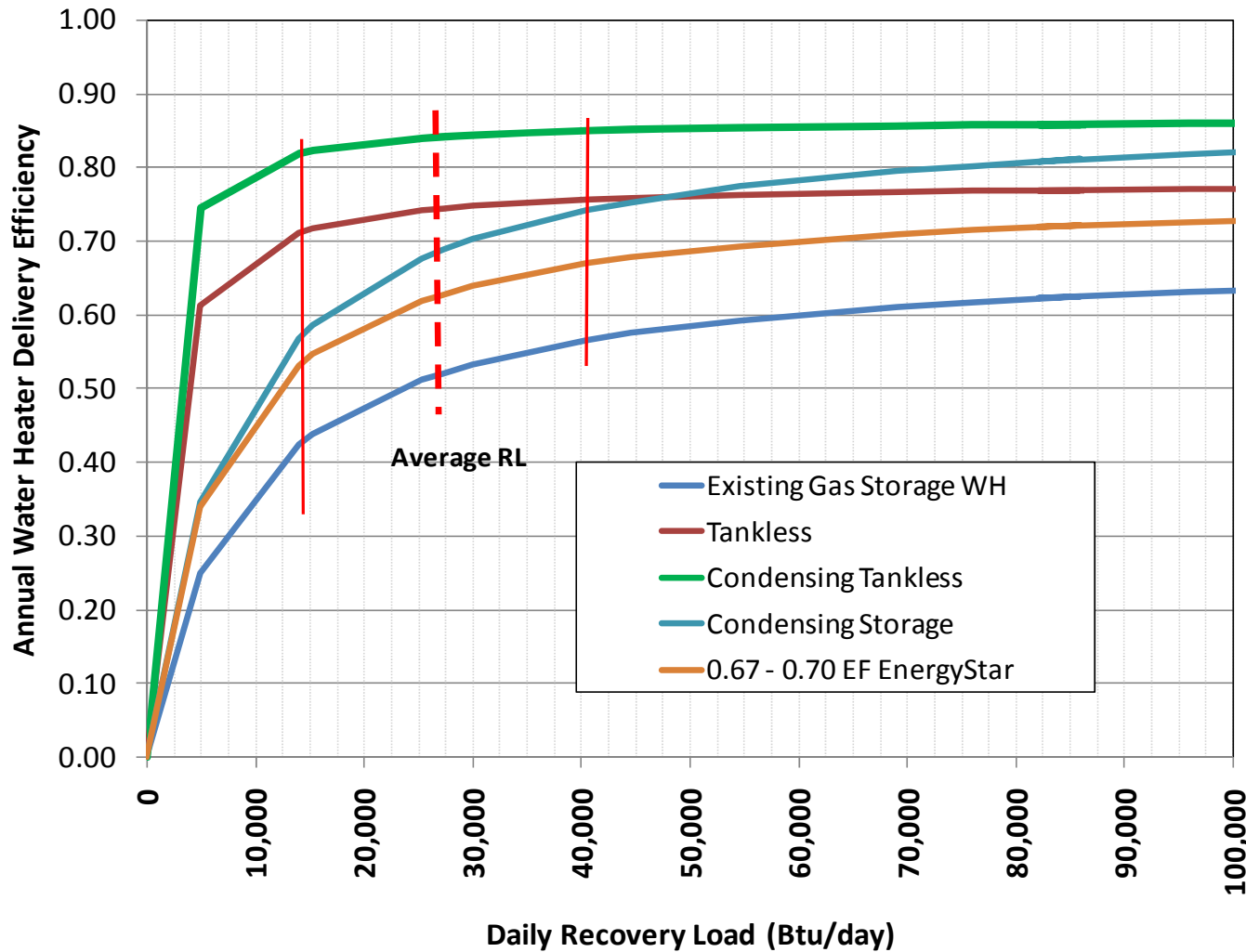
Sample Daily Input-Output Curves (pre and post)





DEG/GTI Water Heating Research

- Efficiency Comparison Among System Types





Other Water Heating Research

- **LBNL – CEC PIER Project: (completion date- 2013)**
 - Develop and demonstrate new wireless gas and water end use metering technologies
 - Literature review
 - Develop specs and protoypes
 - Lab and field test
 - Develop improved open source water heating system models
 - Review existing tools & algorithms (distribution & WH models)
 - Integrate/develop simulation tool
 - Reducing waste in residential distribution systems
 - Develop wireless temperature and flow sensors
 - Test sensors and data acquisition systems
 - Implement in the field (6-30 sites)



Other Water Heating Research

- EPRI: Field testing of HPWH's in approximately 170 residences throughout the U.S.
 - BPA- testing at 40 homes; have completed six month post-install customer survey
- NEEA: Working on HPWH market transformation efforts throughout the entire distribution chain (mfgs, training, incentives, QA, etc)
 - Involved in Northern Climate HPWH specification
 - Ongoing lab testing
 - Field testing 30 Air Generate units this year (billing analysis)



Upcoming Activities

- **ACEEE Hot Water Forum**

May 21-23, 2012

DoubleTree Hotel & Executive Meeting Center Berkeley Marina

<http://www.aceee.org/conferences/2012/hwf>

This year's Forum features over 36 sessions covering cutting-edge developments in technologies, programs, practices, and policies affecting the way we produce and use hot water in residential and commercial buildings.

- **ASHRAE Summer Meeting (TC 6.6 & SPC 118.2)**

June 23-27, 2012, San Antonio

- **ARBI Experts Meeting (tentative late September in Denver)**

- “Exploring the disconnect between rated and field performance of water heating systems”

- **Participate in regular Standing Technical Committee calls**

- Go to <https://sites.google.com/site/bastchotwater/> for calendar of calls and meeting minutes from prior calls