2013 Building Energy Efficiency Standards Staff Workshop

Single Family DHW Distribution System Enhancements

California Energy Commission

May 24, 2011

Background

- Proposal sponsored by the California Statewide Utilities Codes and Standards Program as a Codes and Standards Enhancement (CASE) study
- CASE study author Marc Hoeschle, Davis Energy Group
- Presented at stakeholder meeting May 13, 2011

Overview

- Summary of current code requirements
- Typical practice
- Summary of code change proposals
- Data/findings
- Analysis approach
- Specific code change proposals

Current Code Requirements

- Pipe insulation required for
  - First five feet from water heater
  - Recirculation loops
  - Underslab piping
  - Lines to kitchen ¾” or greater
- Maximum 15 feet from WH to home run manifold
- No requirement for plumbing design

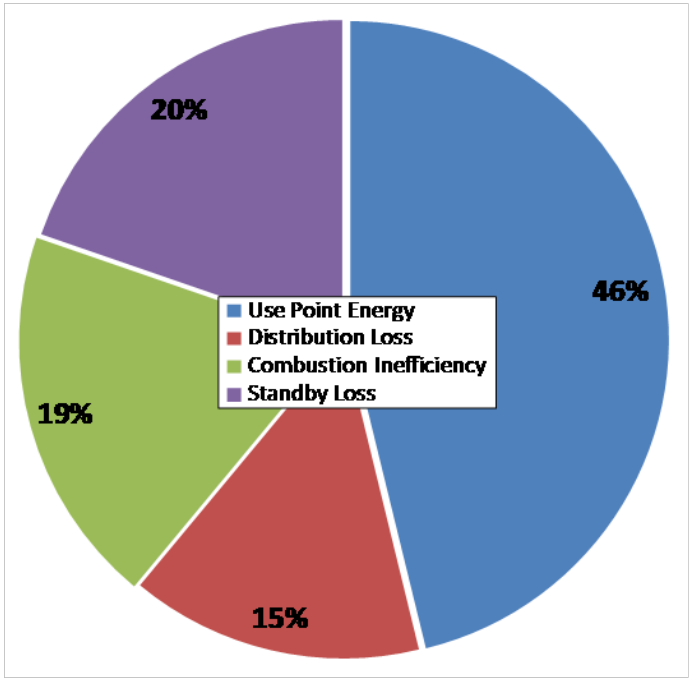
Typical Practice

- Design
  - No attention to WH location relative to hot water use points
  - Plumbing design completed in the field
- Materials used
  - Virtually all piping found in the field is PEX
    - PEX Good: Low cost, easy to install, flexible, smaller ID than copper
    - PEX Bad: Flexible = random pipe runs

Typical Practice

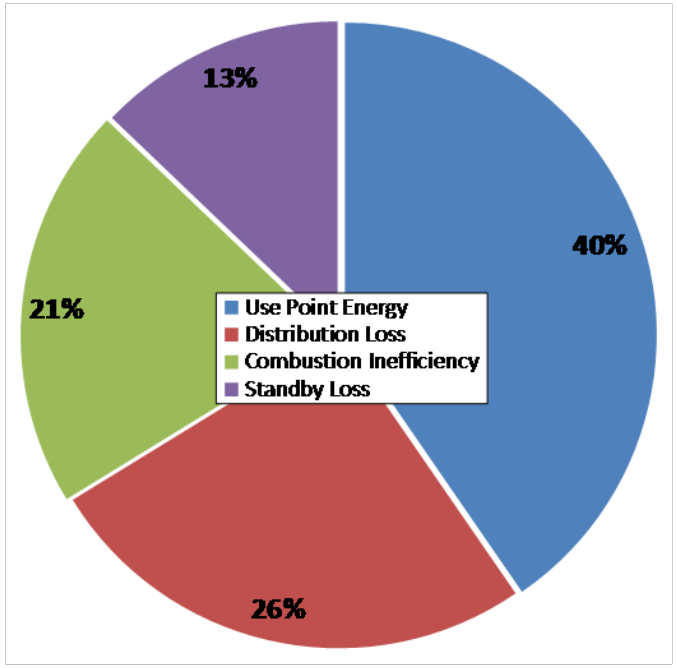
- End Result
  - Random plumbing layouts with oversized piping results in:
    - Energy waste
    - Water waste
    - Long hot water wait times

Typical Practice- Performance Impacts



2,010 ft^2 Prototype

3,080 ft^2 Prototype



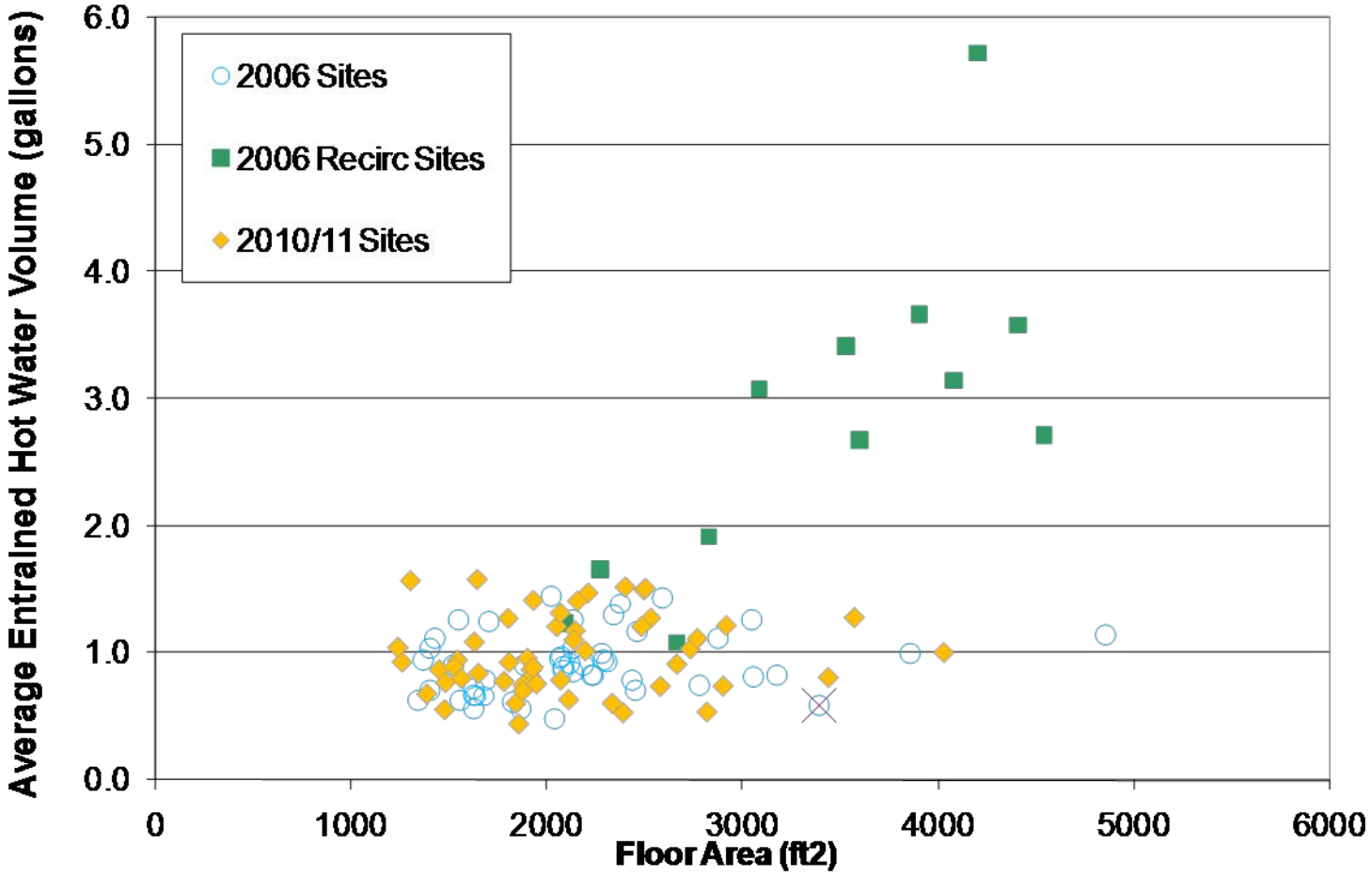
Code Change Proposals

- All ¾” and larger piping to be insulated
- Limit 1” piping to a maximum 10’ length
- Make compact hot water distribution systems the prescriptive standard
- Update ACM
  - Recalibrate ACM projected usage with RASS
  - New ACM relationships and DSMs
- Add HERS inspection for some measures

Data/Findings

- 2006 PIER Study completed field plumbing survey of 60 production homes
  - Identified typical layouts for different distribution system types
  - Developed six representative prototype plans
- GTI PIER study (currently underway) looking at additional 100 homes
- AET lab testing of piping materials
- HWSIM model development/enhancement

Data/Findings



Data/Findings

- What do the field findings tell us?
  - Need to reduce large diameter piping length (i.e entrained volume)
  - Need to insulate piping when cost effective
  - Need to promote compact hot water distribution system (HWDS) designs

Analysis Approach- HWSIM

- Layout of the plumbing system
- Piping materials used – L, D, location
- Presence of insulation
- The (hourly) temperature of the thermal environment the pipe is located
- Short time step heat transfer calculations
- 7 day hot water use schedule
- Hot water use behavioral assumptions

Insulated Piping (>= 3/4")

Prototype	Length of Piping (¾" or larger)	Projected Annual Savings (therms)	PV* of savings	Addl Cost †	LCC
1367	21.5	4.0	$111	$83	$28
1430	32	2.8	$78	$124	($46)
2010	44	13.5	$374	$170	$204
2881	71	14.9	$412	$275	$137
3080	50	18.6	$515	$194	$221
4402	90	12.2	$338	$348	($10)

"*" at $27.68 per therm 30 year residential value

" † " $3.87/foot

Overall BCR = 1.53

Max 10 ft 1” Piping Length

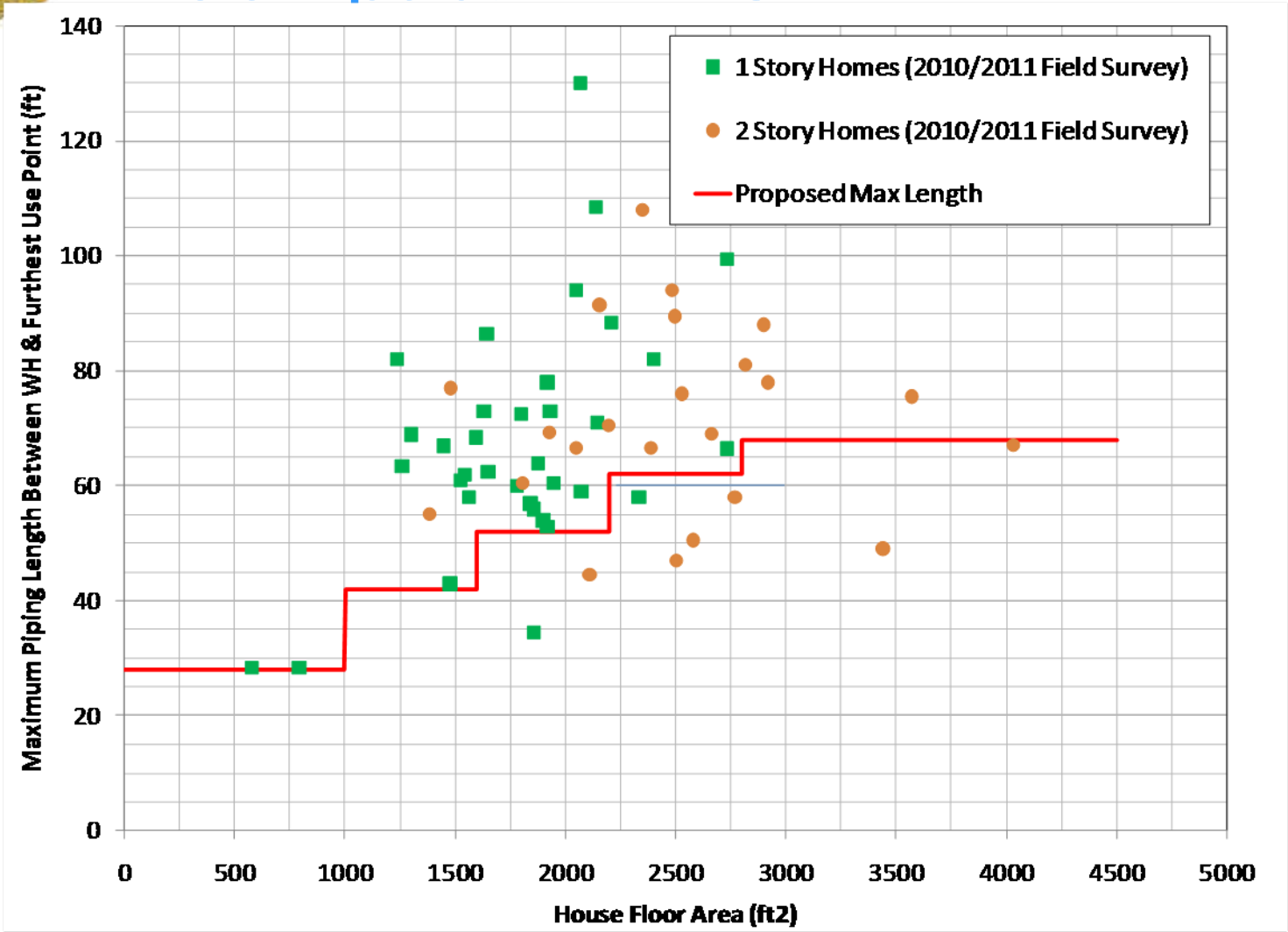
Prototype	Reduced Length of 1” Piping	Added Length of ½” Piping	Projected Annual Savings (therms)	PV* of savings	Addl Cost	LCC
Actual House	22.5’	185’	8.4	$233	$131	$102

Compact HWDS

- Improve WH location
- In some cases, modify design
- Improve plumbing layout

Prototype	Projected Annual Savings (therms)	PV* of savings	Added Cost (gas + vent pipe)	Cost Impact (reduced PEX piping)	Total Addl Cost	LCC
2010	19.8	$548	$390	($28)	$362	$186
2811	30.7	$850	$390	($183)	$207	$643
3080	16.8	$465	$390	($35)	$355	$111
4402	29.5	$817	$390	($44)	$346	$471

Compact HWDS



Analysis- RASS Adjustment

- Current ACM model predicts WH energy use ~15+% too high
- Energy Use depends upon:
  - HW usage
  - Distribution losses
  - Water heater efficiency
  - Cold water inlet and Tank setpoint temperatures

  } Recovery Load
- Limited basis for cold water adjustment
- DOE Survey says 124.2F average setpoint based on survey of 340 contractors

Analysis- Update Res ACM Appendix E

- Update ACM equations
- Revise DSM table with new values
- Add HERS sampling inspections

2008 ACM

Distribution System Measure	DSM
Pipe Insulation (all lines)	0.90
Uninsulated Pipe below Grade	3.80
Insulated and Protected pipe below grade	1.0
Point of Use	0.00
Standard -Kitchen Pipe Insulation– Standard Case	1.00
Standard pipes with no insulation	1.20
Parallel Piping	1.00
Recirculation (no control)	4.50
Recirculation + timer control	3.00
Recirculation + temperature control	3.70
Recirculation + timer/temperature	2.50
Recirculation + demand manual control	0.90
Recirculation + demand motion-sensor control	1.0
Temperature Buffering Tank	1.2

Code Change Proposal

- Add pipe insulation and maximum 1” pipe length (with exception) to Section 150 (j)2 mandatory measures

- Update RACM Appendix E to reflect changes in fixture end use, standard distribution loss, water heater setpoint, and DSMs. Updated DSMs will reflect compact hot water distribution system as standard design.

Add to 150(j)

6. The prescriptive standard for distribution system performance will be based on a compact hot water distribution system approach which limits the maximum length of distribution piping between the water heater and the furthest use point in the house. The table below defines the maximum pipe length as a function of Floor Area Served, where Floor Area Served equals the conditioned floor area divided by the number of installed water heaters.

Floor Area Served (ft^2)	Maximum Length
< 1001	28 ft
1001-1600	42 ft
1601-2200	52 ft
2201-2800	62 ft
>2800	68 ft

2013 Standards Update

Send related comments by May 31, 2011 to:

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