



CALIFORNIA  
ENERGY  
CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

# Second Stakeholder Meeting for Residential Water Heating **Compact Hot Water Distribution Design**

March 23, 2017

Marc Hoeschele

[mhoeschele@davisenergy.com](mailto:mhoeschele@davisenergy.com)

Peter Grant

[pgrant@davisenergy.com](mailto:pgrant@davisenergy.com)



# 1. Background



## What's the Problem?

- Issues impacting distribution system performance
  - Typical architectural design
  - Non-existent plumbing design
  - PEX can lead to sprawling layouts
  - Wait times impacted by:
    - Low(er) flow rate devices
    - Pipe sizing conservatism
- Recirculation is a solution for water waste, but not energy

## Advantages of Compact Hot Water Design

- Compact hot water design reduces the inefficiencies of conventional hot water distribution system designs
- Issue:
  - Distribution system energy loss



## Advantages of Compact Hot Water Design

- Compact hot water design reduces the inefficiencies of conventional hot water distribution system designs
- Issue:
  - Distribution system energy loss → Reduced



## Advantages of Compact Hot Water Design

- Compact hot water design reduces the inefficiencies of conventional hot water distribution system designs
- Issue:
  - Distribution system energy loss → Reduced
  - Wasted water





## Advantages of Compact Hot Water Design

- Compact hot water design reduces the inefficiencies of conventional hot water distribution system designs
- Issue:
  - Distribution system energy loss → Reduced
  - Wasted water → Reduced



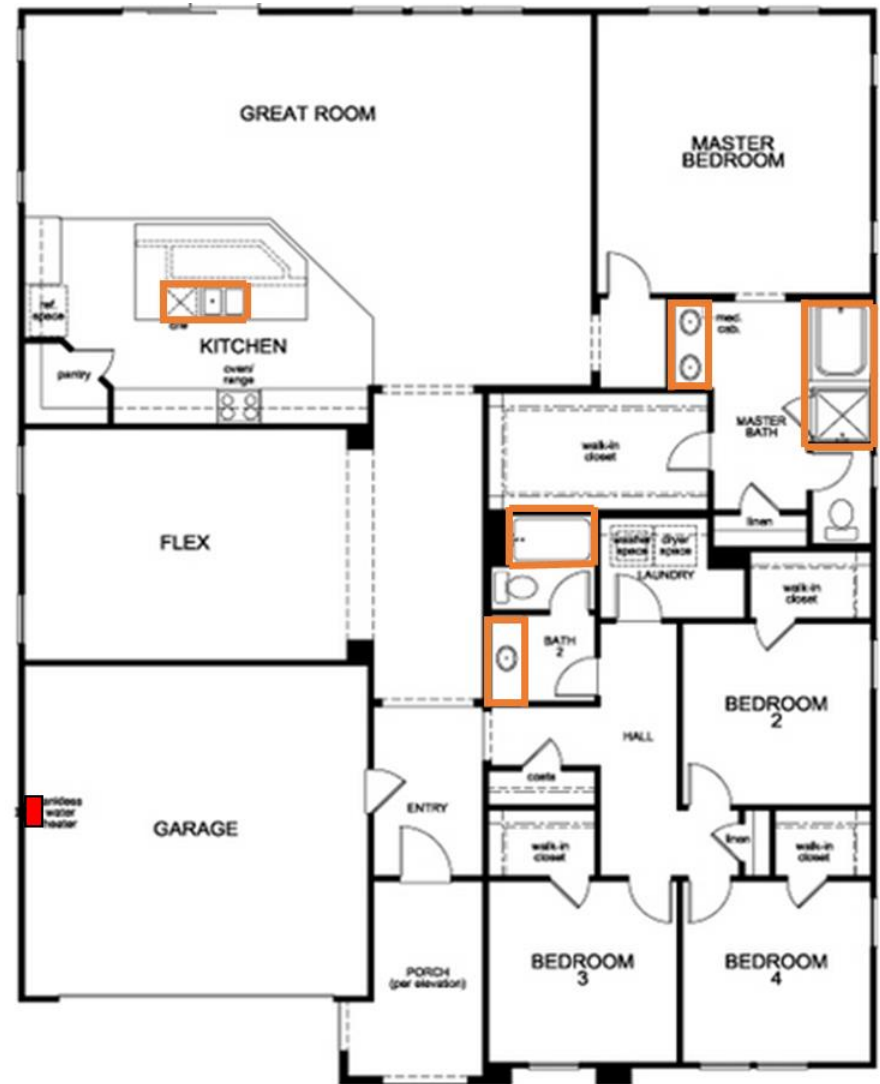
## Advantages of Compact Hot Water Design

- Compact hot water design reduces the inefficiencies of conventional hot water distribution system designs
- Issue:
  - Distribution system energy loss → Reduced
  - Wasted water → Reduced
  - Wait time → Reduced, but shower singing increased

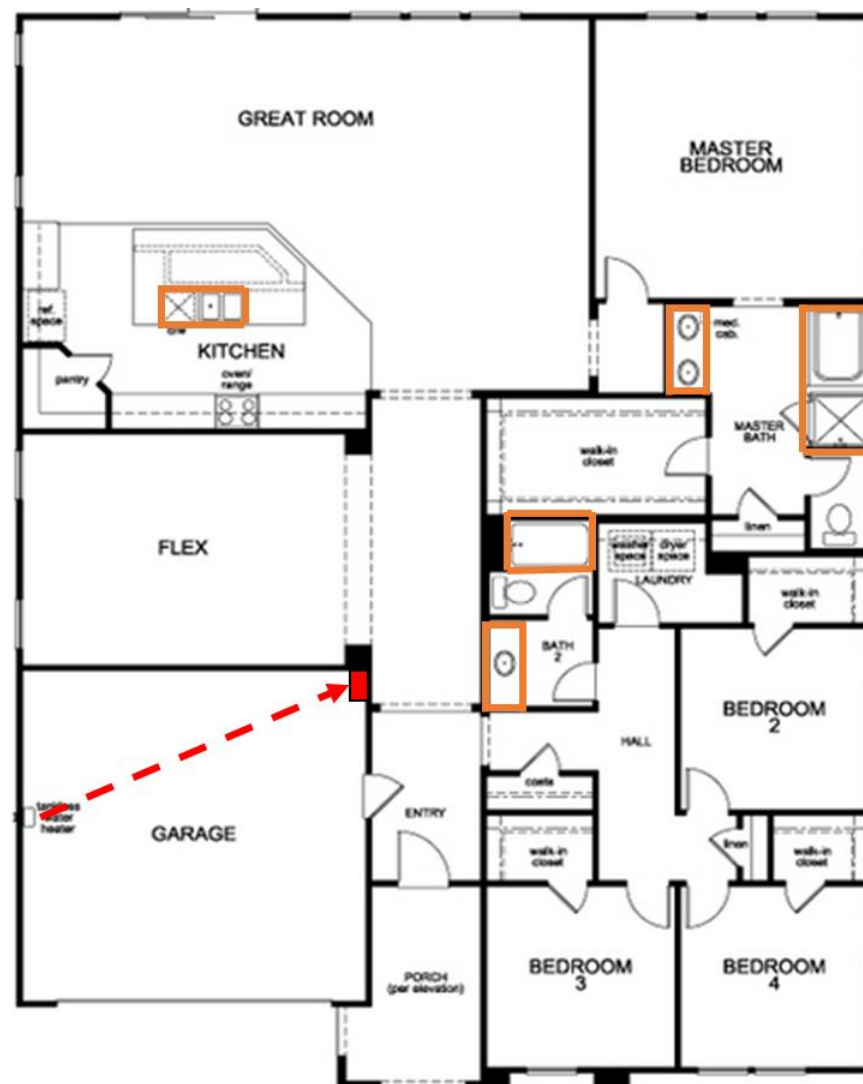




# Typical Distribution System Layout



## More Compact Distribution Layout



## Measure Goal

- Encourage builders to bring the water heater in closer proximity to all use points
  - Focus on Master Bath and Kitchen as primary sources of hot water draw events and hot water load



## Relevant Code History

- Compact design is an existing 2016 compliance option
  - HERS-Verified compact hot water design credit
    - Uptake close to zero (CalCerts registry data)
- Other Relevant Requirements/Specifications
  - EPA WaterSense®
    - 0.5 gallon between hot water source and any hot water fixture
  - 2016 CalGreen
    - Voluntary measures Appendix A4 (demand recirculation)
  - 2015 IAPMO Green Plumbing Supplement
    - Maximum volume between source of hot water and use point
  - IECC 2018: NRDC proposal for compact (wasn't accepted)
    - Maximum length (prescriptive), with performance credit for > compactness

## 2. Proposed Code Changes

---

## Proposed Code Change

- Revision to existing compliance option
- Single family residential new construction only
- Two tiered credit strategy
  - Basic: no HERS verification required
  - Expanded: greater credit, with limited HERS verification

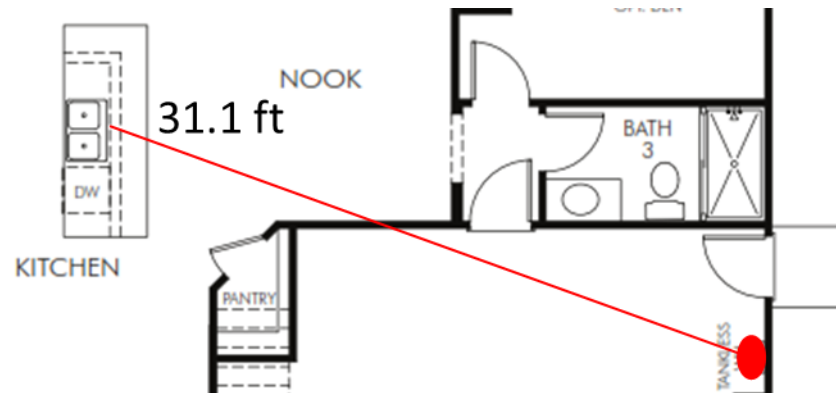


## Why Are We Proposing This Code Change

- Help support ZNE goals
- Achieve energy (and water) savings
- Provide builders with flexible means of compliance
- Promote improved plumbing practices
  - Homeowners benefit (wait time, less waste)
  - Builders benefit (homeowner satisfaction)

## Basics of Proposed Compact Design Measure

- Two versions: Basic Credit, Expanded Credit
  - Both are based on plan view calculation



- Comparison between two calculated values
  - Weighted Distance (WD)
  - Qualification Distance (QD)

## Basics of Measure

- WD & QD equations vary with:
  - Non-recirculation or recirculation (both WD, QD)
  - Number of stories (QD)
  - Conditioned floor area (QD)
- Adds Compactness Factor (CF) to distribution loss equations in the **ACM**
  - CF = 1.0 for non-compact system (default)
  - CF = 0.7 for Basic Credit
  - CF < 0.7 for Expanded Credit


$$DLM_k = 1 + (SDLM_k - 1) * DSM_k \underline{* CF}$$

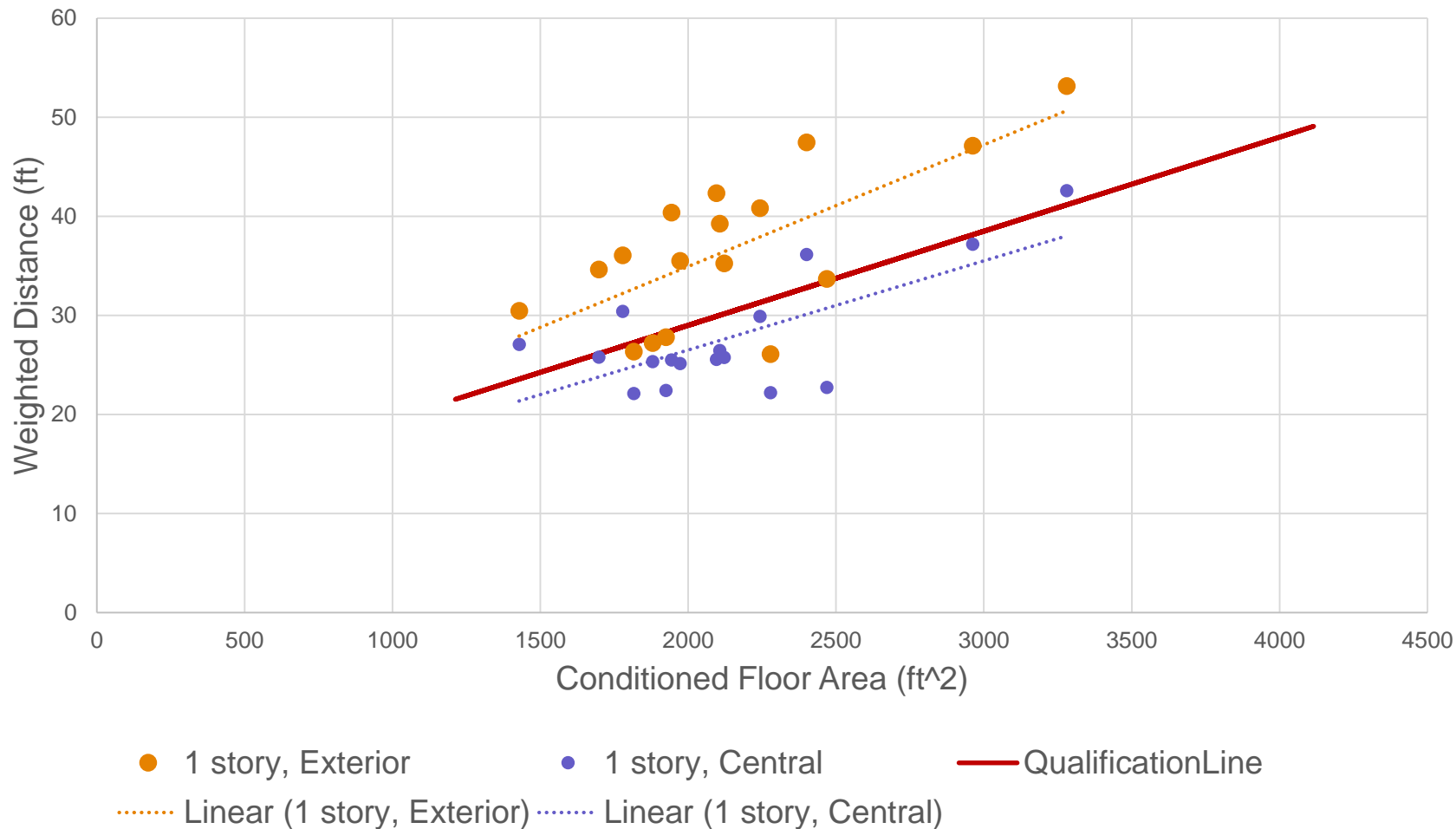
Equation  
5

## Weighted Distance (WD) Calculation

- $WD = x * d\_MasterBath + y * d\_Kitchen + z * d\_FurthestFixture$ 
  - $d\_MasterBath$  = Distance from water heater to furthest master bathroom fixture
  - $d\_Kitchen$  = Distance from water heater to furthest fixture in kitchen
  - $d\_FurthestFixture$  = Distance from water heater to furthest fixture in house
    - Not in the master bathroom or kitchen

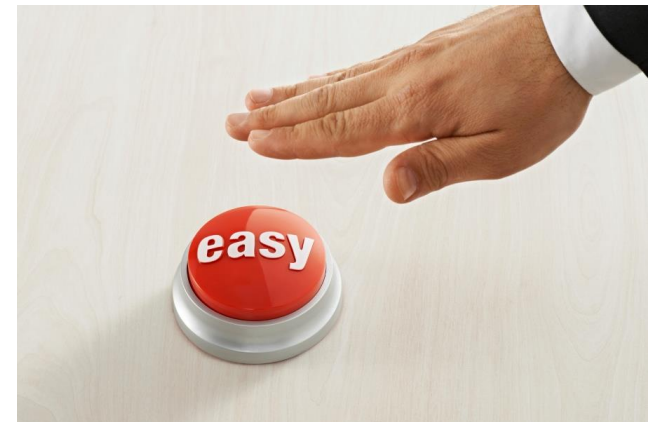
Distribution System	x	y	z
Non-Recirculating	0.4	0.4	0.2
Recirculating	0	0	1

## Qualification Distance Criteria Development – 1 story, Non-Recirculating



## Basic Credit

- Qualification:
  - Weighted Distance < Qualification Distance
- Reward
  - $CF = 0.7$





## Expanded Credit

- Qualification:
  1. Weighted Distance < Qualification Distance
  2. HERS verification steps:
    - Less than 8' of 1" diameter pipe (and no larger piping)
    - No hot water piping allowed in attic in two and three story homes unless water heater is located in the attic
    - Eligible recirculating systems must be HERS-Verified Demand Recirculation: Manual Control conforming to RA4.4.17.
- If meeting 1 & 2, the Expanded Credit criteria is satisfied
  - And,  $CF = 0.3 + 0.4 * WD/QD$

## Base Case Example: 1814 ft<sup>2</sup> two-story, Qualification Distance = 23.2

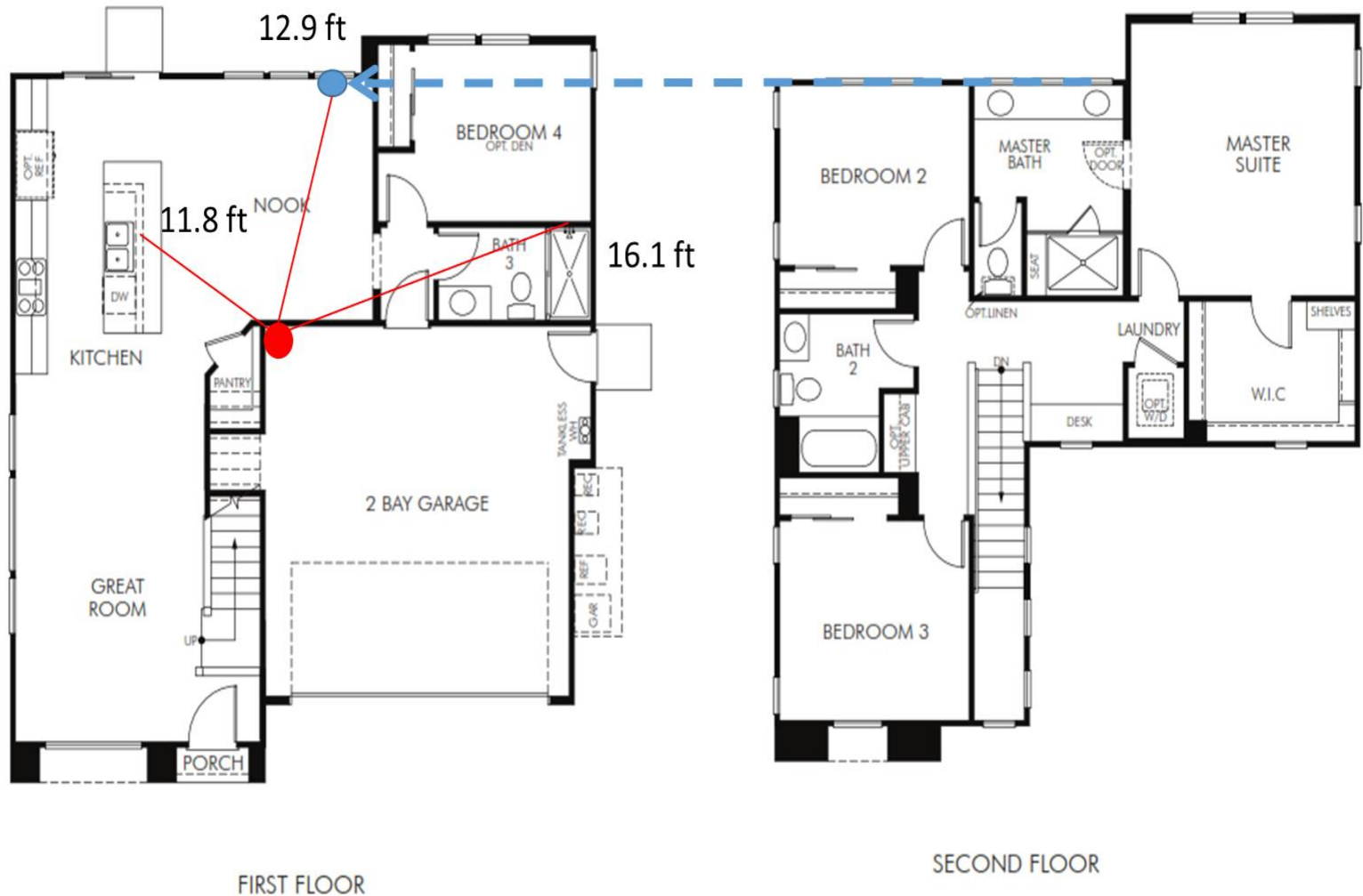
**Fails Basic Credit**



Weighted Distance =  $0.4 * 28.9 \text{ ft} + 0.4 * 31.1 \text{ ft} + 0.2 * 34.3 \text{ ft} = 30.9 \text{ ft}$

## Compact Example: 1814 ft<sup>2</sup> two-story, Qualification Distance = 23.2 ft

### Meets Basic Credit



$$\text{Weighted Distance} = 0.4 * 12.9 \text{ ft} + 0.4 * 11.8 \text{ ft} + 0.2 * 16.1 \text{ ft} = 13.1 \text{ ft}$$

## What do you think?



What do you think about the proposed code change?

# 3. Technical and Market Barriers

---

## Technical and Market Barriers

- Centrally locating water heater is a challenge
  - Increased venting distance/costs
  - Impacts garage space
- Possible solutions:
  - Condensing water heater (cheaper plastic vent pipe)
  - External wall (non-garage) mounting close to key use points
  - Attic

*Expensive  
vent kits for  
non-condensing*



*Cheaper  
plastic for  
condensing*





## Technical and Market Barriers

- Title 24 Consultant ↔ Builder ↔ Plumber communication
  - The consultant specs Expanded Credit, but plumber does not know
  - Plumber installs non-compliant system & fails HERS verification
- Solution → Clear direction to plumber
  - Eligibility criteria on plans
  - Plumber training

## Technical and Market Barriers

- Piping required between floors for Expanded Credit
  - Open web floor trusses not standard
  - Added labor when dealing with I-joists
  - Is this a significant problem?
- Solution → **Builder can default to Basic Credit**

## 4. Compliance and Enforcement

---

# Compliance Process



## Design Phase

- What happens during design phase
  - Water heater in more central location and/or architectural design reflects compact design approach
  - Provide Weighted Distance vectors on floor plan for easier plan review
  - For Expanded Credit, clearly specify eligibility criteria on plumbing plans

# Compliance Process



## Permit Application Phase

- What happens in permit application phase?
  - Prepare documentation
  - Complete Title 24, Part 6 calculations indicating Basic or Expanded Credit
    - Expanded Credit would trigger installation and HERS verification reports (CF2R and CF3R)
  - Plan reviewer verifies Weighted Distance qualification is met

# Compliance Process



## Construction Phase

- What happens in construction phase?
  - Basic Credit: No impact
  - Expanded Credit: Plumber follows compact design eligibility requirements



# Compliance Process

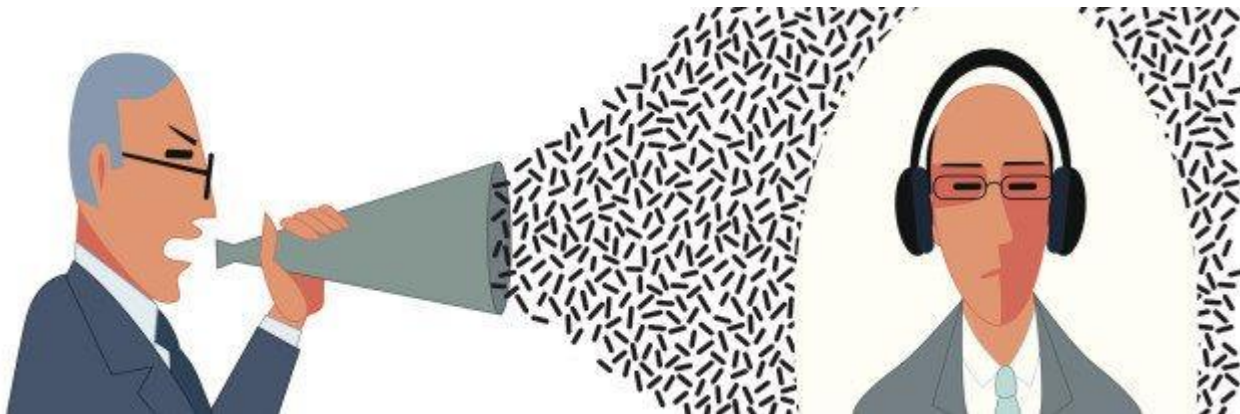


## Inspection Phase

- What happens in inspection phase?
  - For Basic Credit, nothing
  - For Expanded Credit, simple HERS visual inspections:
    - a. Less than 8' of 1" diameter pipe (and no larger piping)
    - b. No hot water piping in attic in two and three story homes unless water heater is located in the attic
    - c. Recirculating systems must be HERS-Verified Demand Recirculation: Manual Control conforming to RA4.4.17.

## Compliance and Enforcement Barriers

- Issue: Developing clear communication for Expanded Credit between Title 24 consultant and plumber
  - Plumber installs non-compliant system, fails HERS inspection
- Solution → Plumber education on eligibility criteria critical
- Solution → Documentation on credit provided to plumber



## Compliance and Enforcement Barriers

- Issue: Added plan checker verification requirement
  - Plan check process needs to verify WD calculation
- Solution → Brief training for plan reviewers

## What do you think?



What do you think about the compliance and enforcement barriers?

## 5. ~~Cost-Effectiveness and~~ Energy and Water Impacts

---

# Definition of Baseline and Proposed Conditions

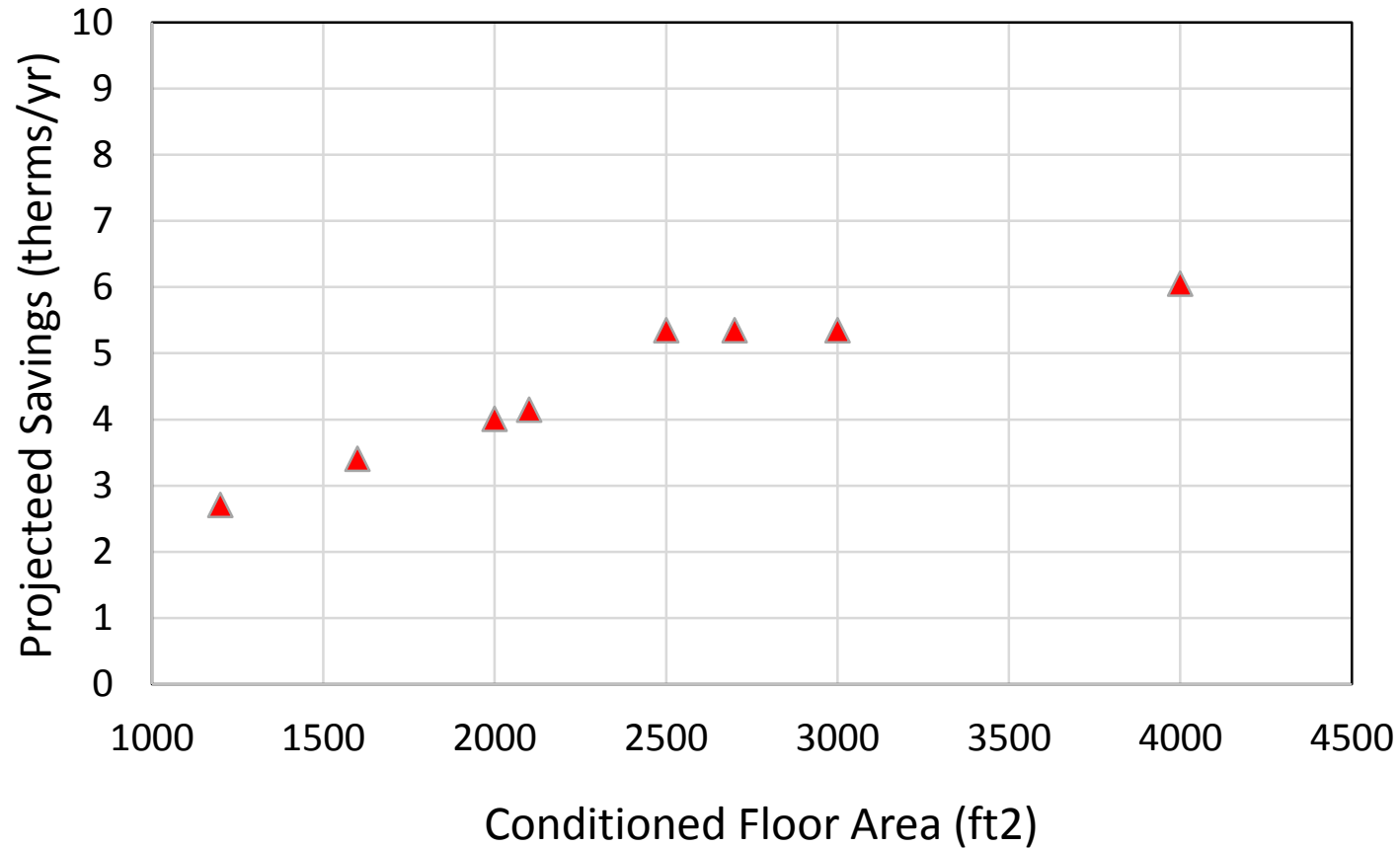
## Baseline Conditions

- Minimally compliant with 2016 Standards
- List key assumptions
  - Develop standard water heating budget for house sizes ranging from 1,200 to 4,000 ft<sup>2</sup>, assuming all hot water pipes insulated using CBECC-Res
  - CBECC water heating model assumes hot water loads vary with number of bedrooms

## Proposed Conditions

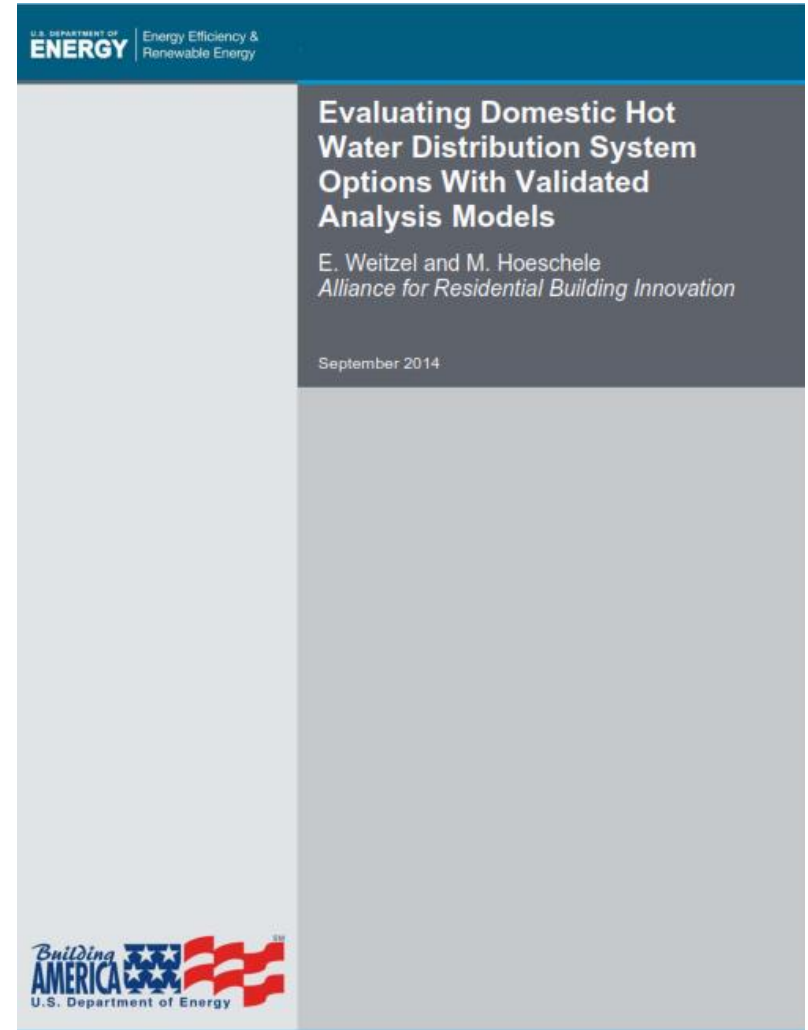
- Simulate compact hot water distribution Basic Credit (CF = 0.7)

## Projected Savings as a Function of House Size



## Estimated Water Savings Impact

- Water-use impacts are highly dependent upon behavior and occupancy
- Can only assess with detailed, short time step simulation models
- Building America report looked at performance in six U.S. climates
- Based on findings, estimating **typical water savings of 962 gallons/year** for ~2,000 ft<sup>2</sup> home





## What do you think?



- Do the projected energy savings seem reasonable?
- Are the estimated water savings appropriate?

### Estimated Water Savings

- 962 gallons/year

For typical 2,000 ft<sup>2</sup> home

(Based on findings from *Building America* report)

### Projected Energy Savings

- 1,200 ft<sup>2</sup> CFA — 2.8 therms/yr
- 2,500 ft<sup>2</sup> CFA — 5.2 therms/yr
- 4,000 ft<sup>2</sup> CFA — 6.0 therms/yr



A STATEWIDE UTILITY PROGRAM

## 6. Next Steps

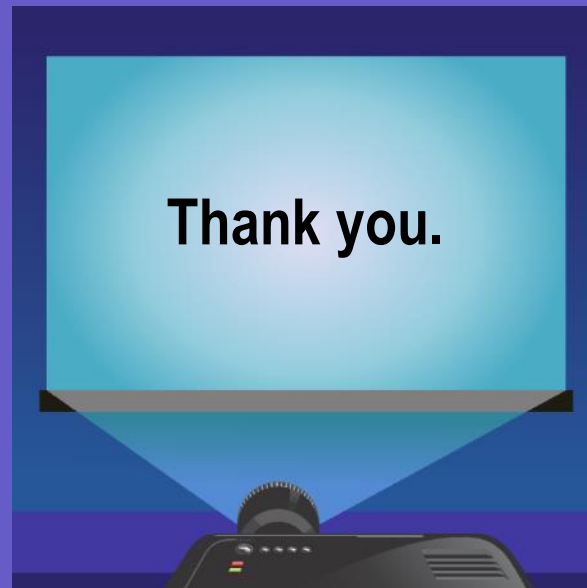
---

## Next Steps

- Please send any additional feedback to:
  - CASE authors:
  - [Info@title24stakeholders.com](mailto:Info@title24stakeholders.com)
- Keep an eye on [Title24Stakeholders.com](http://Title24Stakeholders.com) for:
  - Presentations from today's meeting
  - Draft Code Change Language
  - Notes from today's meeting
  - Draft CASE Report (will be posted in April)

Let's move on to...

## Drain Water Heat Recovery (DWHR)



- **Marc Hoeschele**  
mhoeschele@davisenergy.com
- **Peter Grant**  
pgrant@davisenergy.com

## References

- [Title24Stakeholders.com](https://www.title24stakeholders.com)
- [EnergyCodeAce.com](https://www.energycodeace.com)
  - See [Reference Ace](#) for 2016 Standards, Appendices, and Compliance Manuals
- [California Energy Commission 2019 Standards Webpage](#)