DOCKETED

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2019 Building Energy Efficiency Standards
Water Heating Proposals

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2019 Pre-rulemaking
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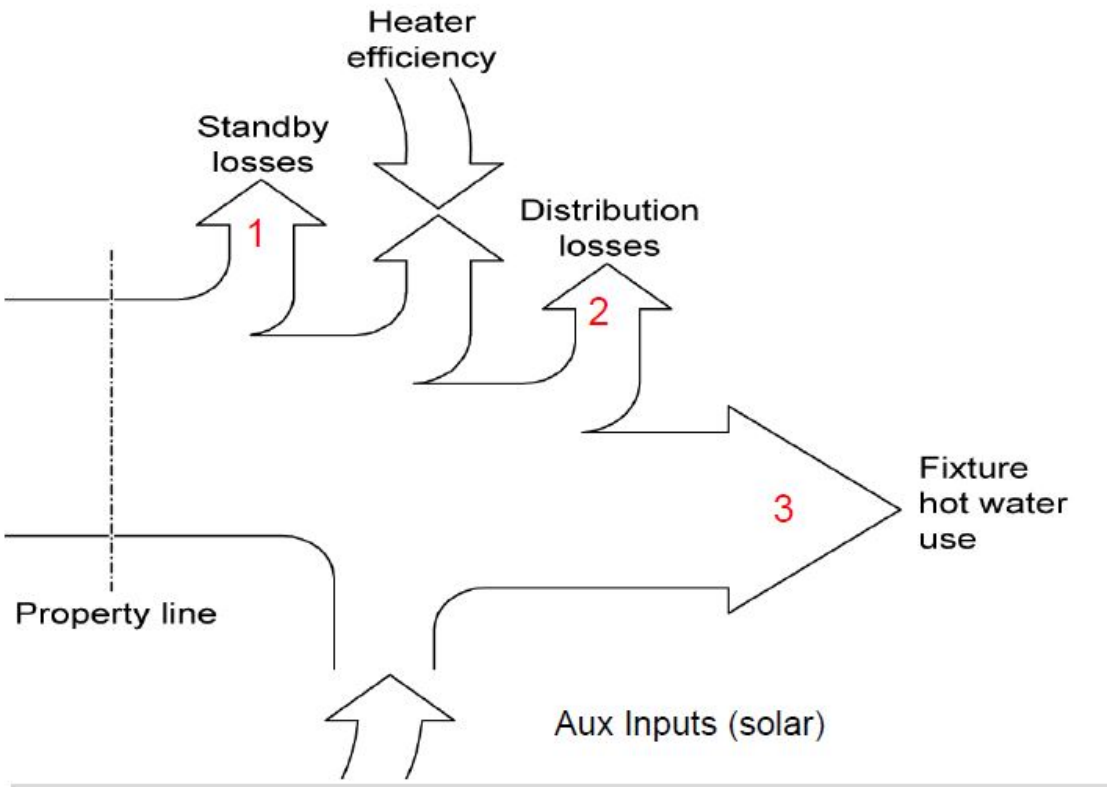
Compact Hot Water Distribution

Acknowledgements

Marc Hoeschele, Davis Energy Group

Peter Grant, Davis Energy Group

Water heating energy flow



1. 2016 gas inst. water heater prescriptive requirement reduced standby losses by ~40 therms/year.

2. 2017 CPC Pipe insulation requirement results in ~10% lower distribution losses.

3. Future Energy Commission showerhead & lavatories gpm requirements; increasing use of water efficient appliances and wait time

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:
    - Lower flow rate devices
    - Pipe sizing conservativism

- 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

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- Issue:
  - Distribution system energy loss → Reduced

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- Issue:
  - Distribution system energy loss → Reduced
  - Wasted water

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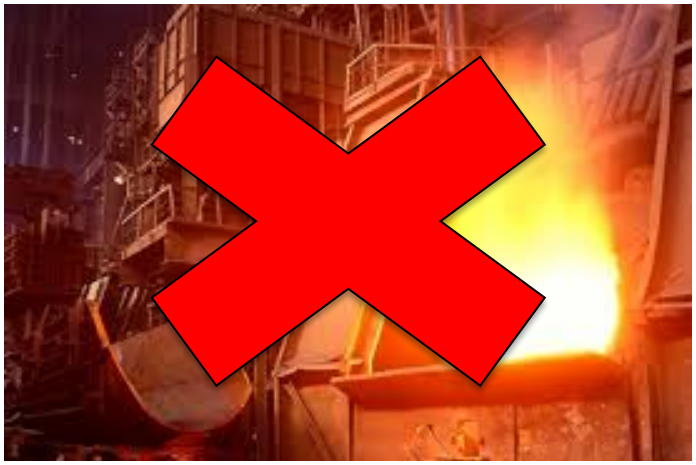
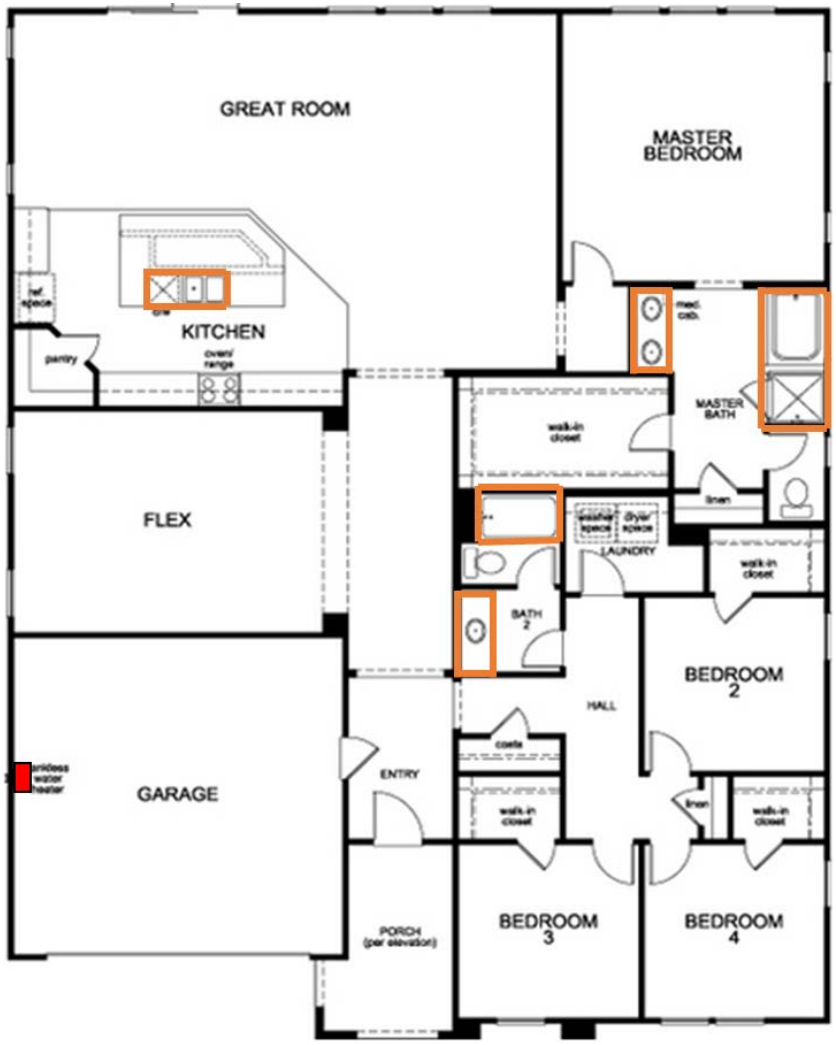


Advantages of Compact Hot Water Design

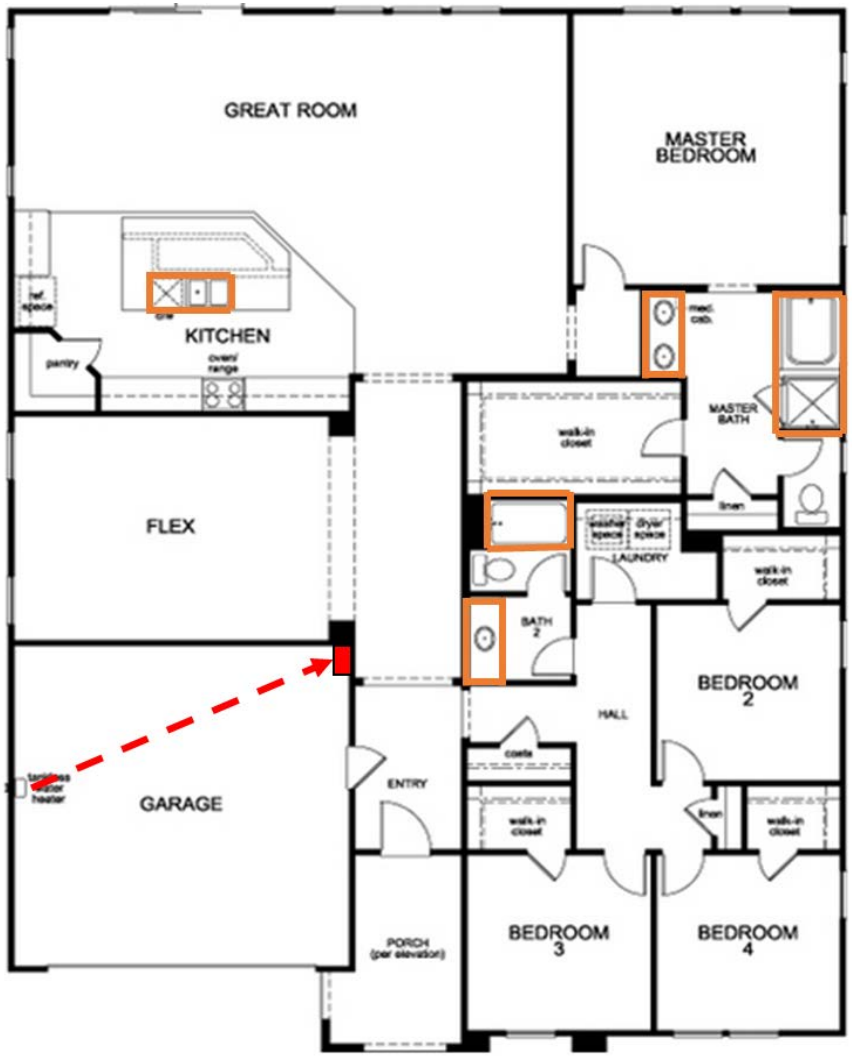
- Compact hot water design reduces the inefficiencies of conventional hot water distribution system designs

- 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

Proposed Code Changes

Proposed Code Change

- Revision to existing compliance option
- Newly constructed single family only
- Two tiered credit strategy
  - Basic: no HERS verification required
  - Expanded: greater credit, with limited HERS verification

Proposed Code Change

Mandatory, Prescriptive, Addition and Alteration Requirements

- No change

Reference Appendices

- Updates to existing Compact Hot Water Distribution System Credit

ACM Reference Manual

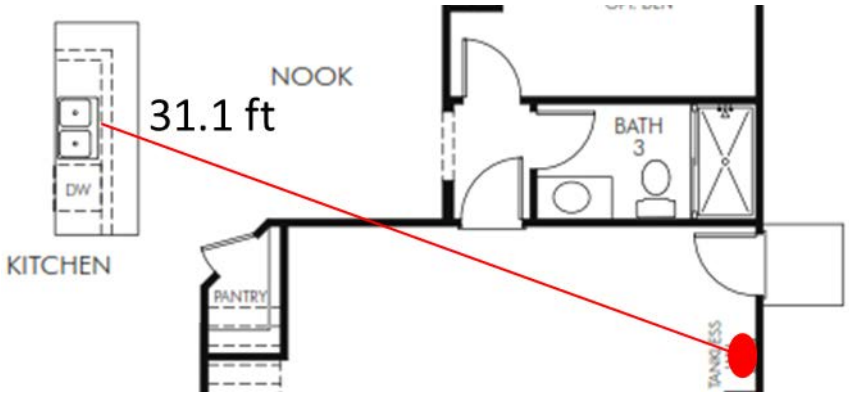
- New Compactness Factor to Distribution loss multiplier equation

Why Are We Proposing This Code Change

- Additional option to achieve EDR target
- 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

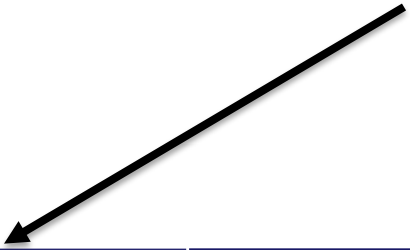


- Comparison between two calculated values
  - Weighted Distance (WD)
  - Qualification Distance (QD)

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



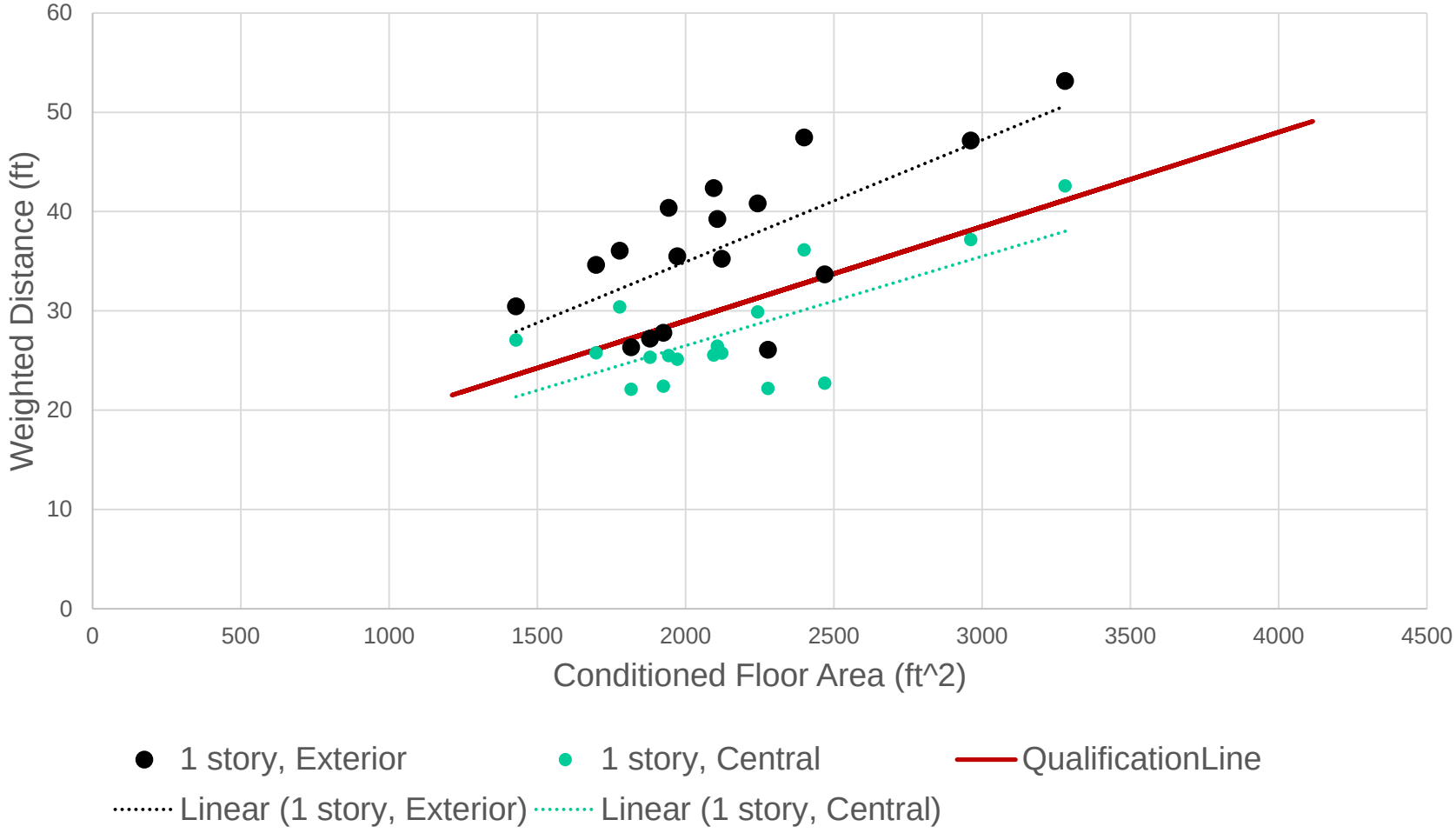
$DLM_k = 1 + (SDLM_k - 1) * DSM_k$ *** CF**	Equation 5

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

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

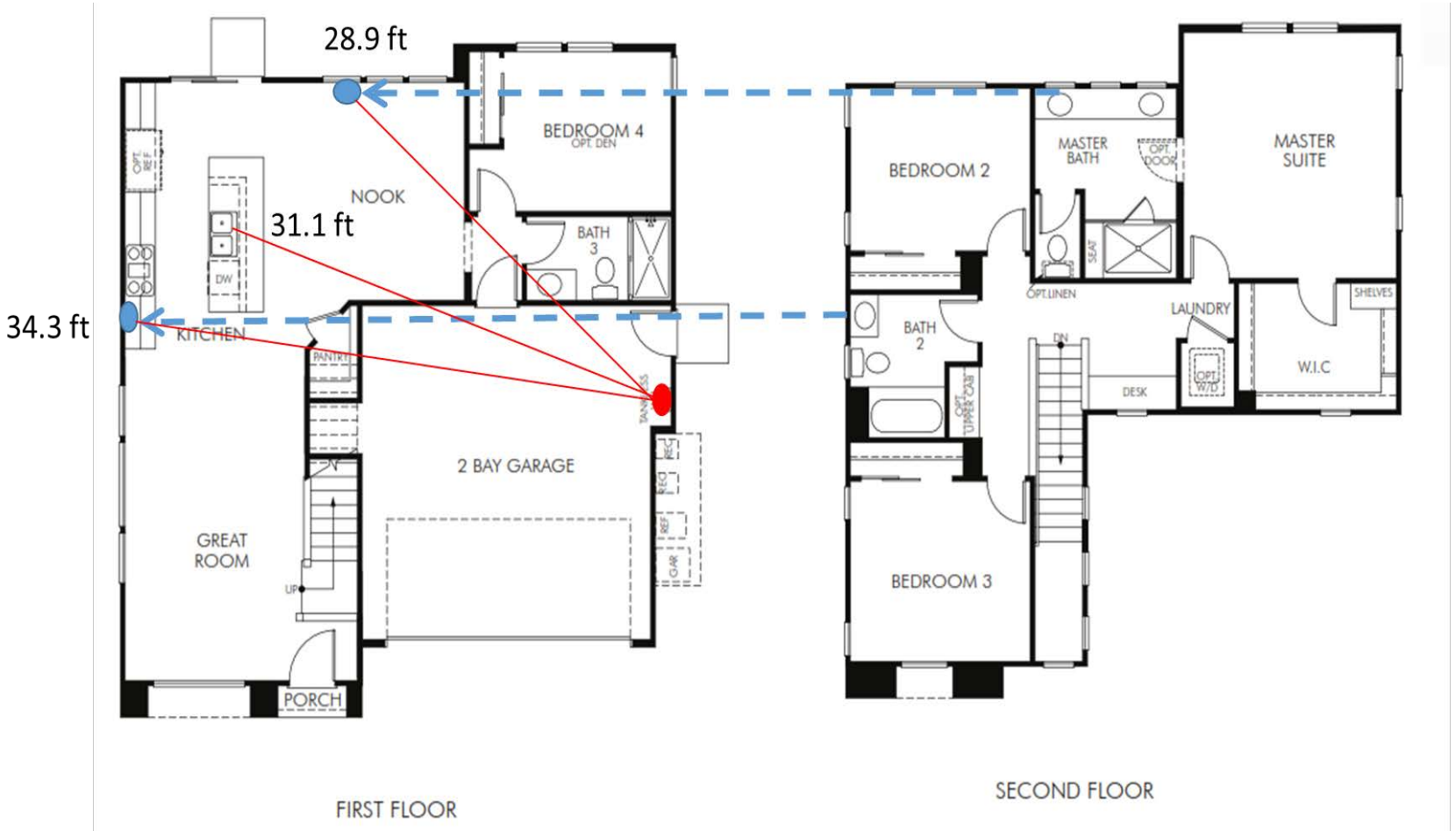
- Qualification:
  - Weighted Distance < Qualification Distance
- Reward
  - CF = 0.7

Expanded Credit

- Qualifications:
  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

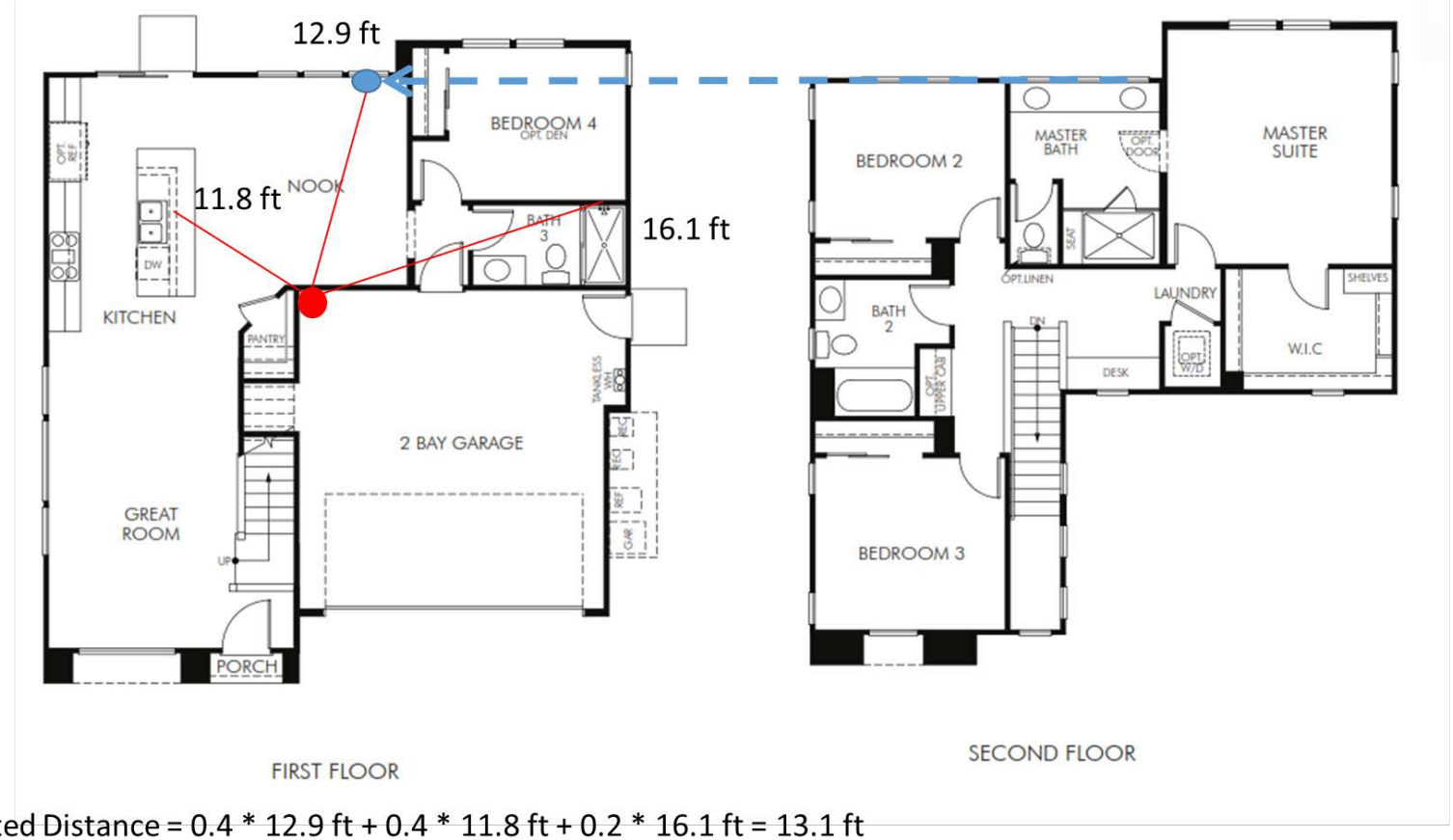
Base Case Example: 1814 ft^2 two-story, Qualification Distance = 23.2



Weighted Distance = 0.4 * 28.9 ft + 0.4 * 31.1 ft + 0.2 * 34.3 ft = 30.9 ft

Fails Basic Credit

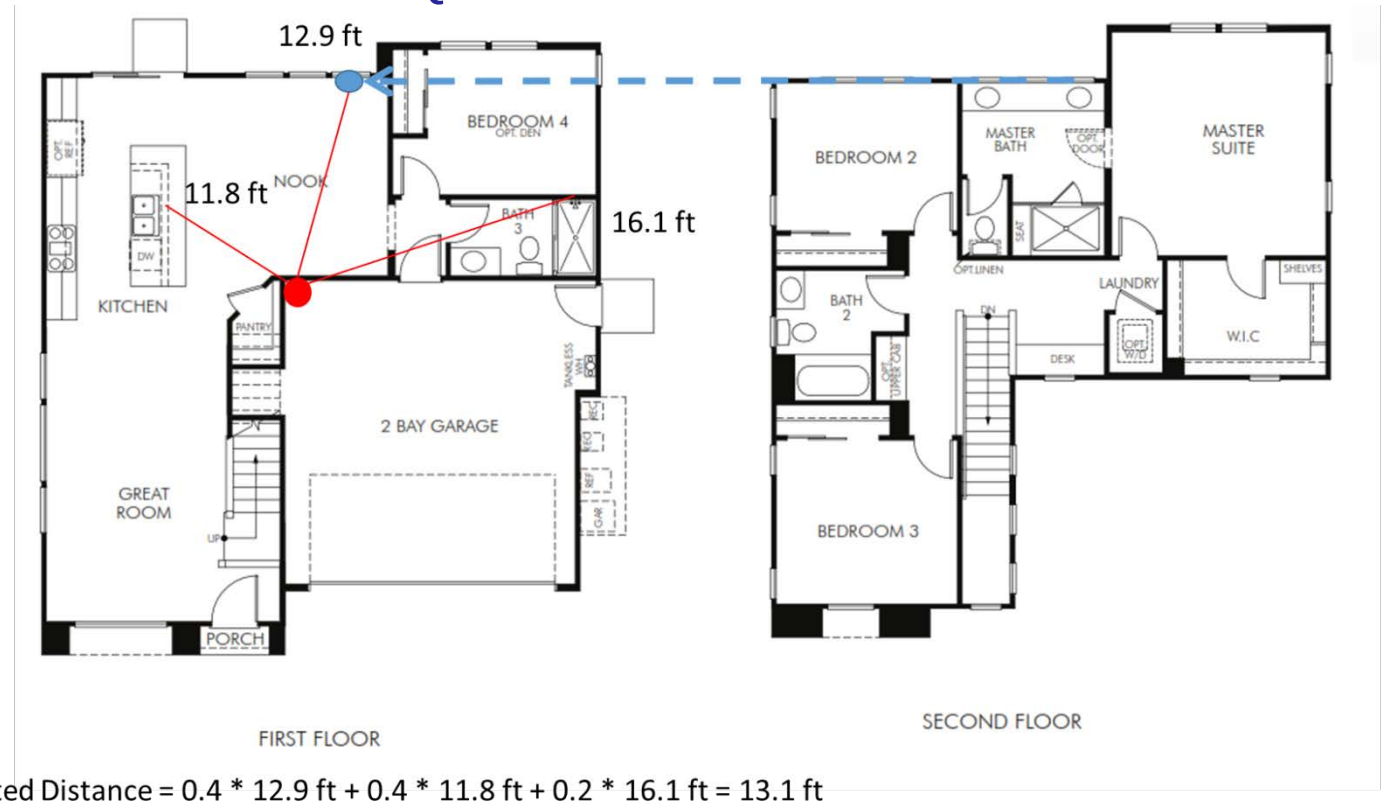
Compact Example: 1814 ft^2 two-story, Qualification Distance = 23.2 ft



Weighted Distance = 0.4 * 12.9 ft + 0.4 * 11.8 ft + 0.2 * 16.1 ft = 13.1 ft

Meets Basic Credit

Expanded Credit Compact Example: 1814 ft^2 two-story, Qualification Distance = 23.2 ft



Weighted Distance = 0.4 * 12.9 ft + 0.4 * 11.8 ft + 0.2 * 16.1 ft = 13.1 ft

$$CF = 0.3 + 0.4 * WD/QD$$
$$= 0.3 + 0.4 * (13.1/23.2)$$
$$= \underline{0.53}$$

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

- Solution → Builder can default to Basic Credit

Compliance and Enforcement

Compliance Process

Architect

- Provide Weighted Distance vectors on floor plan for easier plan review
- For Expanded Credit, clearly specify eligibility criteria on plumbing plan

Plan Reviewer

- Verifies Weighted Distance qualification is met.
- For basic credit, no additional requirement beyond this step

HERS Rater (Expanded Credit Only)

- Visual inspection of expanded credit requirements:

  1) < 8’ of 1” diameter pipe 2) no hot water piping in attic in > two stories homes unless water heater is located in the attic 3) Any recirculation system must be HERS-Verified Demand Recirculation with Manual Control

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^2, assuming all hot water pipes insulated using CBECC-Res
    - CBECC water heating model assumes hot water loads vary with number of bedrooms

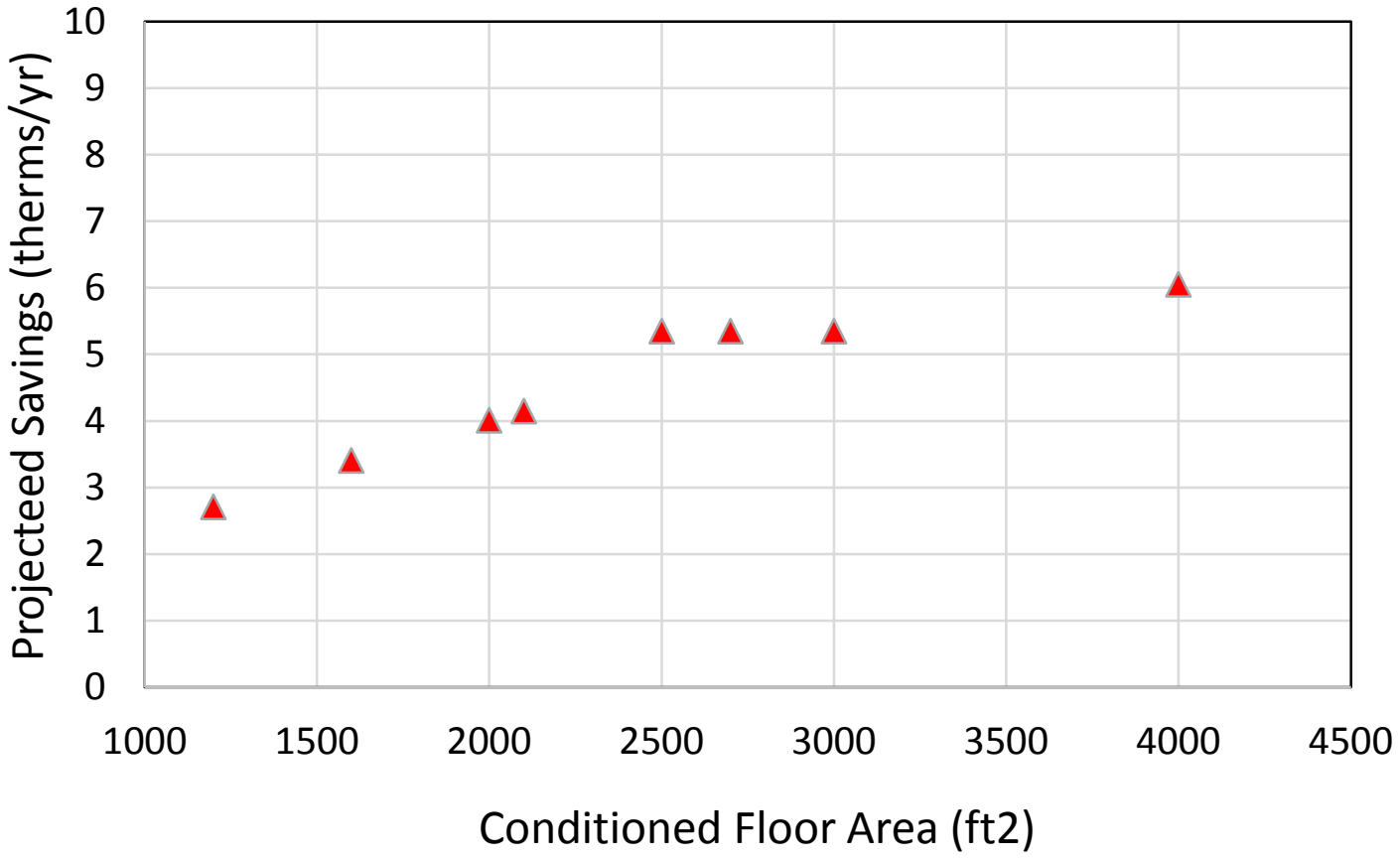
- Proposed Conditions
  - Simulate compact hot water distribution Basic Credit (CF = 0.7)

Per-unit Energy Impacts

Table 5: First-Year Energy Impacts per 2,430 Square Feet Single Family Prototype– New Construction

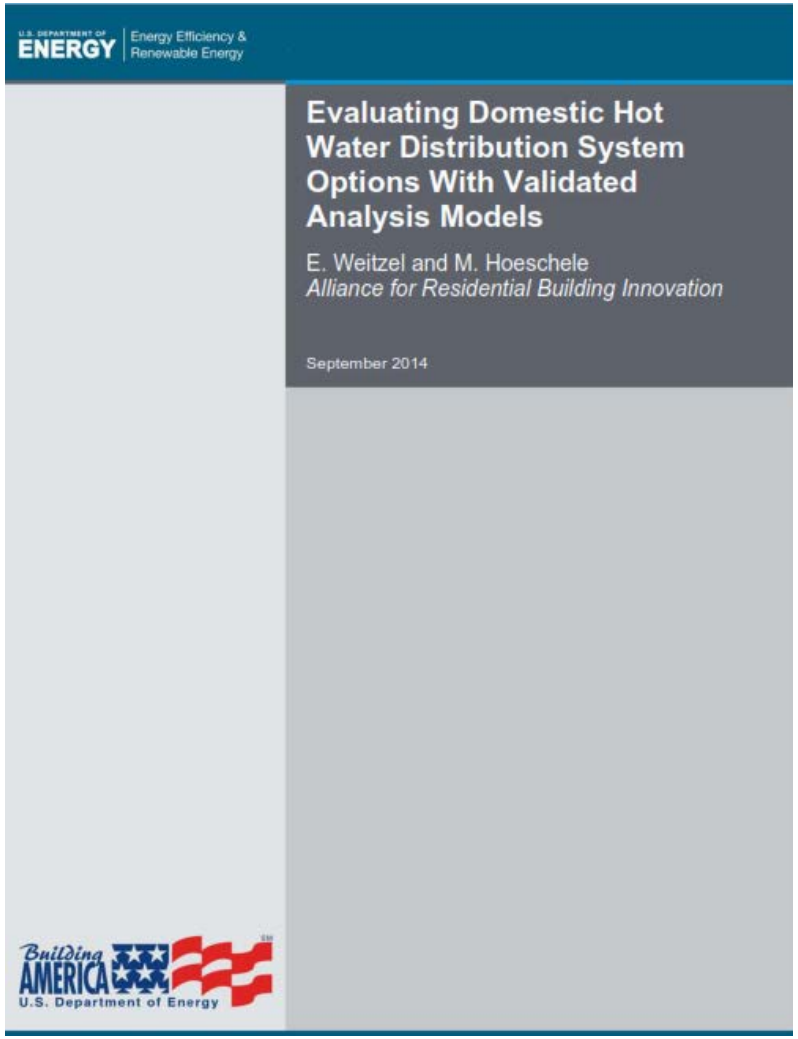
Climate Zone	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions (kW)	Natural Gas Savings (therms/yr)	TDV Energy Savings (TDV kBtu/yr)
1	0	0	6.0	1,205
2	0	0	5.4	1,079
3	0	0	5.4	1,080
4	0	0	5.1	1,028
5	0	0	5.5	1,107
6	0	0	4.9	982
7	0	0	4.8	948
8	0	0	4.6	938
9	0	0	4.6	938
10	0	0	4.6	932
11	0	0	4.7	954
12	0	0	5.0	1,002
13	0	0	4.6	934
14	0	0	4.8	972
15	0	0	3.3	686
16	0	0	6.0	1,213

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^2 home



Questions?