CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

2019 Title 24 Codes & Standards Enhancement (CASE) Proposal

Drain Water Heat Recovery

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What is Drain Water Heat Recovery (DWHR)?

Photo 1: Lab setup

Figure 1: Unequal Flow to WH Diagram

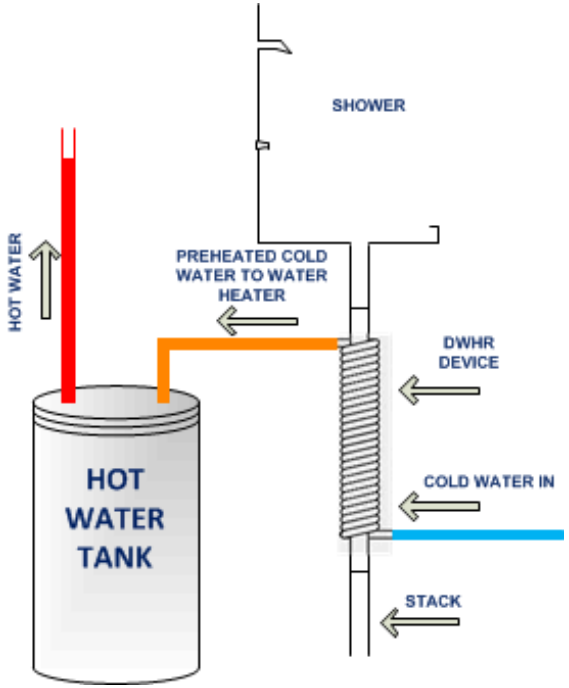
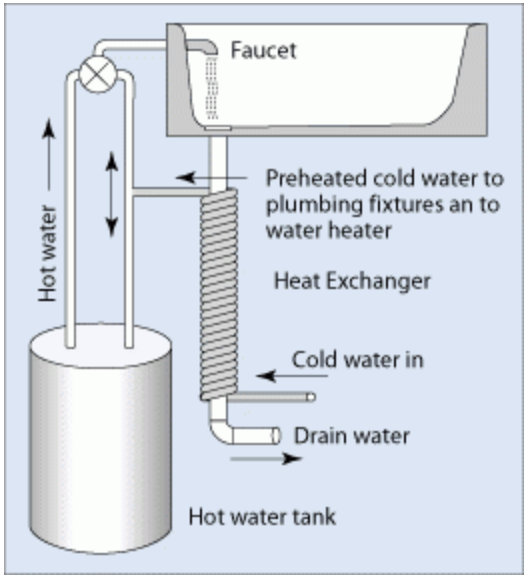


Figure 2: Equal Flow Diagram



Source for Photo 1 & Figure 1 : DEG's Phase 1 report

Source for Figure 2: http://energy.gov/energysaver/drain-water-heat-recovery

Proposed Code Change Overview

- **Types of building impacted**
  - Single Family
  - Multifamily
  - Commercial
- **Building system impacted**
  - Water heating
- **Anticipated type of change**
  - Single Family: Compliance option; energy modeling
  - Multifamily: Prescriptive option; energy modeling
  - Commercial: Uncertain since no draw schedules
- **Description of change**
  - Introduce drain water heat recovery (DWHR) into Title 24 as a method to save water heating energy usage

Proposed Code Change History

- Why are we proposing this measure?
  - Significant savings opportunity for some buildings & climate zones
  - Reduces domestic hot water heating load
  - DWHR not included in Title 24

Current Code Requirements

- **Existing Title 24 Requirements**
  - None
- **Existing Model Code Requirements**
  - Manitoba and Ontario, Canada Require DWHR Via Their Housing Energy Efficiency Codes
  - Included in the IECC 2015
  - Performance credit in HERS
  - Recognized by RESNET, EnergyStar, LEED, and the National Green Building Standard (NGBS) grants points (Ch. 7)
- **Other regulatory considerations**
  - Canadian Standards Association (CSA) certification required
    - CSA 55.1 verifies efficiency and performance
    - CSA 55.2 verifies safety of construction and components

Typical Practices

- **Trends**
  - Sales primarily in new residential construction
    - Largest market is in Canada
    - Ontario Building Code mandates DWHR for prescriptive compliance beginning January 2017
      - 70,000 housing starts in 2015
  - Vertical units dominate sales
  - Consumer uptake minimal; builders and plumbers are the buyers
  - Marketed as a cost-effective way for RESNET builders to get points
  - Interest in commercial and institutional building markets
    - A significant opportunity for energy and cost savings
    - Integration research with other appliances (such as dishwashers) underway
- **Do you agree with this description?**

Market Overview and Analysis

- **Manufacturers**
  - Four manufacturers
  - Estimated 20,000 units sold in 2015
  - 4-10 year warranties, and 30-50 year product life
  - Typical costs = $325 to $425 for one 3” diameter x 48” long, plus $100 to $200 for parts & labor
- **Builders**
  - Very limited U.S. market penetration
- **Plumbing Contractors**
  - Training/installation support provided by manufacturers
- **Utilities**
  - U.S. utility incentive programs have had little impact
  - Ontario, Canada market transformation initiatives effectively helped incorporate DWHR into the energy code over time

Market Barriers

- Known as a “cold climate” technology
- Competition from typical non-energy features (granite counter tops) and new energy features (HEMS, Powerwall)
- Water/energy savings benefits difficult to understand for some
- Low builder awareness in the U.S.
- Limited U.S. experience, and very few California applications
- Import duties add to cost of product shipped to U.S.
- Fluctuating copper commodity prices
- Other market information sources we should know about?

Incremental Cost Estimation

- How we collected costs of base case technology and proposed technology
  - Interviews with manufacturers
  - Manufacturers' websites
- We found the costs to be:
  - $300 - $350 for one 2" dia. x 60" long
  - $325 - $425 for one 3" dia. x 48" long
  - $450 - $525 for one 4" dia. x 48" long
  - $100 - $200 for parts & labor (will refine for prototype buildings)
- Do you find these costs to be reasonable?
- Did we miss any cost components?

Assumptions for Energy Impacts Analysis

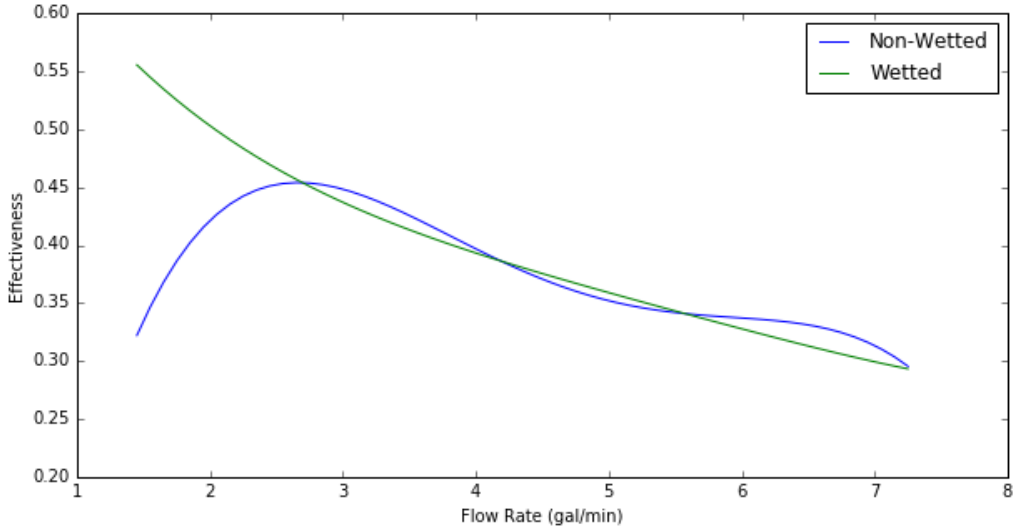
- **Data sources**
  - DEG/PG&E lab work and analysis, CSA rated effectiveness, CBECC-Res 2016, 2016 Residential ACM Manual, 2019 TDV
- **Prototype Buildings**
  - Single Family: 1BR (555 sf.), 2BR (922 sf.), 3BR (2100 sf.), 4BR (2700 sf.), & 5BR (2831 sf.)
  - Multifamily: (4) 2nd fl. units w/ central water heater. 1BR (780 sf.), 2BR (960 sf.), 3BR (1160 sf.), 4BR (1380 sf.), & 5BR (1620 sf.)
  - Meet Prescriptive Requirements
- **Key assumptions**
  - Shower quantity and duration per CBECC-Res draw schedules
  - All showers on 2nd floor & all drains routed to one DWHR device
  - Equal flow configuration for SF & unequal flow to WH for MF
  - No pipe heat loss
  - No savings during shower warm up period (will approximate later)
  - 3” dia. device for Single-Family and 4” for Multi-Family (will study 2”)

Methodology for Energy and Cost Savings Analysis

- Approach
  - For each day of showering
    - Calculate recovered heat
    - Divide by overall WH efficiency to obtain site gas savings
    - Multiply by daily TDVkBtu/therm to get TDV energy
    - Multiply by present TDV cost multiplier ($0.1732/TDV kBTU)
  - Sum over full year
  - Complete calculation for every combination of number of bedrooms (1-5) and climate zone

Initial Data and Findings

- Created algorithm to identify DWHR performance in various conditions
- Partial wetting reduces heat transfer and occurs at low flows

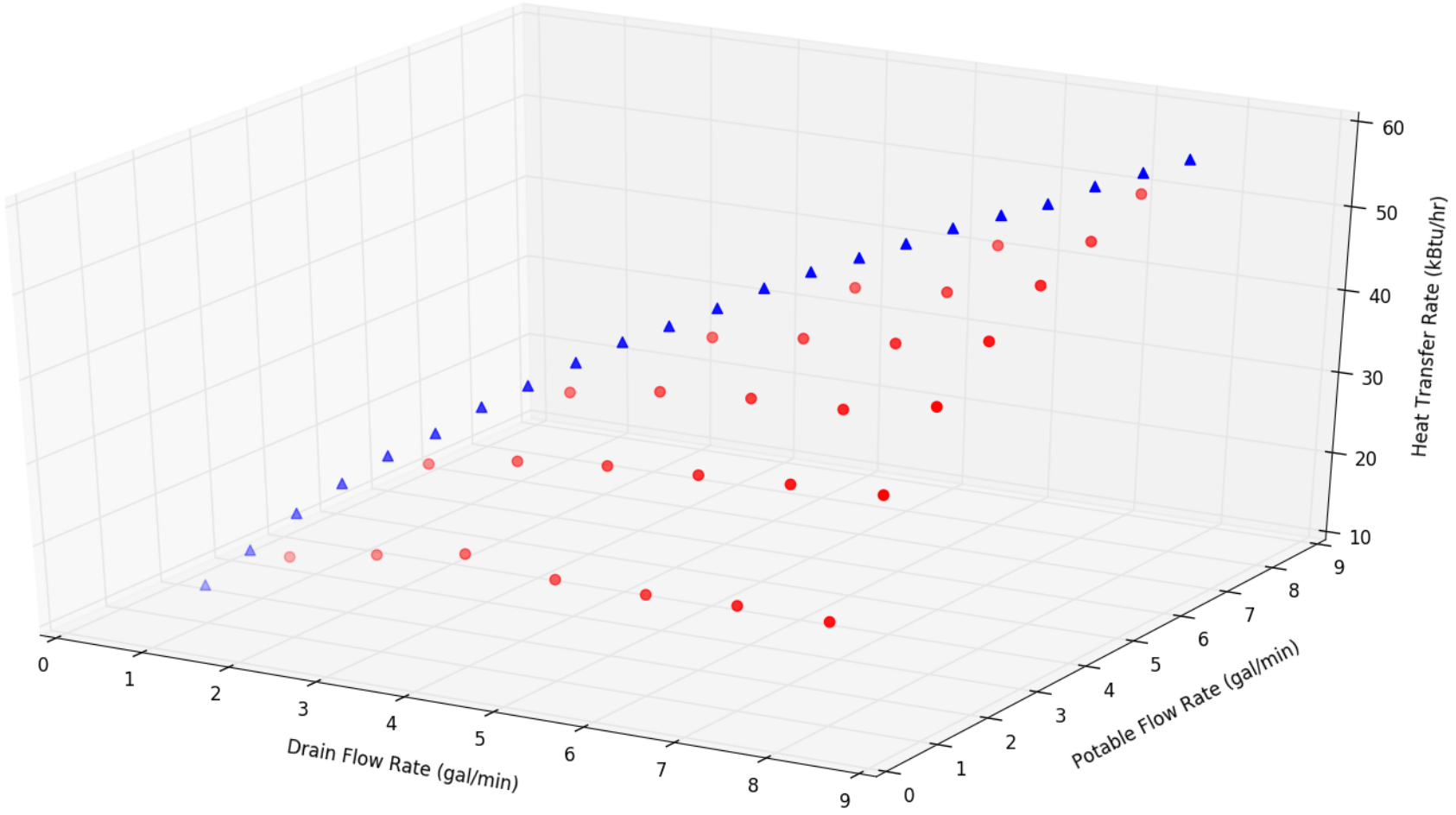


- Low flow showerheads, small households, high cold water temperature, & short showers increase payback period
- **Any input on these findings or your own findings?**

Phase 2 Testing Goals

- Compare performance of multiple units
- Generate generic algorithm
- Study impact of installation on unit performance
  - Length of preceding vertical pipe
  - Length of preceding horizontal pipe
  - Tilted installations
  - Presence of soap in hot water

Phase 2 Initial Results



Preliminary Energy Savings & Cost Effectiveness Estimates (Single Family, Equal Flow, Pre-Wet)

SF Equal Flow	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
1BR Therms Saved	13.8	12.4	12.4	11.8	12.7	11.3	11.1	10.7	10.7	10.6	10.8	11.4	10.5	10.9	7.4	13.6
2BR Therms Saved	16.1	14.5	14.6	13.8	14.9	13.2	12.9	12.5	12.5	12.4	12.5	13.3	12.3	12.7	8.6	15.8
3BR Therms Saved	18.7	16.8	16.9	16.0	17.3	15.2	15.0	14.5	14.5	14.4	14.6	15.5	14.3	14.8	10.1	18.4
4BR Therms Saved	21.7	19.5	19.6	18.6	20.1	17.7	17.4	16.9	16.8	16.7	17.0	18.0	16.6	17.2	11.7	21.4
5BR Therms Saved	25.6	23.0	23.1	21.9	23.7	20.9	20.5	19.9	19.9	19.7	20.0	21.2	19.6	20.2	13.8	25.1

SF Equal Flow	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
1BR Benefit/Cost	1.0	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.6	1.0
2BR Benefit/Cost	1.2	1.1	1.1	1.0	1.1	1.0	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.6	1.2
3BR Benefit/Cost	1.4	1.2	1.2	1.2	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.8	1.3
4BR Benefit/Cost	1.6	1.4	1.4	1.3	1.4	1.3	1.2	1.2	1.2	1.2	1.2	1.3	1.2	1.3	0.9	1.6
5BR Benefit/Cost	1.9	1.7	1.7	1.6	1.7	1.5	1.5	1.5	1.5	1.4	1.5	1.6	1.4	1.5	1.0	1.8

Constants

CSA rated effect.	0.466
WH Efficiency	0.82
WH derating factor	0.92
First cost per home	$475

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Note 1: Unequal flow calculations are still in progress.
Note 2: Assumes all showers included, but in CBECC modeler will give % of showers included

Preliminary Energy Savings & Cost Effectiveness Estimates (Multi-Family, Equal Flow, Pre-Wet)

MF Equal Flow	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
1BRs Therms Saved	12.0	10.8	10.8	10.3	11.1	9.8	9.6	9.3	9.3	9.2	9.4	9.9	9.2	9.5	6.5	11.8
2BRs Therms Saved	16.8	15.1	15.2	14.4	15.5	13.7	13.5	13.1	13.1	13.0	13.2	14.0	12.9	13.4	9.1	16.6
3BRs Therms Saved	20.0	18.0	18.1	17.2	18.5	16.4	16.1	15.6	15.6	15.4	15.7	16.7	15.4	15.9	10.9	19.7
4BRs Therms Saved	27.1	24.3	24.5	23.2	25.1	22.1	21.7	21.1	21.1	20.9	21.2	22.5	20.8	21.5	14.7	26.7
5BRs Therms Saved	24.5	22.0	22.1	21.0	22.7	20.0	19.6	19.1	19.0	18.8	19.1	20.3	18.7	19.3	13.1	24.1

MF Equal Flow	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
1BRs Benefit/Cost	2.3	2.1	2.1	2.0	2.2	1.9	1.9	1.8	1.8	1.8	1.9	2.0	1.8	1.9	1.3	2.3
2BRs Benefit/Cost	3.3	3.0	3.0	2.8	3.0	2.7	2.6	2.6	2.6	2.6	2.6	2.7	2.6	2.7	1.8	3.3
3BRs Benefit/Cost	3.9	3.5	3.5	3.3	3.6	3.2	3.1	3.0	3.0	3.0	3.1	3.3	3.0	3.1	2.2	3.9
4BRs Benefit/Cost	5.3	4.7	4.8	4.5	4.9	4.3	4.2	4.1	4.1	4.1	4.2	4.4	4.1	4.3	2.9	5.2
5BRs Benefit/Cost	4.7	4.3	4.3	4.1	4.4	3.9	3.8	3.7	3.7	3.7	3.7	4.0	3.7	3.8	2.6	4.7

Constants

CSA rated effect.	0.466
Overall WH eff.	0.8 to 0.84
First cost per home	$178
# homes per DWHR	4

Note: Unequal flow calculations, impact of simultaneous showers, & using MF prototype building in progress.

Compliance and Enforcement – Market Actors, Resources, & Tasks

Market Actor	Resource(s)	Task(s)	Success Criteria
Design Team	- Title 24 / Energy Code Ace - Manufacturer guidance - CBECC-Res software	- Specify the DWHR device - Layout the system - Energy Modeling	- Get proper credit in the energy model - Functional and cost effective design
Plans Examiner	- Title 24 / Energy Code Ace - Plans	- Plan checks	- Pass plan check
Builders	- Title 24 / Energy Code Ace - Plans - Manufacturer guidance	- Procure the DWHR device - Install the DHWR system	- Functional & cost effective installation
HERS Rater	- Title 24 / Energy Code Ace - Plans - Manufacturer guidance - CBECC-Res model	- Inspect system for proper installation	- Proper installation

What are we not capturing?

Strawman Code Change Language

- Standards
  - Multifamily: Prescriptive option in the water heating section 150.1(c)8B
- Residential Alternative Compliance Method (ACM) Ref. Manual
  - Single Family: Compliance option only
  - Multifamily: This section is applicable, in addition to the Standards
  - Must comply with CSA B55.2
  - Must be tested in accordance with CSA B55.1
  - Inspection required to verify make/model, proper installation, and configuration matching the energy model
  - Require at least the master bathroom to be connected
  - Applies to retrofits and new construction
  - Considering requiring insulation around the DWHR device

Feedback Request from Stakeholders

- Your input is valuable
- Please call or email us anytime
  - Contact info on following slide

Thank you.

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