

Hot Water & Human Behavior Don't Get Burned



We Must Address Structure & Behavior

Creation

Use



water heater

fixtures

We Must Address Structure & Behavior

Creation

Structure/Delivery

Behavior

Use



plumbing

human interaction



If We Don't Address These Areas
Homes Remain Inefficient &
Customers Interactions Are Negative

We've Been Talking About
Compact Plumbing Design Today

**People Won't Waste Hot Water
If It Arrives Quickly
– Right?**

December 2013 LBNL Field Study – DHW Use

Lawrence Berkeley National Lab conducted a field study of domestic hot water usage in N. California homes. Evolve Technologies identified the following data points regarding shower usage in homes with usable data for the period Dec 1-31, 2013.

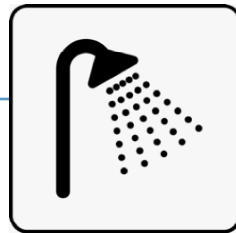


11

HOMES

- 27% 1001 to 1500 Square Ft
- 27% 1501 to 2000 Square Ft
- 36% 2001 to 3000 Square Ft
- 9% more than 3000 Square Ft

good mix of different home sizes



44%

DEDICATED SHOWERS

(est. based on master bath count)



56%

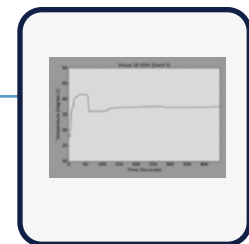
TUB/SOWER COMBOS

(est. based on secondary bath count)

18

BATHROOMS

data includes dedicated showers and tub/shower combos as well as cold start and clustered events



283

“GOOD” SIGNATURES

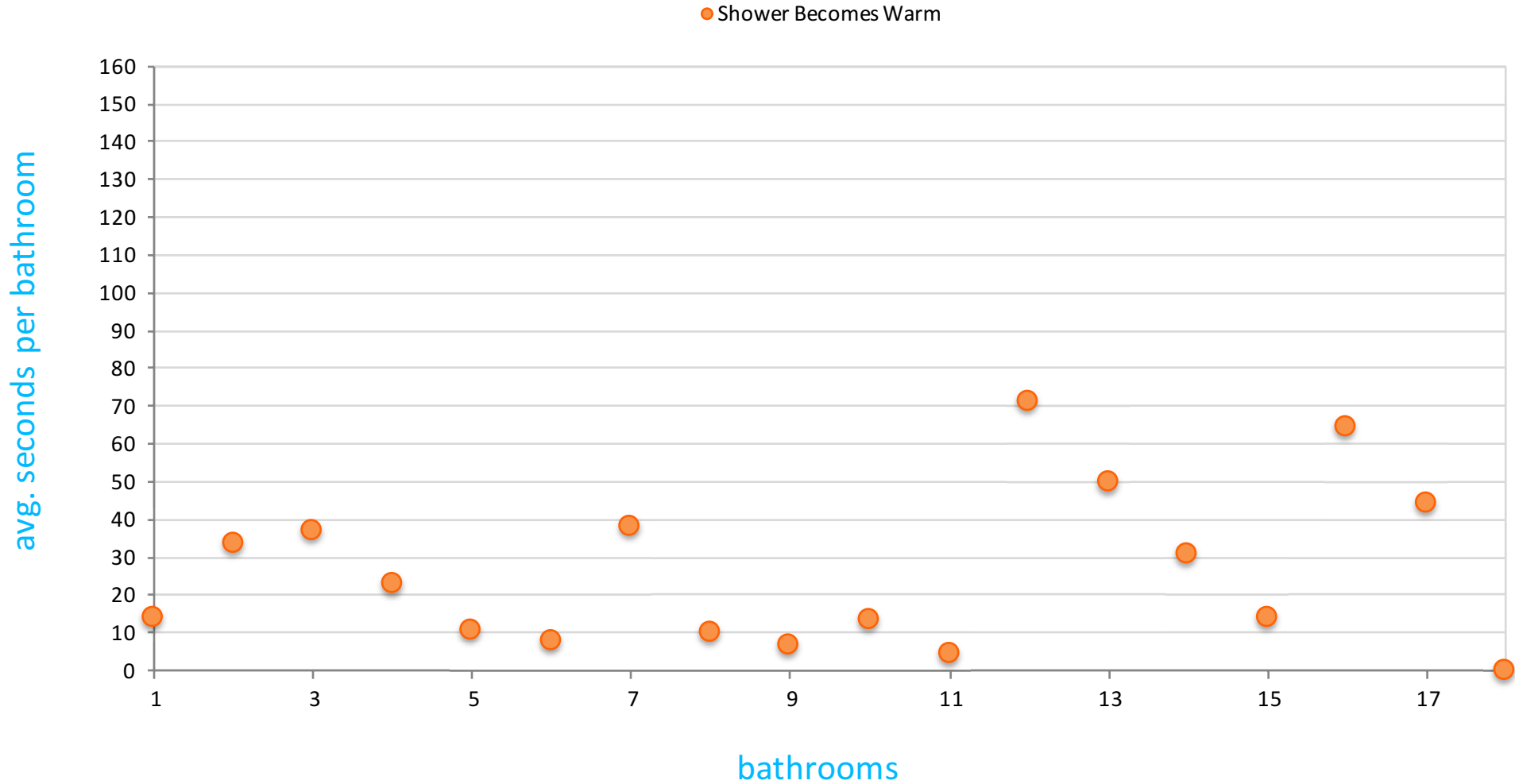
- 528 total events
- 54% identifiable signatures

significant number of individual shower events

SOURCE: 2014 Disaggregating Residential Shower Warm-Up Waste – An Understanding and Quantification of Behavioral Waste Based On Data From Lawrence Berkeley National Lab

Behavior Is Persistent – 10 Sec Waits Are Too Long

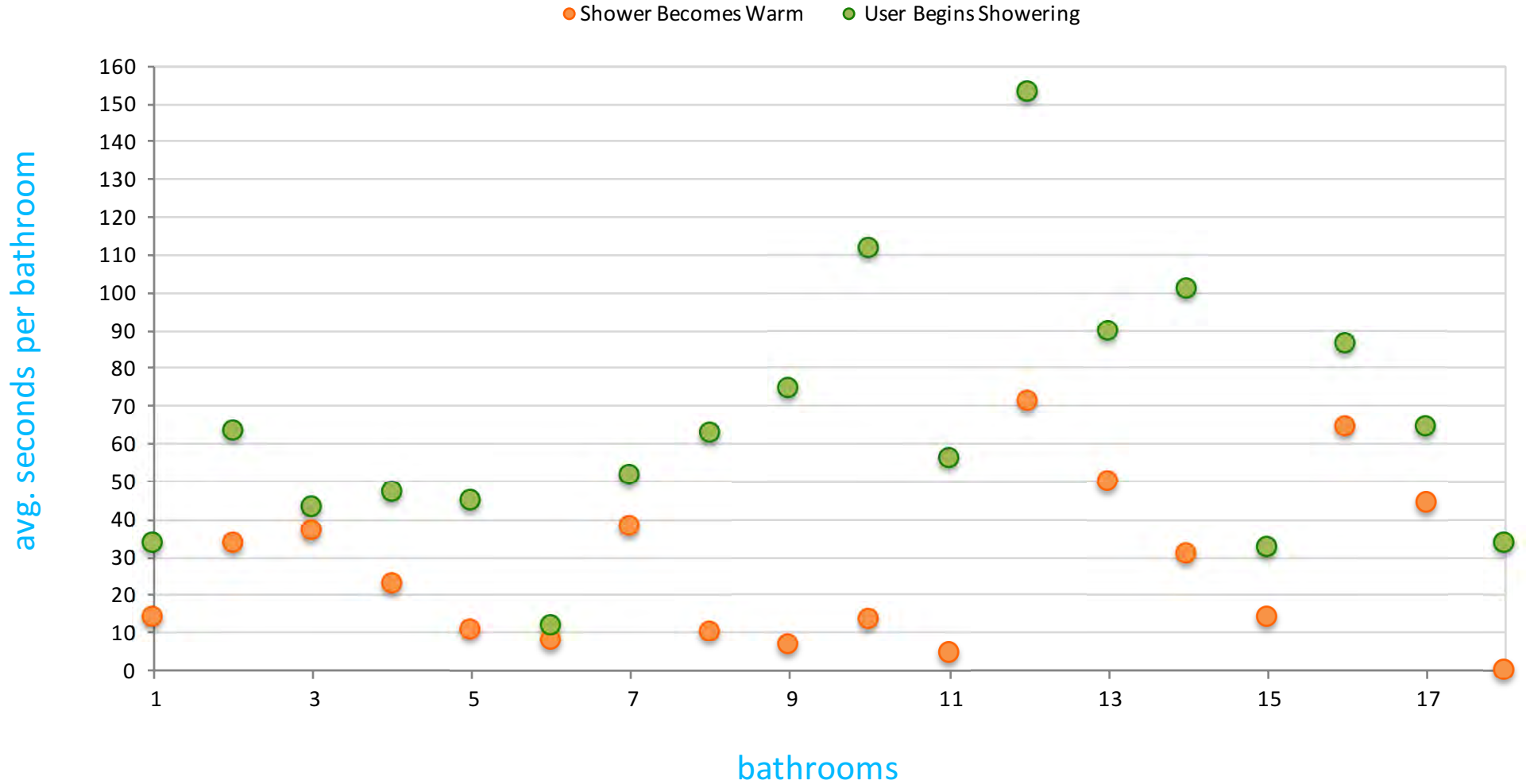
50% of bathrooms average about a 10 second wait for hot water, but exhibited above average Behavioral Waste.



SOURCE: 2014 Disaggregating Residential Shower Warm-Up Waste – An Understanding and Quantification of Behavioral Waste Based On Data From Lawrence Berkeley National Lab

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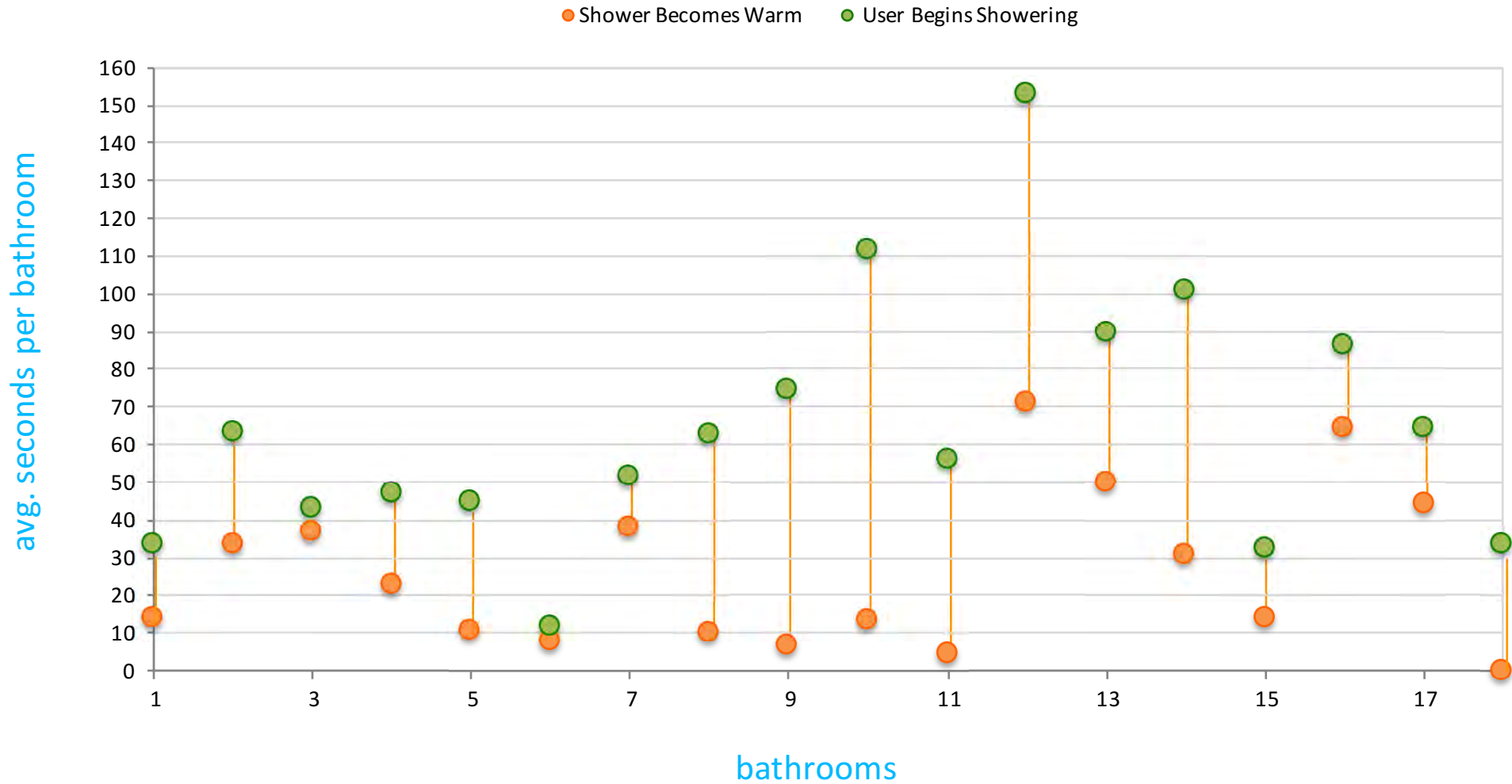
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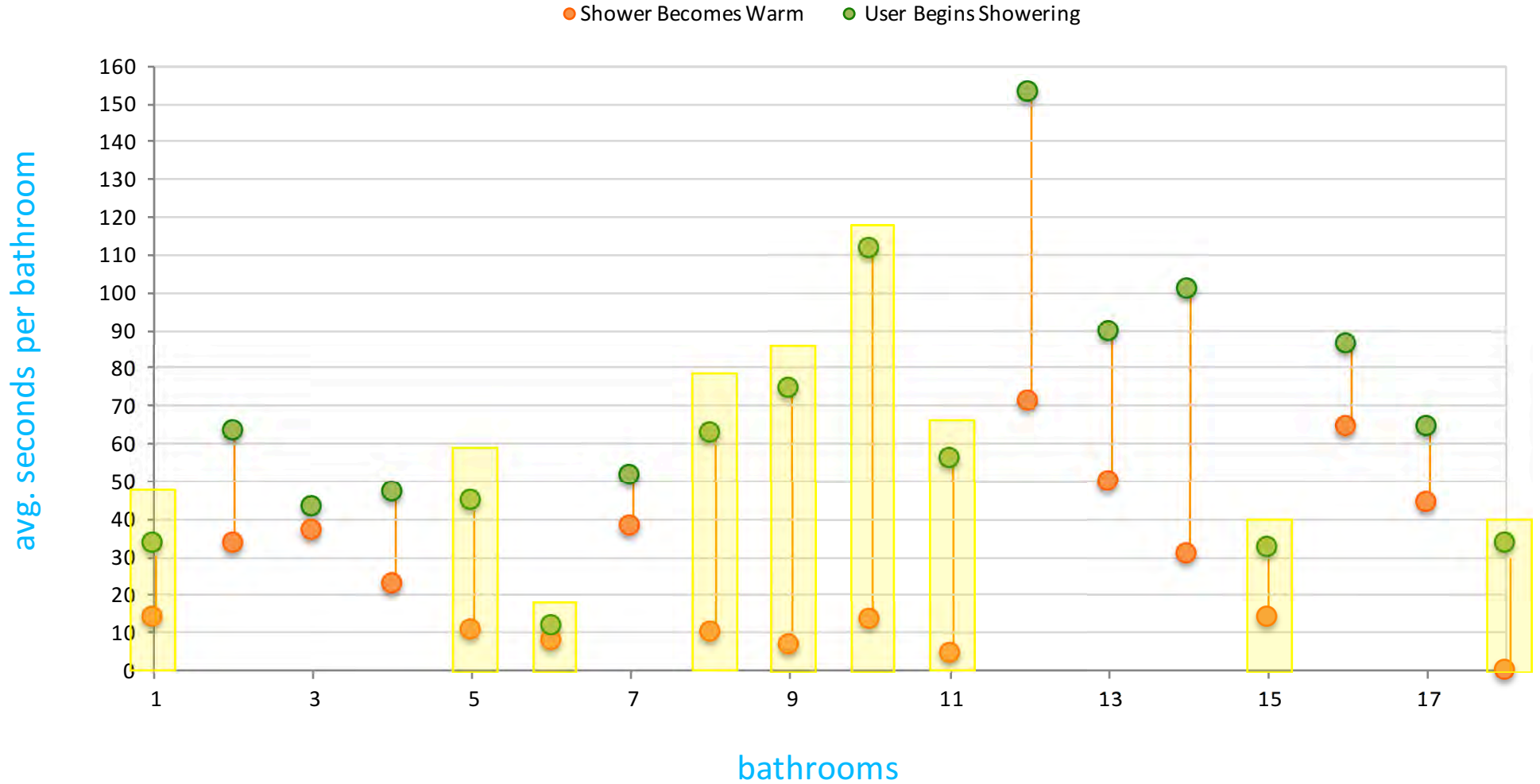
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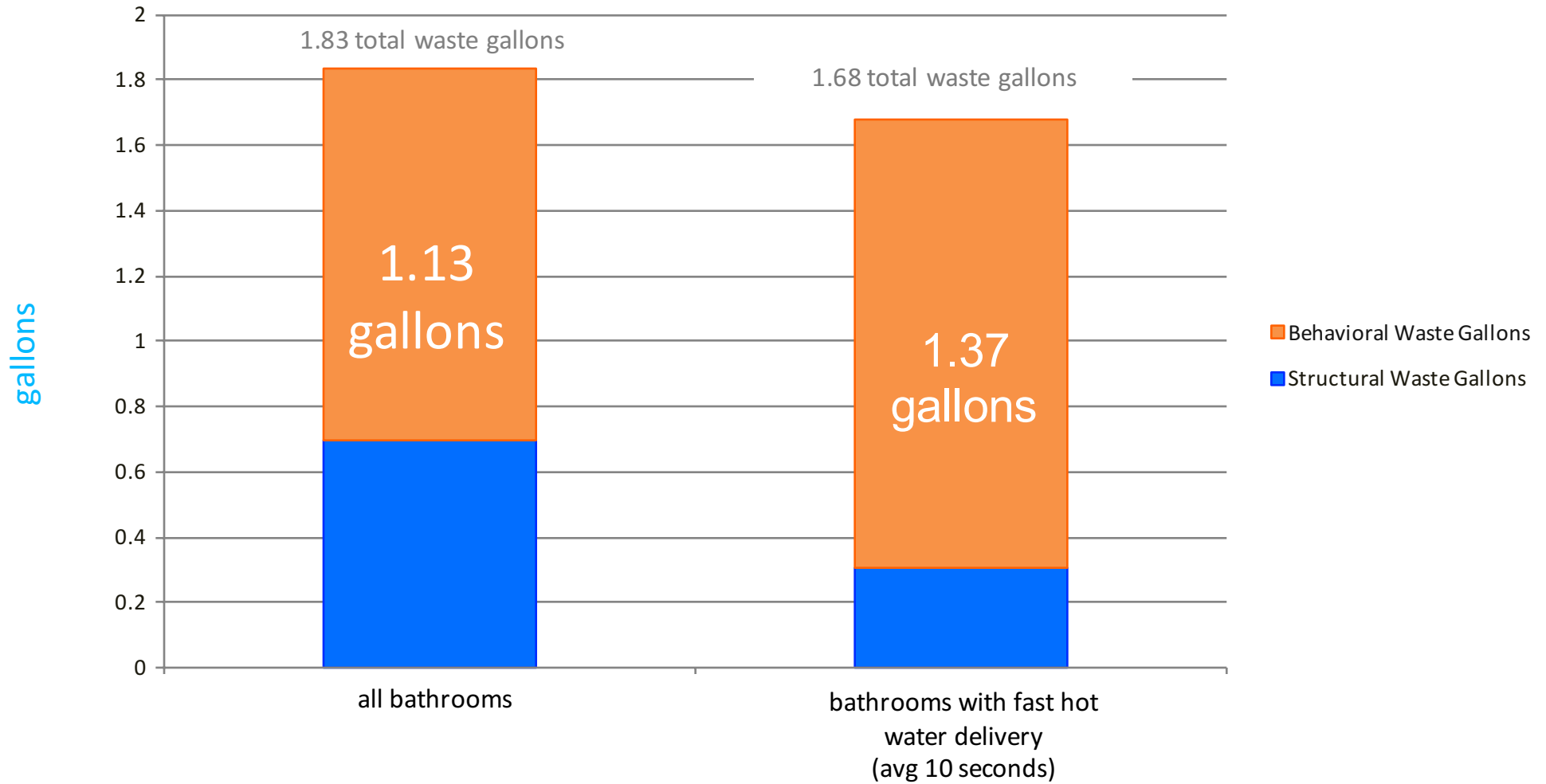
Behavior Is Persistent – 10 Sec Waits Are Too Long

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SOURCE: 2014 Disaggregating Residential Shower Warm-Up Waste – An Understanding and Quantification of Behavioral Waste Based On Data From Lawrence Berkeley National Lab

Fast Hot Water Delivery Increases Hot Water Waste



SOURCE: 2014 Disaggregating Residential Shower Warm-Up Waste – An Understanding and Quantification of Behavioral Waste Based On Data From Lawrence Berkeley National Lab

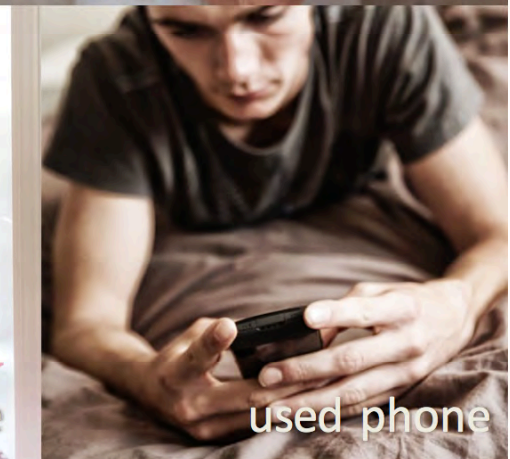
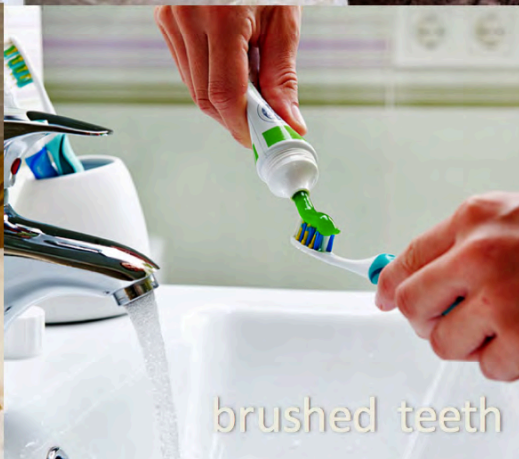
What's Going On Here?

Insights Into Behavioral Waste

Consider how
hard it is to change yourself
and you'll understand what
little chance
you have in trying to
change others.

- Benjamin Franklin

Have You Or A Family Member Ever _____ While Waiting For The Shower To Get Warm?



Most People Multitask – Behavioral Waste

Behavioral waste occurs when bathers use their time comfortably and efficiently while waiting for hot water to reach the shower. Activities include brushing teeth, using the washroom, picking out clothes, drinking coffee ...



71%

do other stuff while waiting for hot water to reach the shower

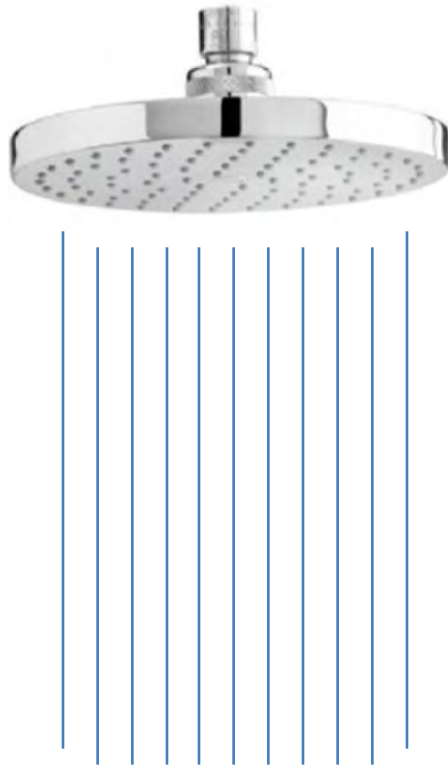
52%

do more than one thing as part of their warm-up routine

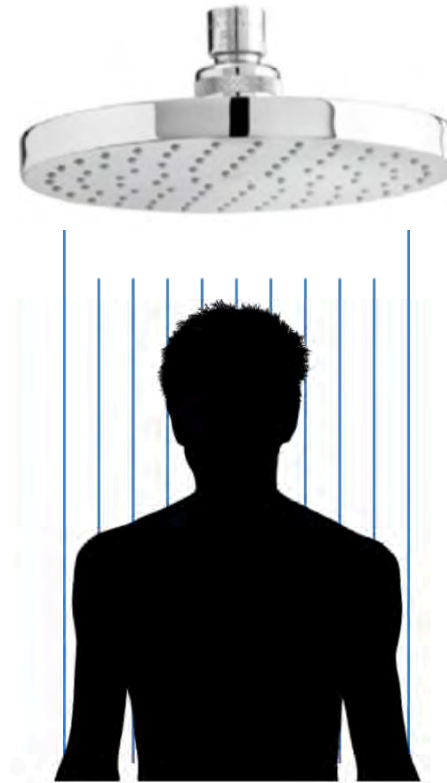
Evolve Technologies: Shower Survey 2008
Lawrence Berkeley National Lab: Lutz 2011 "Water And Energy Wasted During Residential Shower Events"

20% - 30% Of Shower Is Wasted Before Bathing Begins

In 2004 and 2011 papers Jim Lutz at Lawrence Berkeley National Lab indicates that shower warm-up waste falls in the 20% - 30% range.



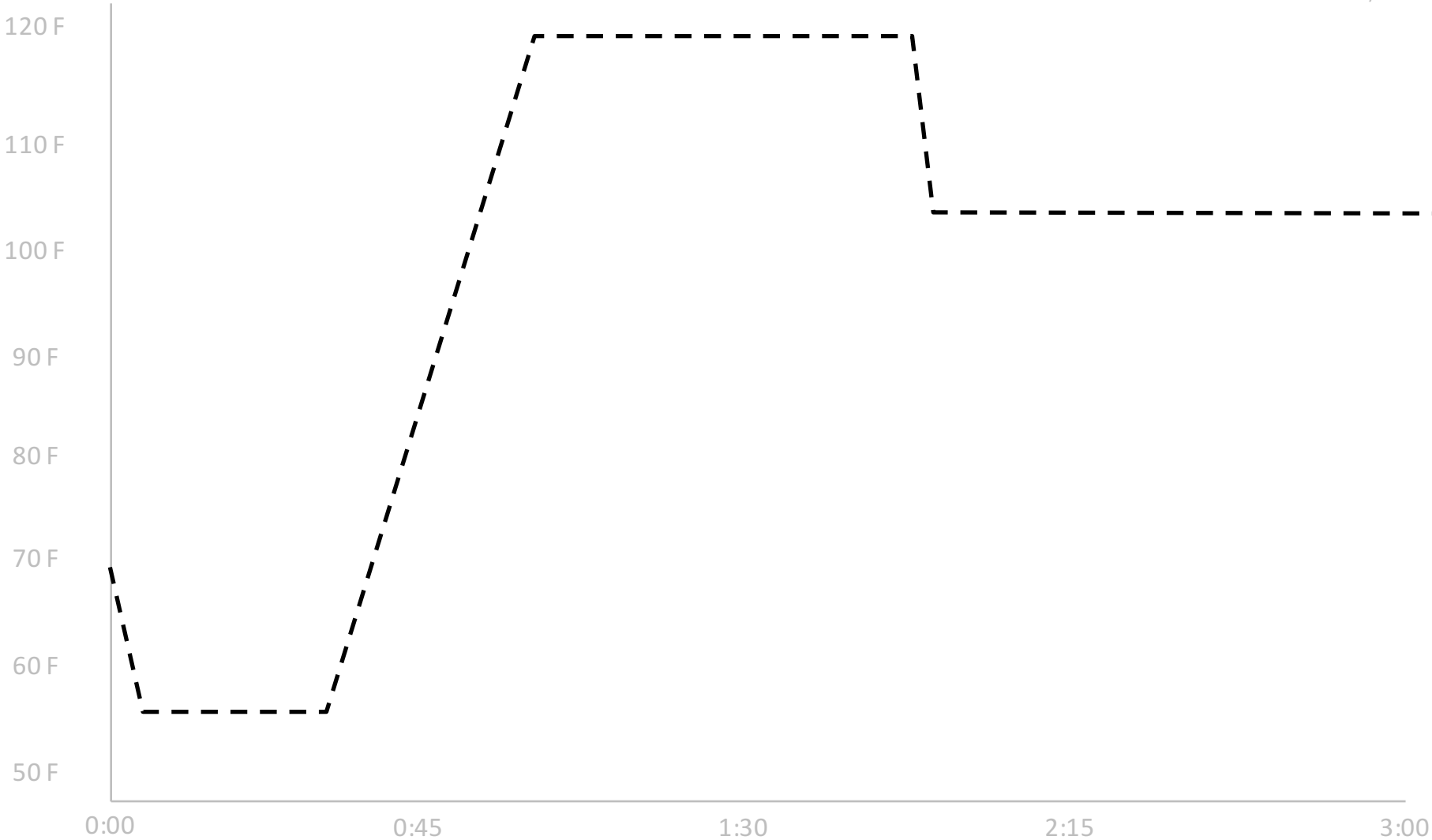
~ 2 Minutes
Of This
WARM-UP WASTE



Before 6 Minutes
Of This

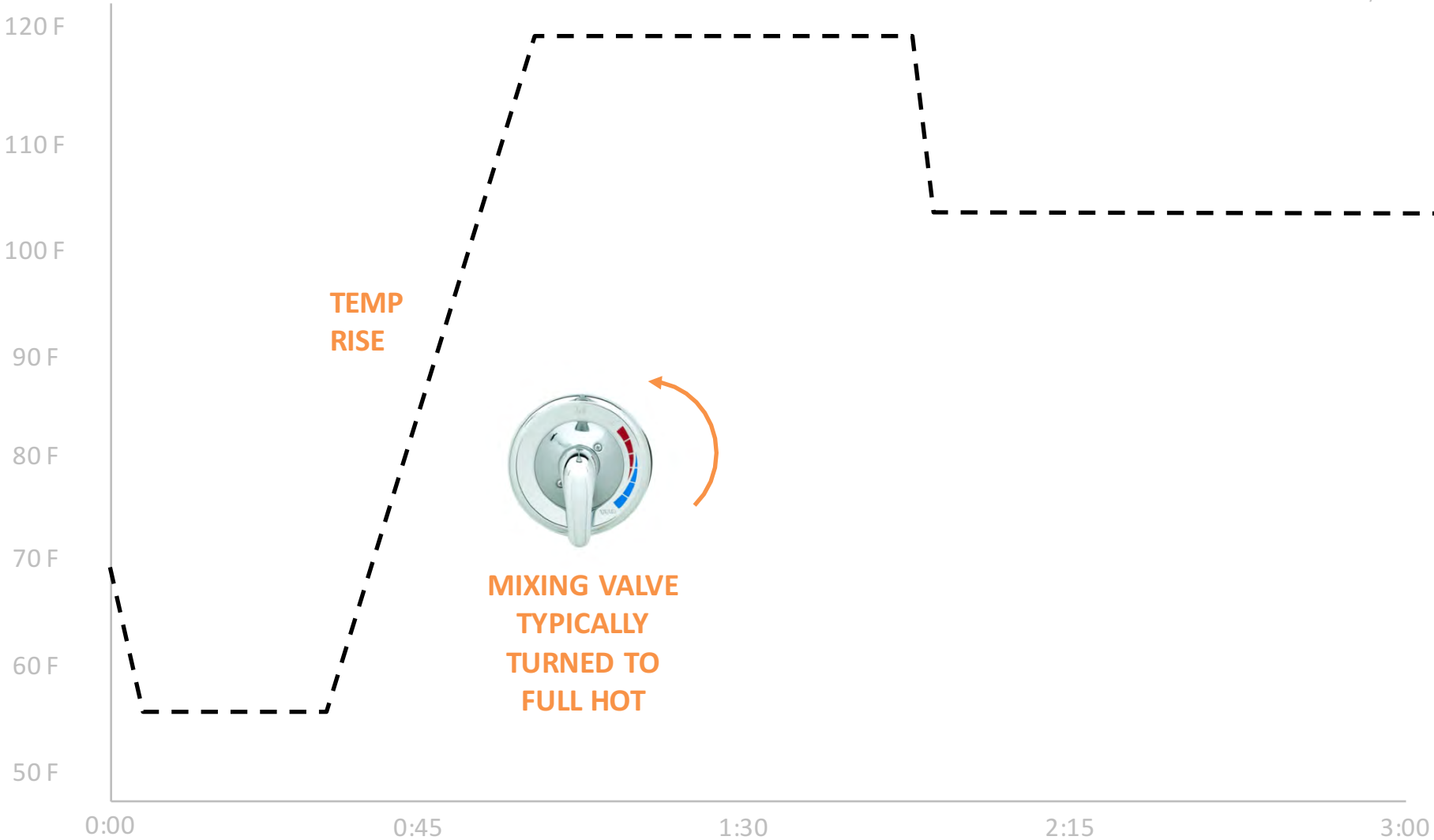
Anatomy Of A Shower Warm-Up – LBNL Data

SOURCE: 2014 Disaggregating Residential Shower Warm-Up Waste – An Understanding and Quantification of Behavioral Waste Based On Data From Lawrence Berkeley National Lab



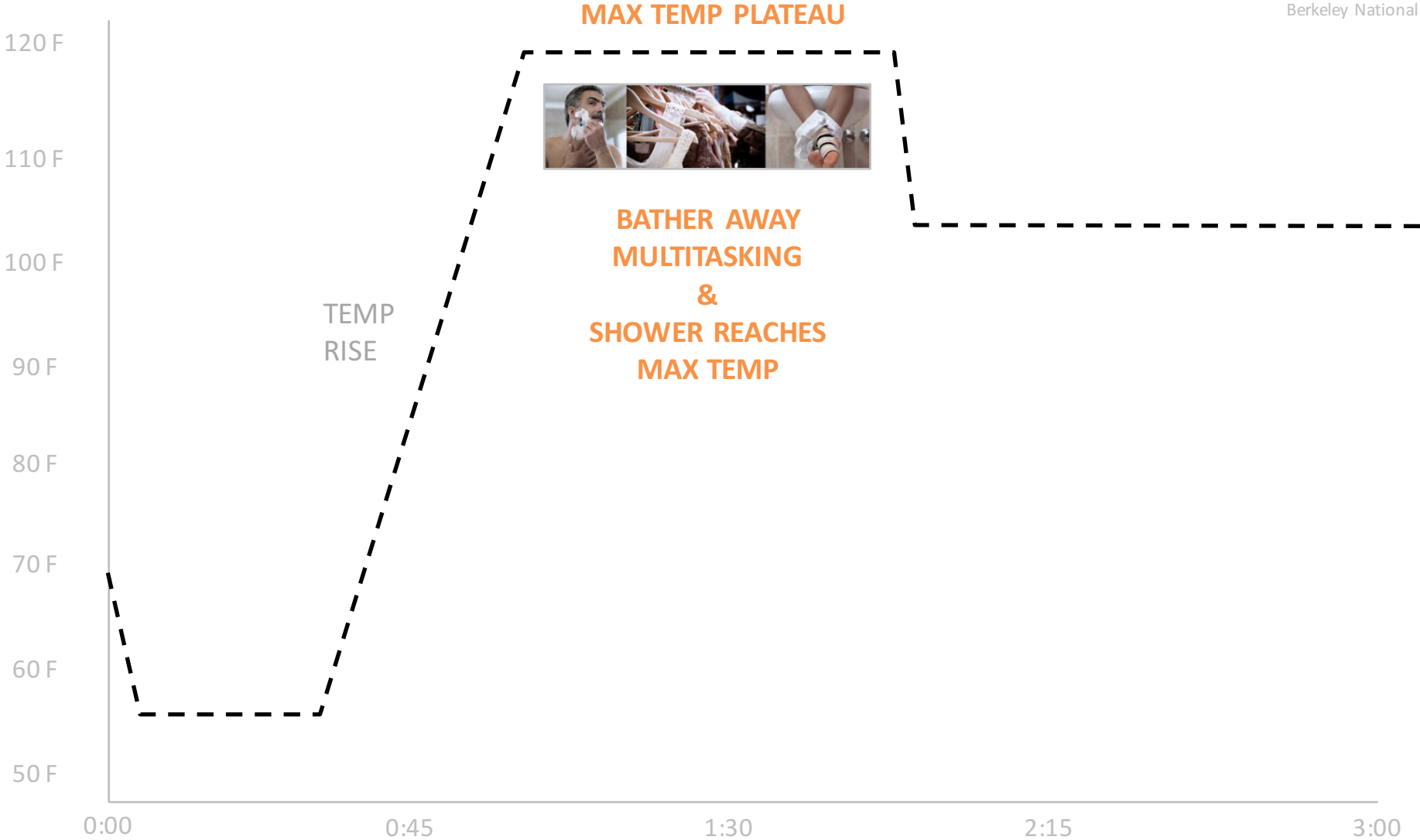
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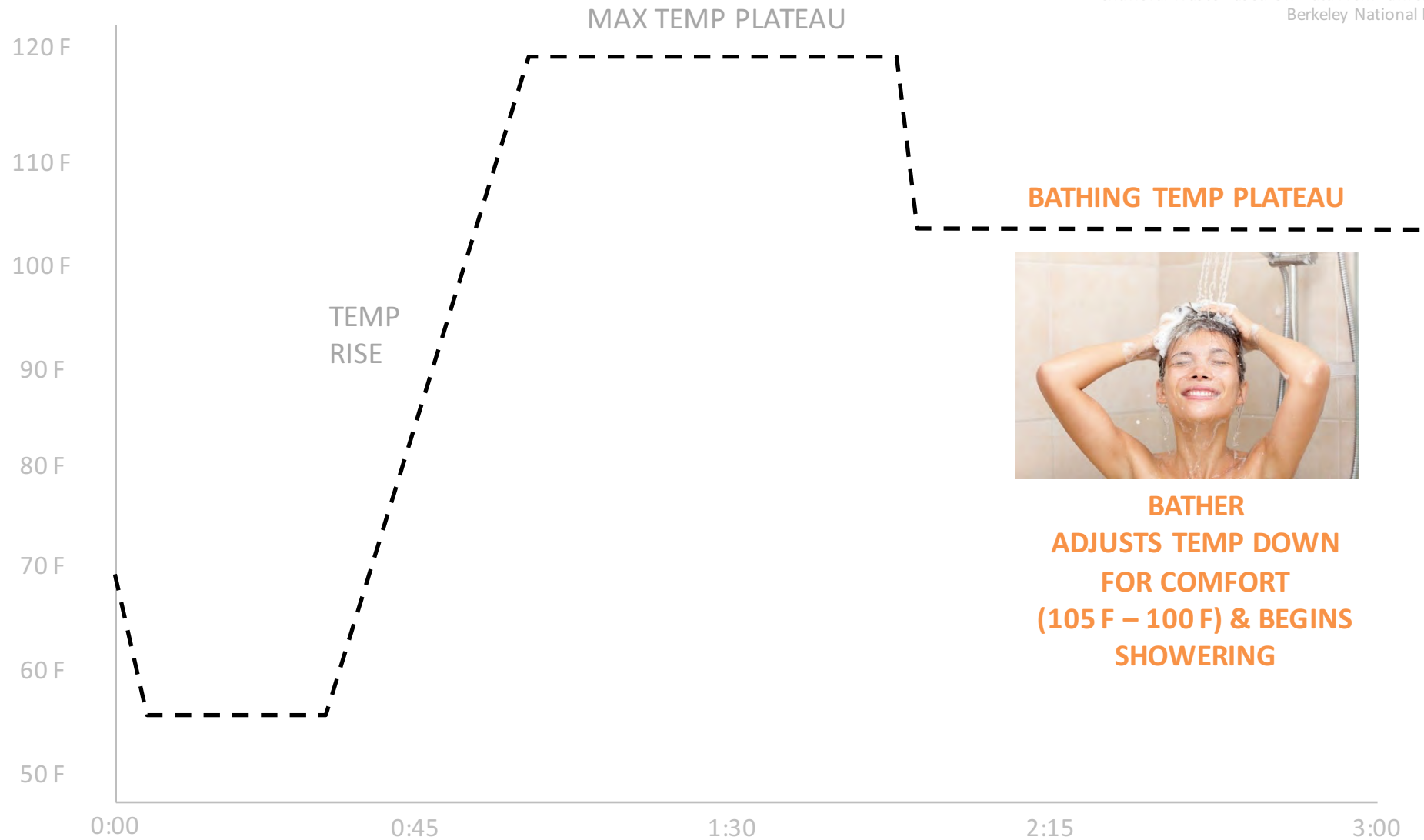
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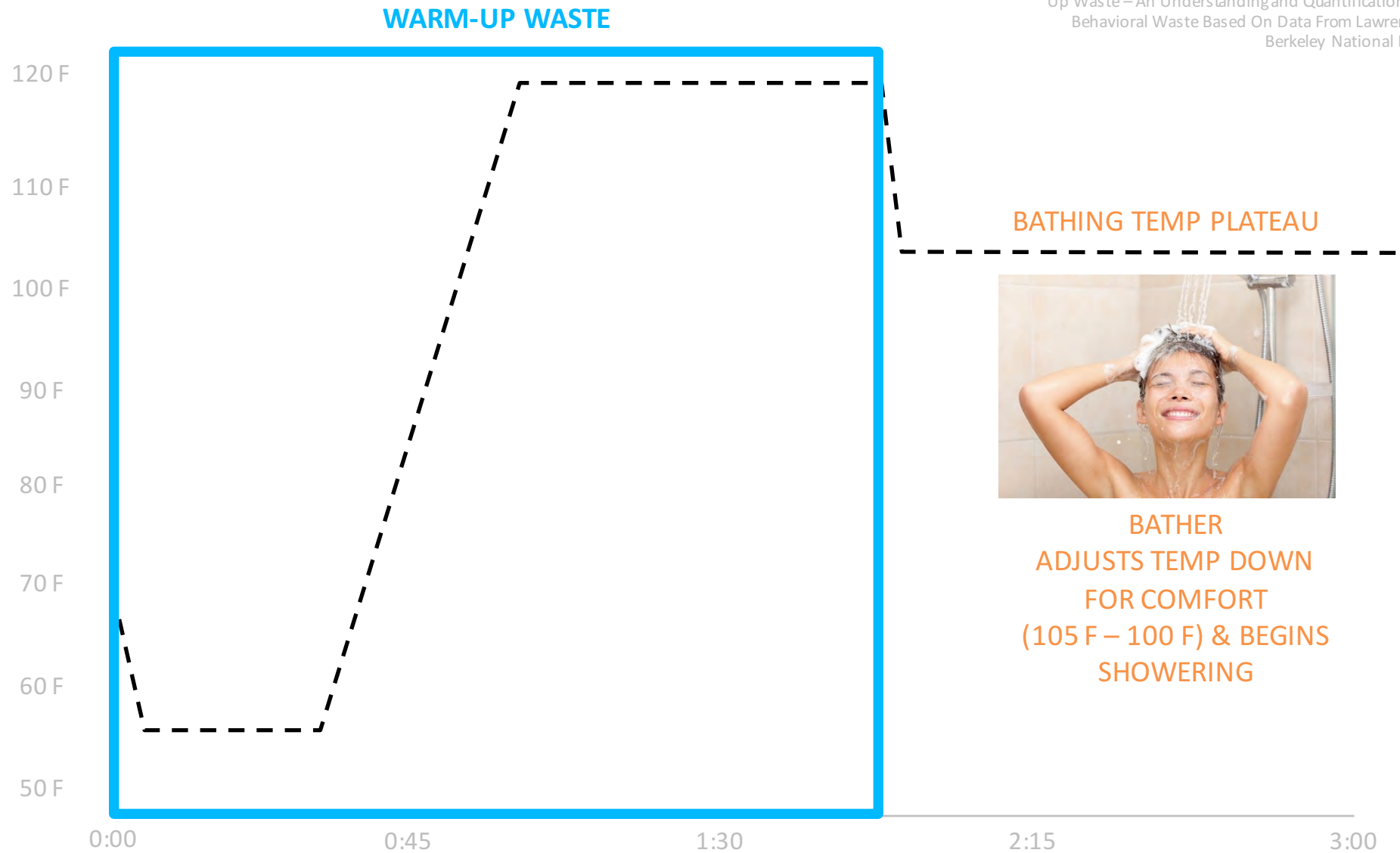
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**BATHER
ADJUSTS TEMP DOWN
FOR COMFORT
(105 F – 100 F) & BEGINS
SHOWERING**

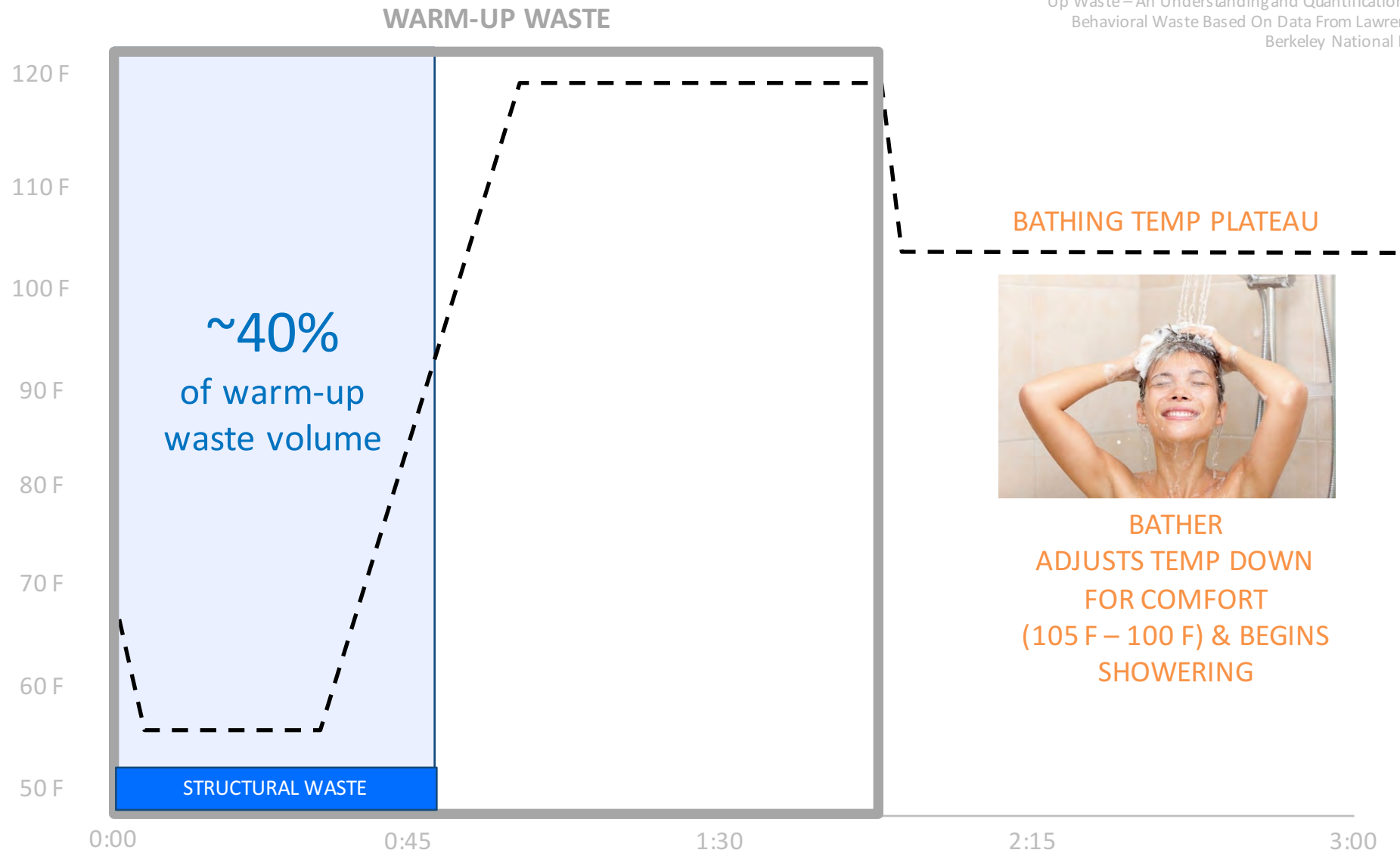
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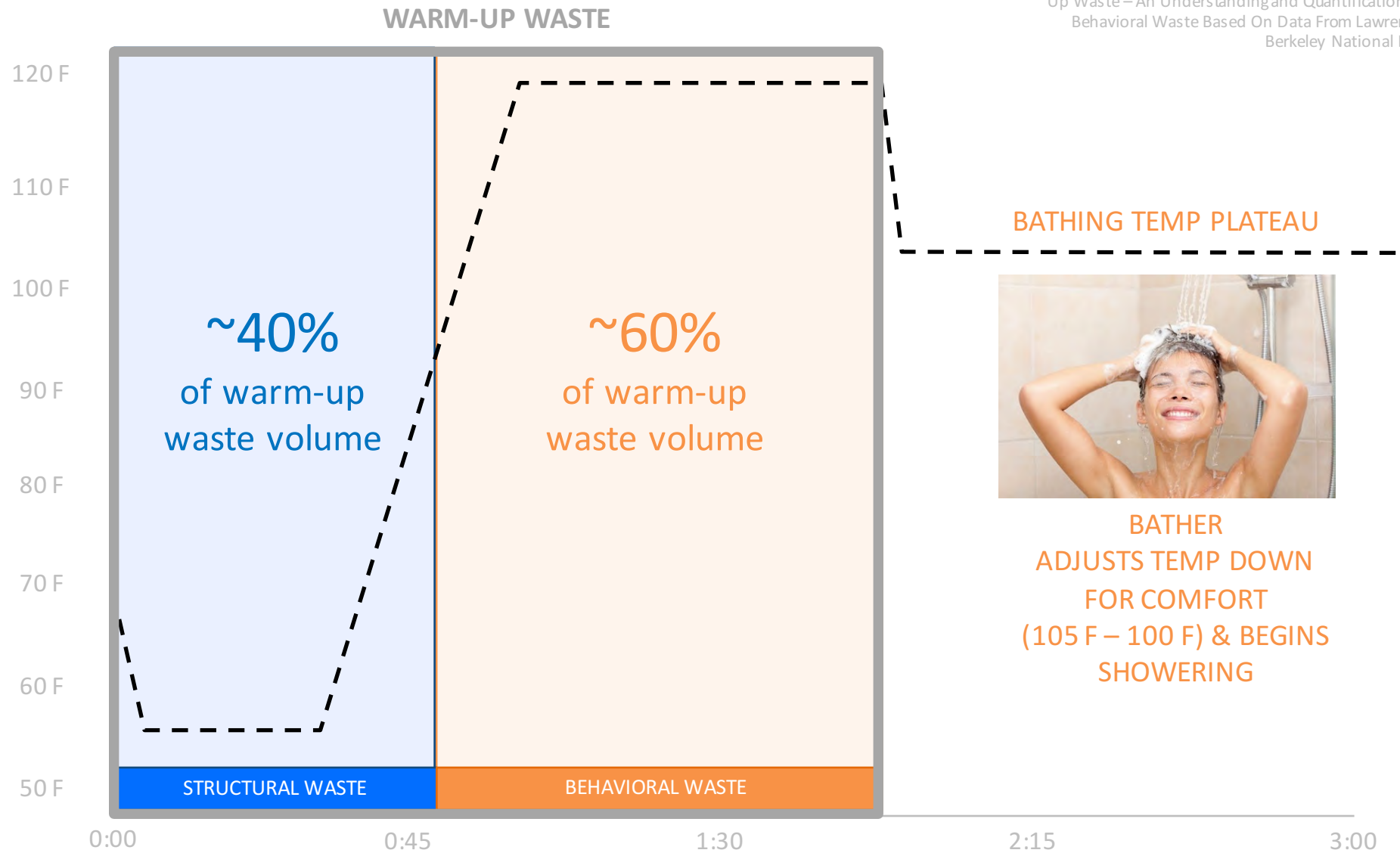
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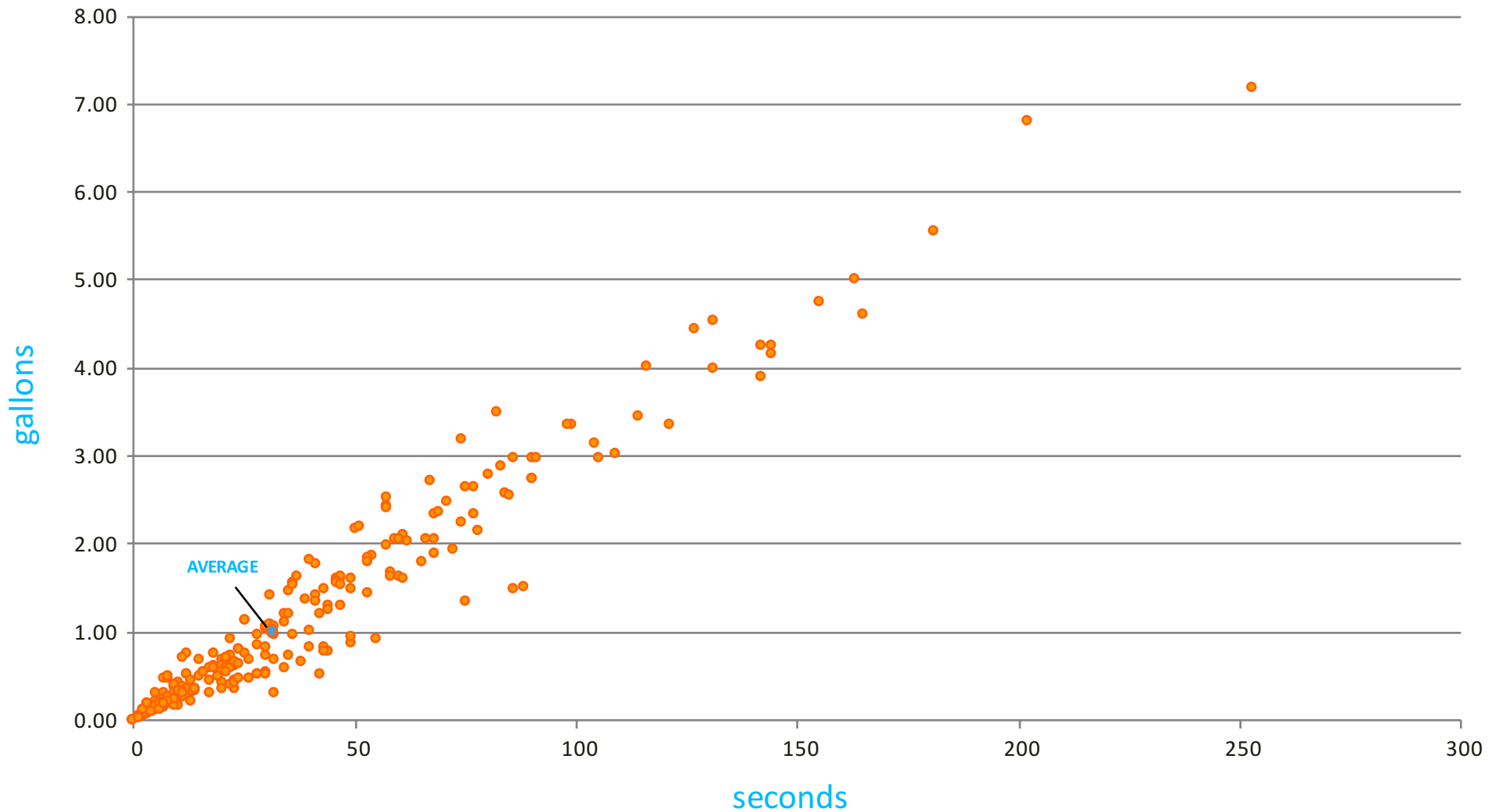
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2013 LBNL Analysis - Some Waste A Little – Others Waste A Lot

Behavioral Waste By Individual Shower Event

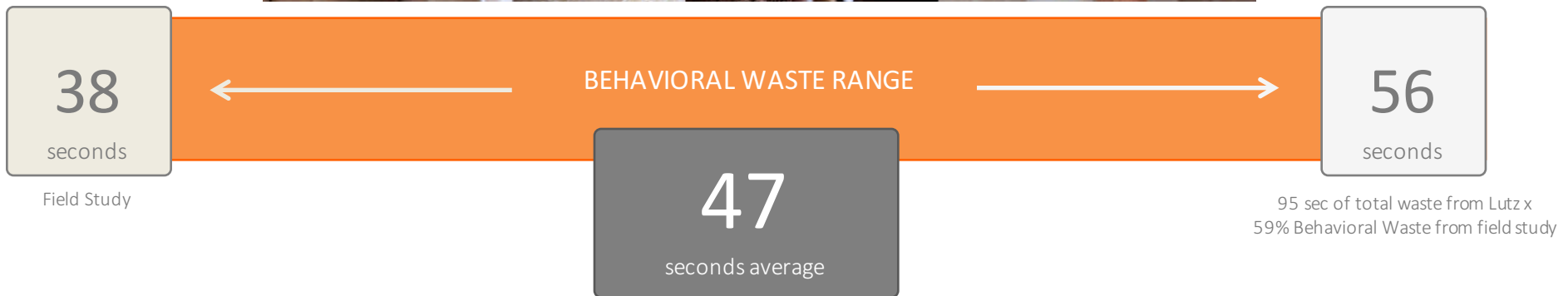


Behavioral Waste Estimates From '04 – '13 LBNL Analysis

Estimate range is inclusive of cold starts and clustered events.

Estimate range is based on LBNL work from 2004 – 2013.

Estimate is likely conservative as data was collected in one of the “greenest” regions of the country (SF Bay area).



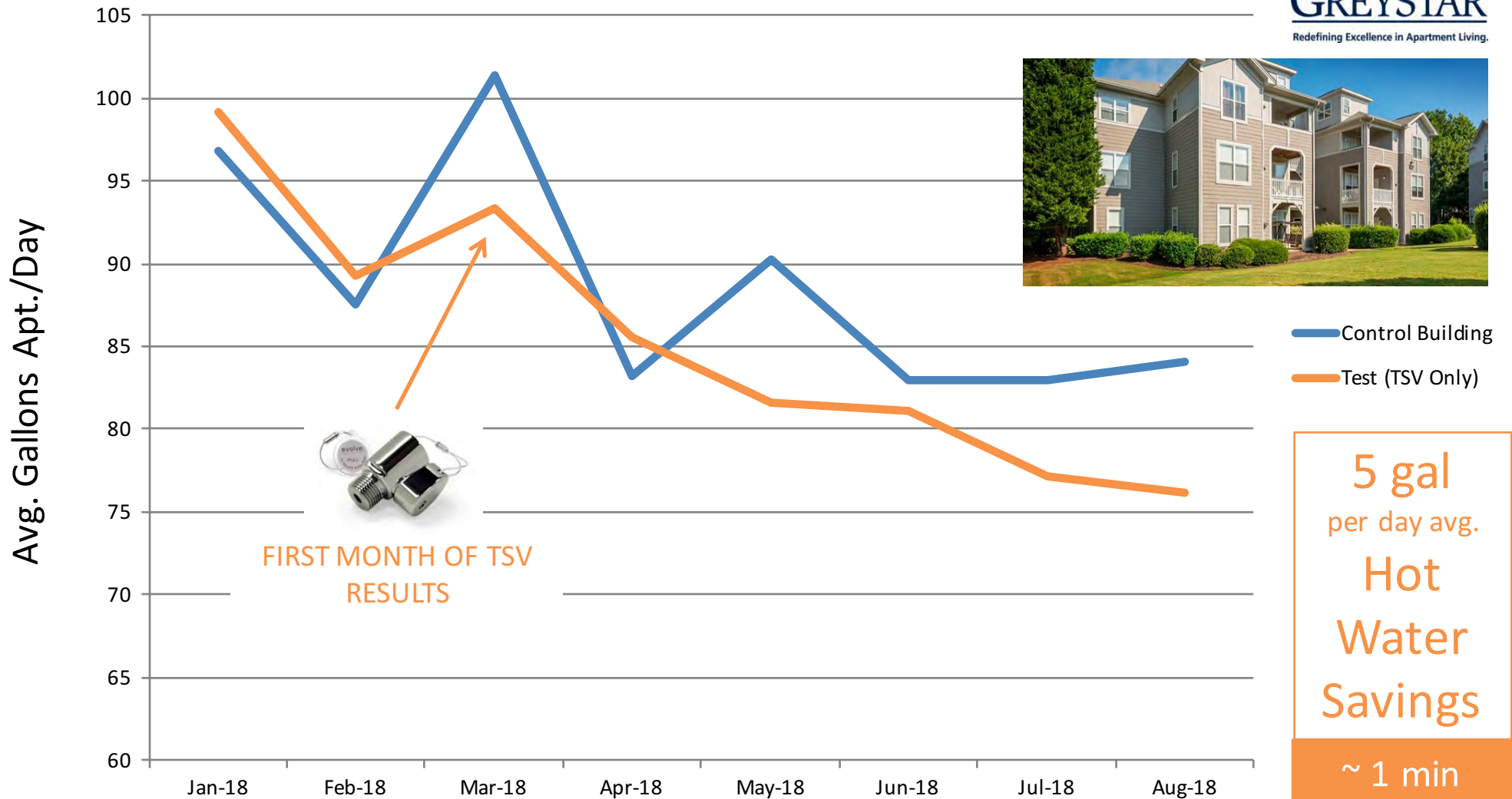
The LBNL Data Is Interesting, But ...

**Is There Other 3rd Party Data
Regarding Behavioral Waste?**

8 Month Multifamily 2014 Field Study In NC

2014 Greystar TSV evaluation in Raleigh, NC indicates average savings of 5 gallons per unit per day.
N=240 apartments: 120 unit test & 120 unit control

GREYSTAR
Redefining Excellence in Apartment Living.



PPL Electric & Cadmus 2015 Field Study

2015 Pilot Study including 22 metered showers in 18 unique homes (581 events) for one month revealed average TSV savings of 59 seconds per shower.



Pilot Study for a Thermostatic Shower Restriction Valve

*Anders Wood, Cadmus, Boulder, CO
Joseph D'Acquisto, PPL Electric, Allentown, PA*

ABSTRACT

The ShowerStart device is a thermostatic valve installed in line with the user's showerhead that is designed to reduce hot water and energy waste by shortening the time that hot water is left running before the user steps into the shower. Many users multi-task while waiting for their showers to reach bathing temperature: wasting hot water if the shower reaches bathing temperature and remains unoccupied. The device cuts the flow of hot water to a trickle until the user enters the shower and pulls a cord to restart the full flow of hot water. In this 2014 pilot study of ShowerStart devices, Pennsylvania Power and Light (PPL Electric), located in central and eastern Pennsylvania, worked with Cadmus to answer two questions: (1) how much energy does the ShowerStart™ device save users and (2) what kind of experience do these users have when showering with the device?

Cadmus metered 22 showers for one month and fielded 18 satisfaction surveys with the participants in the pilot study. We found that a ShowerStart device installed in a single-family home with an electric water heater saves on average 121 kWh per year: in the context of other hot water measures in the Pennsylvania Technical Reference Manual (PA TRM), this represents less savings than a low flow showerhead or a kitchen faucet aerator, and more savings than a bathroom faucet aerator. The surveys showed that many participants were satisfied with the device and said it was easy to use. Three of the 18 participants reported malfunctions or were dissatisfied with specific aspects of their experience, citing issues that may be addressed with user education and screening.

Thus, the pilot study found that the ShowerStart device achieves savings, and satisfied many of the users, while about a quarter of the users were less than very satisfied overall. These conclusions suggest that this measure can offer savings for residential programs, and also requires some level of education to avoid dissatisfied participants.

Introduction

In the fall of 2014, PPL Electric and Cadmus conducted a pilot study of ShowerStart, a thermostatic shower restriction valve. The device restricts the shower's hot water from flowing down the drain and being wasted while the user waits for the water to warm to bathing temperature.

Cadmus and PPL Electric had previously collaborated on developing an interim measure protocol (IMP) for the 2015 PA TRM. The IMP provided the method to quantify deemed savings for thermostatic shower restriction valves, but it had relied on estimates for several input values, especially for the duration that the device would be engaged and the temperature of the water that it would prevent from being wasted. PPL Electric initiated the pilot study and asked Cadmus to collect data to support or revise these estimates and to evaluate the functionality and usability of the device for inclusion in its programs.

Objectives

The primary objectives of PPL Electric's ShowerStart pilot study were to:

- Test the product's functionality and usability
- Collect data to support the input values in the 2015 PA TRM
- Evaluate energy savings
- Assess user satisfaction

2015 International Energy Program Evaluation Conference, Long Beach

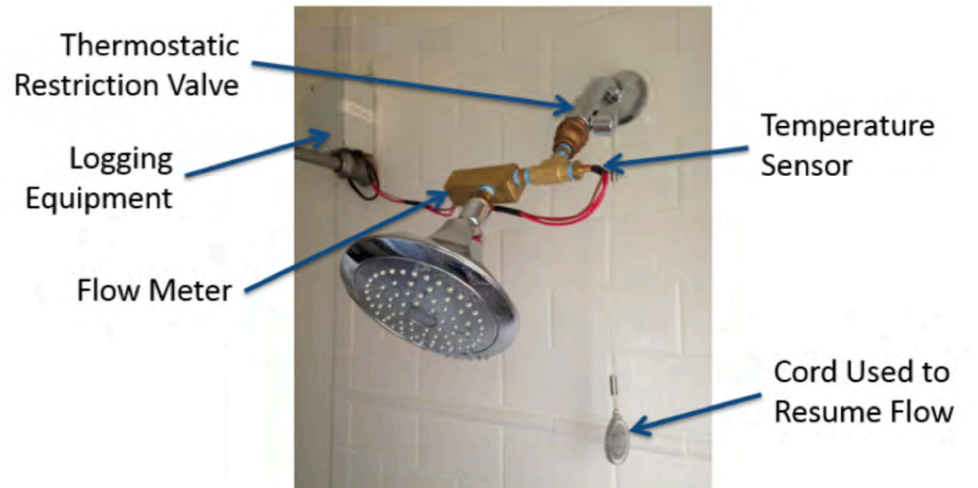


Table 4. Metering Results Summary

Parameter	Value	Units	Description
ShowerStart Event Time (BehavioralWasteSeconds)	59	Seconds	Average metered behavioral waste duration
Shower Water Temperature (T _{out})	104	°F	Average temperature of water saved by the ShowerStart device
Number of Shower Events	581	-	Quantity of shower events metered
Number of ShowerStart Events	430	-	Quantity of ShowerStart events metered with a duration greater than zero seconds
Shower Event Time	9.5	Minutes	Average metered shower event duration, which includes warmup and ShowerStart event times, as well as the time the user is in the shower
Structural Waste Time	64	Seconds	Average metered structural waste duration

SOURCE: 2015 Pilot Study For A Thermostatic Shower Restriction Valve, Anders Wood (Cadmus) and Joseph D'Acquisto (PPL Electric)

Behavioral Waste Averages About A Minute Per Shower



BEHAVIORAL WASTE

Wow, If Behavior Doesn't Change
Compact Plumbing Design Is Useless!

Not At All - There's A Simple Solution

The Thermostatic Shut-Off Valve (TSV)

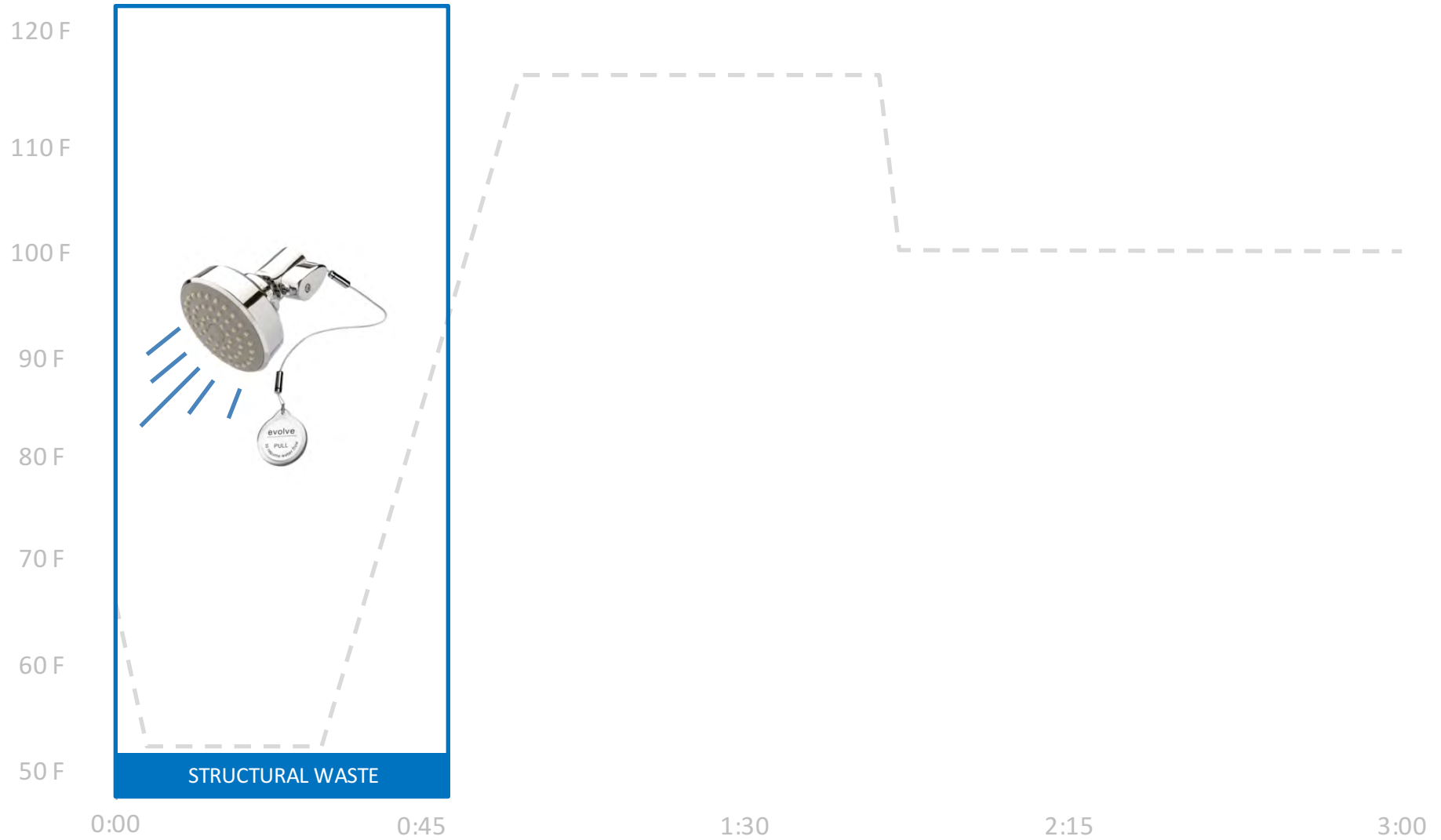
Keep Your Routine – Save Your Hot Water



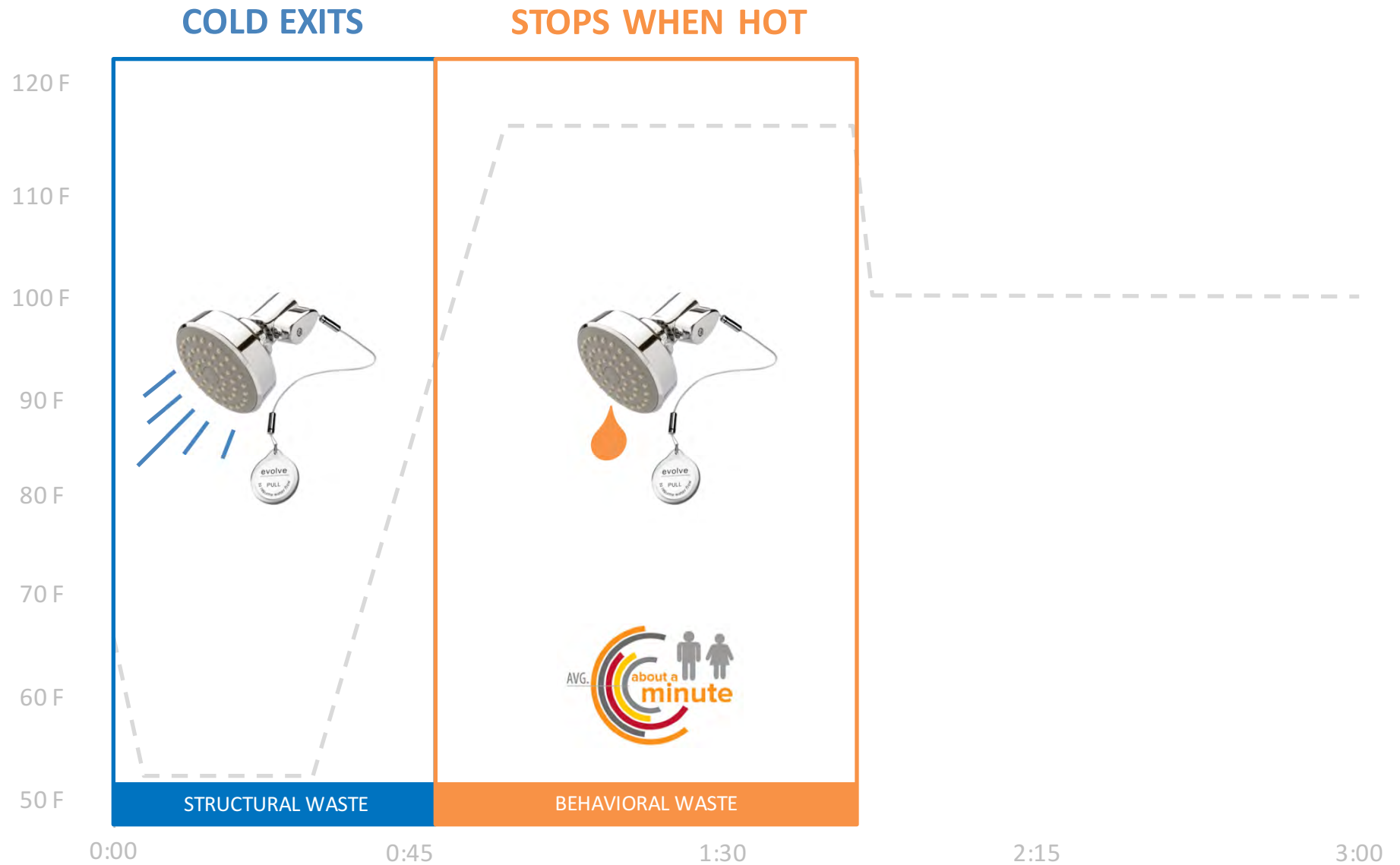
- Eliminates Behavioral Waste – Saves the water and energy most bathers don't even realize they're wasting.
- Savings occur without changing shower flow, feel or even your morning routine.

How A TSV Works

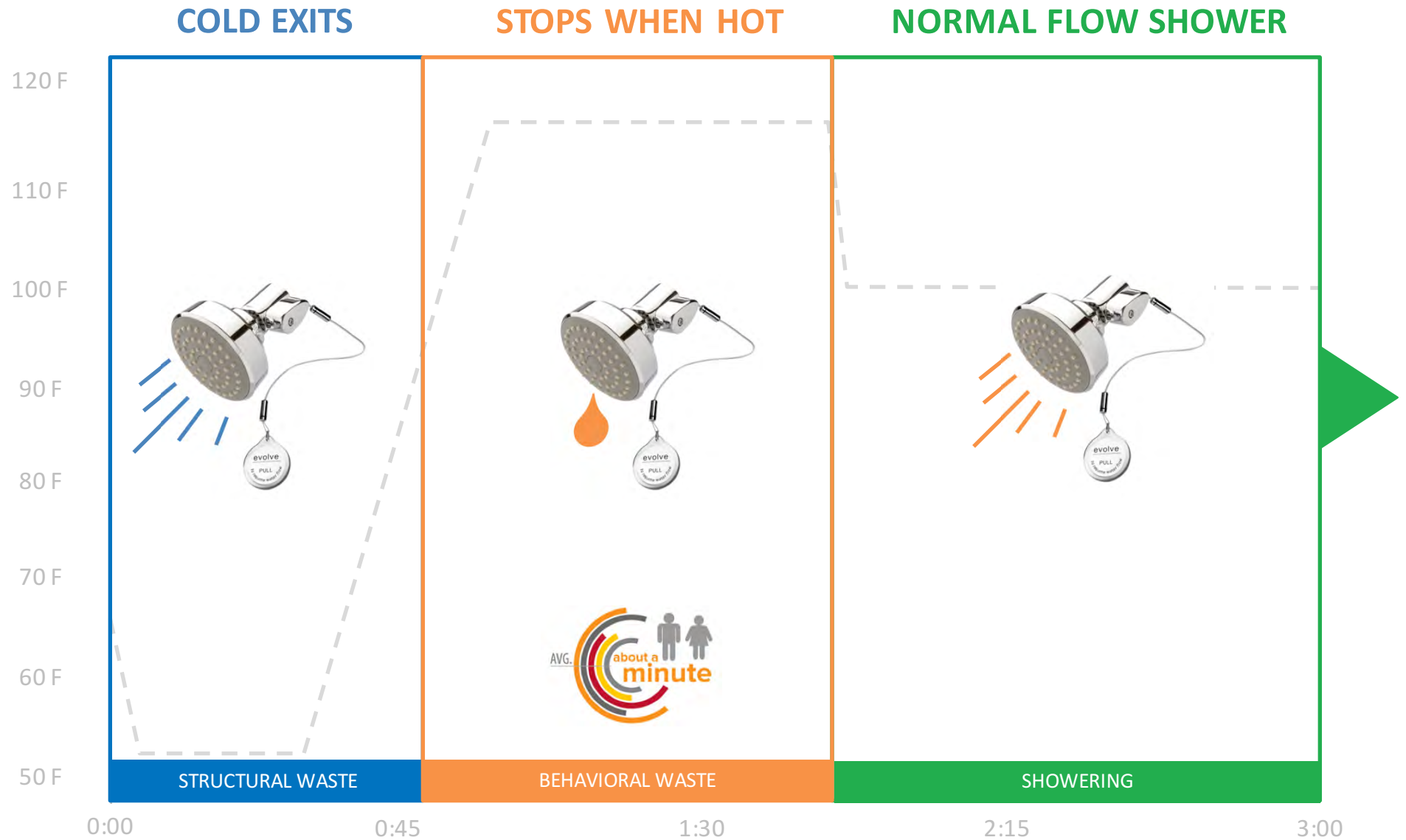
COLD EXITS



How A TSV Works

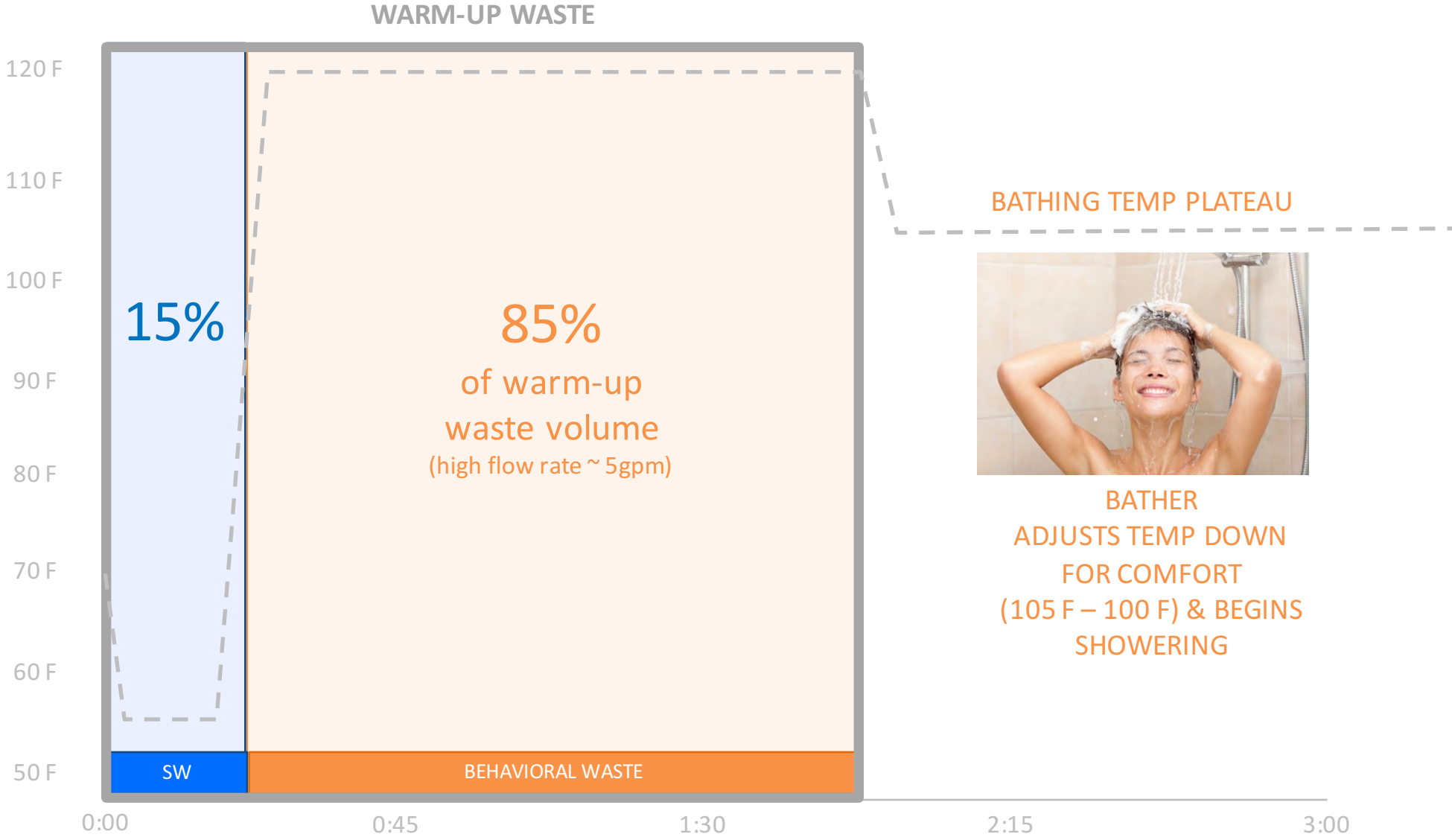


How A TSV Works



But 60% Of Showers Take Place In A Tub Shower Combo

Anatomy Of A Tub Spout Warm-Up



A System Solution For Lots And Lots Of Water And Energy

What Happens When You Marry A TSV To A Tub Spout



Most Convenient & Efficient Showering Solution Ever

AUTO-DIVERTING TUB SPOUT SYSTEM

Most Convenient

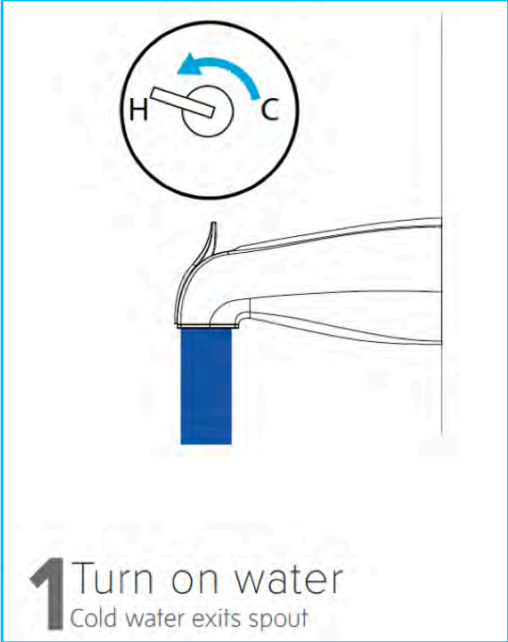
- **Greatly Reduces Wait Times**
Structural waste is purged significantly faster because of higher flow rates and fluid dynamics
- **Automatically Diverts Hot Water To Showerhead**
Sends hot water to showerhead once it arrives at tub spout

Most Efficient

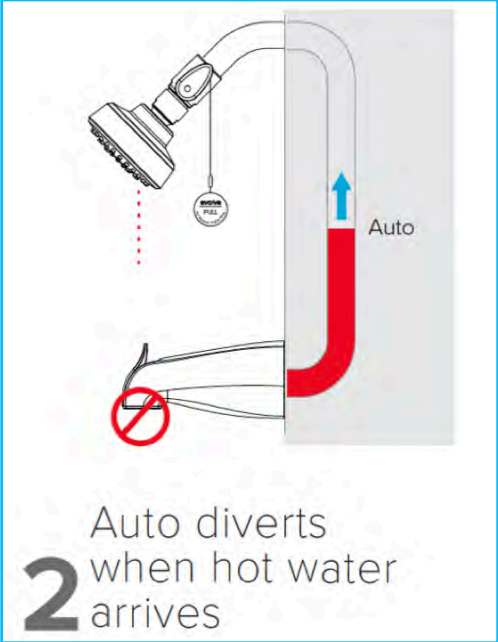
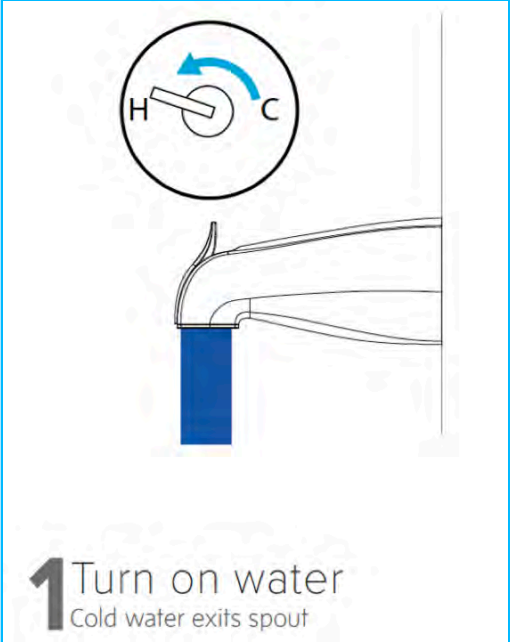
- **Reduces Structural Waste**
Structural waste volume is reduced as a result of “plug flow” at higher flow rates
- **Eliminates Behavioral Waste**
Stops hot water from running down drain when user is away from shower during warm-up
- **Anti Leak Tub Spout Design**
Tub spout leaks during shower can waste up to 5.5 gallons or more per shower
- **More Efficient Shower**
A specialized WaterSense showerhead is part of the system



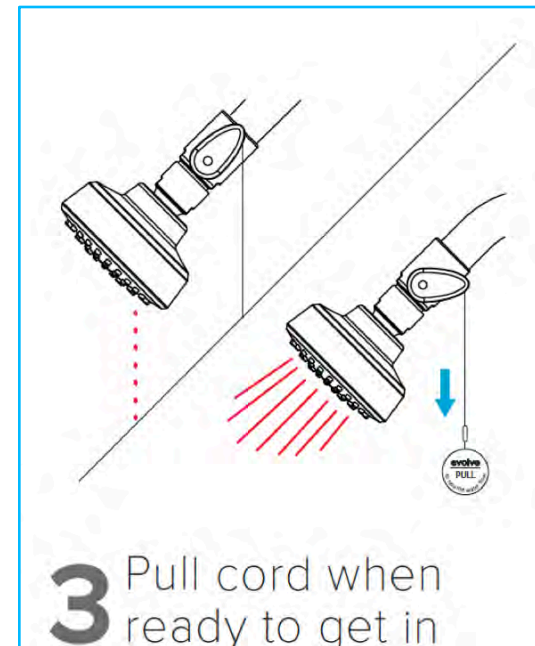
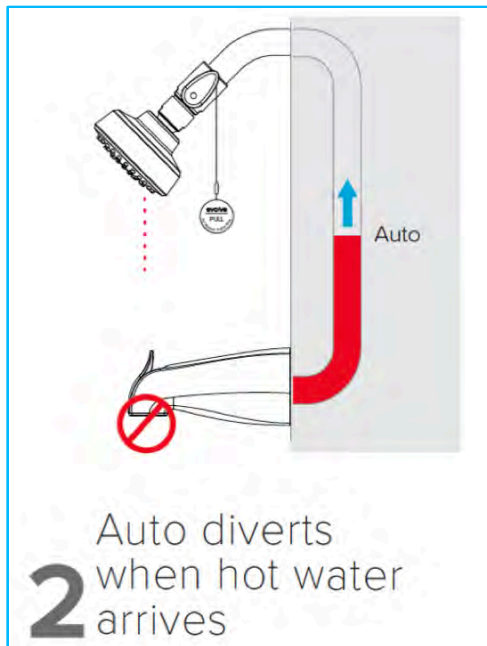
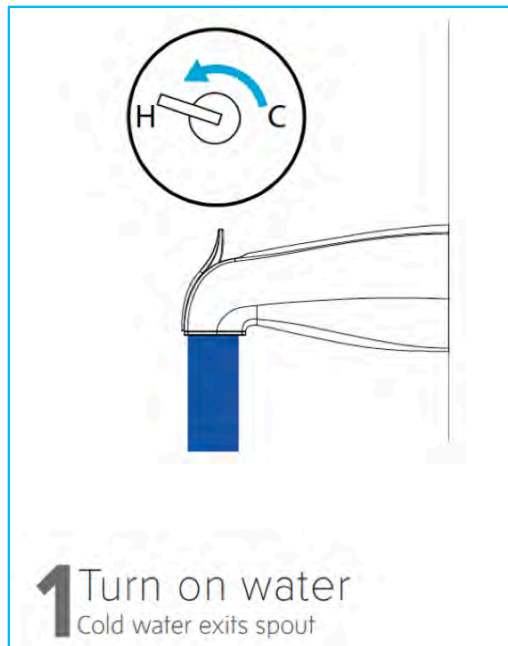
Auto-Diverting Tub Spout + TSV



Auto-Diverting Tub Spout + TSV



Auto-Diverting Tub Spout + TSV



Unique Water & Energy Savings Opportunities With Auto-Diverting Tub Spout



.4 GALLONS
SAVED

Structural Waste

Unique Water & Energy Savings Opportunities With Auto-Diverting Tub Spout



.4 GALLONS
SAVED

Structural Waste



5.1 GALLONS
SAVED

Behavioral Waste

Unique Water & Energy Savings Opportunities With Auto-Diverting Tub Spout



.4 GALLONS
SAVED

Structural Waste



5.1 GALLONS
SAVED

Behavioral Waste



5.0
GALLONS
SAVED

Efficient Showering

Unique Water & Energy Savings Opportunities With Auto-Diverting Tub Spout



.4 GALLONS
SAVED

Structural Waste



5.1 GALLONS
SAVED

Behavioral Waste



5.0
GALLONS
SAVED

Efficient Showering



4.5
GALLONS
SAVED

Anti-Leak Tub Spout

SAVE UP TO 15 GALLONS SAVED PER SHOWER

TSVs Guarantee The Benefits of Compact Plumbing Design

Behavior is persistent and a Thermostatic Shut-Off Valve is necessary to guarantee the assumed effectiveness of compact plumbing design.



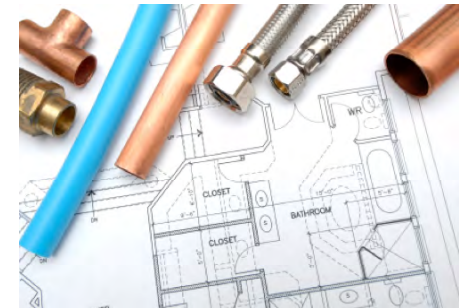
TSV



Auto-Diverting
Tub Spout

GUARANTEE

Without a TSV compact plumbing may actually increase water and energy consumption.



compact plumbing designs (efficient)

Comparative Savings

50%
Greater Savings

350%
Greater Savings



ShowerStart TSV



+



ShowerStart TSV +
Compact Plumbing



Auto-Diverting
Tub Spout System

Therms



4 – 7

6 – 10

18 – 32

kWh



95 – 160

140 – 235

415 – 740

Gallons



880 - 1,460

1,320 - 2,190

8,687

ASSUMPTIONS: 1 Min Behavioral Waste, 57F inlet, 105F temp, .76 gas recover efficiency, 2.56 people per household, .625 showers person/day, 1.5 – 2.5 gpm flow rates, compact plumbing saves 90% of structural waste. Auto Diverting Tub-Spout System savings estimate based on calculations from SoCalGas & Navigant Consulting.

Thank You

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