

Hot Water & Human Behavior – Efficiency Through New Technology



Changing Behavior Is Hard – Really Hard

Consider how

hard it is to change yourself

and you'll understand what

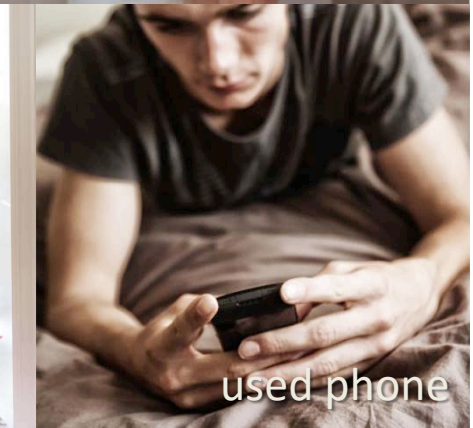
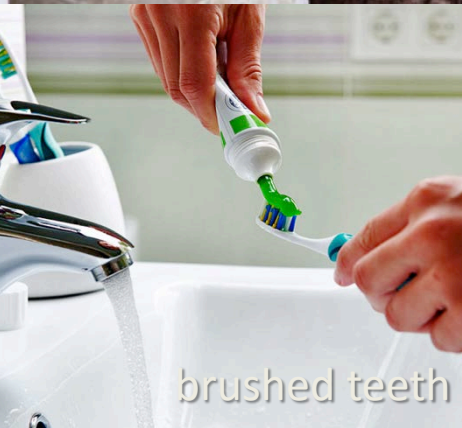
little chance

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

Most People Multitask – Behavioral Waste

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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

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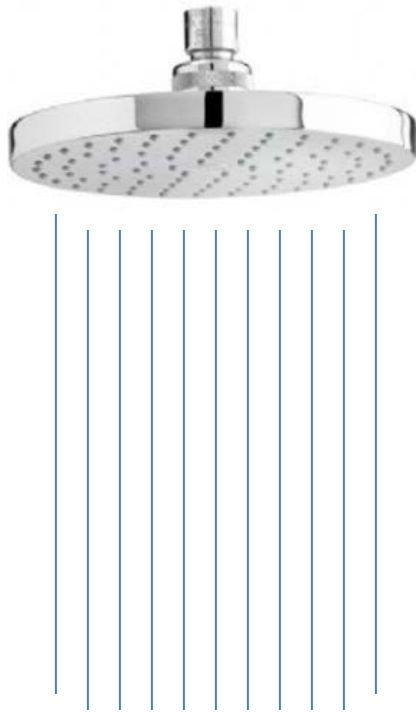
do more than one thing as part of their warm-up routine

60%

say routine, not presence of hot water, dictates time spent away from shower

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

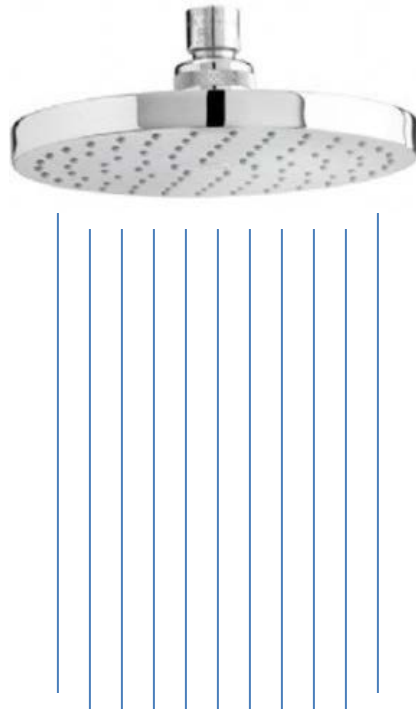
In 2004 and 2011 papers Jim Lutz at Lawrence Berkeley National Lab indicates that shower warm-up waste falls in the 20% - 30% range.



~ 2 Minutes
Of This
WARM-UP WASTE

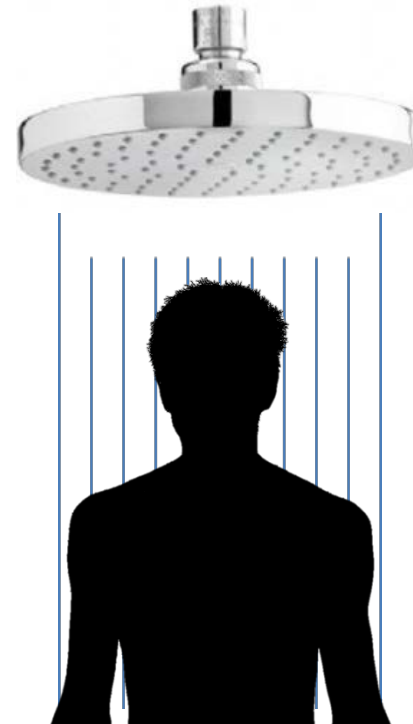
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~ 2 Minutes
Of This

WARM-UP WASTE



~ 6 Minutes
Of This

BATHING USE

What's Causing These Behaviors?

Lower Flow Rates Mean Even Longer Waits

All things being equal, we've increased wait times 2x-3x over the past 25 years. But all things aren't equal!

Flow Rate	Volume To Purge	Seconds Waiting
5 GPM	1.5 gallons	18

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Flow Rate	Volume To Purge	Seconds Waiting
5 GPM	1.5 gallons	18
2.5 GPM	1.5 gallons	36



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Flow Rate	Volume To Purge	Seconds Waiting
5 GPM	1.5 gallons	18
2.5 GPM	1.5 gallons	36
2 GPM	1.5 gallons	45
1.5 GPM	1.5 gallons	60



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Flow Rate	Volume To Purge	Seconds Waiting
5 GPM	1.5 gallons	18
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1.5 GPM	1.5 gallons	60



2X – 3X
Longer Wait
For Hot Water
To Arrive

But Lower Flow Rates Have An Event Greater Impact - They Actually Increase The Volume To Purge

At lower flow rates, 50% or more water must clear the pipe than is actually sitting in the pipe before hot water becomes available at the point of use.



0% - 10%
more than
volume of pipe

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At lower flow rates, 50% or more water must clear the pipe than is actually sitting in the pipe before hot water becomes available at the point of use.



0% - 10%
more than
volume of pipe



10% - 50%
more than
volume of pipe



SOURCE: Koeller, J (2007) Residential Hot Water Distribution Potential Best Management Practices.pdf

But Lower Flow Rates Have An Event Greater Impact - They Actually Increase The Volume To Purge

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0% - 10%
more than
volume of pipe

10% - 50%
more than
volume of pipe

50% - 100%
more than
volume of pipe



SOURCE: Koeller, J (2007) Residential Hot Water Distribution Potential Best Management Practices.pdf

How Long Do You Wait?

How Long Should We Wait For Hot Water?

Volume in the Pipe (ounces)	<u>Minimum</u> Time-to-Tap (seconds) at Selected Flow Rates					
	0.25 gpm	0.5 gpm	1 gpm	1.5 gpm	2 gpm	2.5 gpm
2	4	1.9	0.9	0.6	0.5	0.4
4	8	4	1.9	1.3	0.9	0.8
8	15	8	4	2.5	1.9	1.5
16	30	15	8	5	4	3
24	45	23	11	8	6	5
32	60	30	15	10	8	6
64	120	60	30	20	15	12
128	240	120	60	40	30	24

ASPE Time-to-Tap Performance Criteria

	Acceptable Performance	≤ 10 seconds
	Marginal Performance	> 10 ≤ 30 seconds
	Unacceptable Performance	> 30 seconds

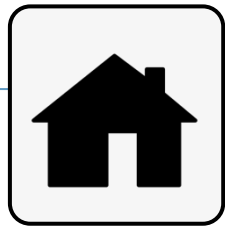
Source: Domestic Water Heating Design Manual – 2nd Edition, ASPE, 2003, page 234

How Long Are Others Waiting?

Data From Lawrence Berkeley National Lab

December 2013 LBNL Field Study – DHW Use

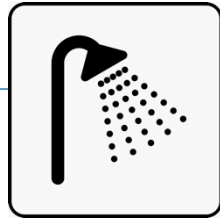
Lawrence Berkeley National Lab conducted a field study of domestic hot water usage in N. California homes. Evolve Technologies identified the following data points regarding shower usage in homes with usable data for the period Dec 1-31, 2013.



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



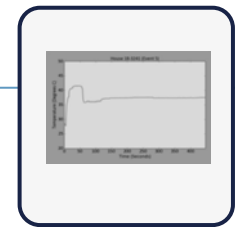
44%
DEDICATED SHOWERS
(est. based on master bath count)



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

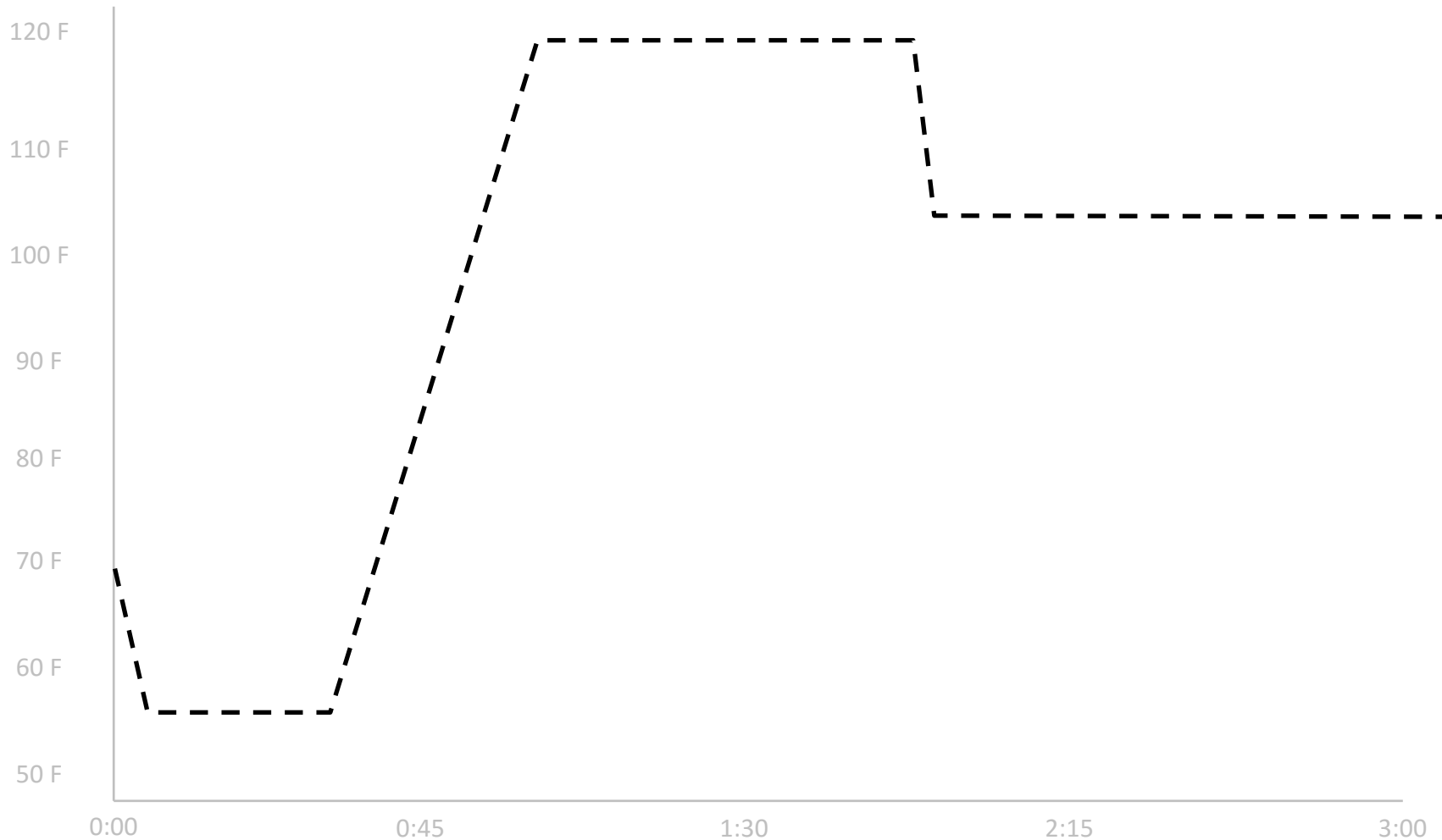
- 528 total events
- 54% identifiable signatures

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

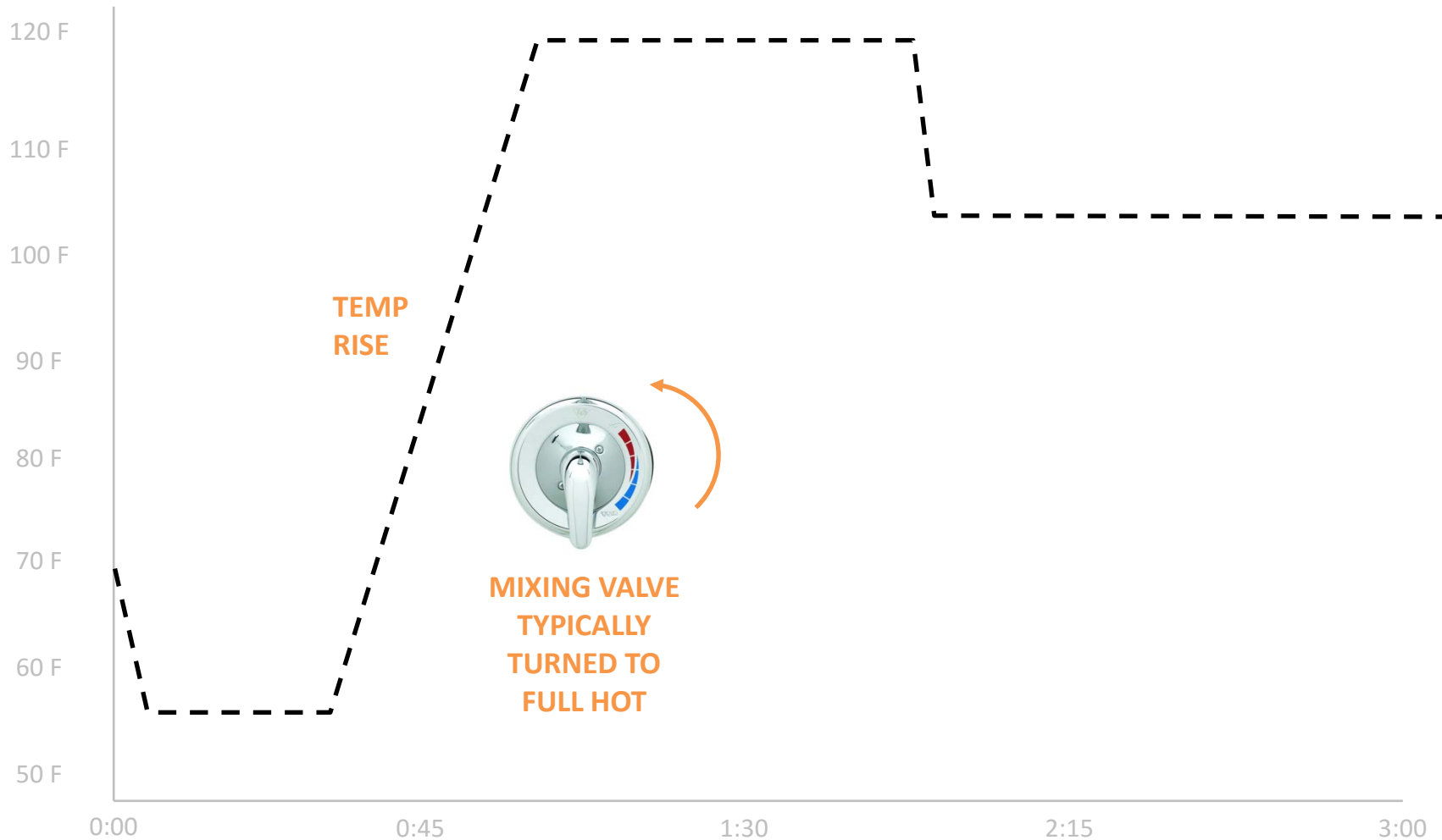
Anatomy Of A Shower Warm-Up – Lawrence Berkley National Lab Data Analysis

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



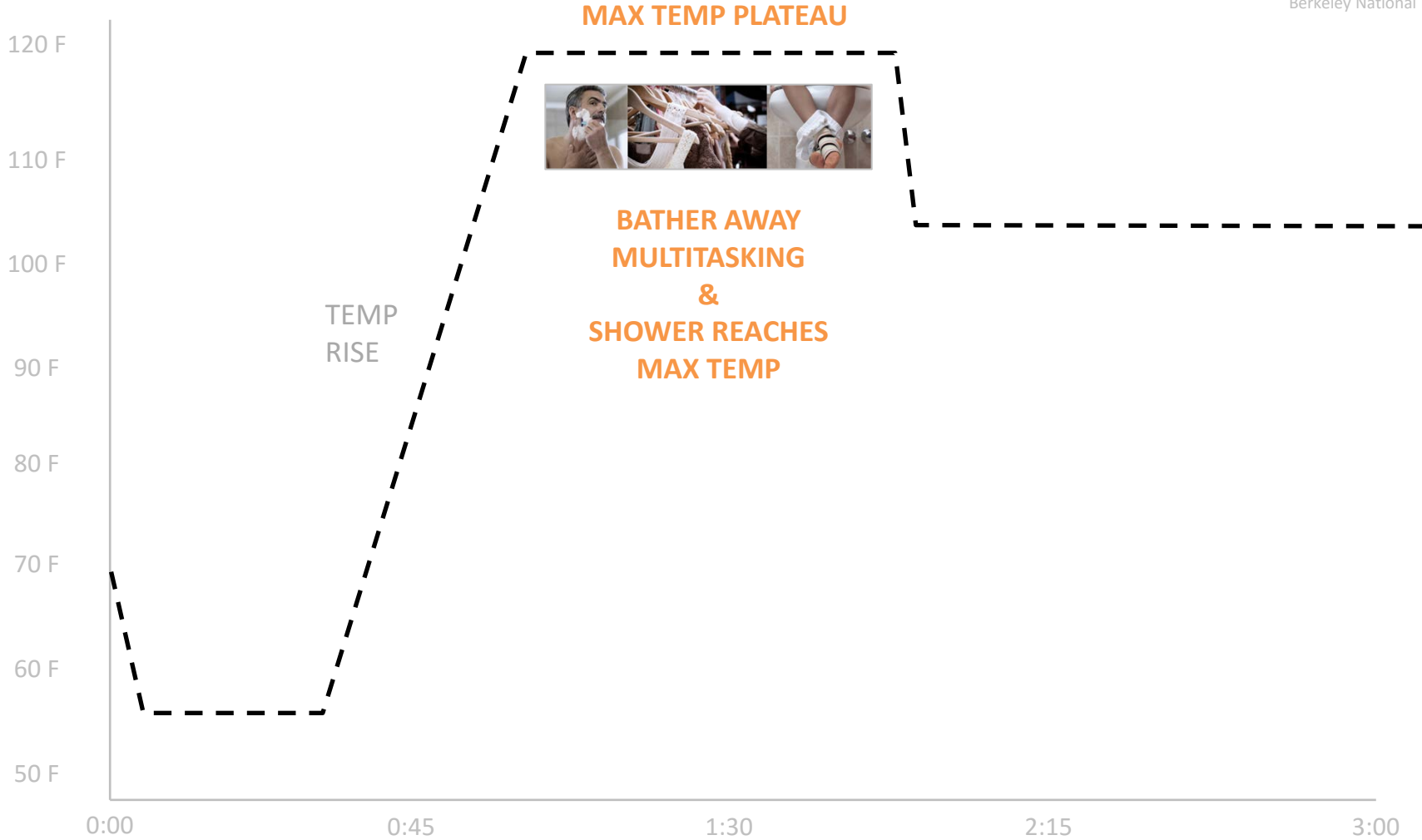
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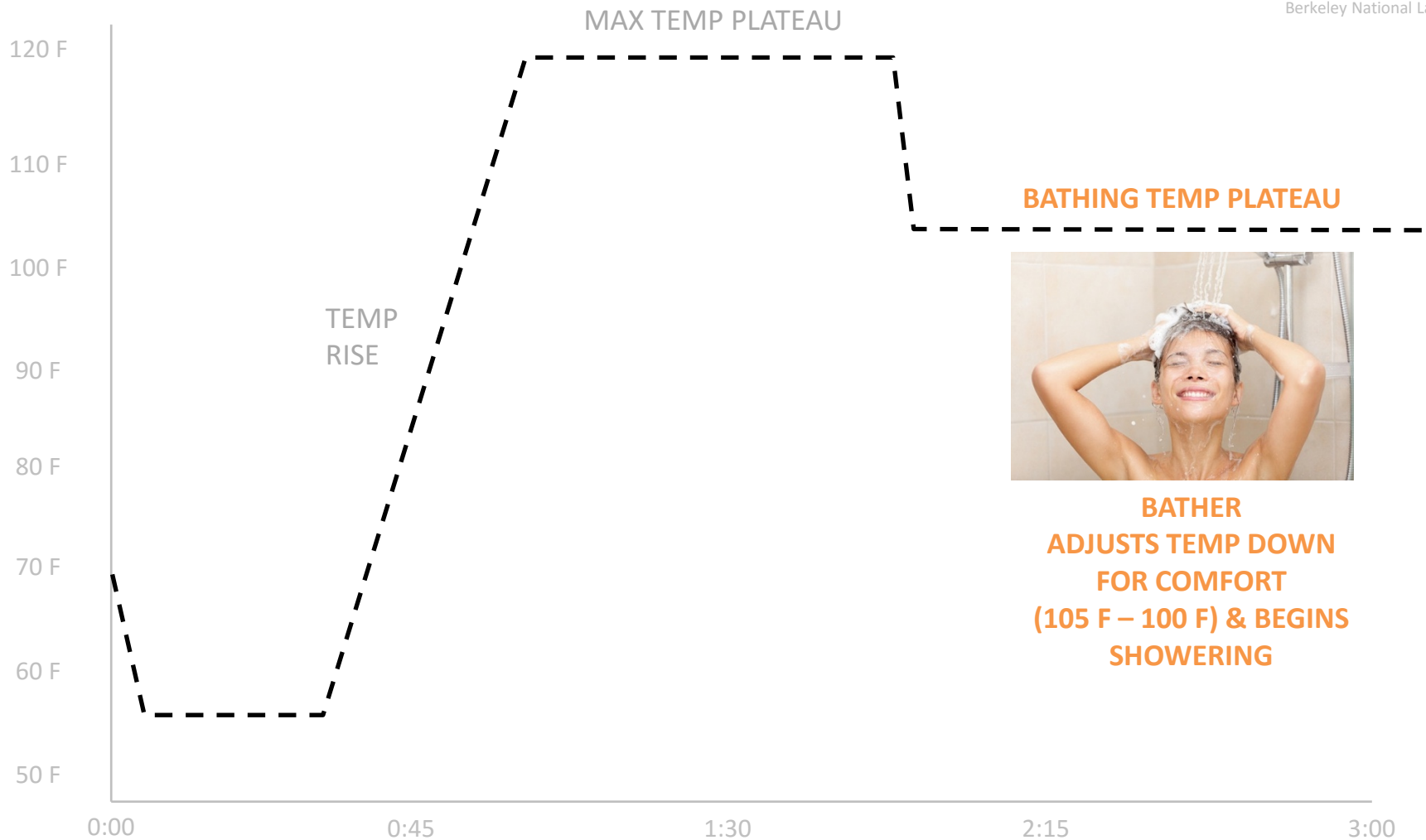
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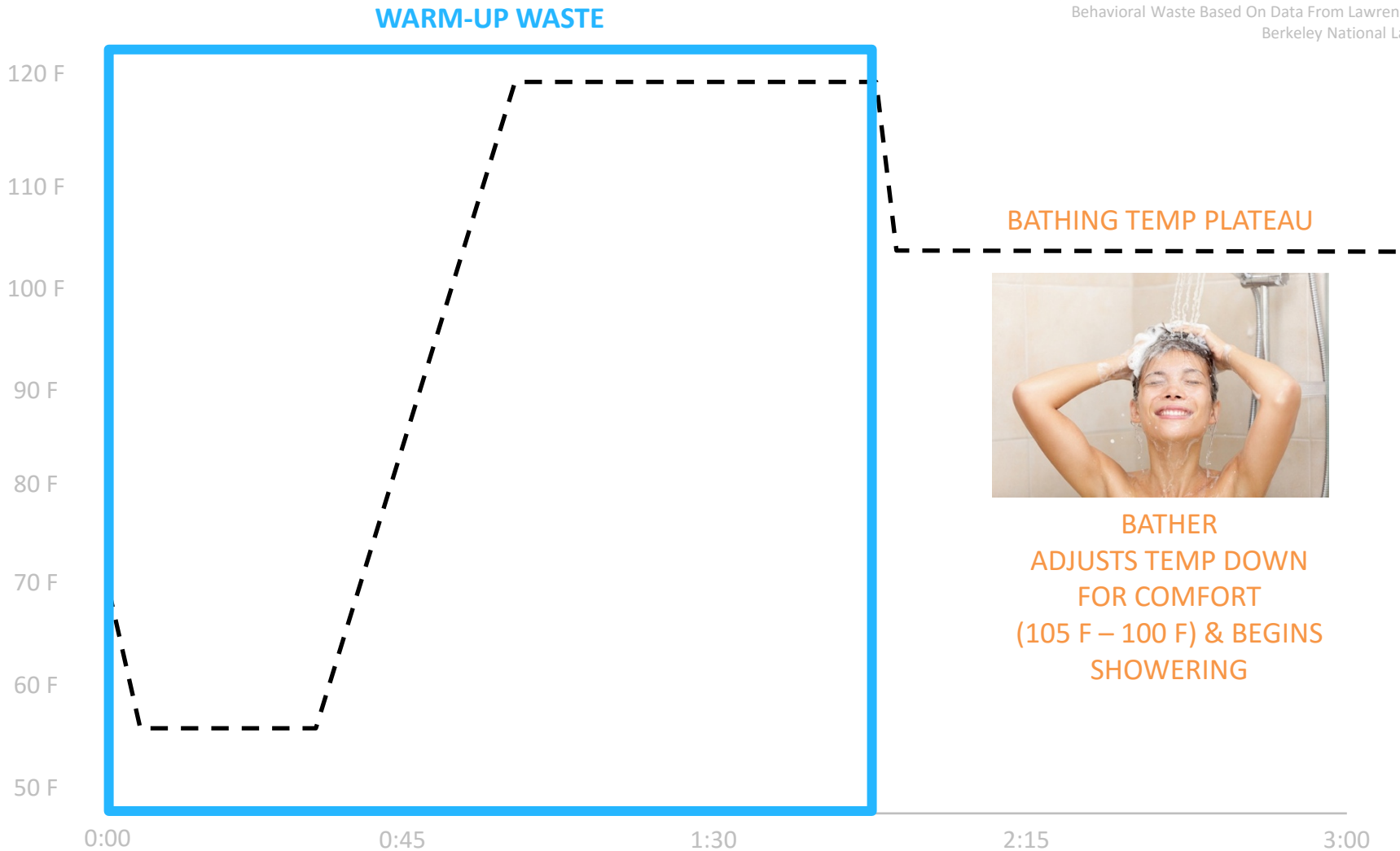
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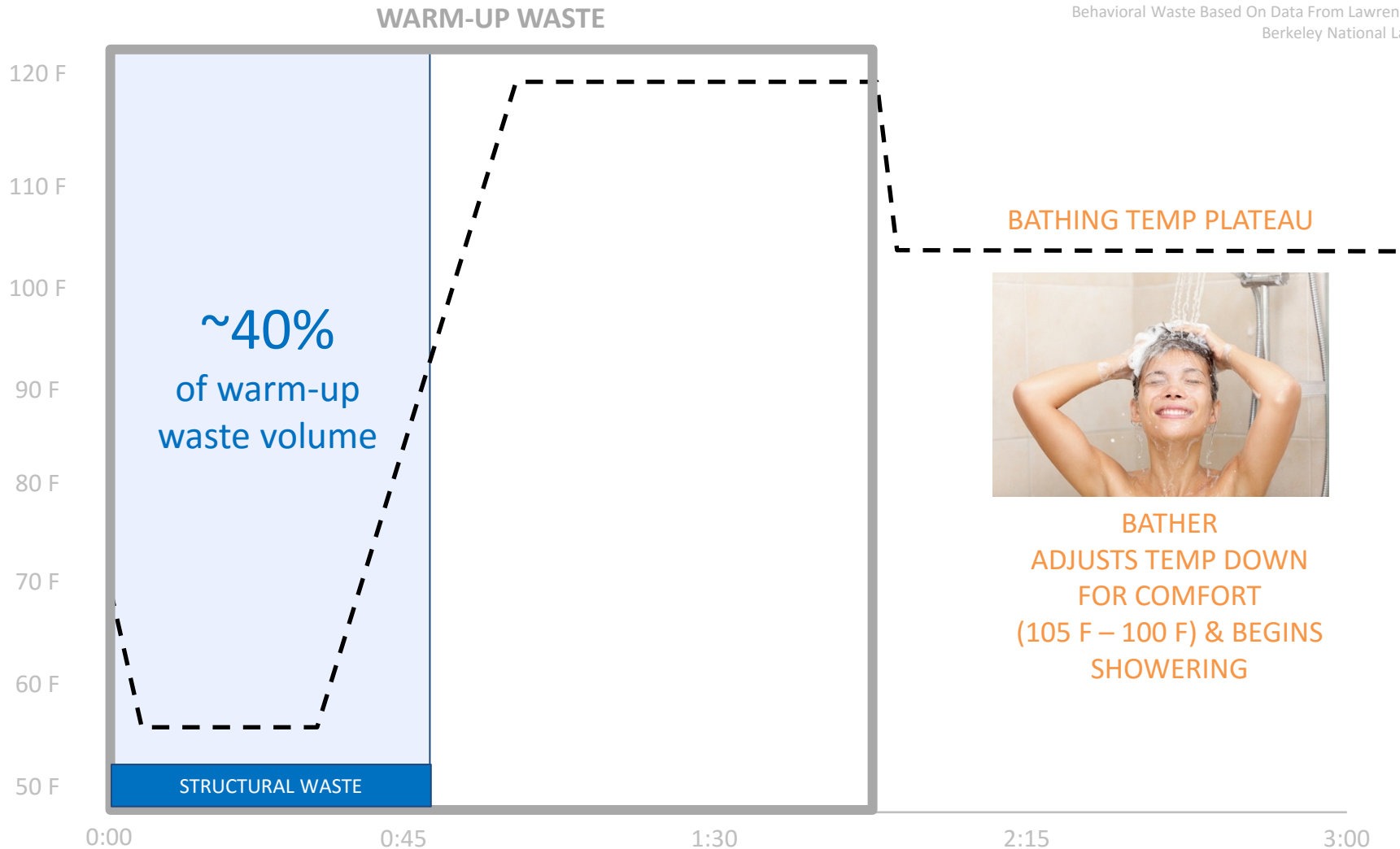
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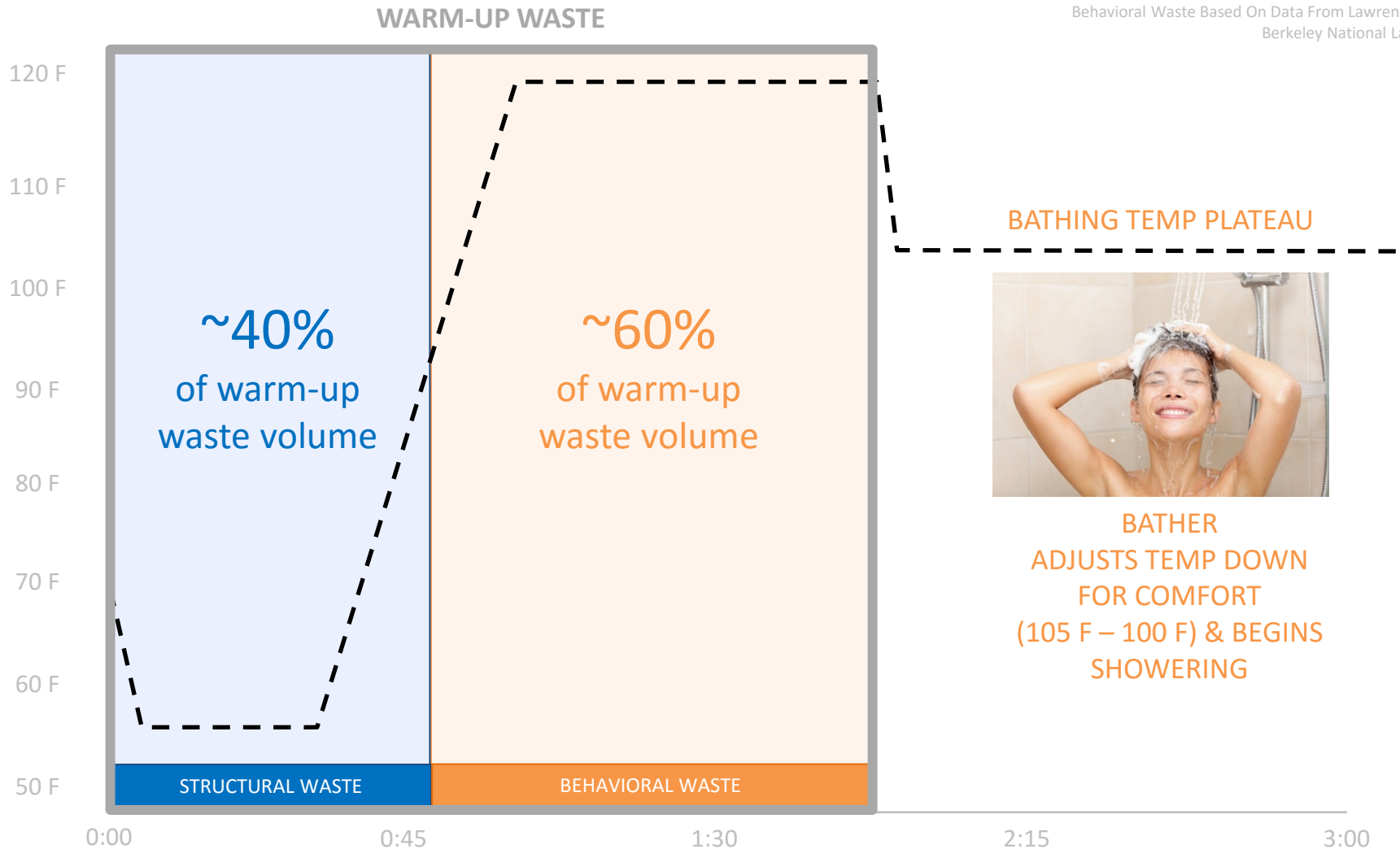
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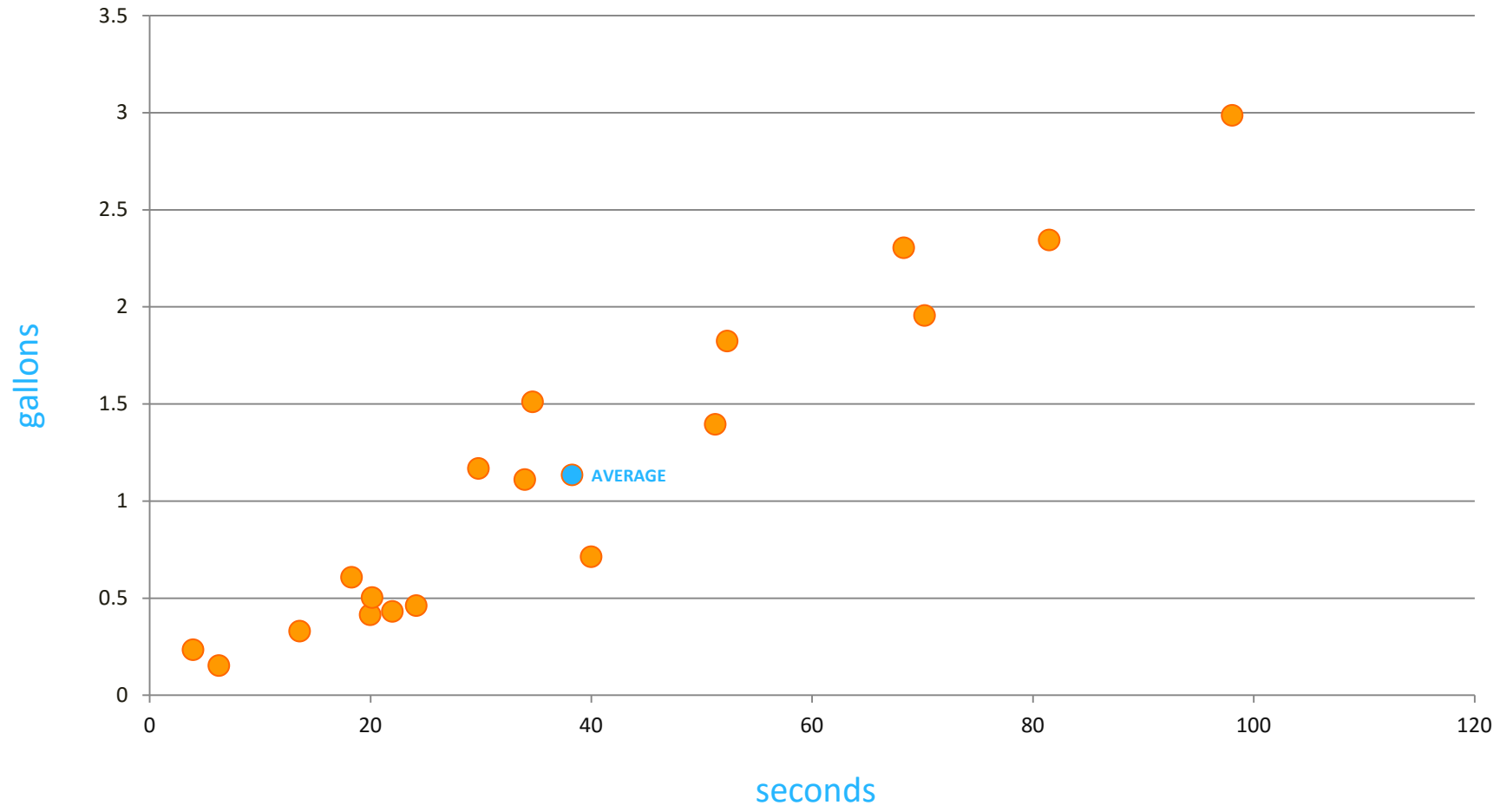
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2013 LBNL Analysis - Some Waste A Little – Others Waste A Lot

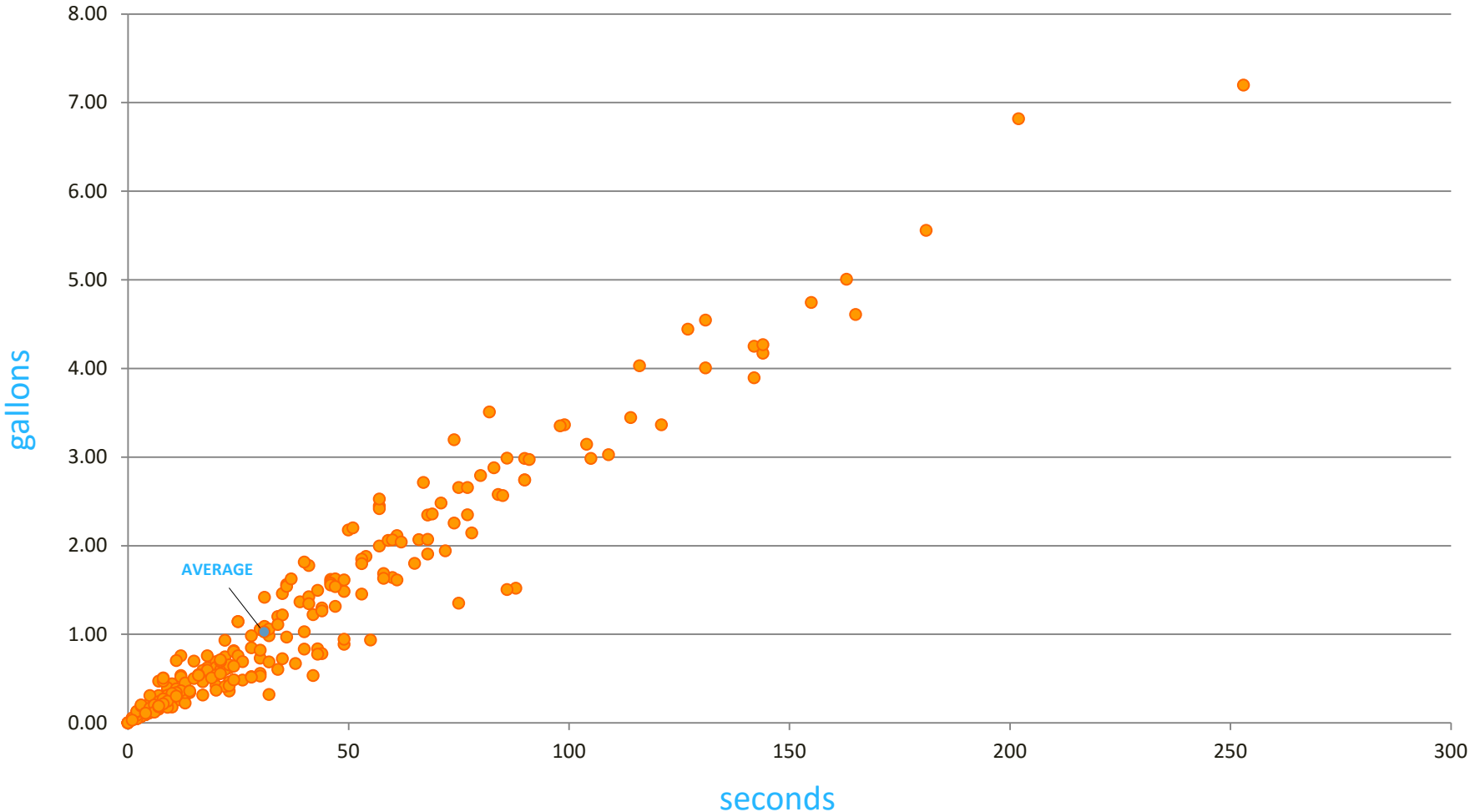
Average Behavioral Waste By Bathroom



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

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

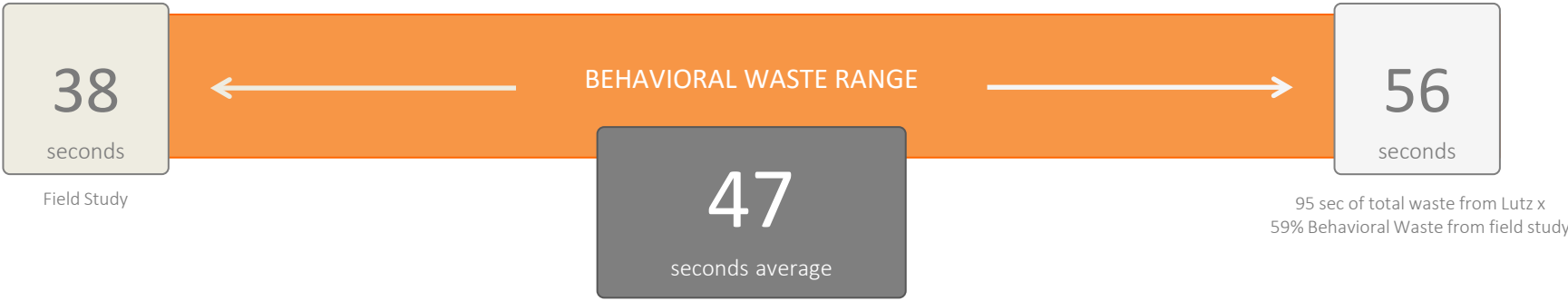
Behavioral Waste By Individual Shower Event



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

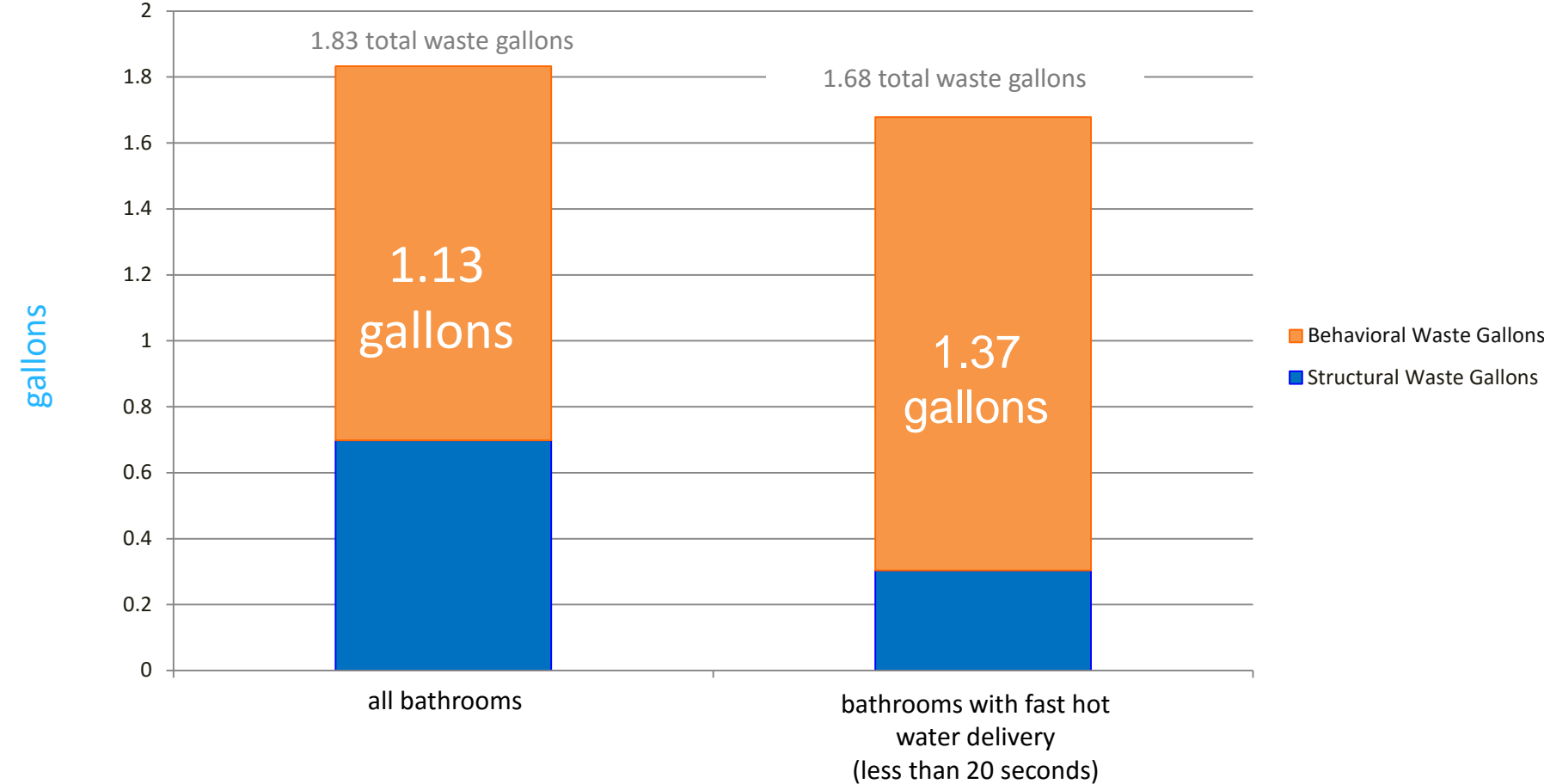
Behavioral Waste Estimates From '04 – '13 LBNL Analysis

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).



Fast Hot Water Delivery Increases Hot Water Waste

Fast hot water delivery increases average behavioral waste volume by +20%, while only reducing total average shower warm-up waste by 6%



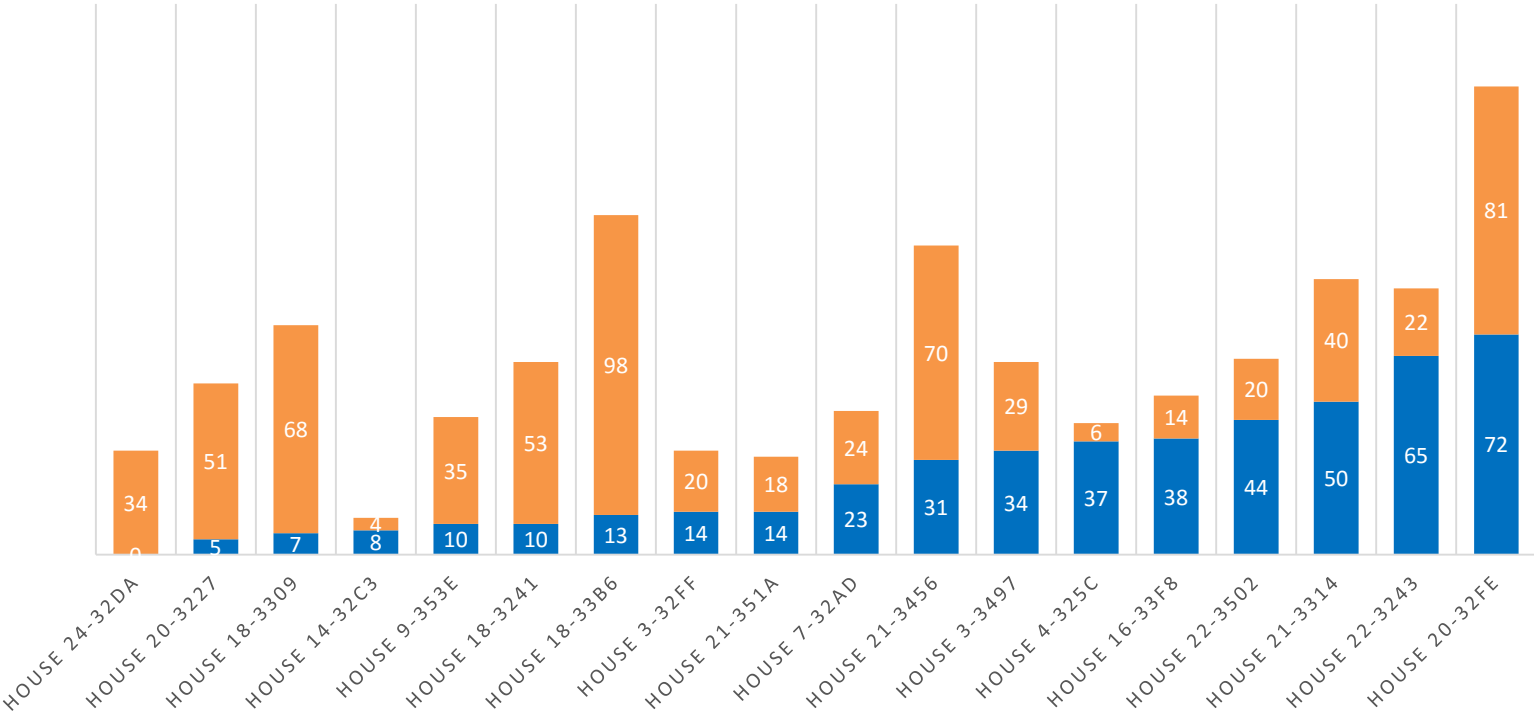
SOURCE: 2014 Disaggregating Residential Shower Warm-Up Waste – An Understanding and Quantification of Behavioral Waste Based On Data From Lawrence Berkeley National Lab

Behavior Is Persistent – 10 Second Waits Are Too Long

Fast hot water delivery increases average behavioral waste volume by +20%, while only reducing total average shower warm-up waste by 6%

WARM-UP WASTE COMPONENTS AVG. SECONDS PER BATHROOM

■ Structural Waste Seconds ■ Behavioral Waste Seconds



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

What If Americans Could Eliminate Behavioral Waste ...

Without Changing Behavior or Making Sacrifices?

The Thermostatic Shut-Off Valve (TSV) Solution

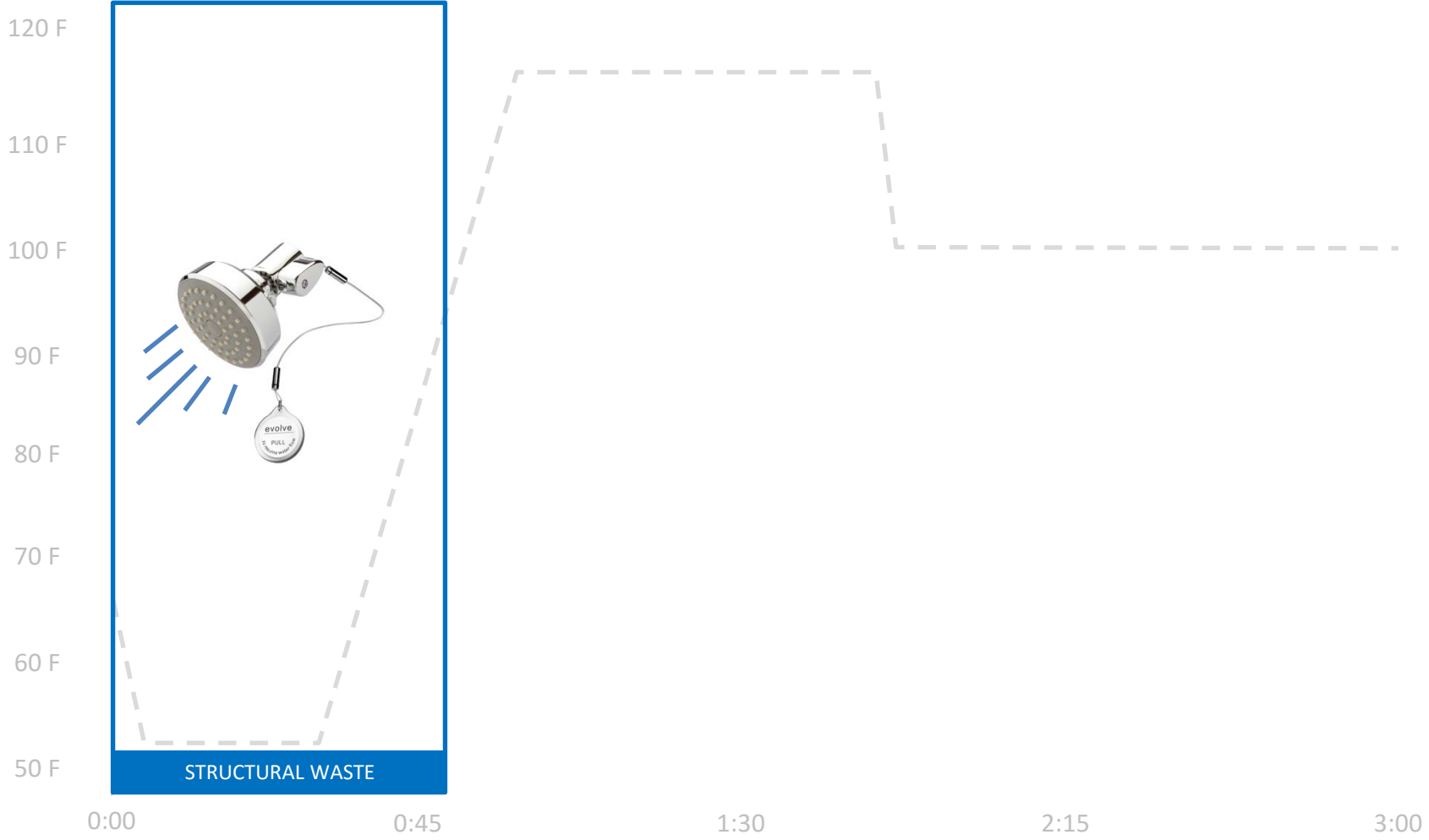
Keep Your Routine – Save Your Hot Water



- 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

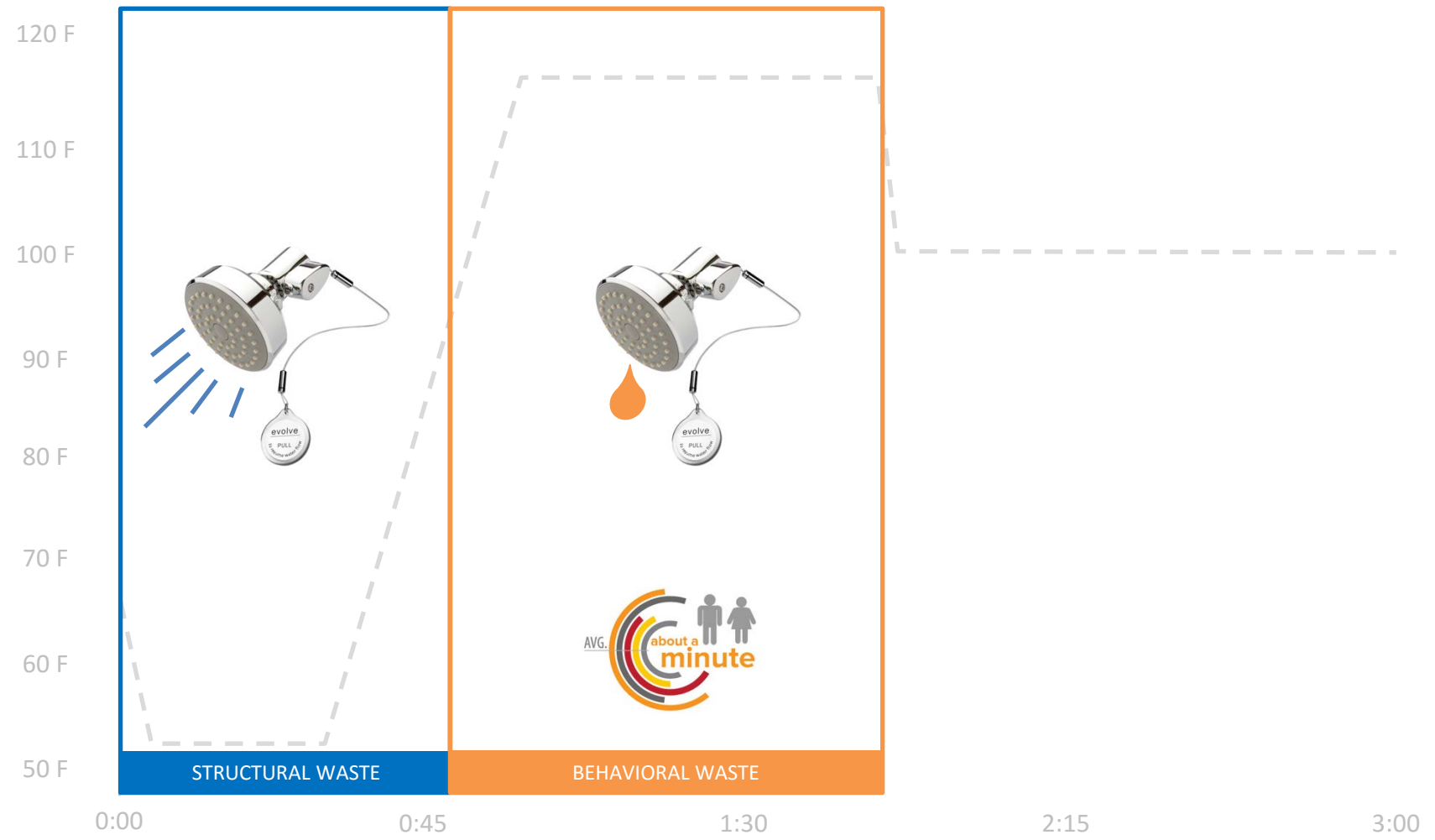
COLD EXITS



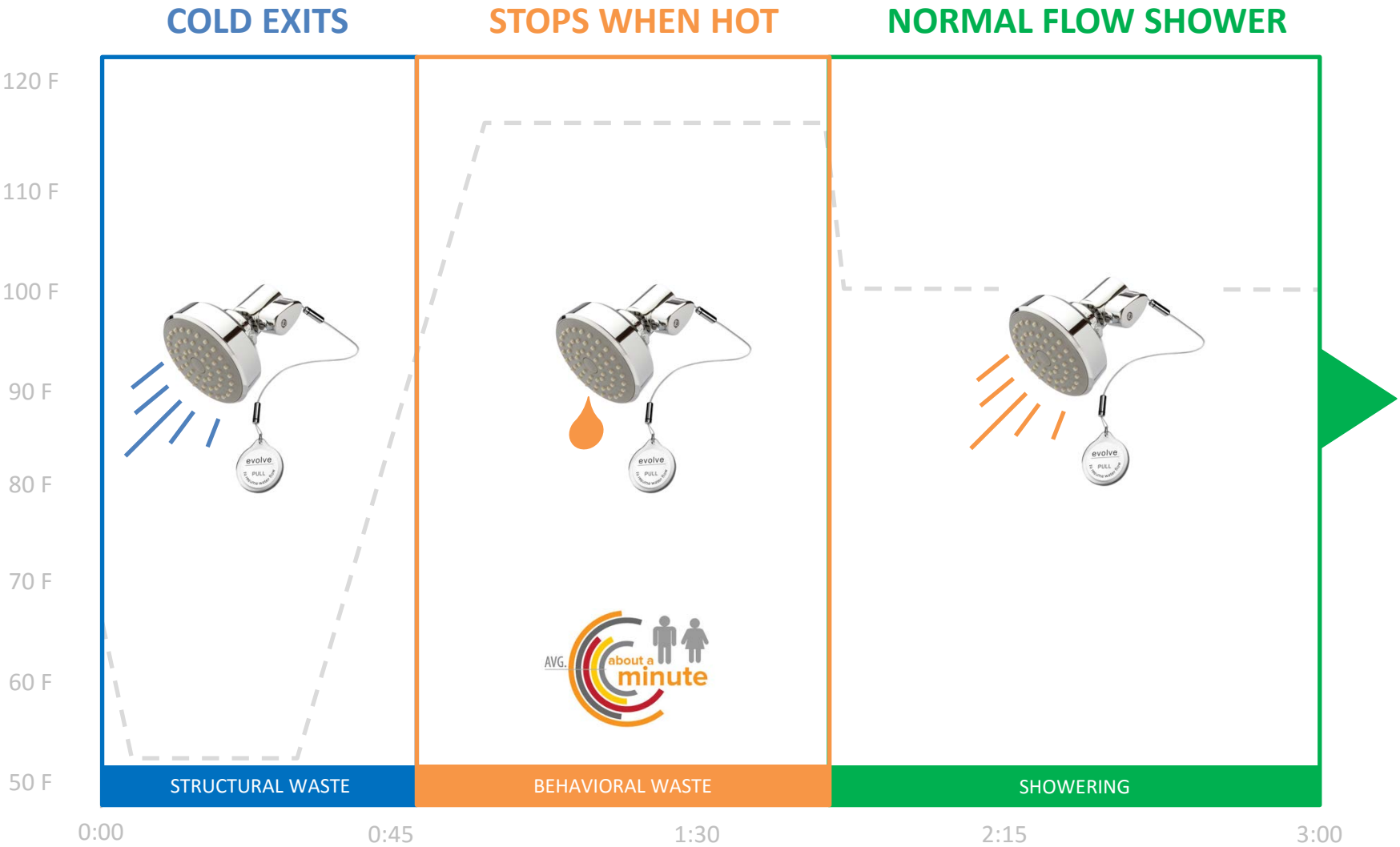
How A TSV Works

COLD EXITS

STOPS WHEN HOT



How A TSV Works



Annual Impact Of Eliminating Behavioral Waste - USA

168 Billion
Gallons Water/Year
in USA



9 years
of drinking water for
everyone in USA
(58 gallons person/year)

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809 Million
Therms/Year
in USA



1.3 MM
cars
gasoline fueled
for a year
(13K miles per year @ 25 mpg)

Annual Impact Of Eliminating Behavioral Waste - USA

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+

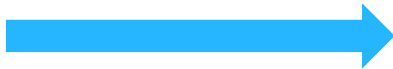
809 Million
Therms/Year
in USA



1.3 MM
cars
gasoline fueled
for a year
(13K miles per year @ 25 mpg)

or

18.5 Billion
kWh/Year
in USA



1.6 MM
homes
electricity consumption
for a year
(11,320 kWh home/year)

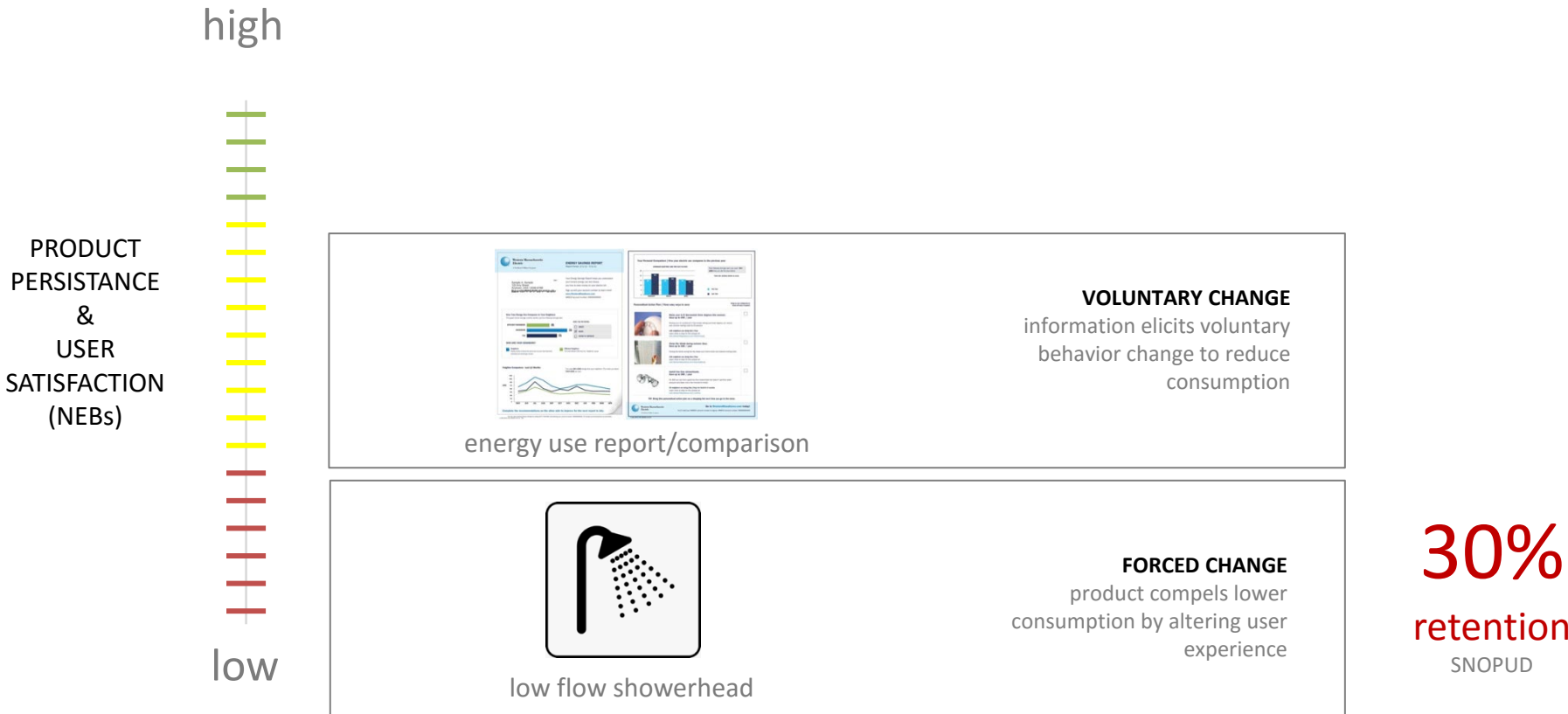
Opportunities For Improved Efficiency – Paradigm Shift

The most widely used products in today’s efficiency programs fall within the FORCED CHANGE category. Meaningful long-term savings and higher resident satisfaction geared towards comfort and convenience can be achieved by focusing on the NO CHANGE category.



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high

PRODUCT
PERSISTENCE
&
USER
SATISFACTION
(NEBs)



low



TSV


NO CHANGE
technology reduces consumption
without need for altered
experience or
behavior change

85%
retention
SNOPUD



energy use report/comparison

VOLUNTARY CHANGE
information elicits voluntary
behavior change to reduce
consumption



low flow showerhead

FORCED CHANGE
product compels lower
consumption by altering user
experience

30%
retention
SNOPUD

TSVs Are Used In Nation's Largest Efficiency Programs

- + 1.2 MM units installed in single family and multifamily homes via the largest efficiency & weatherization programs in the country.
- Inclusion in Build It GREEN's updated Green Point energy and water calculator.
- Inclusion in WERS (Water Efficiency Rating Score) program - Green Building Coalition.



Thank You

Troy.Sherman@ThinkEvolve.com
480.250.4563

What Happens If We Start ...

Thinking About Bathing As A System

Most Showers Take Place In A Tub Shower Combo

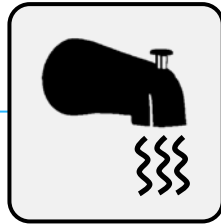
Tub Spout warm-ups, multitasking during the warm-up and leaky tub spouts are commonplace.



62%

TUB/SHOWER COMBOS

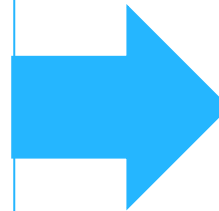
648 of the people surveyed reported that they typically shower in a tub/shower combination unit



40%

TUB SPOUT WARM UP

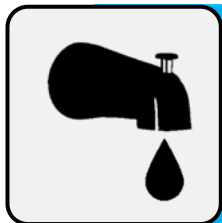
258 people with tub/shower combo units warm their shower by letting the water run through the tub spout and activating the diverter AFTER the water becomes warm



58%

MULTITASK

149 people doing tub spout warm ups regularly or occasionally leave to do something else while waiting for the water to become warm



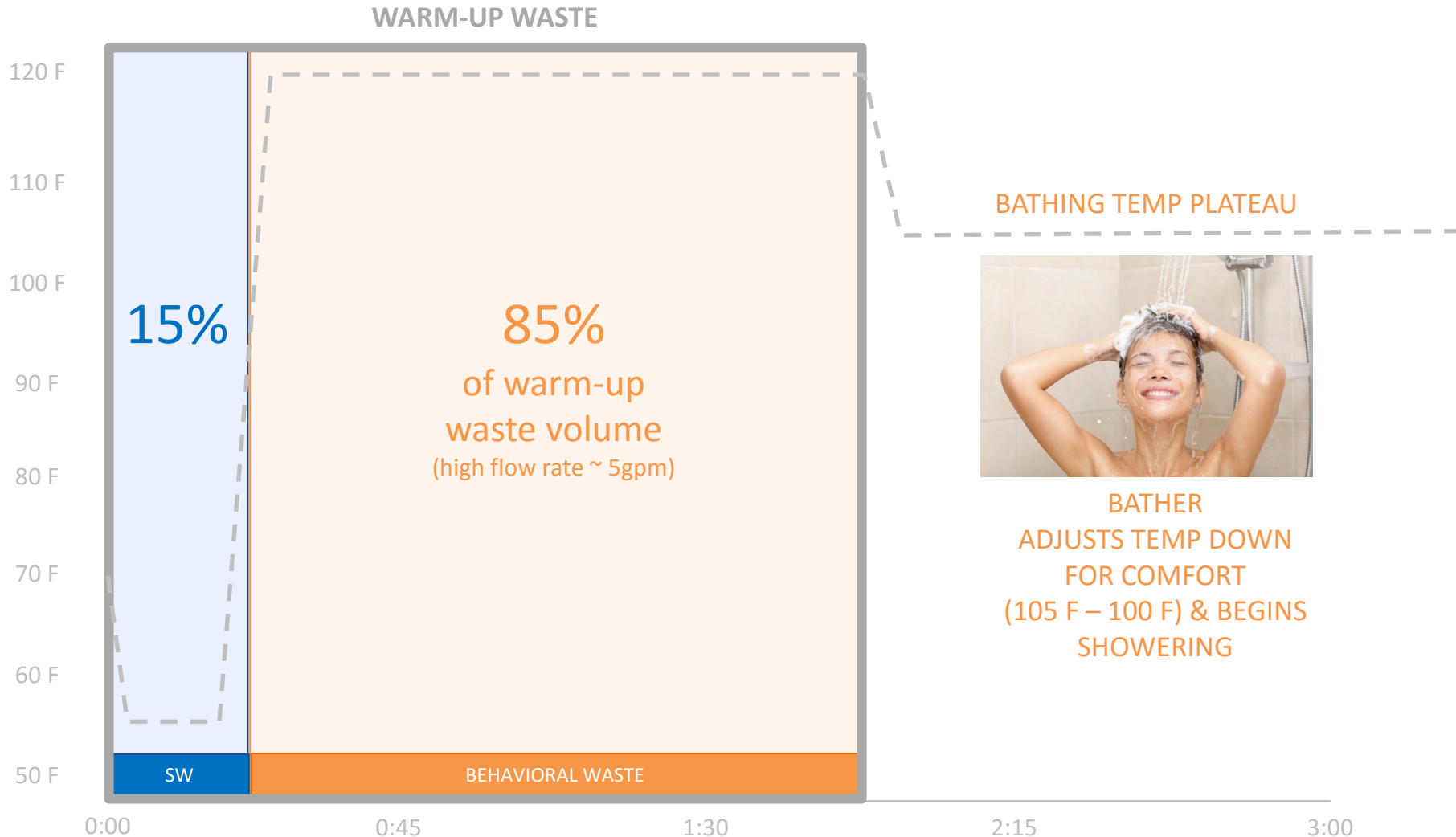
34%

LEAKY TUB SPOUT

220 showering in a tub/shower combo unit report that their tub spout leaks during their showers

SOURCE: 2014 Evolve Technologies Warming Your Shower Survey

Anatomy Of A Tub Spout Warm-Up



What Happens When You Marry A TSV To A Tub Spout



The Benefits Of A Systematic Approach – The Most Convenient And Efficient Showering System Available

Most Convenient

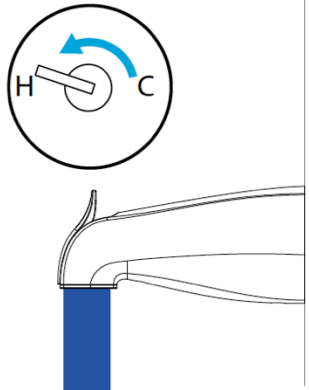
- **Greatly Reduces Wait Times**
Structural waste is purged significantly faster because of higher flow rates and fluid dynamics
- **Automatically Diverts Hot Water To Showerhead**
Sends hot water to showerhead once it arrives at tub spout

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

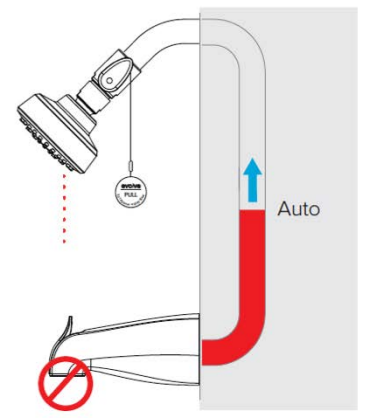


Auto-Diverting Tub Spout System – How It Works



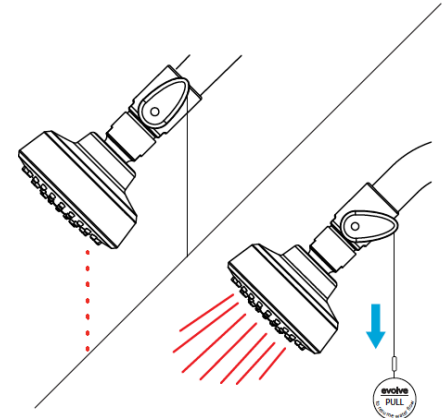
1 Turn on water
Cold water exits spout

Continue with your typical routine - the things you do while waiting for the shower to become warm.



2 Auto diverts when hot water arrives

Upon reaching 95°F, ShowerStart Technology automatically diverts flow. Showerhead trickles - saving hot water until you get in.



3 Pull cord when ready to get in

Pull the cord to activate normal flow and begin showering.

Unique Water & Energy Savings Opportunities With A System Solution



.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

15 GALLONS SAVED PER SHOWER

SOURCE: Calculating Savings For Auto-Diverting Tub Spout System With ShowerStart TSV, December 2015

Comparative Savings

400%
Greater Savings



TSV



Auto-Diverting
Tub Spout System

Therms



4 – 7

18 – 32

kWh



95 – 160

415 – 740

Gallons



880 - 1,460

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, improved plumbing saves 90% of structural waste. Auto Diverting Tub-Spout System savings estimate based on calculations from SoCalGas & Navigant Consulting.