Hot Water & Human Behavior
Don’t Get Burned
We Must Address Structure & Behavior
We Must Address Structure & Behavior

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

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

good mix of different home sizes

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

56% TUB/SHOWER COMBOS
(est. based on secondary bath count)

18 BATHROOMS

283 “GOOD” SIGNATURES
- 528 total events
- 54% identifiable signatures

significant number of individual shower events

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.

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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.

Fast Hot Water Delivery Increases Hot Water Waste

1.83 total waste gallons

1.68 total waste gallons

1.13 gallons

1.37 gallons

all bathrooms

bathrooms with fast hot water delivery (avg 10 seconds)

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
Anatomy Of A Shower Warm-Up – LBNL Data

**Diagram:**
- **TEMP RISE**
- **MIXING VALVE TYPICALLY TURNED TO FULL HOT**

**Graph Details:**
- X-axis: Time in minutes (0:00 to 3:00)
- Y-axis: Temperature in °F (50°F to 120°F)

**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 – LBNL Data
Anatomy Of A Shower Warm-Up – LBNL Data

TEMP RISE

MAX TEMP PLATEAU

BATHING TEMP PLATEAU

BATHER ADJUSTS TEMP DOWN FOR COMFORT (105 F – 100 F) & BEGINS SHOWERING
Anatomy Of A Shower Warm-Up – LBNL Data

WARM-UP WASTE

0:00 0:45 1:30

120 F 110 F 100 F 90 F 80 F 70 F 60 F 50 F

BATHING TEMP PLATEAU

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

065/65512

Anatomy Of A Shower Warm-Up – LBNL Data

WARM-UP WASTE

~40% of warm-up waste volume

STRUCTURAL WASTE

BATHING TEMP PLATEAU

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

Anatomy Of A Shower Warm-Up – LBNL Data

**WARM-UP WASTE**

- **~40% of warm-up waste volume**
- **~60% of warm-up waste volume**

**BATHING TEMP PLATEAU**

-Bather adjusts temp down for comfort (105 F – 100 F) & begins showering.
2013 LBNL Analysis - Some Waste A Little – Others Waste A Lot

Behavioral Waste By Individual Shower Event

seconds

gallons

AVERAGE
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).

BEHAVIORAL WASTE RANGE

38 seconds
Field Study

47 seconds average

56 seconds

95 sec of total waste from Lutz x
59% Behavioral Waste from field study
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

FIRST MONTH OF TSV RESULTS

5 gal
per day avg.
Hot Water
Savings
~ 1 min
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.

Table 4. Metering Results Summary

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

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
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

STRUCTURAL WASTE
How A TSV Works
How A TSV Works

COLD EXITS

STOPS WHEN HOT

NORMAL FLOW SHOWER

STRUCTURAL WASTE

BEHAVIORAL WASTE

SHOWERING
But 60% Of Showers
Take Place In A Tub Shower Combo
Anatomy Of A Tub Spout Warm-Up

WARM-UP WASTE

15%

85% of warm-up waste volume
(high flow rate ~ 5gpm)

BATHING TEMP PLATEAU

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

1. Turn on water
   Cold water exits spout
Auto-Diverting Tub Spout + TSV

1. Turn on water
   Cold water exits spout

2. Auto diverts when hot water arrives
Auto-Diverting Tub Spout + TSV

1. Turn on water. Cold water exits spout.
2. Auto diverts when hot water arrives.
3. Pull cord when ready to get in.
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-Diverging Tub Spout

0.4 GALLONS SAVED
Structural Waste

5.1 GALLONS SAVED
Behavioral Waste

5.0 GALLONS SAVED
Efficient Showering
Unique Water & Energy Savings Opportunities
With Auto-Diveriting 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.

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, 57°F inlet, 105°F 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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