This presentation premiered at WaterSmart Innovations

watersmartinnovations.com
Domestic Hot Water Distribution Challenges in Multi-Family Construction
Presentation Overview

Typical Systems
- in-unit electric or natural gas storage or tank-less
- heat pump water heaters per floor or cluster of apartments
- central recirculation
- central on demand

Energy Savings
- modeling predictions
- real world results

Water Savings
- tools for analysis
- continued monitoring
- the real cost of water

Common Practice vs. Good Design
- typical distribution design
- efficient layout
- pipe insulation, fixtures

Further Exploration On-Demand Recirculation
- in practice: Title 24; IECC; DOE ZERH, Passive House
- examples projects & results

Moving Forward
- additional research, monitoring, measuring and qualifying results
- emerging technologies & controls
Learning objectives

• Identify opportunities in layout, design and specifications

• Analyze tools to predict water and energy savings

• Explore alternative equipment and controls

• Evaluate success stories; verify, measure and qualify savings
What’s Typical in Unit
Less Typical
Not So Typical in Unit
Central DHW
DHW - Recirculation
DHW – Recirculation

Code Requirements

- Central must have recirculation for MF
- Individual Pipe runs from recirc. lines to taps < 20 ft.

Design

- One vertical riser per several apartments

Better Design

- Reduce # of risers
- Cluster plumbing locations when feasible
- Install Insulation R4 min
DHW - Recirculation

Building Section - Base Design
Efficient DHW - Recirculation
Internal Heat Gains – End Uses

Building A - Internal Heat Gains (Btu/hr)

- MELs - Dwellings - 31.0%
- People (net) - 15.0%
- Refrigerator - 12.1%
- Lighting - Corridors - 11.3%
- Lighting - Dwellings - 9.2%
- DHW - Recirculation - 5.3%
- Dryer - 5.0%
- Cooking - 4.3%
- Lighting - Other Common - 0.7%
- MELs-Common - 0.1%
- Washer - 0.1%
- Other - 0.2%

Source: SWA PH Modeled Data, 28 Story NYC MF
Recirculation Controls

- Timer Control
- Temperature Control
- Temperature Modulation Control
- Demand Recirculation Control
- Demand + Temperature Modulation Control

Balance the System:
- Include DHW balancing specs
- Include a detail for the riser balancing valves including a check valve
- Show balancing valves on the riser diagram

On a recent 54 story 700 unit building the designer specified 5gpm auto flow balancing valves at each of 25 risers that was served by a 20gpm pump! So all of the water circulated through the first few risers leaving other risers cold.
Codes & Certifications

California leads the way (as usual)

• 2016 California Plumbing Code – IAMPO

• LEED v4 BD+C Homes & Multifamily Mid rise

• DOE Zero Energy Ready Homes

• Water Sense Labeled
Recirculation Controls
Recirculation Controls
Recirculation Controls

Conway Street Water Heating & Recirc

- Recirc. Losses
- Useful Heat

Average Daily Hot Water Load [kBtu]

Month

May 14, Jul 14, Sep 14, Nov 14, Jan 15, Mar 15, May 15, Jul 15, Sep 15, Nov 15, Jan 16, Mar 16, May 16

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Savings Opportunity

Water use in a typical home without Efficient Hardware
72.5 gallons per capita per day

- Toilets: 28%
- Clothes washers: 21%
- Showers: 17%
- Faucets: 15%
- Leaks: 14%
- Baths: 2%
- Dishwashers: 1%
- Other Indoor: 2%
Savings Quantified

How much energy savings can be achieved in multifamily buildings?

• Independent research demonstrates 10 – 30% reduction in water heater gas usage
• 90% reduction in electricity used for pumping
• Cost payback is typically between 0.5 to 2 years
• Demand Recirculation Control
• Demand + Temperature Modulation Control
THE COST OF WATER
THE COST OF WATER

Source: NY Times
THE COST OF WATER

Dollars per 100 cubic feet (748 gallons)

- 2004: $3.94
- 2005: $4.14
- 2006: $4.27
- 2007: $4.69
- 2008: $5.23
- 2009: $5.98
- 2010: $6.76
- 2011: $7.64
- 2012: $8.21
- 2013: $8.78
THE COST OF WATER

• It takes \( \frac{1}{2} \) gallon of water to produce 1 kWh

• To run a 60 watt bulb for 12 hours equates to using 15 gallons of water

Source: Consumptive Water Use for U.S. Power Production
P. Torcellini, N. Long, R. Judkoff, NREL
THE COST OF WATER

Virtual Water Use

- The water used to create the goods and services we consume

53 Gallons = 0.5 Gallons + 1.5 Gallons + 3 Gallons + 48 Gallons +
THE COST OF WATER

Meatless Mondays save water too

- Up to 2700 Gallons!
**THE COST OF WATER**

https://water.usgs.gov/edu/activity-watercontent.html

How much water does it take to grow a hamburger?

**What is the water content of things?**

Water is needed to not only grow everything we eat but also to produce almost all the products we use every day. This water is supplied by nature as precipitation or during the growing and production process. You can’t tell by the size of a product or the appearance of a food how much water was actually used to produce the item.

Use the form below to enter your guess about how much water is used to produce some common foods and products. Please realize this exercise is meant to give you an idea of how much water is needed to produce these items. It is very difficult to come up with accurate water-use numbers, and the large variety of food-growing and production techniques can vary a huge amount, depending on how and where the food is grown.

Yet another consideration is how far back to go in the chain of production to estimate water use. For beef, some estimates only consider drinking water for cattle, while others include the water needed to grow the food that the cow eats.

The data here were taken from two sources:

- The Water Footprint Network

Choose how much water it takes to make/grow:

<table>
<thead>
<tr>
<th>Item</th>
<th>Water Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread (1 pound/.45 kilogram (kg) loaf):</td>
<td>20 gallons</td>
</tr>
<tr>
<td>Chicken: 1 pound (.45 kilogram (kg)):</td>
<td>10 gallons</td>
</tr>
<tr>
<td>Coffee (1 cup):</td>
<td>2 gallons</td>
</tr>
<tr>
<td>Corn (1 pound):</td>
<td>50 gallons</td>
</tr>
<tr>
<td>Eggs (1 egg):</td>
<td>20 gallons</td>
</tr>
<tr>
<td>Hamburger: 1/4 pounder (113 grams):</td>
<td>150 gallons</td>
</tr>
<tr>
<td>An orange:</td>
<td>1 gallon</td>
</tr>
<tr>
<td>Paper (1 sheet):</td>
<td>3 gallons</td>
</tr>
<tr>
<td>Potato (1 pound):</td>
<td>5 gallons</td>
</tr>
<tr>
<td>Cotton shirt: 250 grams:</td>
<td>100 gallons</td>
</tr>
<tr>
<td>Steel (1 pound):</td>
<td>4 gallons</td>
</tr>
<tr>
<td>Wheat (1 pound):</td>
<td>50-100 gallons</td>
</tr>
</tbody>
</table>

Submit
THE COST OF WATER

https://water.usgs.gov/edu/activity-watercontent.html

The Water Content of Things:
How much water does it take to grow a hamburger?

Water is needed not only to grow everything we eat but also to produce almost all the products we use every day. This water is supplied by nature as precipitation or added by people during the growing and production process. You can’t tell by the size of a product the appearance of a particular food how much water was actually used to produce the item.

**Bread, 1 pound (lbs) (.45 kilogram (kg)) loaf:**
Your answer: 79 gallons
Correct answer: About 200 (193) gallons, 731 liters

193 gallons is an estimated global average. Actual production and use of the wheat flour uses 80% of the water.

Source: *Water Footprint*

**Chicken, 1 pound (.45 kg) of meat:**
Your answer: 30 gallons
Correct answer: 500 gallons/pound (1,890 liters/.45 kg)

Water is needed for the chicken to drink and to maintain the chicken house, and for growing the grains that the chicken eats.

Source: *Water Footprint*

**Coffee, 1 cup:**
Your answer: 5 gallons
Correct answer: 3.5 gallons (132 liters)

The world population requires about 120 billion cubic meters of water per year in order to be able to drink coffee. This is equivalent to 1.5 times the annual Rhine River runoff and constitutes 2% of the global water use for crop production.

Source: *Water Footprint*

**Corn, 1 pound (.45 kg):**
Your answer: 50 gallons
Correct answer: 110 gallons (416 liters)

Maize (corn) consumes about 550 billion cubic meters of water annually, which is 8% of global water use for crop production.

Source: *Water Footprint*

**Riggs, 1 egg:**
Your answer: 20 gallons
Correct answer: 50 gallons (189 liters)

Most of the water is required for feeding the chickens.

Source: *Water Footprint*

**Hamburger (beef, in general) (1/4 pound, 113 grams):**
Your answer: 1000 gallons
Correct answer: About 480 gallons for 1/4 pound of beef, or about 1,750 liters per 113 grams

Estimates vary a lot due to different conditions of raising cows. The number also varies depending on how far back in the production chain you go. It takes a lot of water to grow grain, forage, and roughage to feed a cow. Water is also needed for drinking supplies as well as for servicing the cow. Per kilogram of product, animal products generally have a larger water footprint than crops and grains.

Source: *Water Footprint*

**Orange (150 grams):**
Your answer: 12 gallons
Correct answer: 12 gallons (46 liters)

One glass of orange juice (300 ml) takes about 45 gallons (170 liters) of water.

Source: *Water Footprint*

**Paper, sheet:**
Your answer: 3 gallons
Correct answer: 3 gallons (11 liters)

This number has a lot of variation and depends on the source of the wood. Forest evapotranspiration and wood yield vary from forest to forest. The number will likely fall in a range of 1/2 gallon and 8 gallons per sheet (34 sizes).

Source: *Water Footprint*

**Potato:**
Your answer: 10 gallons
Correct answer: 100 gallons (375 liters)

Source: *Water Footprint*

**One cotton shirt:**
Your answer: 250 gallons
Correct answer: 650 gallons (2,495 liters/250 grams shirt)

Of the total water volume, 45% is irrigation water consumed (evaporated) by the cotton plant; 41% is rainwater evaporated from the cotton field during the growing period; and 14% is water required to dilute the wastewater flows that result from the use of fertilizers in the field and the use of chemicals in the textile industry.

Source: *Water Footprint*

**Steel, 1 pound (.45 kg):**
Your answer: 14 gallons
Correct answer: 30 gallons (114 liters)

Source: *The Water Content of Things, Table 15, Guild, 1995*

**Wheat:**
Your answer: 110 gallons
Correct answer: 110-220 gallons (415-846 liters)

Wheat consumes about 750 billion cubic meters of water annually, which constitutes 12% of global water use for crop production.

Source: *Water Footprint*
THE COST OF WATER
THE COST OF WATER
In Summary

Solutions Are Everywhere

- Low flow fixtures
- Efficient irrigation
- Efficiently delivering domestic hot water in central recirc systems requires an efficient layout
- Temperature and flow sensors placed at the source and furthest fixtures means less wasted water in the pipes
- Quantifying savings can help building owners make informed decisions
Thank You

Questions?

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