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High Performance Hot Water: *On the Path to* Deep Energy Reductions - Part 2

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Questions

- Great questions!
- We received more than 40
- Questions appear at the end of each relevant section

Learning Objectives

4. Learn from case studies that apply the principles & technologies discussed in the first webinar

5. Better understand the advantages of a systems approach to reducing water heating energy use

6. Get their questions answered

Thousand Home Challenge

Overview – Deep Reductions

- 70 – 90% reduction
- Identify performance threshold
- One year of measured verifiable use
- Includes efficiency, behavioral choices, community solutions, & renewables

Thousand Home Challenge

Summary of Goal for “Hot Water”

- OPTION A
  - 75% reduction
  - Determine baseline from energy bills
- OPTION B
  - 10 gal/person hot water @ 100% efficiency;
  - 7 gal (3 or more occupants)
  - Consideration of incoming water temp
- Hot Water Budget
  - Gallons/day & system efficiency
- Do We
  - Redeem what exists?
  - Start from scratch?
  - Develop creative solutions?
  - Blend all 3?

Your Instructor

Gary Klein, Affiliated International Management, LLC, provides consulting on sustainability through an international team of affiliates. He has been intimately involved in energy efficiency & renewable energy since 1973. Gary has a passion for hot water: getting into it, getting out of it, & efficiently delivering it to meet customers' needs. In addition to presenting seminars to audiences throughout the United States, Gary has been working to develop better language for codes & standards with the goal of getting all new hot water systems to be "good" by 2015.

Annual Energy Use for Heating Water

	Natural Gas	Electricity
Gallons per Day	60	
Gallons per Year	21,900	
Energy into Water	16.4 Million Btu	
Efficiency	0.6	0.9
Cost per Unit	$1.00/therm	$0.10/kWh
Cost per Year	$275	$535

Assumes hot water is 90º F above incoming cold water. Cost per year has been rounded off.

Add about $130 per year for water & sewer (at $0.006 per gallon combined)

Proportion costs to your fuel & water rates.

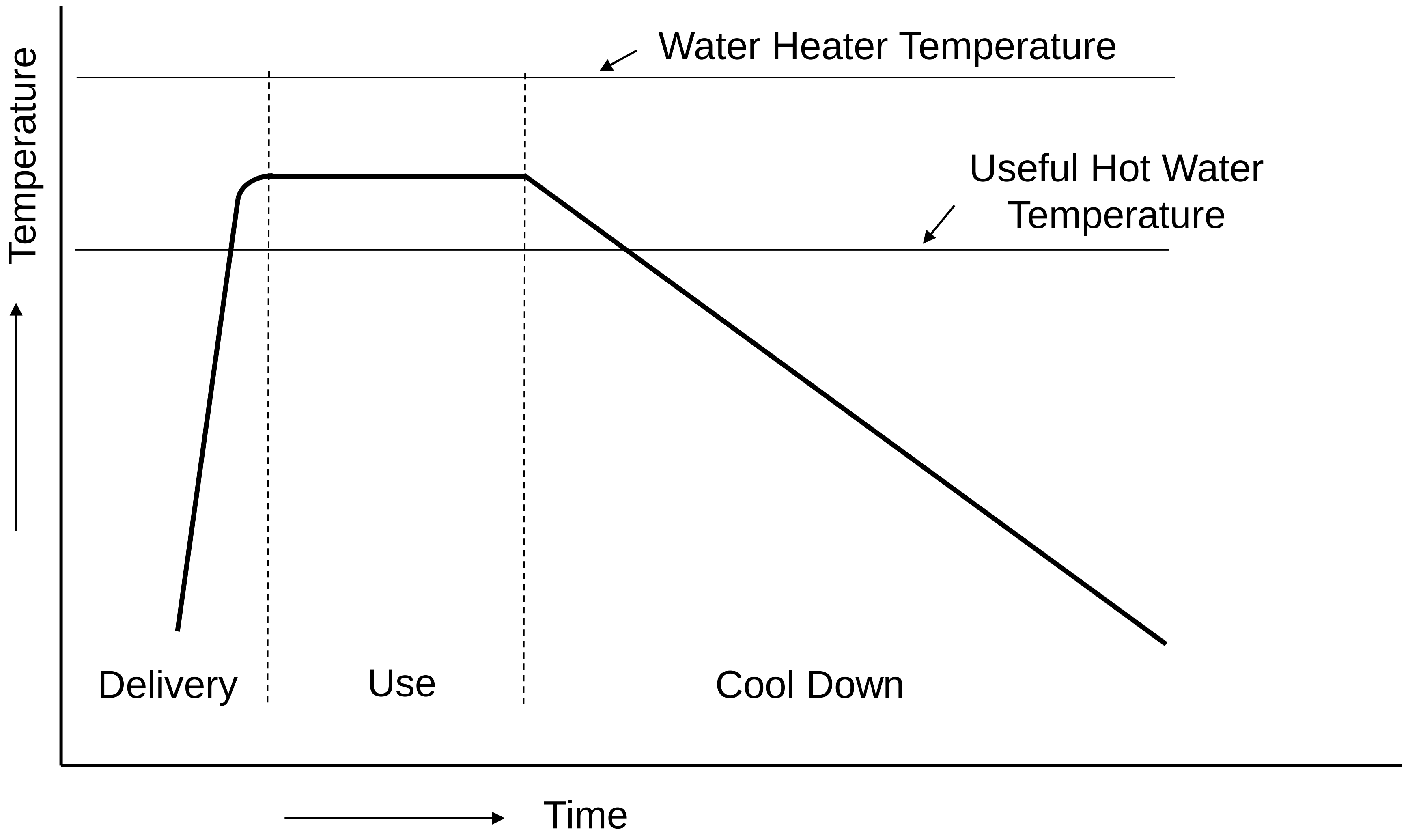
The Hot Water System

- Treatment & Delivery to the Building
- Use in the Building
  - Water Heater
  - Piping
  - Fixtures, Fittings & Appliances
  - Behavior
  - Water Down the Drain
- Waste Water Removal & Treatment

Which is the biggest ***variable*** in determining water & energy use?

How do the ***interactions*** among these components affect ***system*** performance?

Typical Hot Water Event



Remember What People Want

- Hot Water Now = “Instantaneousness”
  - – Need hot water available before the start of each draw
    - A tank with hot water
    - Heated pipes
  - – Need the source of hot water close to each fixture or appliance
  - – Point of Use is not about water heater size, its about location
- Never Run Out in Shower = “Continuousness”
  - – Need a large enough tank or a large enough burner or element
  - – Or, a modest amount of both

Key Strategies

- Wring out the wastes
  - Decrease the volume between source of hot water & the use – instantaneousness
  - Insulate the hot water piping
  - Utilize the waste heat running down the drain
- Improve the water efficiency of the uses
  - Reduce hot water outlet flow rates
  - Reduce the volume of hot water needed for each task
- Combine water & space heating
- Increase the efficiency making hot water
  - Preheat – solar, heat pump, off-peak electric
  - Select one or more very efficient supplemental heaters that work with preheated water to reach the desired temperature & for continuousness

Step 1:
Improve the Hot Water Distribution System

To Improve the Delivery Phase:

Get hotter water sooner by minimizing
the waste of water, energy, & time

- Reduce the volume of water in the pipe
  - Smaller diameter, shorter length
  - As flow rates go down, water waste goes up
- Reduce the number of restrictions to flow
  - Decrease "effective length"
- Increase the flow rate
  - Prime the hot water trunk just prior to use with a demand-controlled pump
- Insulate the pipe
  - Becomes critical for very low flow rates & adverse environmental conditions

Water Waste as a Function of Flow Rate (Really Velocity)

Flow Rate	¾ inch Nominal Diameter Pipe	
	Relative Water Waste Percent	Approximate Velocity Feet per Second
Greater than 4 gpm	Just over 100%	Greater than 3
4 gpm	110%	2.65
3 gpm	120%	1.99
2 gpm	130%	1.33
1 gpm	150%	0.66
0.5 gpm	Roughly 200%	0.33
0.25 gpm	????	0.17

The velocity of 0.5 gpm in ¾ inch nominal pipe
is roughly equivalent to the velocity of
2 gpm in 1.5 inch nominal pipe

Definitions

1. A **Twig** line serves one outlet or appliance.
   – The diameter of the twig should be determined by the flow rate of the outlet or appliance it serves & the pressure drop that will occur due to length, velocity & restrictions to flow (e.g. elbows & tees).
2. A **Branch** line serves more than one twig.
3. A **Trunk** line serves branches & twigs.
4. A **Main** line serves the building.
5. A **Hot Water Location** contains one or more hot water outlets & some cold ones, too.

The Ideal
Hot Water Distribution System

- Has the smallest volume (length & smallest "possible" diameter) of pipe from the source of hot water to the hot water outlet
- Sometimes the source of hot water is the water heater, sometimes a trunk line
- For a given layout (floor plan) of hot water locations the system will have
  - The shortest buildable trunk line
  - Few or no branches
  - The shortest buildable twigs
  - The fewest plumbing restrictions
  - Insulation on all hot water pipes, minimum R-4

The Challenge

Deliver hot water

to every hot water outlet

wasting no more energy

than we currently waste and

wasting no more than 1 cup

waiting for the hot water to arrive

Question

If you want to waste no more than 1 cup
while waiting for hot water to arrive,
what is the maximum amount of water
that can be in the pipe that is not usefully hot?

Answer

1 cup = 8 ounces = 1/16th gallon = 0.0625 gallon

Question

If you want to waste no more energy than you would have wasted waiting for hot water to arrive while running water down the drain, how much energy can any alternative consume?

Answer

No more than was originally wasted!

Length of Pipe that Holds 8 oz of Water

	3/8" CTS	1/2" CTS	3/4" CTS	1" CTS
	ft/cup	**ft/cup**	**ft/cup**	**ft/cup**
"K" copper	9.48	5.52	2.76	1.55
"L" copper	7.92	5.16	2.49	1.46
"M" copper	7.57	4.73	2.33	1.38
CPVC	N/A	6.41	3.00	1.81
PEX	12.09	6.62	3.34	2.02
Ave	**8 feet**	**5 feet**	**2.5 feet**	**1.5 feet**

Gallons Wasted as a Function of Time and Fixture Flow Rate

(Green < 2 cups), Red >1/2 Gallon)

Time Until Hot Water Arrives (Seconds)

Flow Rate (GPM)	1	2	3	4	5	10	15	20	25	30	35	40	45	50	55	60
0.5	0.01	0.02	0.03	0.03	0.04	0.08	0.13	0.17	0.21	0.25	0.29	0.33	0.38	0.42	0.46	0.50
1	0.02	0.03	0.05	0.07	0.08	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.83	0.92	1.00
1.5	0.03	0.05	0.08	0.10	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	1.13	1.25	1.38	1.50
2	0.03	0.07	0.10	0.13	0.17	0.33	0.50	0.67	0.83	1.00	1.17	1.33	1.50	1.67	1.83	2.00
2.5	0.04	0.08	0.13	0.17	0.21	0.42	0.63	0.83	1.04	1.25	1.46	1.67	1.88	2.08	2.29	2.50
3	0.05	0.10	0.15	0.20	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
3.5	0.06	0.12	0.18	0.23	0.29	0.58	0.88	1.17	1.46	1.75	2.04	2.33	2.63	2.92	3.21	3.50
4	0.07	0.13	0.20	0.27	0.33	0.67	1.00	1.33	1.67	2.00	2.33	2.67	3.00	3.33	3.67	4.00
4.5	0.08	0.15	0.23	0.30	0.38	0.75	1.13	1.50	1.88	2.25	2.63	3.00	3.38	3.75	4.13	4.50
5	0.08	0.17	0.25	0.33	0.42	0.83	1.25	1.67	2.08	2.50	2.92	3.33	3.75	4.17	4.58	5.00
5.5	0.09	0.18	0.28	0.37	0.46	0.92	1.38	1.83	2.29	2.75	3.21	3.67	4.13	4.58	5.04	5.50
6	0.10	0.20	0.30	0.40	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00
6.5	0.11	0.22	0.33	0.43	0.54	1.08	1.63	2.17	2.71	3.25	3.79	4.33	4.88	5.42	5.96	6.50
7	0.12	0.23	0.35	0.47	0.58	1.17	1.75	2.33	2.92	3.50	4.08	4.67	5.25	5.83	6.42	7.00
7.5	0.13	0.25	0.38	0.50	0.63	1.25	1.88	2.50	3.13	3.75	4.38	5.00	5.63	6.25	6.88	7.50
8	0.13	0.27	0.40	0.53	0.67	1.33	2.00	2.67	3.33	4.00	4.67	5.33	6.00	6.67	7.33	8.00
8.5	0.14	0.28	0.43	0.57	0.71	1.42	2.13	2.83	3.54	4.25	4.96	5.67	6.38	7.08	7.79	8.50
9	0.15	0.30	0.45	0.60	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50	8.25	9.00
9.5	0.16	0.32	0.48	0.63	0.79	1.58	2.38	3.17	3.96	4.75	5.54	6.33	7.13	7.92	8.71	9.50
10	0.17	0.33	0.50	0.67	0.83	1.67	2.50	3.33	4.17	5.00	5.83	6.67	7.50	8.33	9.17	10.00

1 cup = 8 ounces = 1/16th gallon = 0.0625 gallon

Cups Wasted as a Function of Time and Fixture Flow Rate

(Green < 2 cups), Red >1/2 Gallon)

Time-to-Tap (Seconds)

Flow Rate (GPM)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.25	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93	1.0
0.5	0.13	0.27	0.40	0.53	0.67	0.80	0.93	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0
0.75	0.20	0.40	0.60	0.80	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
1	0.27	0.53	0.80	1.1	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.0
1.25	0.33	0.67	1.0	1.3	1.7	2.0	2.3	2.7	3.0	3.3	3.7	4.0	4.3	4.7	5.0
1.5	0.40	0.80	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0
1.75	0.47	0.93	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7	5.1	5.6	6.1	6.5	7.0
2	0.53	1.1	1.6	2.1	2.7	3.2	3.7	4.3	4.8	5.3	5.9	6.4	6.9	7.5	8.0
2.25	0.60	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4	9.0
2.5	0.67	1.3	2.0	2.7	3.3	4.0	4.7	5.3	6.0	6.7	7.3	8.0	8.7	9.3	10.0

<u>Cups</u> Wasted as a Function of Time and Fixture Flow Rate

(Green < 2 cups), Red >1/2 Gallon)

Time-to-Tap (Seconds)

Flow Rate (GPM)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.25	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93	1.0
0.5	0.13	0.27	0.40	0.53	0.67	0.80	0.93	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0
0.75	0.20	0.40	0.60	0.80	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
1	0.27	0.53	0.80	1.1	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.0
1.25	0.33	0.67	1.0	1.3	1.7	2.0	2.3	2.7	3.0	3.3	3.7	4.0	4.3	4.7	5.0
1.5	0.40	0.80	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0
1.75	0.47	0.93	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7	5.1	5.6	6.1	6.5	7.0
2	0.53	1.1	1.6	2.1	2.7	3.2	3.7	4.3	4.8	5.3	5.9	6.4	6.9	7.5	8.0
2.25	0.60	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4	9.0
2.5	0.67	1.3	2.0	2.7	3.3	4.0	4.7	5.3	6.0	6.7	7.3	8.0	8.7	9.3	10.0

"Future Proof" the Hot Water Distribution System

Possible Solutions

A. Central plumbing core
   - Only if all hot water outlets are within 1 cup of one water heater. Unlikely without shift in perceptions of floor plans.

B. 1 water heater for every hot water fixture
   - More expensive to bring energy to the water heaters than it is to bring plumbing. Then you have the additional cost for the heaters, flues, & space. Not to mention the future maintenance.

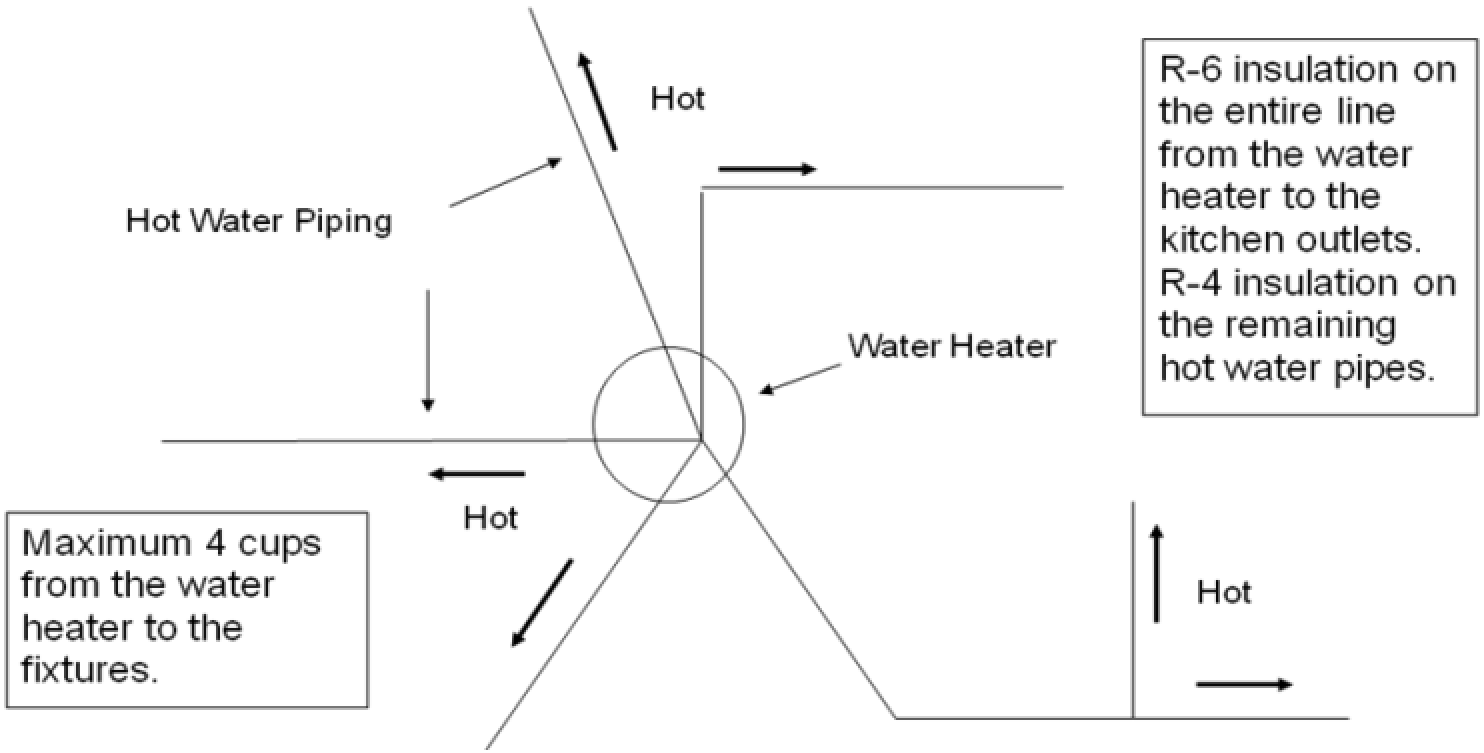
C. 2-3 water heaters per home
   - Same as above. Might make sense in buildings with distant hot water outlets & very intermittent uses.

D. Heat trace on the pipes
   - Long, skinny, under insulated water heater. Expensive to install. Great on water conservation. Competitive in certain applications, otherwise can be very expensive on energy.

E. Circulation loop 1 cup from every hot water fixture
   - Most buildable option. All circulation systems can save water, only one can save energy.

Central Plumbing Core

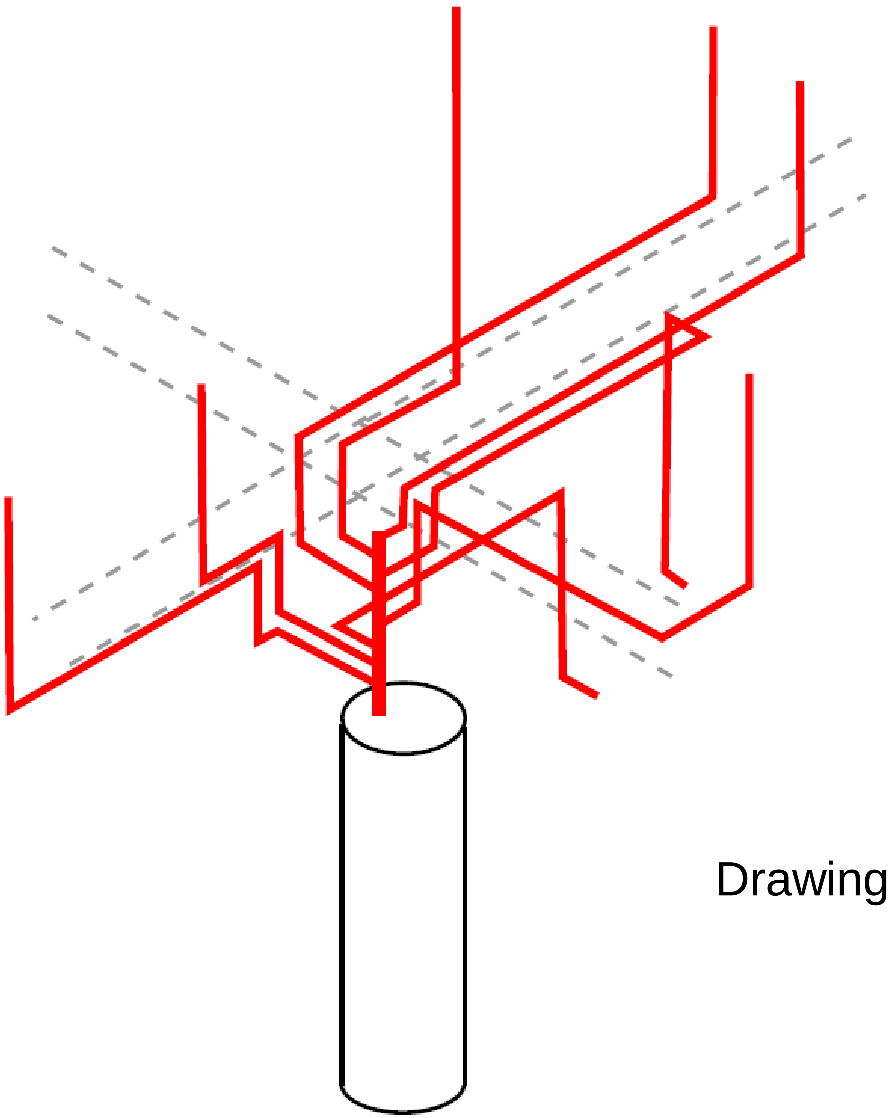
Radial, Manifold, Parallel Pipe



Follows Green Point Rated Rating Manual January 2010

1- Quart Hot Water Distribution System

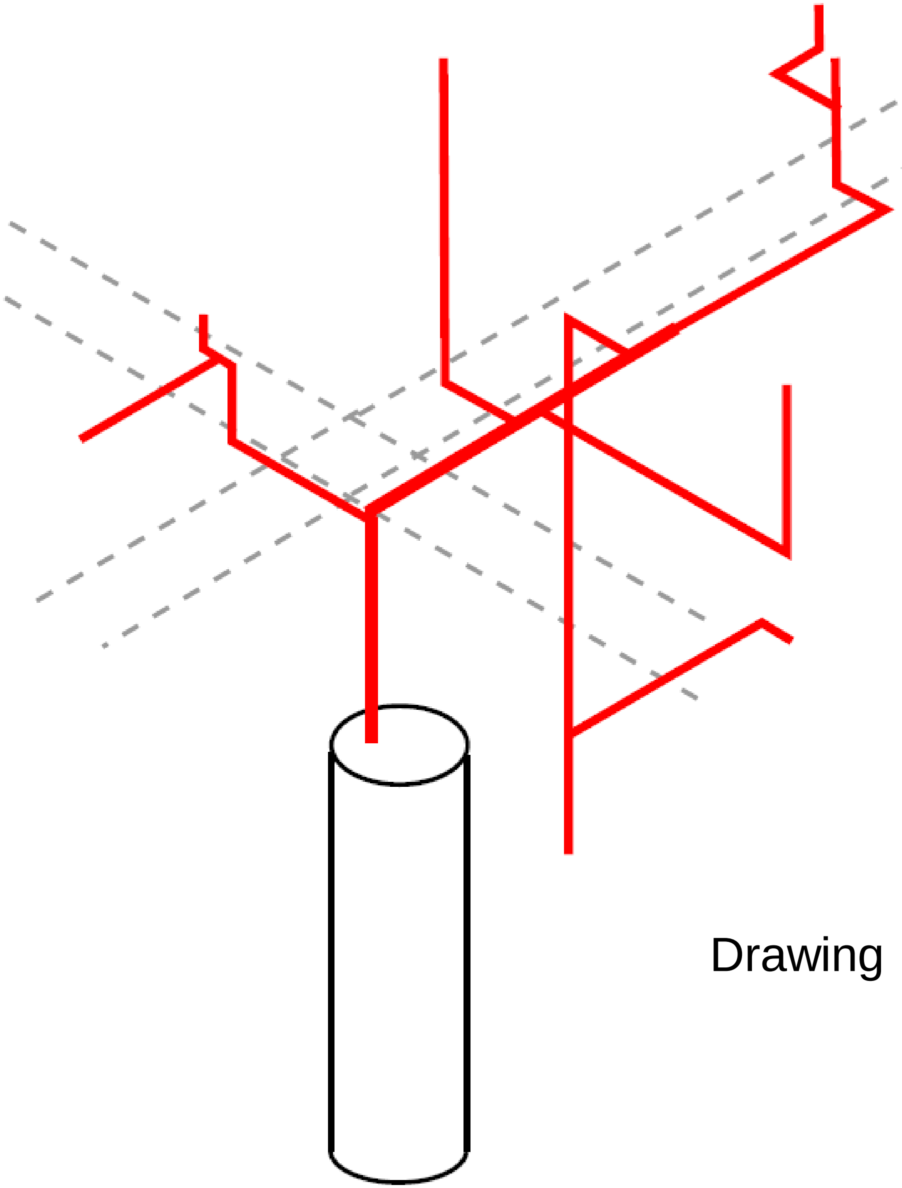
Short Trunk – Long Twig



Drawing by Anne Hess

1- Quart Hot Water Distribution System

Long Trunk – Short Twig



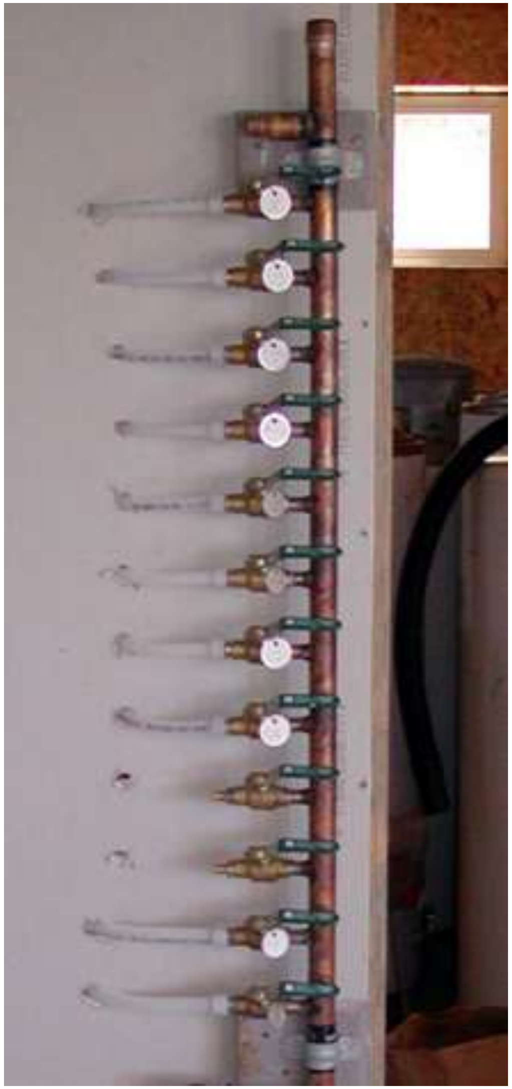
Drawing by Anne Hess

Central Plumbing Core

Copper-to-PEX Manifold

Manifold can be located very close to the water heater. The trunk line is very short.

One manifold for the hot fixtures, another for the cold fixtures.



Separate ball valves for each individual line.

Individual twig lines are 3/8 inch nominal pipe diameter.

Structured Plumbing

Circulation loop located close to the fixtures & appliances

- Fully-heated or half-heated loop, with dedicated or cold-water return line, depending on floor plan

Small volume twig lines

- No larger than ½ inch diameter
  - May need larger diameter for high flow rate fixtures & appliances
- No more than 10 plumbing feet long - 2 cups volume
  - Some exceptions: garden tubs, washing machines, island & peninsula sinks

Demand-controlled pumping system

- Wired or wireless buttons or motion sensors
- Activate the pump to "prime (or preheat) the insulated line"
- Pump shuts off automatically, usually in much less than a minute

Insulation on all hot water pipes

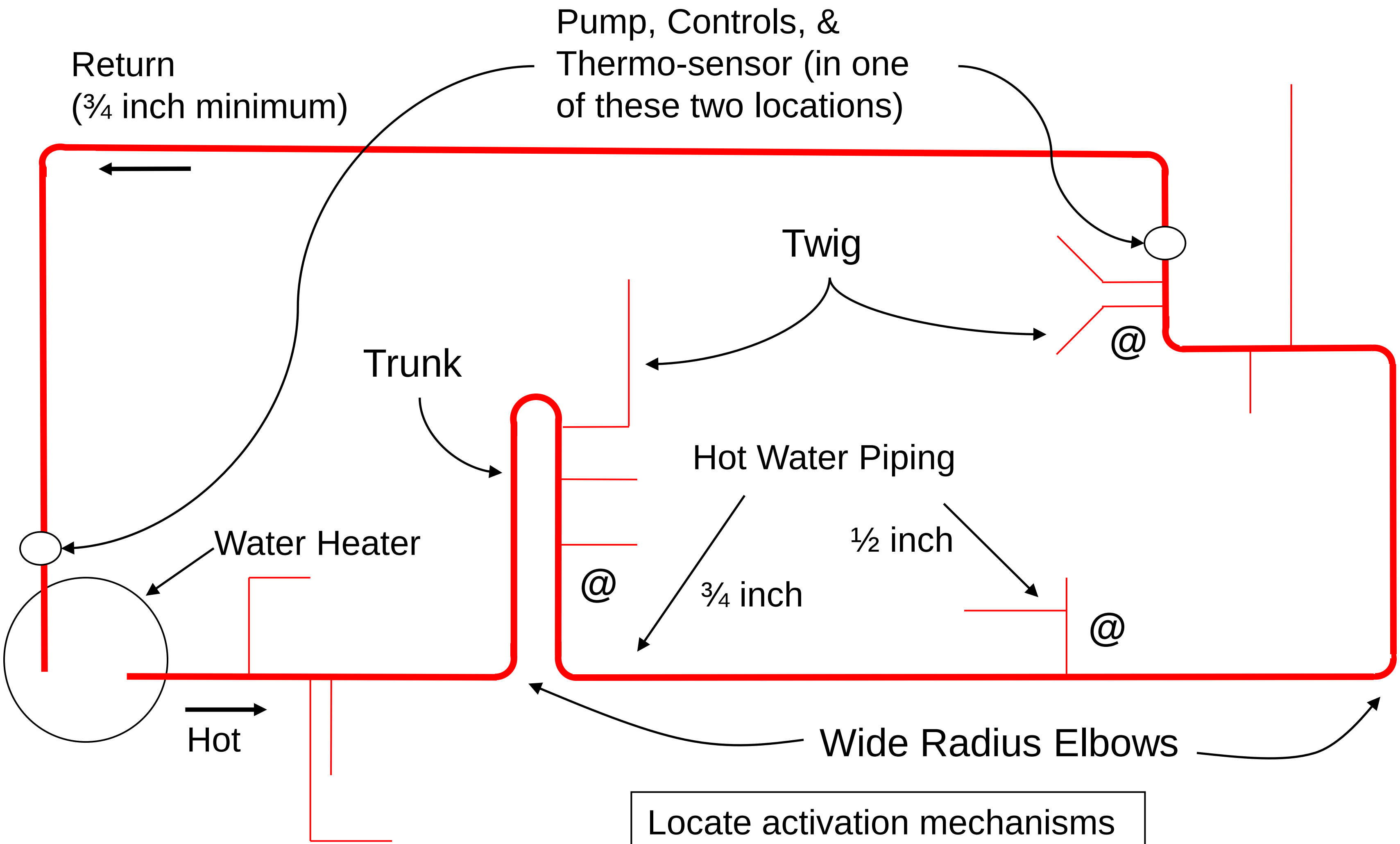
- R-6 on the loop & to the kitchen fixtures. R-4 on all other pipes
- Water in pipes stays hot 30-60 minutes after last hot water event

Benefits:

- Minimizes the waste of water, energy, & time
- The most flexible & cost effective solution for today's floor plans – high customer satisfaction

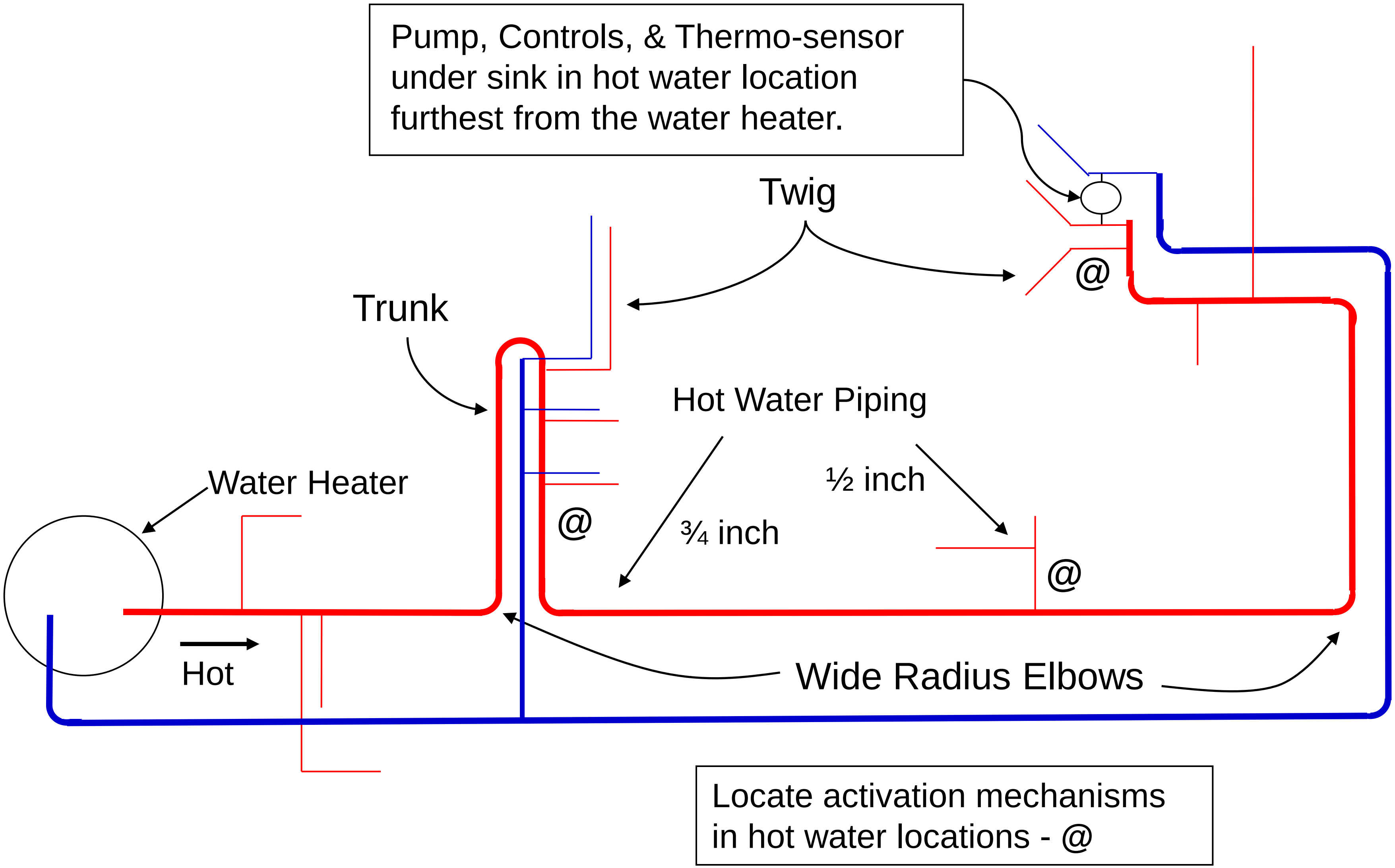
Structured Plumbing Layout

Using a Dedicated Return Line



Locate activation mechanisms in hot water locations - @

Structured Plumbing Layout
Using the Cold Water Trunk Line as the Return



Hot Water Circulation Systems

Recirculating Hot Water Systems

There are six types of recirculation systems

- Thermo-syphon (gravity convection with no pump)
- Continuously pumped
- Timer controlled
- Temperature controlled
- Time & temperature controlled
- Demand controlled

Given the same plumbing layout,
all of these systems will waste the same amount
of water at the beginning of a hot water event.

The difference in these systems
is in the ***energy*** it takes to keep the trunk line
primed with hot water.

Operating Costs of Circulation Loops

- Pump
- Heat loss in the loop
- Maintenance
  - Failure of the pump
  - Incorrect control settings
  - Pipe leaks
- 90% of the cost is from heat loss in the loop, 10% is from the pump operation

Determination of Heat Loss in Circulation Loops

- You could measure the pipe lengths, diameters, insulation & environmental conditions. & calculate the heat loss, if you can get to all of it!

- Or you could measure flow rate & the difference in temperature between the water leaving from, & returning to the water heater.

Heat Loss in Circulation Loops –

Calculation for Loop Losses Only

Sample Calculation: 1 gpm & 1^{o}F temperature drop

- Energy = m* c_p* (T_{hot}-T_{return})=Btu
- 1 gpm * 8.33 pounds per gallon * 1 * 60 minutes per hour * 1^{o}F = 500 Btu/hour/^{o}F

Natural Gas Water Heater

- 500   0.75 efficiency = 667 Btu/hour/^{o}F
- 667   100,000 Btu/Therm = 0.00667 Therm/hour/^{o}F
- 0.00667 * $1.00/Therm = $0.00667/hour/^{o}F

Electric Water Heater

- 500   0.98 efficiency = 510 Btu/hour/^{o}F
- 510   3,412 Btu/kWh = 0.15 kWh/hour/^{o}F
- 0.15 * $0.10/kWh = $0.015/hour/^{o}F

Note, if the heat loss is 10º F, then the cost is 7 cents an hour… not much but for a year it is $613!.

Annual Energy Use for a Circulation System Attached to a Gas Water Heater (Therms)

Continuous Pumping at 1 Gallon Per Minute				
	Temperature Drop in ^{o}F			
Days	**1**	**5**	**10**	**20**
1	0.16	0.80	1.60	3.20
30	5	24	48	96
365	58	292	584	1,168
Pump Flow Rate in Gallons Per Minute				
1	58	292	584	1,168
5	292	1,460	2,920	5,840
10	584	2,920	5,840	11,680
Steady state heat transfer efficiency is assumed to be 75%.				

Electrical energy to operate the pump is additional

Annual Energy Use for a Circulation System Attached to an Electric Water Heater (kWh)

Continuous Pumping at 1 Gallon Per Minute				
	Temperature Drop in ^{o}F			
Days	**1**	**5**	**10**	**20**
1	3.60	18.00	36.00	72.00
30	105	525	1,050	2,100
365	1,278	6,388	12,775	25,550
Pump Flow Rate in Gallons Per Minute				
1	1,278	6,388	12,775	25,550
5	6,388	31,938	63,875	127,750
10	12,775	63,875	127,750	255,500
Steady state heat transfer efficiency is assumed to be 98%.				

Electrical energy to operate the pump is additional

When Do You Not Want to Operate a Hot Water Circulation Pump?

- When you don't need hot water
  - When you aren't there
  - When you are sleeping or doing something else
- When you are using hot water

The only time you want to operate the pump is just before you need hot water.

Use Demand Controlled Circulation

- The pump will run less than ½ hour per day
  - The most energy efficient option

Retrofits of Circulating Pumps

Two basic types are commercially available

- “Push” systems with the pump on the hot (outbound) water line
- “Pull” systems with the pump located under a sink at the hot water location furthest from the water heater

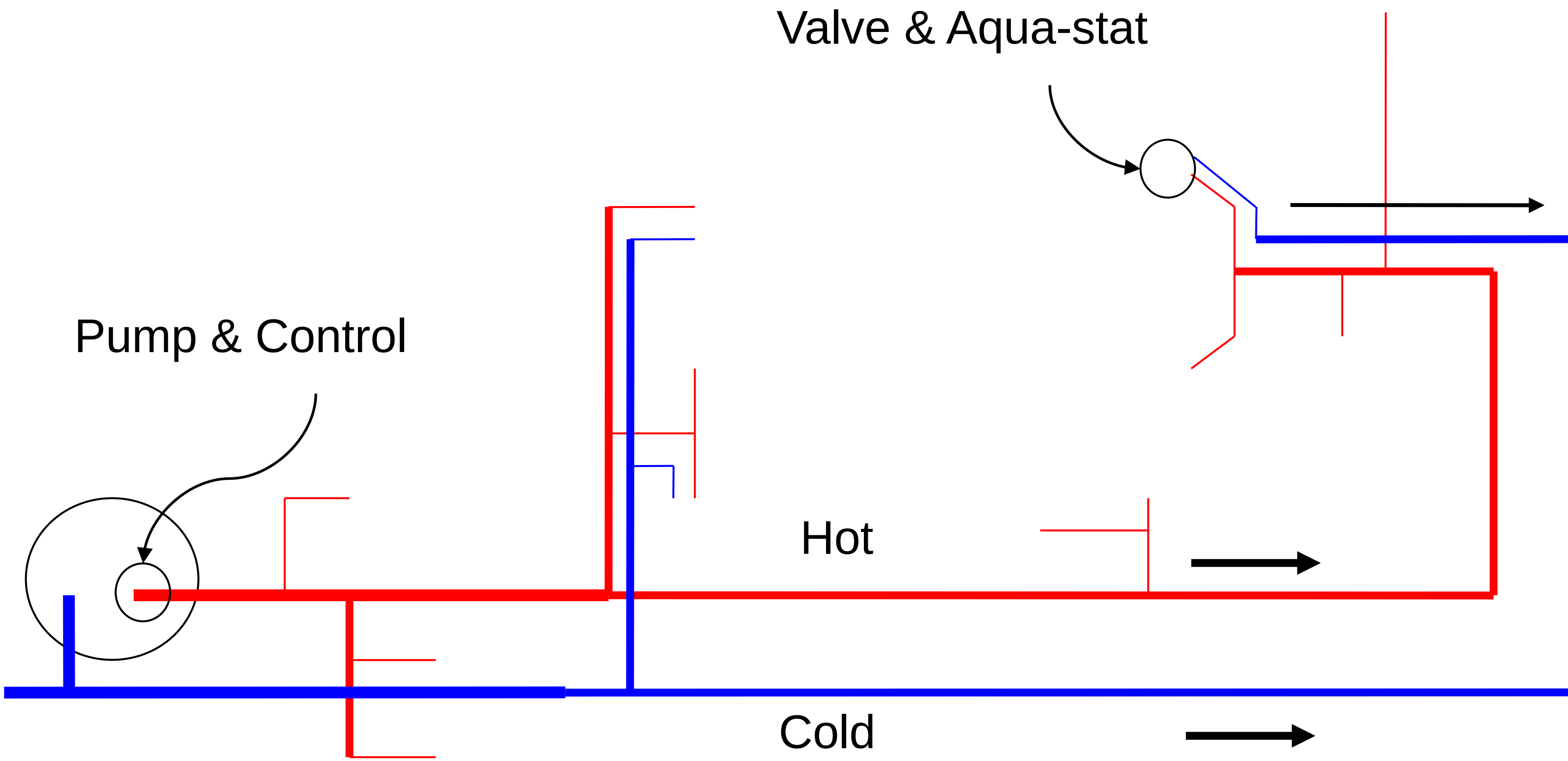
Two control strategies too

- Time & temperature
- Demand controlled

The most efficient is demand controlled (pull)

- On trunk, branch, & twig systems & on manifold systems to save water & energy
- On dedicated recirculation systems to save energy

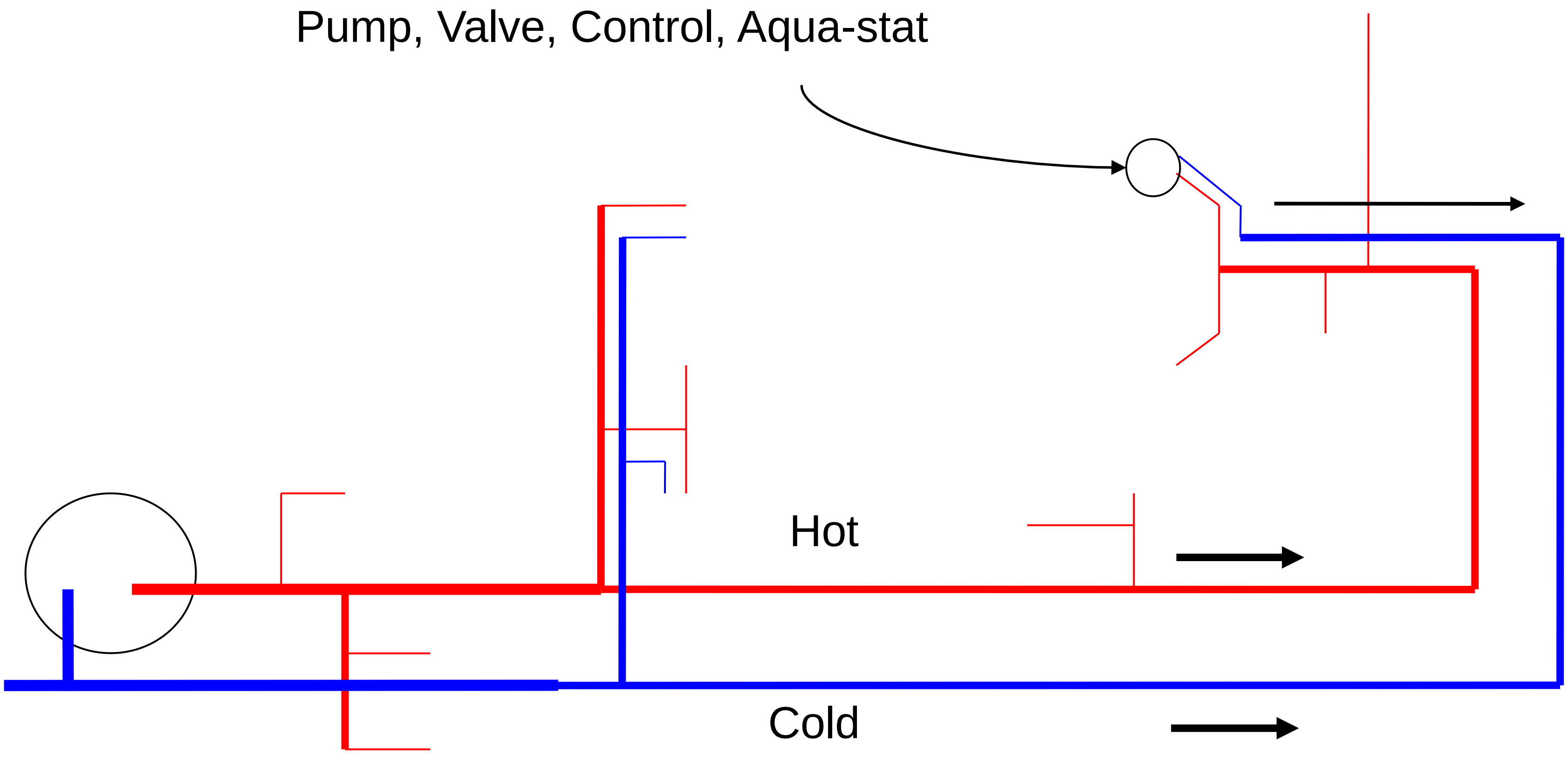
Time & Temperature Controlled Pumping System – "Push" (Grundfos)



Time & Temperature Controlled Pumping System – "Push"

- Pump & control (timer) located at water heater
- Timer controls hours of operation of pump
- Whenever timer is on, pump "pushes" hot water out to fixtures. It returns to the water heater through the cold water line
- Valve & aqua stat allow for "cross-over" during many hours of the day
- Do not really get hot water to the fixtures
- Have lukewarm water in both hot & cold water lines. Still need to waste hot water waiting for it to get hot. Also need to drain cold water line to get cold water.
- Need to place the valve & aqua stat at the worst fixture

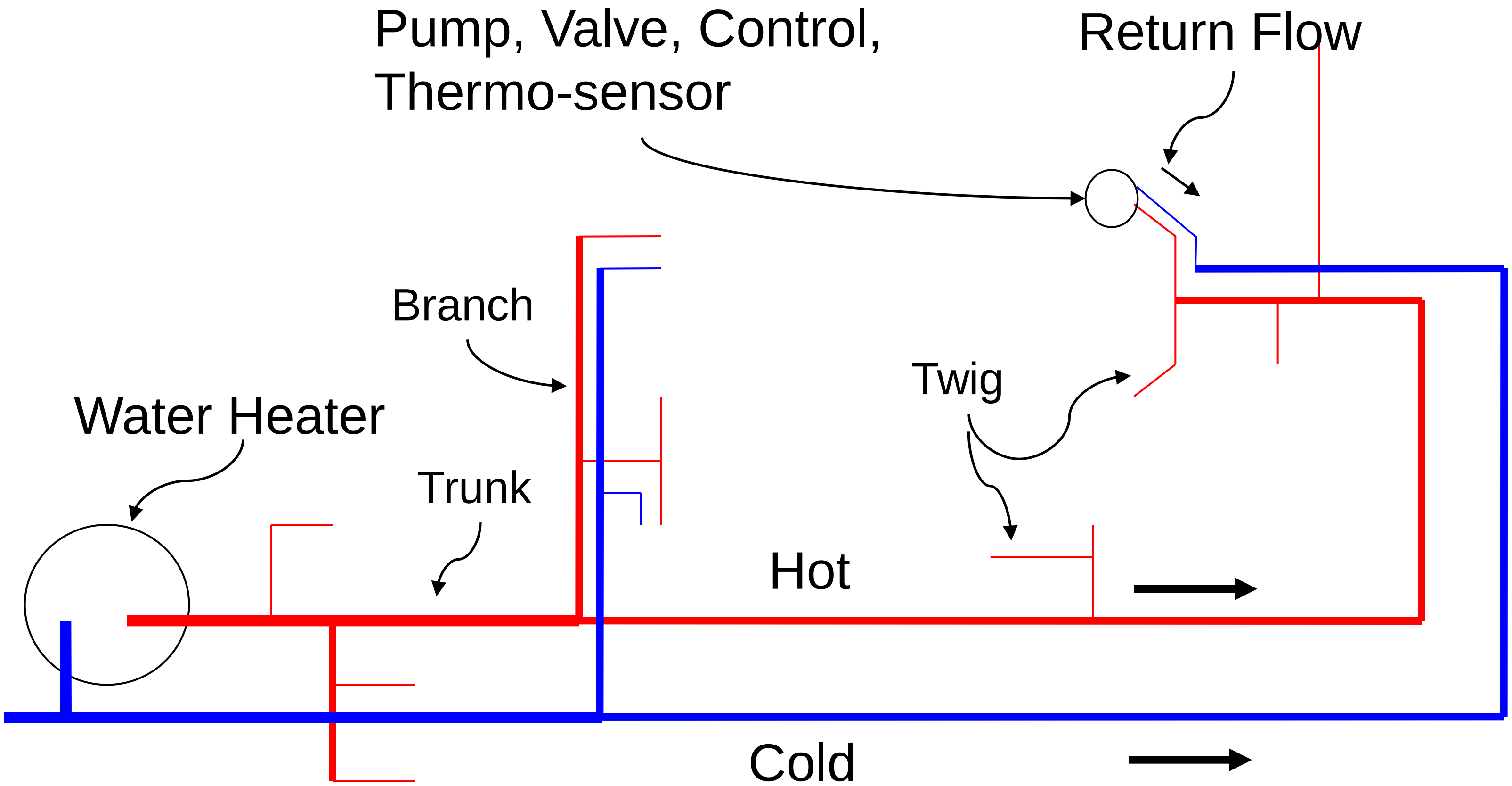
Time & Temperature Controlled Pumping System – "Pull" (Laing)



Time & Temperature Controlled Pumping System – “Pull”

- Pump, valve, control (timer), & aqua stat located at furthest fixture
- Timer controls hours of operation of pump
- Whenever timer is on, pump “pulls” hot water from the water heater & “pushes” water back to the water heater using the cold water line
- Valve & aqua stat allow for “cross-over” during many hours of the day
- Do not really get hot water to the fixtures
- Have lukewarm water in both hot & cold water lines. Still need to waste hot water waiting for it to get hot. Also need to drain cold water line to get cold water.
- Can put an additional system at each problem fixture

Demand Controlled Pumping System – "Pull" (Metlund, Taco, Wirsbo)



Demand Controlled Pumping System

- Pump, valve, control (electronic), & thermo-sensor are located at the fixture furthest from the water heater
- Demand actuated (button, remote, flow sensor, occupancy sensor, energy management system)
- Once activated, the pump “pulls” hot water from the water heater & “pushes” water back to the water heater using the cold water line
- The thermo-sensor closes the valve & shuts off pump whenever it sees a small (5-10^{o}F) rise in temperature at the pump
- Hot water gets to the furthest fixture (and to others on the same main line) quickly
- Hot water never crosses over to the cold water line. If the ambient temperature of the pipes is 70^{o}F, then the pump shuts off at 75-80^{o}F.
- Can put an additional system at each problem fixture

To Improve the Use Phase

Minimize the thermal losses the water heater needs to overcome in the piping during a hot water event

- Insulate the pipes
  - Increases pipe temperature & reduces heat loss during a hot water event
    - Particularly important for low flow rate outlets
  - Temperature drop over a given distance for a given flow rate is cut roughly in half (**pipes in air**)
    - Uninsulated: ≈ 6ºF in 100 feet of ¾ inch pipe
    - Insulated: ≈ 3ºF in 100 feet of ¾ inch pipe
  - Much larger reductions for buried pipe
- Take advantage of the energy savings
  - Keep the water heater temperature the same & change the mix point
  - Reduce the water heater temperature setting.
  - Combine both strategies.

To Improve the Cool-Down Phase

Increase the availability of hot water &
minimize the waste of water, energy & time

Insulate the pipes

- Increases the time pipes stay hot between events
  - On ½ inch pipe in room temperature air R-4 insulation
    - Doubles cool down time
    - ≈ 10 minutes (uninsulated) to 20 min (insulated)
  - On ¾ inch pipe in room temperature air R-4 insulation
    - Triples cool down time
    - ≈ 15 minutes (uninsulated) to 20 min (insulated)
  - What will it be with 3/8 inch? 1 inch? 2 inch?
  - Buried piping – cool-down is 8 times longer (5 to 40 min)

Is there a priority to insulating the pipes?

- Trunks, branches, twigs?
- Duration of hot water events?
- Time between hot water events?

Questions

- What is status of revising codes for minimum pipe diameters? Current minimums?
- Home run systems (generally PEX) have the perception of being green & efficient. Is this true?
- Recirculation
  - Is there a rule of thumb to determine when such systems are energy efficient?

Questions

- What is the better piping material – copper, PEX, CPVC, stainless?
- How bad is it, really, to put uninsulated hot water piping in or under a slab?
- In existing houses, it may not be practical to implement some structural recommendations, such as replacing pipes. How can we prioritize the list of recommendations?

Step 2:
Improve the Water Use Efficiency of the Hot Water Outlets

Questions

- What is the relative efficiency of booster heaters in dishwashers & washing machines?
  - Cold water feed only?
  - Distance from main water heater?
  - Reduce temperature of main water heater?
  - What if I have solar (or other) pre-heat?
  - What temperatures do I need to clean the dishes? Clothes?
- Which is more efficient – hand-washing dishes or using a dishwasher?

Questions

- What about using valves at the showerhead to control flow rate?
  - On – off during shower?
  - Reduce or increase flow during use?
  - Shower Start?

Step 3:
Capture Waste Heat from the Drains

Questions

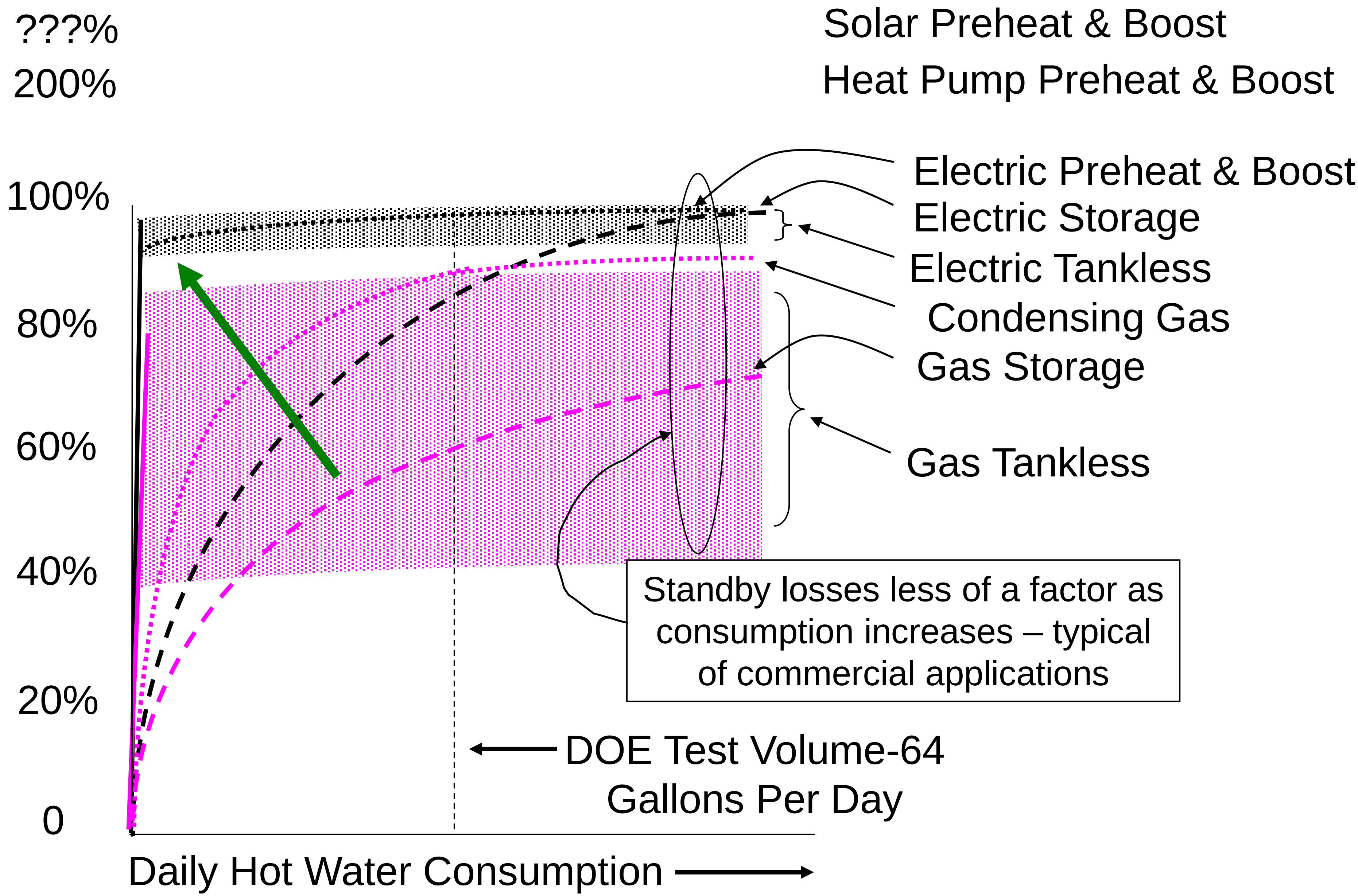
- Drain Water Heat Recovery
  - How much benefit does it provide?
  - What are the best applications?
  - Are there any that work horizontally?
  - Does it make sense to insulate?

Step 4:
Increase Water Heater Efficiency

What About Solar Water Heating?

- Back-up
  - Will you have a back-up?
  - What are your expectations for cloudy days?
  - How does the back-up handle almost-hot-enough pre-heated water?
    - 0.25 gpm, 1ºF temperature rise = 125 Btu
- Solar Fraction
  - Combined Water & Space Heating
- Cost
- Maintenance
- Simple Solar

Relative Efficiency of Water Heaters



Questions

- Assuming goal is high performance over a wide range of hot water use & operating conditions, how do we select equipment when data on performance under varying load conditions is not available?

Questions

- Tankless Gas Water Heaters
  - Why is their rated efficiency as high as it is?
  - Am I correct that tankless uses more Btu per gallon than a 50-gallon tank?
  - How can it be efficient to use a tankless water heater for hydronic heating or recirculation?
  - How do they work with pre-heat systems?
    - Solar?
    - Drain Water Heat Recovery?

Questions

- How do we integrate solar (thermal) into a high performance system?
  - Stand-alone water heating?
  - Combined with space conditioning?
  - Simple solar?
- Combined water heating & space conditioning systems
  - Navien combi system?
  - Integrated with solar (thermal)
    - What temperature for solar storage?

Questions

- Air Source Heat Pump Water Heaters
  - Can they replace a dehumidifier?
  - Can they be a heat sink & help air condition?
  - How can we make them operate most efficiently?
  - What are the climate zone considerations?
- Are there any tankless electric water heaters that play well with a pre-heat solar system?

Questions

- Pre-heat & boost strategy
  - Does this increase the rate of growth of legionella?
  - Why only electric?
  - Why not very high storage temperatures & off-peak heating into an extremely well insulated tank?
- Ground Source Heat Pumps
  - Using a desuperheater
- What about desuperheaters off of an AC system?

Questions

- If I have gas & a high efficiency boiler, should I use a small well-insulated boiler-mate tank(15-20 gallon) with large diameter pipe from the boiler for fast recharge? Sort of like tank & tankless?
- Solar Thermal
  - Do you have any recommendations for inexpensive flow indicators? Flow meters? Flow plus temperature? Overall hot water energy delivered metering or monitoring?

Summary

Questions

- How do I disaggregate hot water from my energy bills (gas, electric, propane)?
- How low can we go?
  - With efficiency?
  - With radical changes in behavior?

Questions

- What are the best, most accurate sources of information about residential water heating systems?
- What are biggest “aha’s” that you have had that have changed your perceptions of the opportunities for improving hot water systems?

ACI Resources

Information about the Thousand Home Challenge:

www.ThousandHomeChallenge.org

Introduction to the Thousand Home Challenge Webinars:

Friday, July 30, 2010 – 11-12:30 (Eastern time)

Friday, August 6, 2010 – 1-2:30 (Eastern time)

Contact: Linda Wigington - lwigington@affordablecomfort.org

Information about upcoming ACI events

www.affordablecomfort.org

Additional Resources on Water Heating

www.ThousandHomeChallenge.org

Select "Resources" for:

Gary Klein's articles on high performance hot water

http://www.aceee.org/conferences/2010/hwf

ACEEE 2010 Hot Water Forum Presentations

Gary Klein

Affiliated International Management, LLC

916-549-7080 gary@aim4sustainability.com

PG&E's Fall 2010 Classes

related to Deep Energy Reductions in existing homes

For a complete schedule: www.pge.com/energyclasses

- **High Performance Residential Hot Water Systems,** by Gary Klein
  - Wed Oct 20, Napa
  - Fri Nov 5, Sacramento
  - Mon Dec 6, San Francisco

- **Air Sealing & Insulating Existing Homes**, by Gavin Healy
  - Tues Oct 5, Stockton + simulcast   Fri Nov 12, Oakland

- **HVAC for Home Performance Contractors**, by Dan Perunko
  - Fri Oct 15, San Jose   Tue Nov 9, Napa

- **Go Ductless California, Try Mini-Splits**, by Dick Rome
  - Thu Oct 7, Stockton

- **Planning a Zero Energy New or Existing Homes in CA**, Danny Parker
  - Thu Oct 14, Pismo Beach   Fri Oct 15, Bakersfield

Thanks for Participating!

Thanks to Pacific Gas & Electric Company's

Energy Training Center

NEXT WEBINAR IN THIS SERIES:

Analyzing Electricity Use: A Critical Step Toward Deep Energy Reductions

August 10, 2010   9 -10:30 AM (Pacific Time)

To register:

http://www.affordablecomfort.org/thc/thcwebinar1.html

www.ThousandHomeChallenge.org