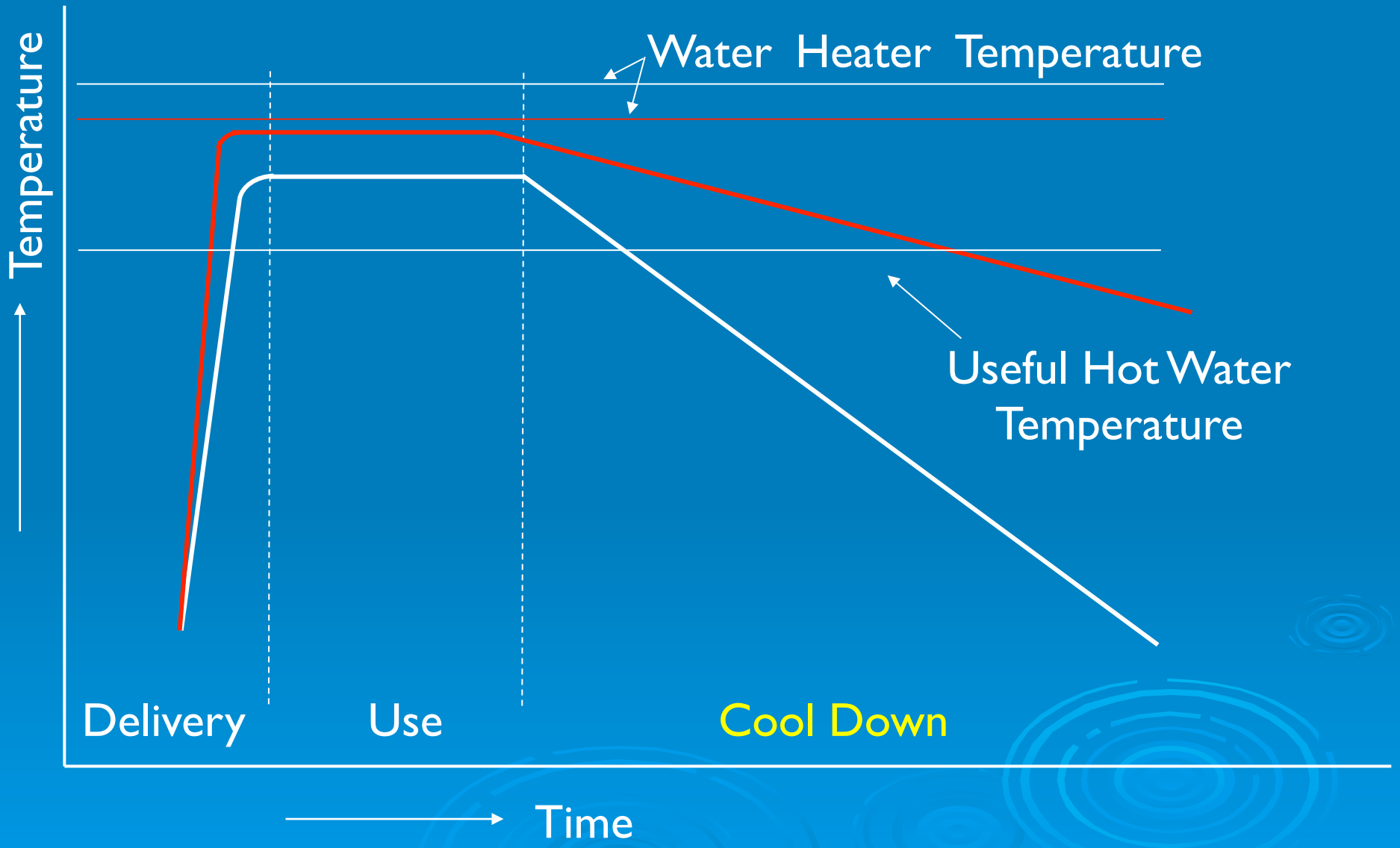
To improve the use phase:

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

- Insulate the pipes
  - Increases pipe temperature and reduces heat loss during a hot water event. This is particularly important for low flow fixtures and appliances.
- Take advantage of the energy savings:
  - Keep the water heater temperature the same and change the mix point
  - Reduce the water heater temperature setting.
  - Combine both strategies.

Improved Hot Water Event



To improve the cool-down phase:

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

Insulate the pipes

- Increases the time pipes stay hot between events.
- R-4 insulation doubles cool down time with ½ inch pipe, triples it with ¾ inch pipe.

Structural Waste

- Even if we improve the hot water event, we still have the structural waste while waiting for hot water to arrive at the fixture!
- To have a high performance hot water system, we must minimize the wait at the fixture.

Possible Solutions for the Structural Waste

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

B. 1 water heater for every hot water fitting
   - 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, and 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 locations and very intermittent uses.

D. Heat trace on the pipes
   - Long, skinny, under insulated water heater. Expensive to install. Great on water conservation. Very expensive on energy.

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

Recirculating Hot Water Systems

There are six types of recirculation systems:

- Thermosyphon (gravity convection with no pump),
- Continuously pumped systems,
- Timer controlled,
- Temperature controlled,
- Time and temperature controlled, and
- 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 percent of the cost is from heat loss in the loop, 10 percent is from the pump operation

Conventional Recirc Loops

- Can easily double or triple hot water energy costs.
- Timers can help but:
  - Six hours a day is still 25% of the energy loss with continuous operation
  - Timers are often disabled
  - Conventional recirc loops are not easy to add to existing homes.

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

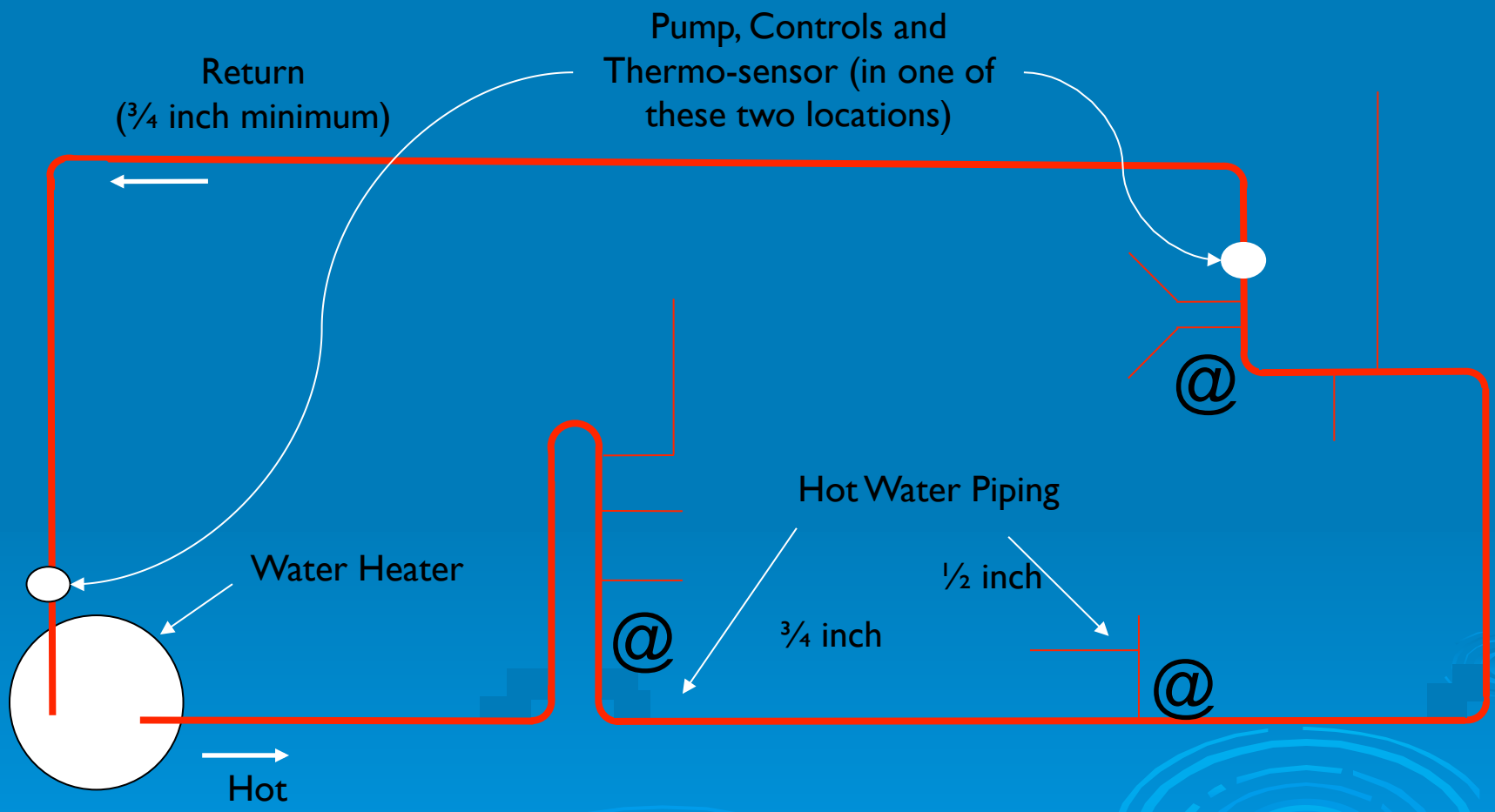
- The pump will run less than ½ hour per day
- The most energy efficient option.

Demand Controlled Pumping System

- Pump, Valve, Control (electronic) and 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 and “pushes” water back to the water heater using the cold water line.
- The thermo-sensor closes the valve and 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 or at the end of each trunk.

On-Demand Recirc

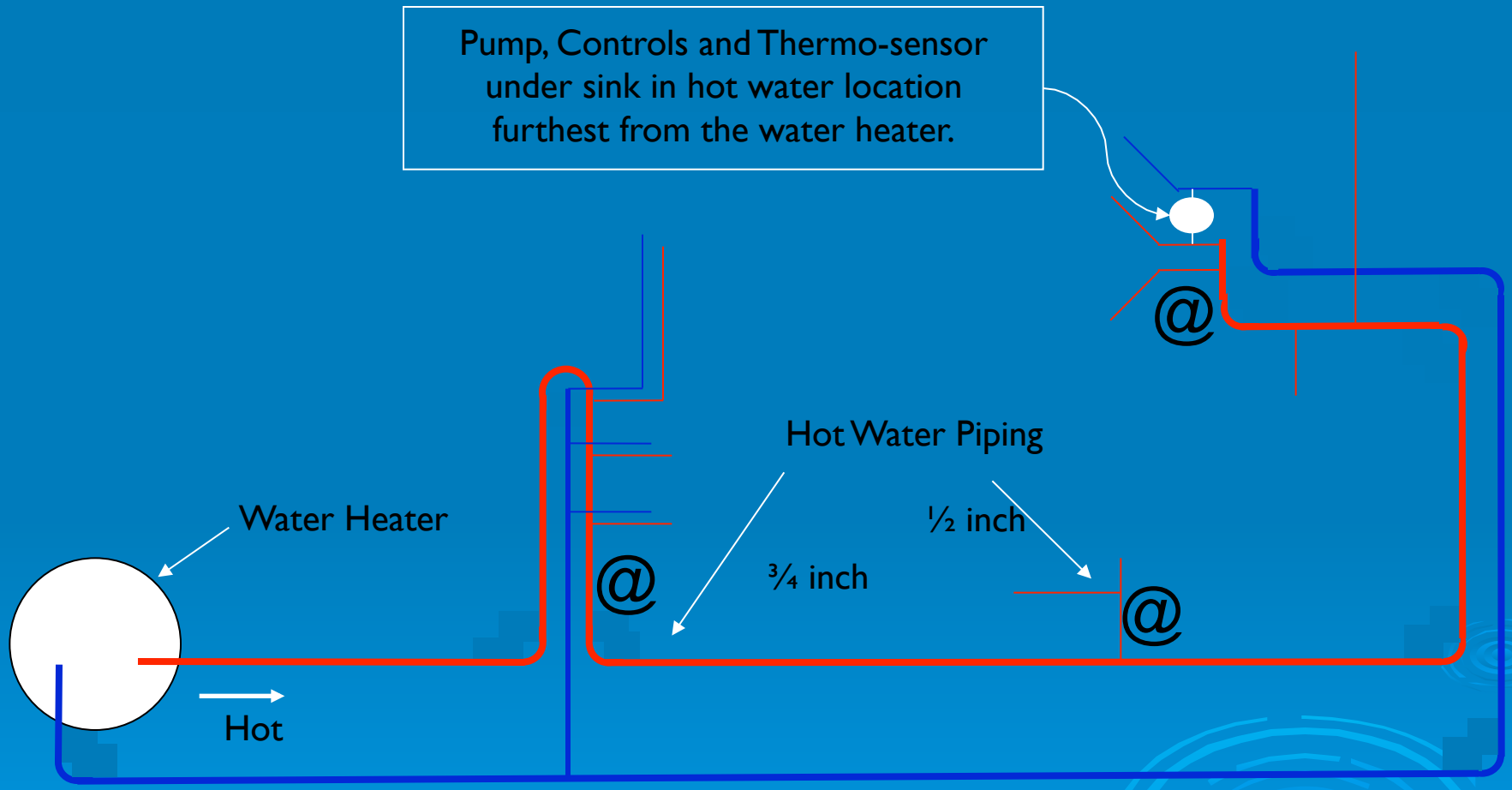
with Dedicated Return Line



Locate activation mechanisms in hot water locations - @

On-Demand Recirc

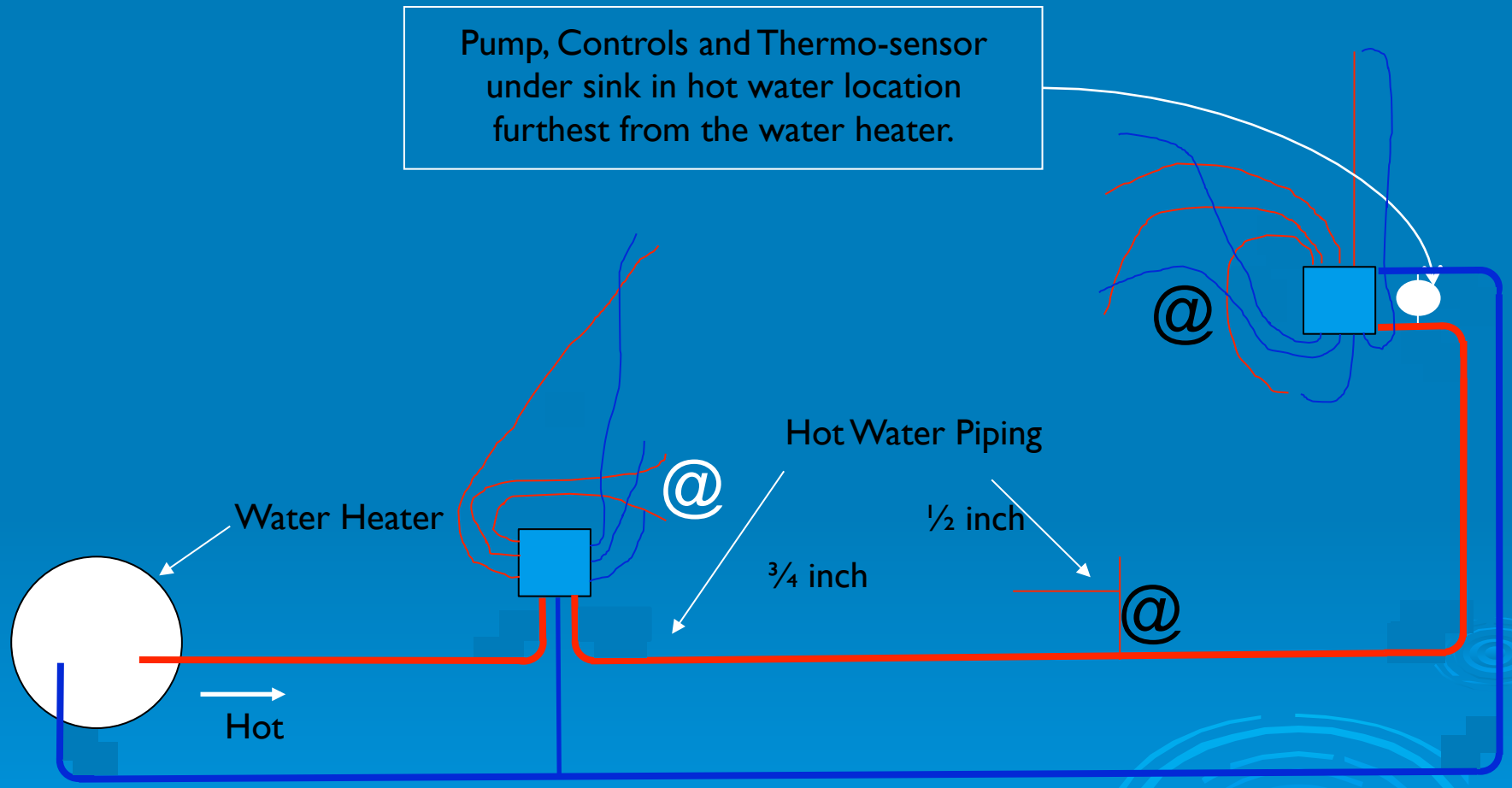
Using the Cold Water Trunk Line as the Return



Locate activation mechanisms in hot water locations - @

On Demand Recirc & Mini-manifolds

Using the Cold Water Trunk Line as the Return



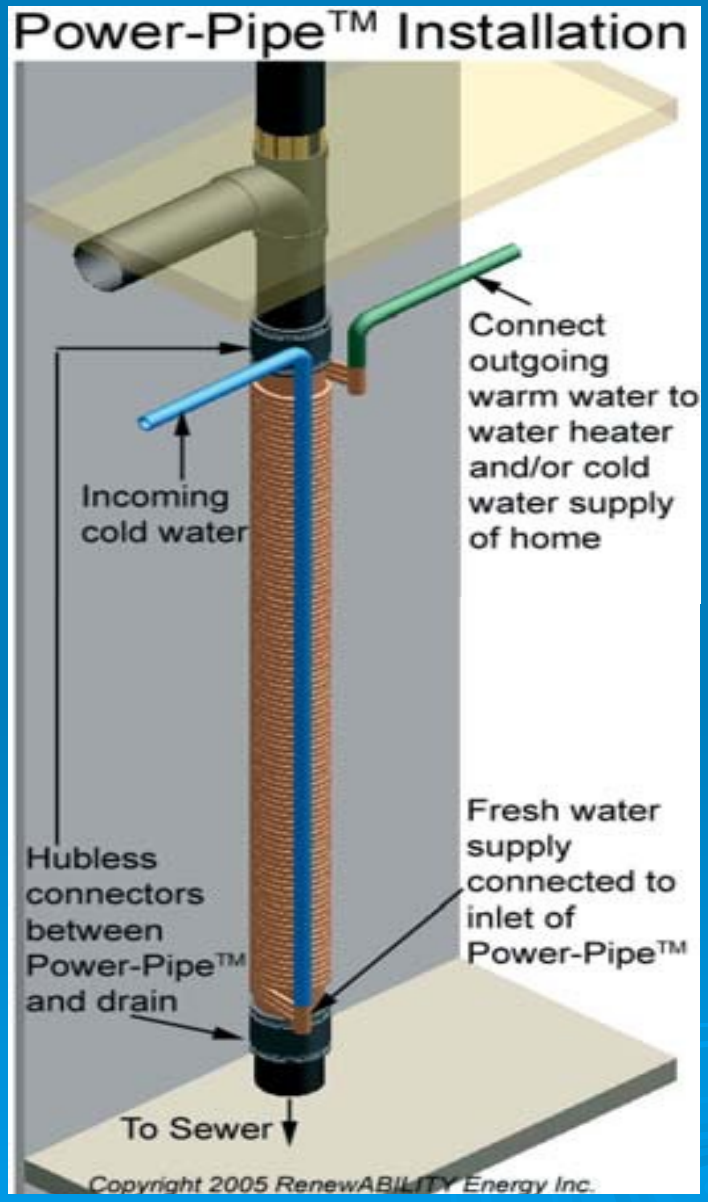
Locate activation mechanisms in hot water locations - @

Mini-manifolds located near fixture clusters - □

Drain Heat Recovery

- Most energy used to heat hot water ends up going down the drain!
- Can we recover the energy which goes down the drain?
- Yes, sometimes!

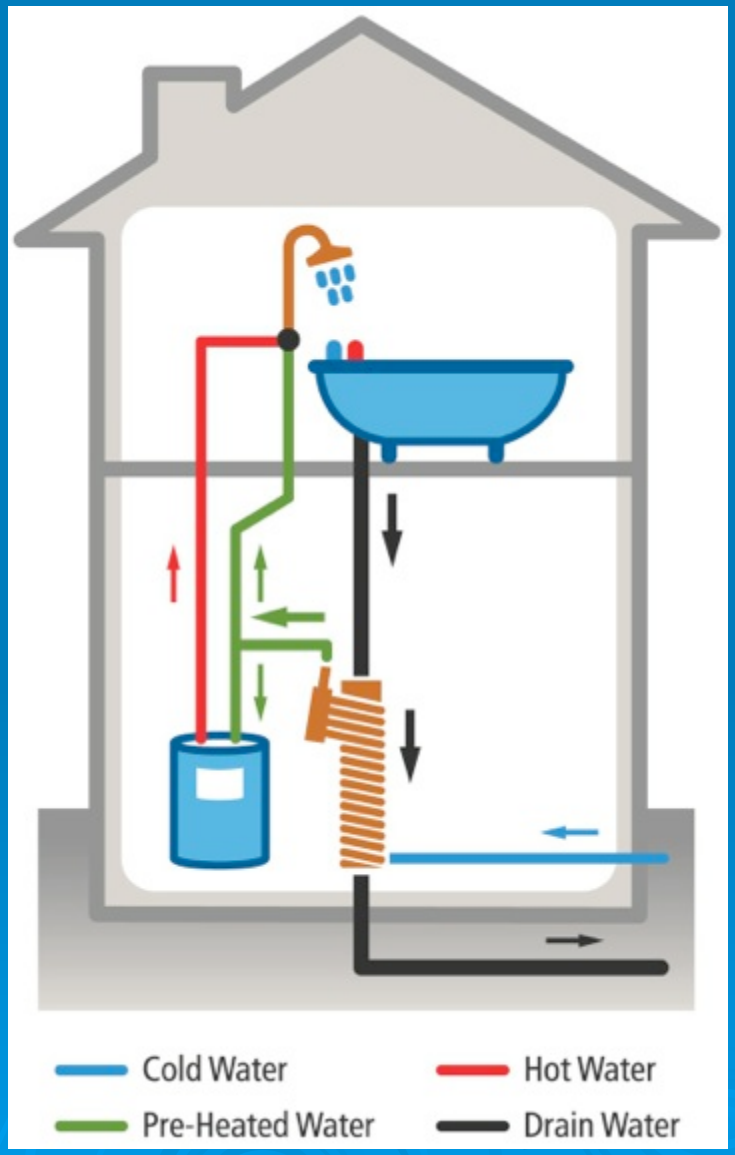
Drain Heat Recovery (DHR)



Drain Heat Recovery Claims

- Recover up to 60% of the energy going down the drain.
- Paybacks of 2 to 5 years.
- 30 to 50 year lifetimes.

DHR Applications



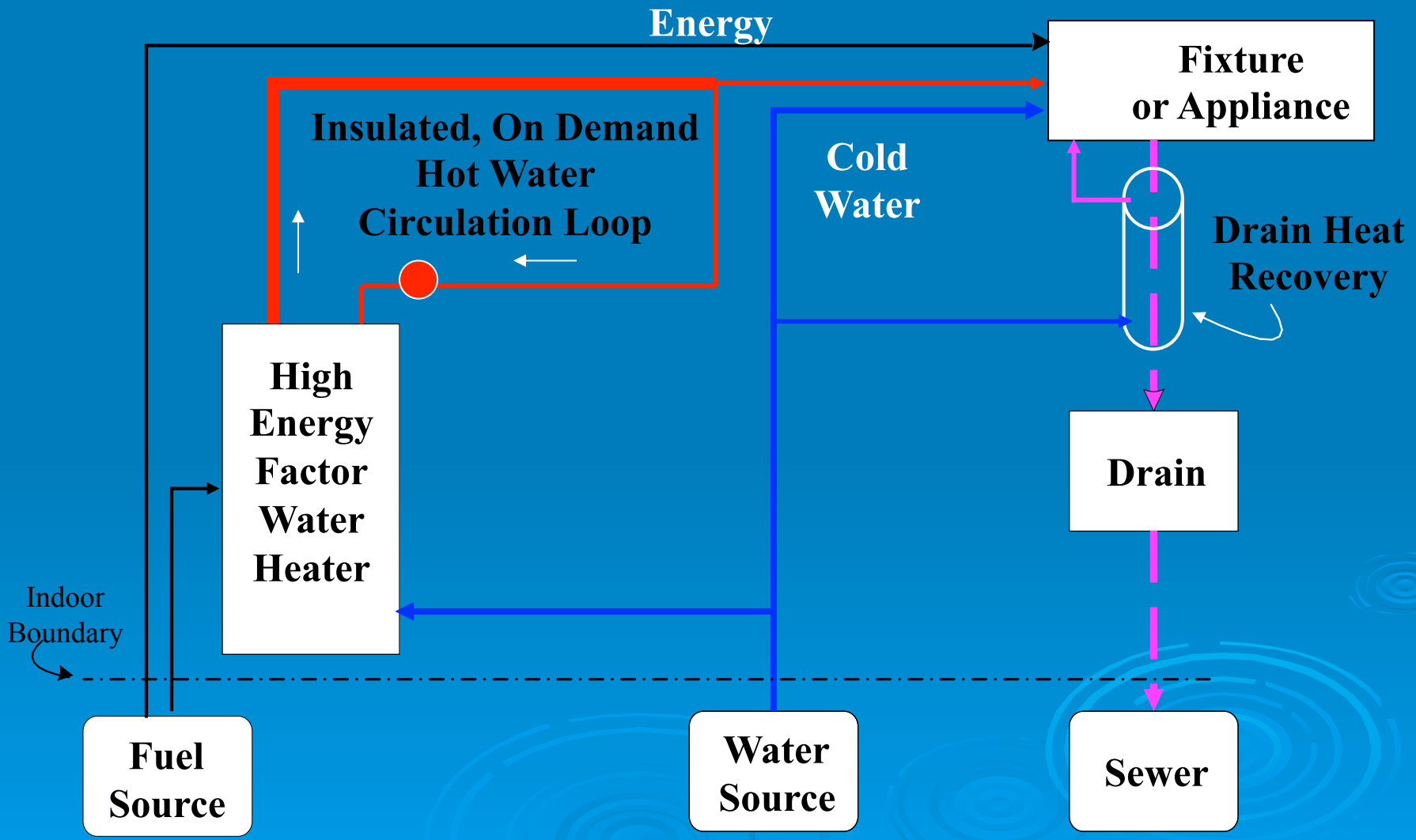
DHR Applications

DHR Applications

Drain Heat Recovery Considerations

- Need a vertical drain for film heat transfer
- Needs simultaneous hot water draws and drainage.
- How does one calculate the energy savings? Depends on use pattern, plumbing details, etc.

Improved "Simple" Hot Water System



Hot Water Distribution System Summary

- The distribution system has a profound impact on the hot water system performance.
- On demand recirc systems can vastly improve the hot water system performance even in *retrofit* situations.
- Drain heat recovery systems may be worth considering.

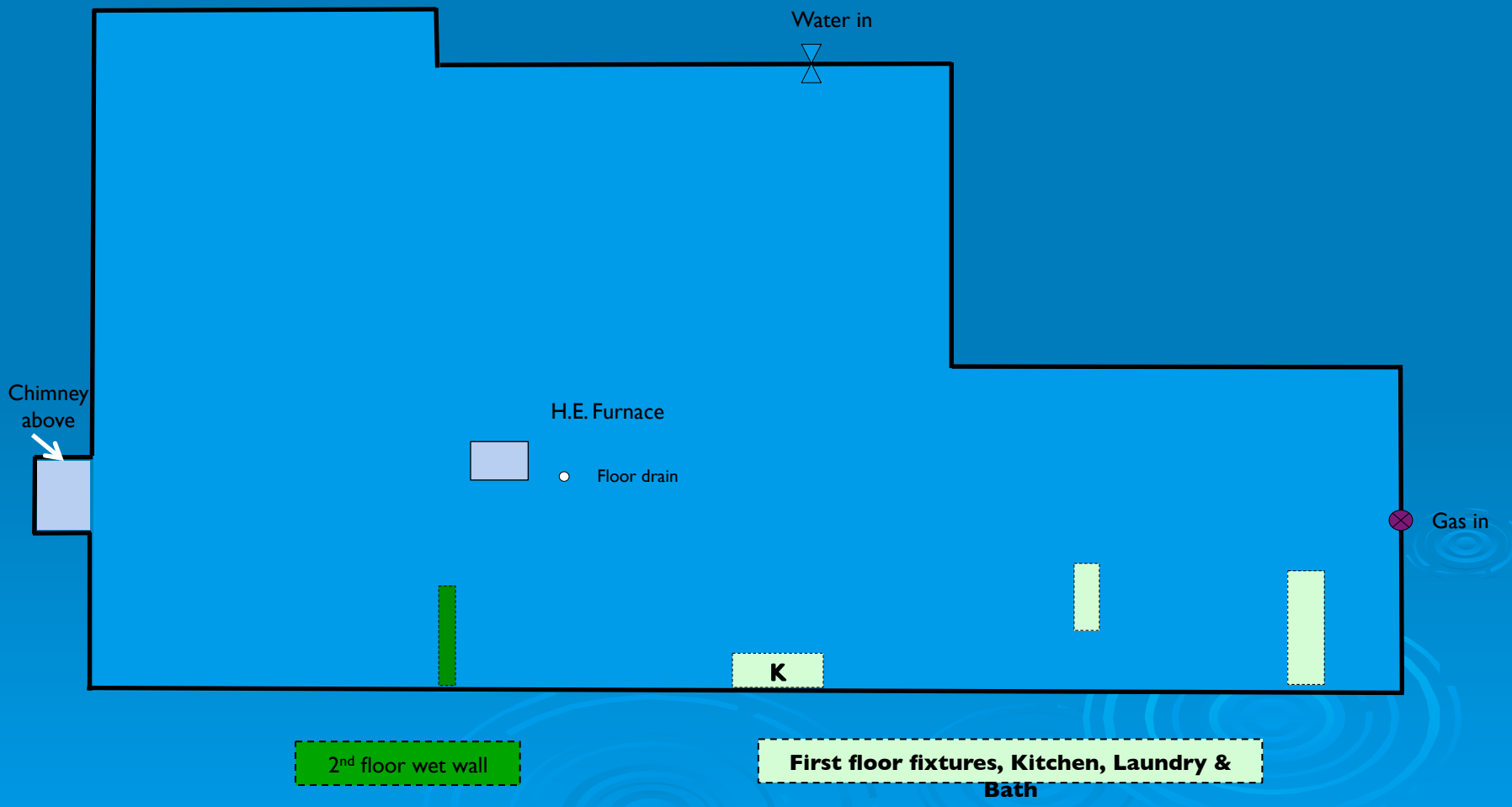
Where should I spend my construction dollars?

- Insulate all hot water lines to R-4
- Install on-demand recirculation system
- Require plumbing that limits the waste no more than 2 cups of water while waiting for hot water at all fixtures
  - WaterSense requires ≤ 1 quart
- Install a high efficiency water heater…condensing gas storage or Heat Pump Water Heater
  - As a minimum install an Energy Star water heater.
  - At least provide power and condensate drain to accommodate future improvements.

Summary

- Installing a high performance hot water system will:
  - Save energy and water for the life of the house
  - Delight the homeowner very time they use a hot water fixture!

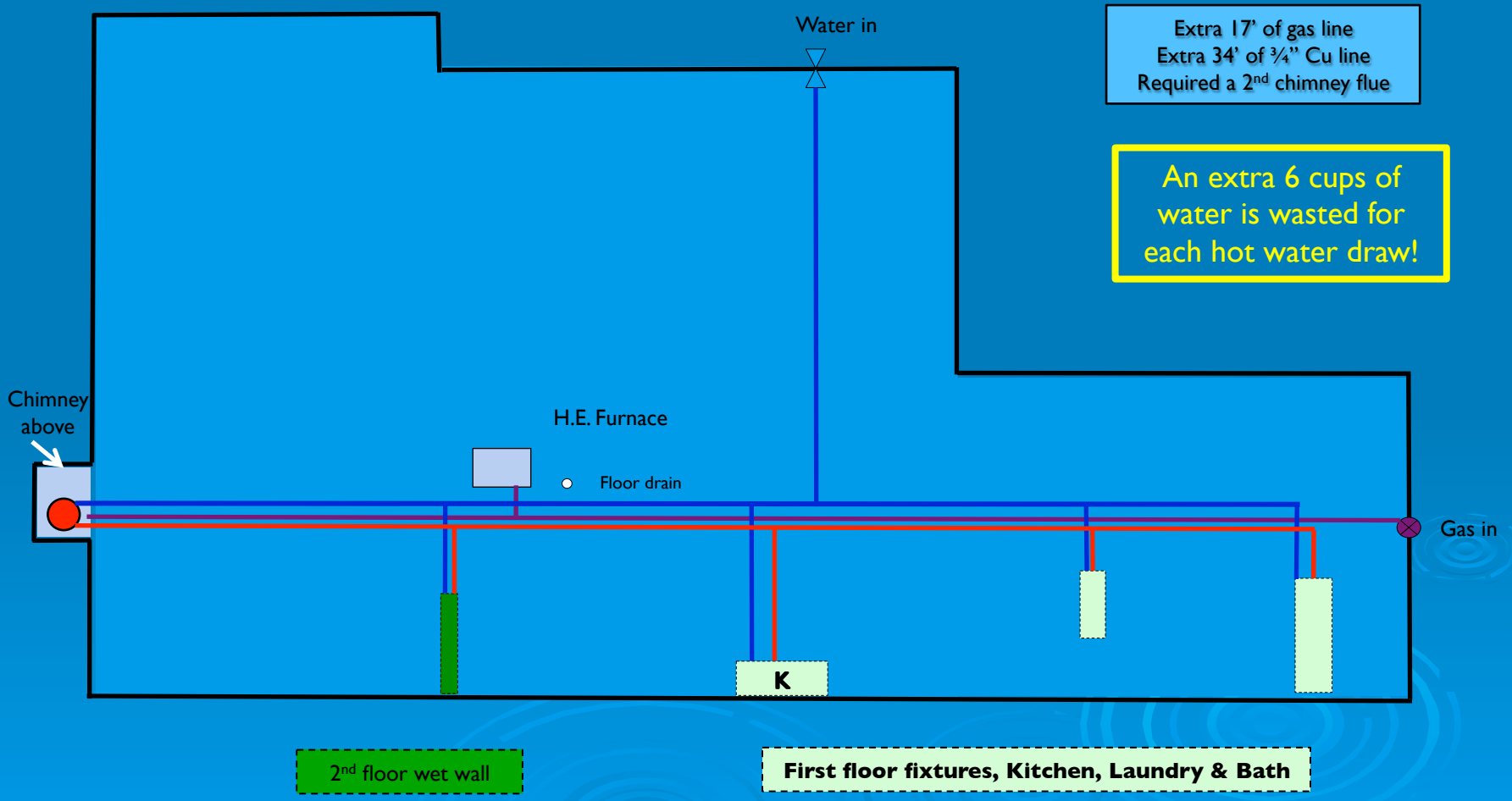
How would you plumb this basement?



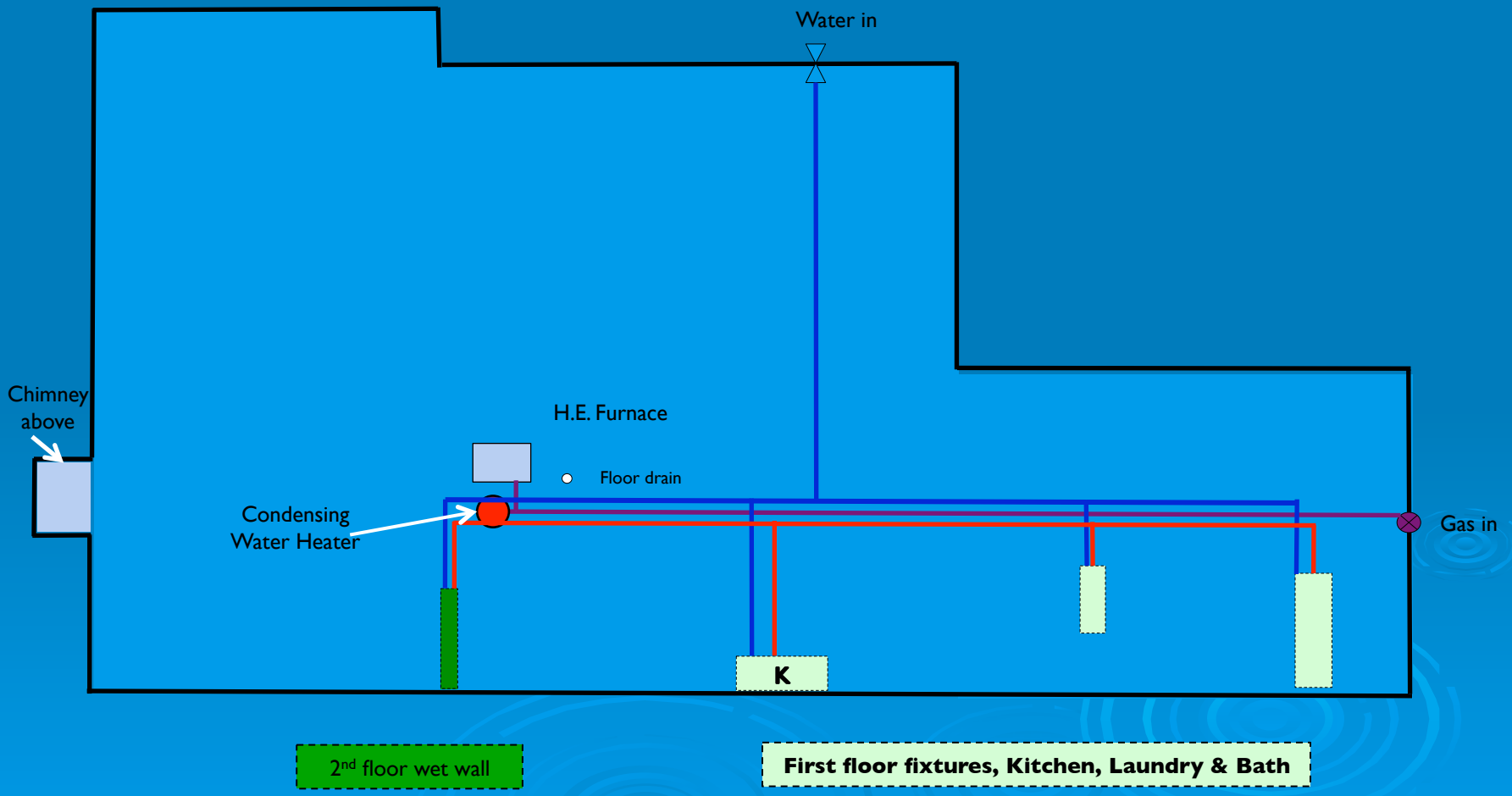
Example of a poor hot water system

- In this house, the custom builder specified the fixtures and told the plumber to use standard practices to plumb the house.
- The result was:
  - The plumber thought he minimized his costs
  - The builders costs were slightly increased
  - The homeowner got a plumbing system with poor performance.

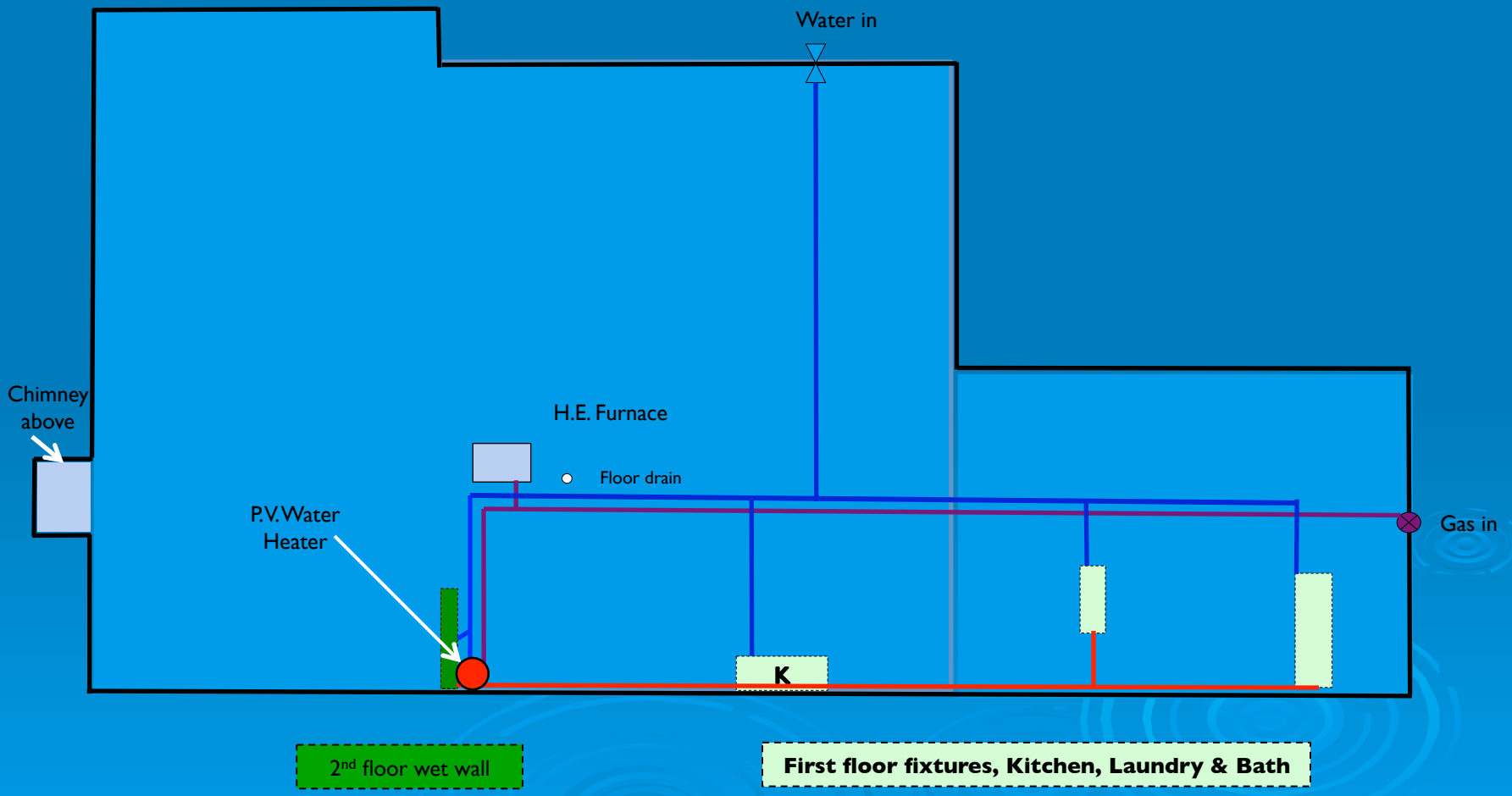
The Plumber's Choice to minimize his costs!



A better layout with improved performance and minimal extra cost



A better layout with improved performance and minimal extra cost



Lesson Learned

- You must be pro-active to insure a high performance hot water system is installed in a new home:
  - Specify hot water pipe insulation
  - Specify an On-Demand Recirc System
  - Specify a maximum water waste of 2 cups at each fixture
  - Specify a high efficiency water heater.