DHW System Energy Flow

Mechanical Room

Cold water supply

Hot water supply

Hot water return

Branch

End-Use Energy

Water Heater Losses

Recirculation Loop Losses

Branch Losses

Distribution Losses
Study Goals

- Conduct field monitoring of DHW systems in more than 30 multi-family buildings in California
- Assess and analyze the detail energy performance of each DHW System components
- Assess the energy saving potential of control strategies
System Definition
System Energy Flow Analysis
DHW Distribution Configuration

Site #1
Sacramento, CA

Site #2
San Francisco, CA
DHW System Energy Flow

- Water Heater Losses: 45%
- Distribution Losses: 25%
- End-Use Energy: 29%
- Recirculation Loop Losses: 1%

Mechanical Room
- Hot water supply
- Hot water return
- Cold water supply
- Branch
DHW System Performance Variation

- E_{Heater Loss} Water Heater Losses
- E_{Recirc Loss} Recirculation Loop Losses
- E_{Branch Loss} Branch Losses
- E_{Draw Overall} System Efficiency

Percentage:
- Site #1
- Site #2
- Site #3
- Site #4

Values:
- Heater Loss: 30%
- Recirculation Loop Loss: 20%
- Branch Loss: 2%
- Draw Overall Efficiency: 49%
Energy Consumption per Gallon of Hot Water Draw

![Energy Consumption Chart]

- **Site #1**: Low energy consumption with minimal losses.
- **Site #2**: Moderate energy consumption with some losses.
- **Site #3**: High energy consumption with significant losses.
- **Site #4**: Moderate energy consumption with minimal losses.

**Legend**:
- End-Use Energy
- Branch Losses
- Recirculation Loop Losses
- Water Heater Losses
DHW system controls

**Pump Control**

**Temperature Supply Control**

**Demand Control**

**Temperature Modulation**
DHW system performance under Controls

Gas Consumption Reduction normalized by gallon of water

Recirculation Loop Losses Reduction normalized by gallon of water

Site #2 – SF, CA
Control Analysis

- **The key to energy savings**
  - Reduce recirculation loop temperatures as much as possible
  - The return portion of the recirculation loop doesn’t need to be warm

- **Pump off ≠ Cold Recirculation loop**
  - Pipe insulation can keep recirculation loop warm for extended period (~1hr)
  - hot water draws will also help sustain recirc. loop temperatures

  pump can be kept off periodically even during peak usage
A Better Control Strategy?

- Turn on recirculation pump periodically (every 1-2 hr)
- Modulate water heater temperature during off-peak time
Hot Water Draw Study

- Wide range of water usage per occupant
- Strong influence of weather on water usage
- No observation of obvious water usage increase under controls
- Analysis of hot water usage pattern to provide peak demand statistics to guide system and pipe sizing
Guideline for DHW System Design

- **Water heater/boiler efficiency is still the most important component to system efficiency**
  Proper system sizing will help to reduce standby and short-cycling losses

- **Distribution system design**
  Place recirc. loop through the middle of the building (this is the same concept as placing water heater near fixture)

- **Control and monitoring**
  Even a simple temperature indicator on HW return can be very useful
Thank you!

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