Combined Space and Water Heating: Making it Work

High Efficiency Heating in a Single Package

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cee
Center for Energy and Environment

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About CEE

The Center for Energy and Environment (CEE) is a nonprofit organization that promotes energy efficiency to strengthen the economy while improving the environment.

CEE conducts research and develops programs so that:

- Businesses operate more efficiently and profitably;
- Government agencies and nonprofits spend less on facilities and functions;
- Utilities achieve their energy-efficiency goals at least-cost; and
- Households save money and improve comfort.

About SRC

- The Sustainable Resources Center is a nonprofit community organization dedicated to creating healthy and efficient home environments for all residents.
- SRC works with homeowners to create healthy homes by providing:
  - Detailed energy audits and building testing
  - Air sealing and insulation services
  - Lead testing and mitigation
  - Radon testing and mitigation

Project Support

- Sustainable Energy Resources for Consumers (SERC)
  - Department of Energy
  - Created to allow local weatherization agencies to install weatherization materials and technologies that have promise for energy savings and benefits to customers, however cannot currently be installed under the traditional Weatherization Assistance Program.
- Building America
  - Department of Energy
  - Conducts research to continually develop innovative, cost-effective energy saving solutions—better products, better new homes, better ways to improve older homes, and better buildings in which we work, shop, and lead our everyday lives.

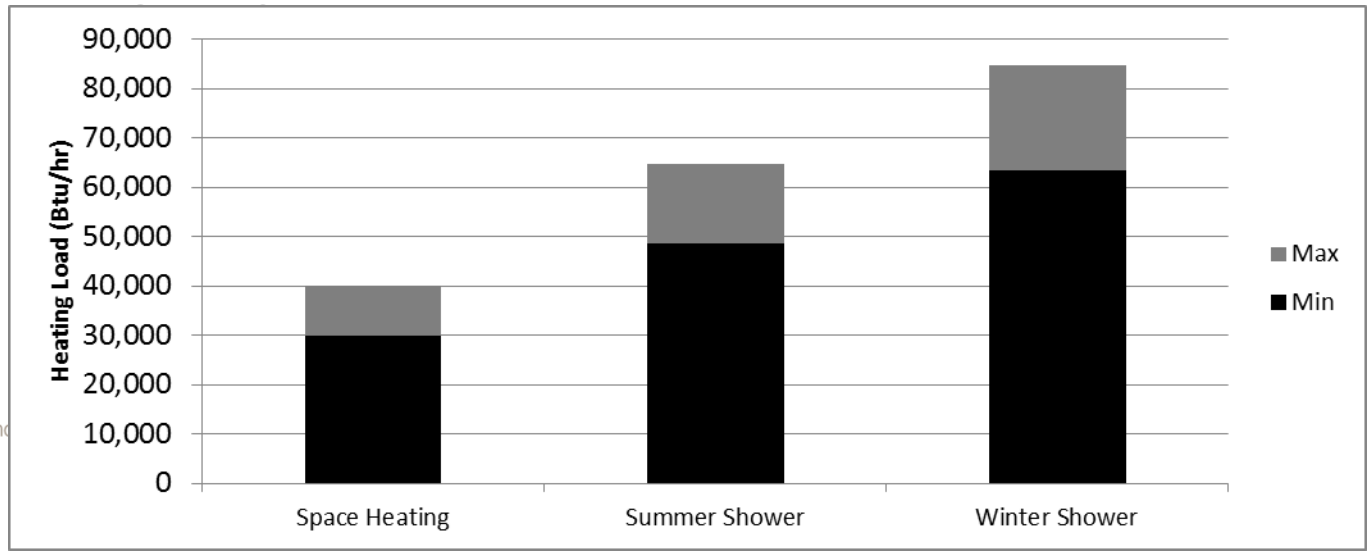
What are Combination Systems?

- Combination Systems…
  - Use a single heating plant to provide both space and water heating
  - Systems can provide space heat with hydronic or forced air distribution

- Also Known As
  - Combi
  - Combo
  - Dual Integrated Appliances

Why use a high efficiency combined system?

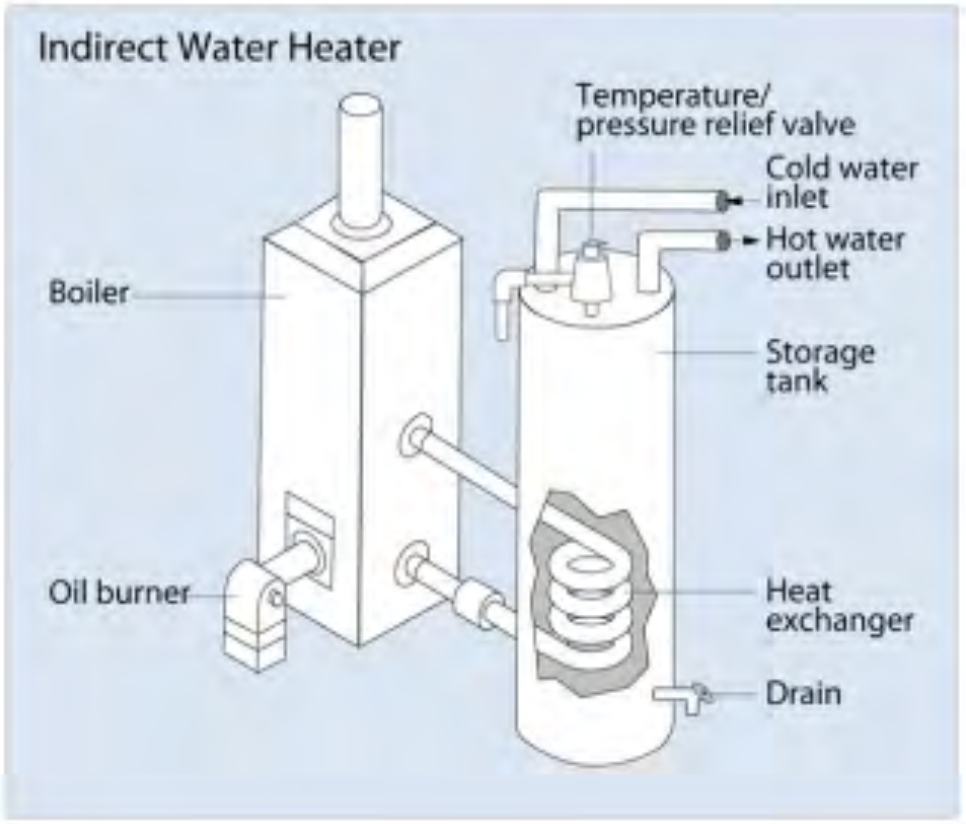
- Combining loads…
  - Improved space and water heating performance
  - Reduced installation costs
  - Reduced venting needs
  - Reduced gas piping
  - Potentially reduced maintenance
  - Easy integration with ventilation, air conditioning, etc
  - Good for retrofits



Our Focus: Systems that Work

- Our Priorities
  - Safety
  - Reliable
  - Easy to install
  - Easy to operate and maintain
  - Energy Savings

Hydronic Combi Systems



System Types

- DHW options
  - Indirect tank
  - Integrated tank
  - Low mass heat exch
- Space heating optic
  - Radiant
  - Radiators
  - Baseboards

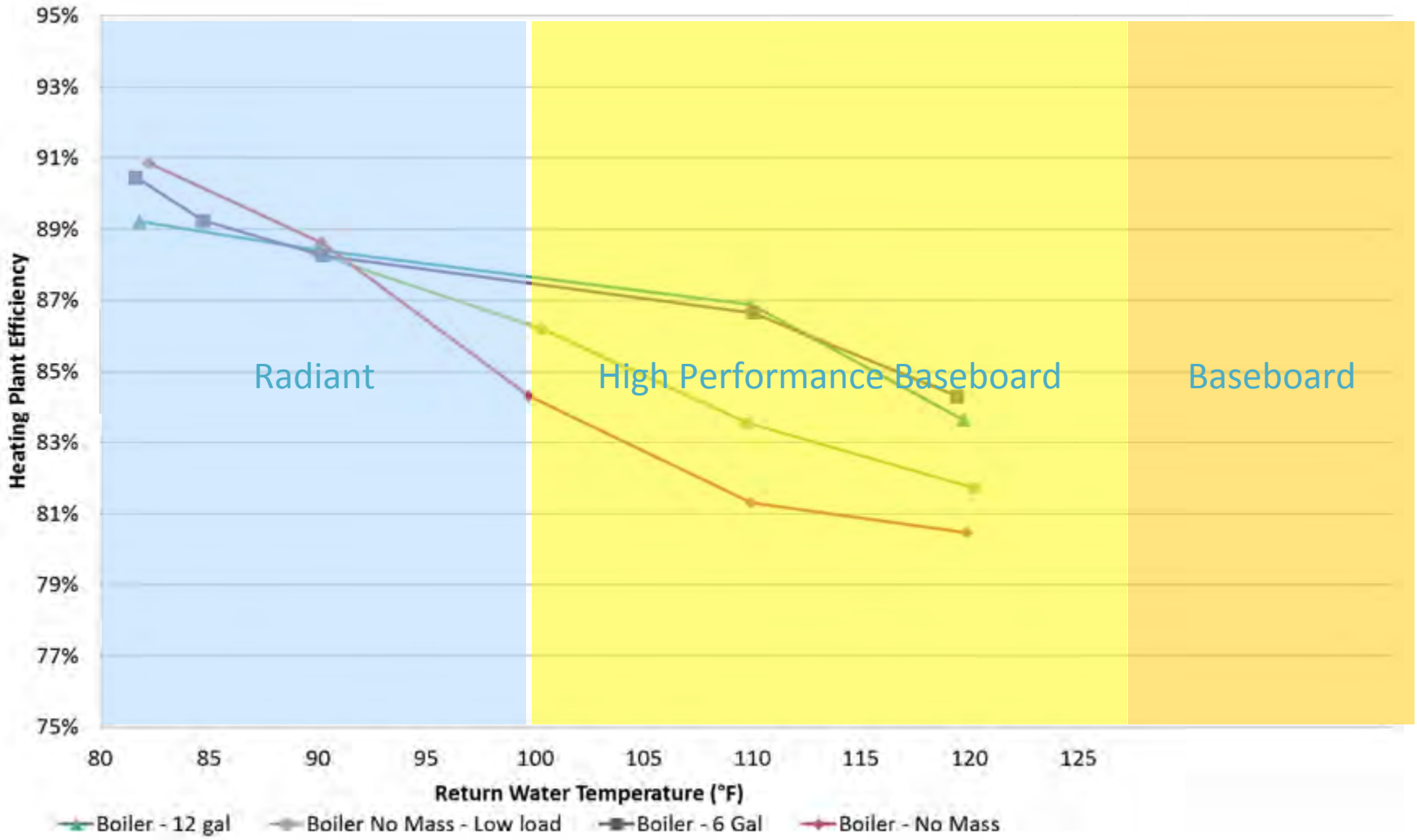
Installation of Condensing Boiler

- Venting
- Combustion air
- Circulation pump
  - High efficiency
  - Variable frequency
- Space heating distribution size and type (new construction)

Condensing Optimizati

- Baseboard
  - Supply Water Temperatures: 170
  - Return Water Temperatures: 150
- High Performance Baseboard
  - Supply Water Temperatures: 120
  - Return Water Temperatures: 100
- Radiant Heating
  - Supply Water Temperatu
  - Return Water Temperatu

Condensing Optimization



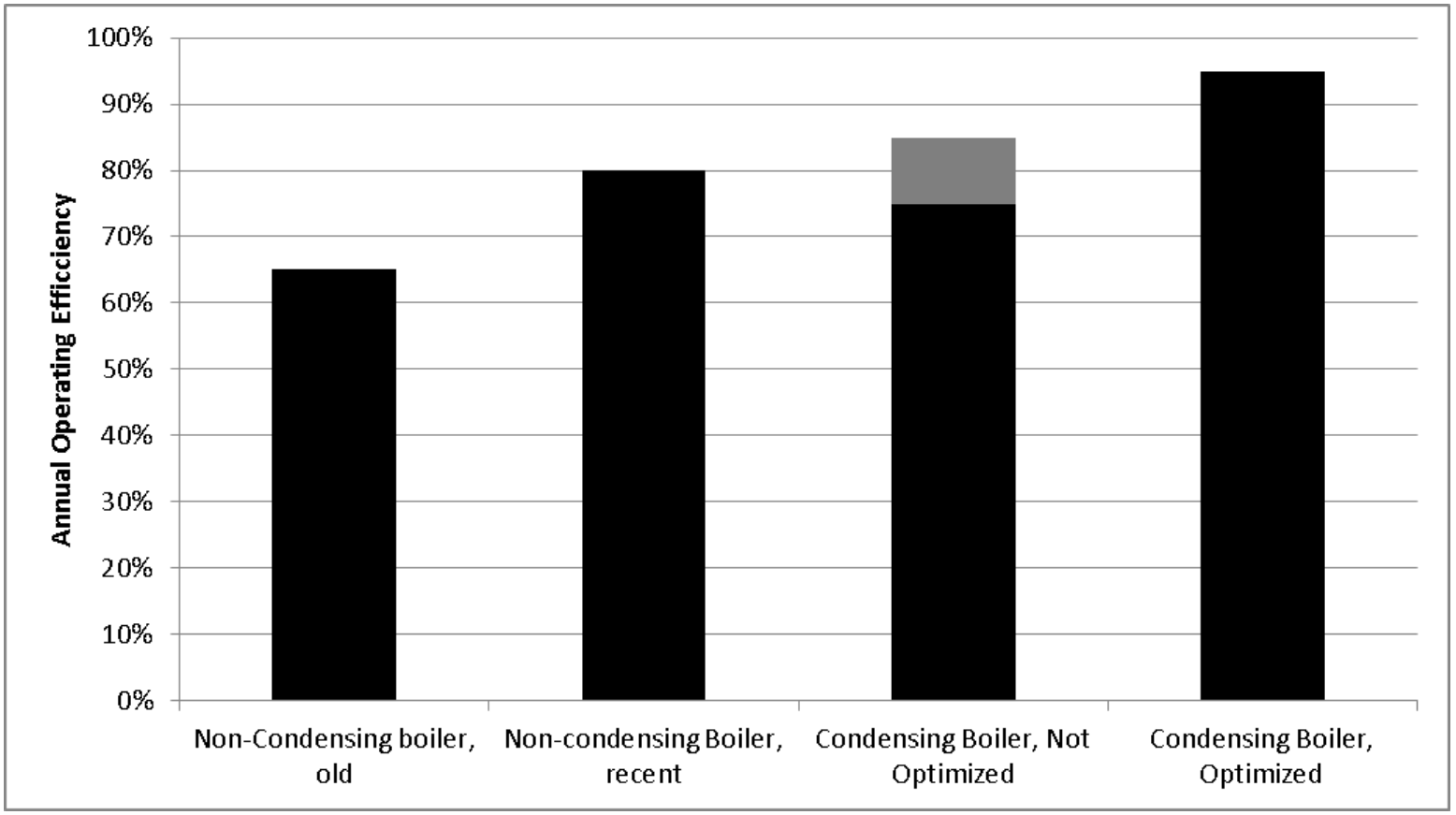
Retrofit Upgrade

- Reduce return water temperature
  - Increased the temperature drop through distribution
    - More output
    - Lower flow rates
- Reduce set point temperature
  - Aggressive outdoor reset
- Purge boiler to indirect tank to reduce loses at end of space heating event

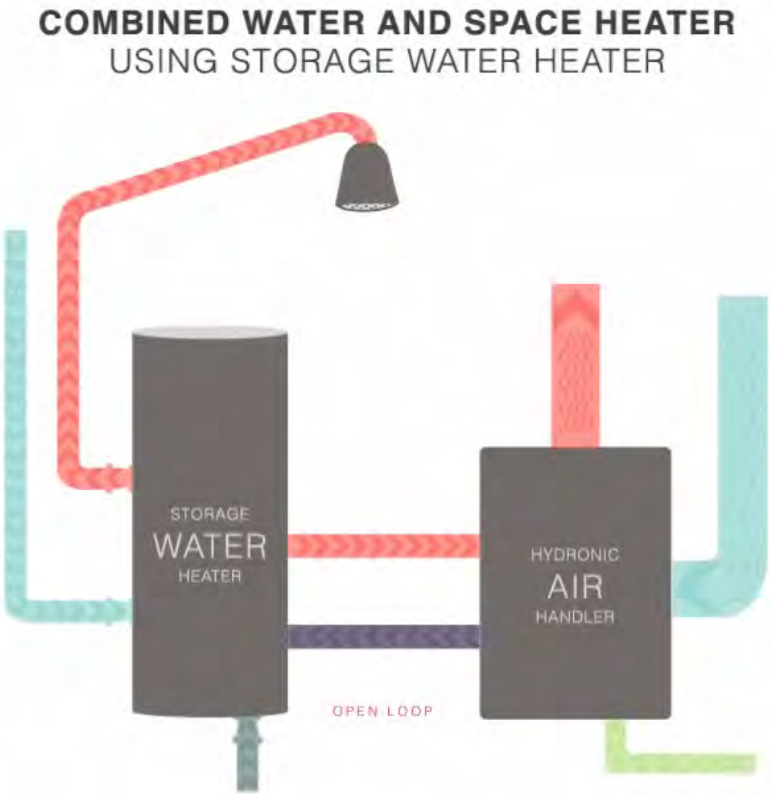
Controls

- Cycle Management
  - Avoid short cycling
  - Pre purge
  - Post purge
- DHW utilizing waste heat
- Outdoor reset
  - Aggressive resets minimize return water temperatures

Performance



Forced Air Systems



System Types

- DHW Options
  - Water heaters
    - **Storage**
    - Tankless
    - Hybrid
  - Boilers
    - Indirect tank
    - Internal – low mass HE or storage
- Space heating
  - **Air handler**
  - Air handler integration with heat recovery ventilation
  - Air handler integration with air conditioning

Best Practices

- Installation
- Optimization
- Operation
- Controls
- Lessons Learned

Installation

System Selection

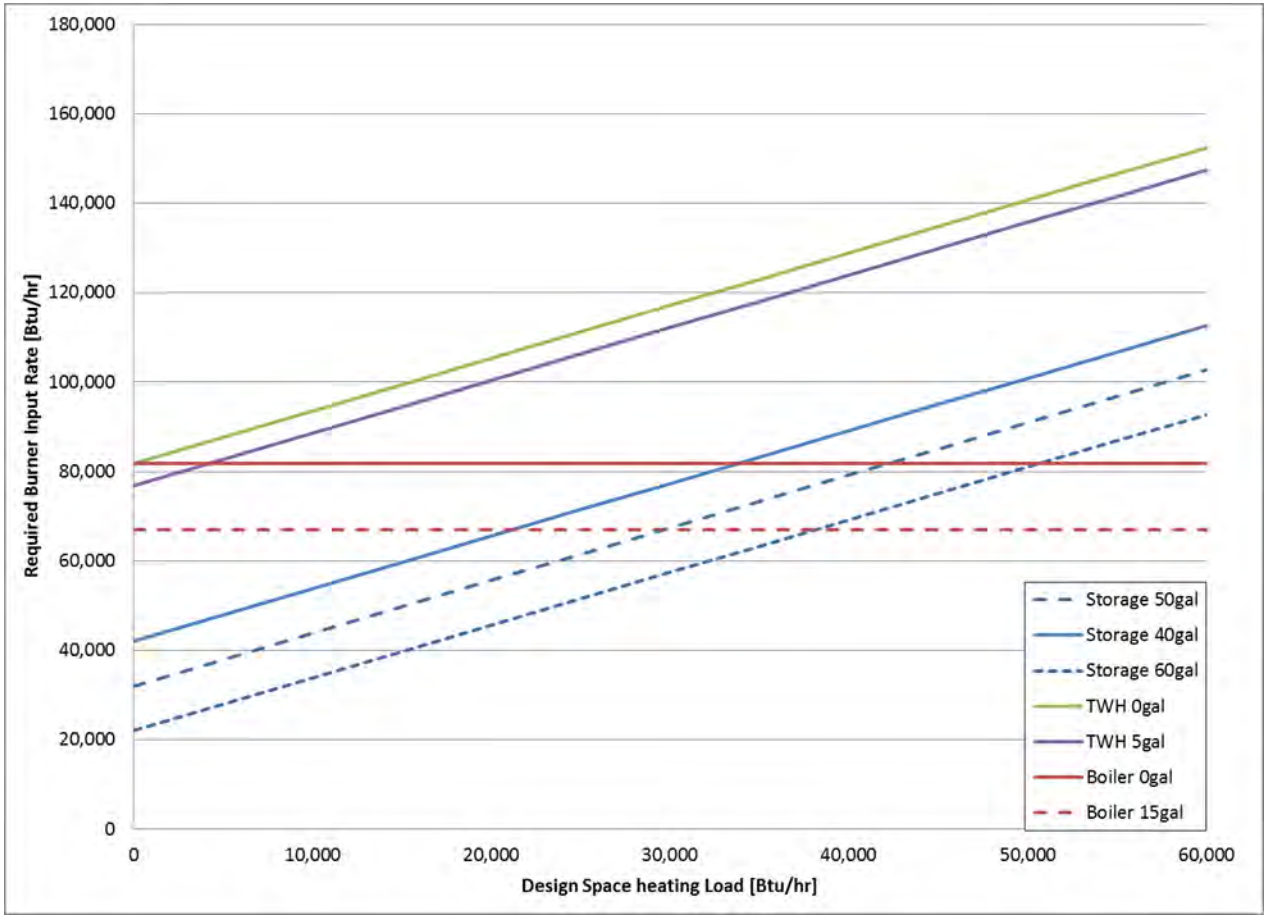
- Safety
  - Combustion
  - Scalding
- Maintenance and durability
- Ease of Installation and Use
- Performance
  - User satisfaction
  - Energy Use

Air Handler Selection

- Important Characteristics to consider:
  - Capacity
  - Return water temperature
  - Electric usage

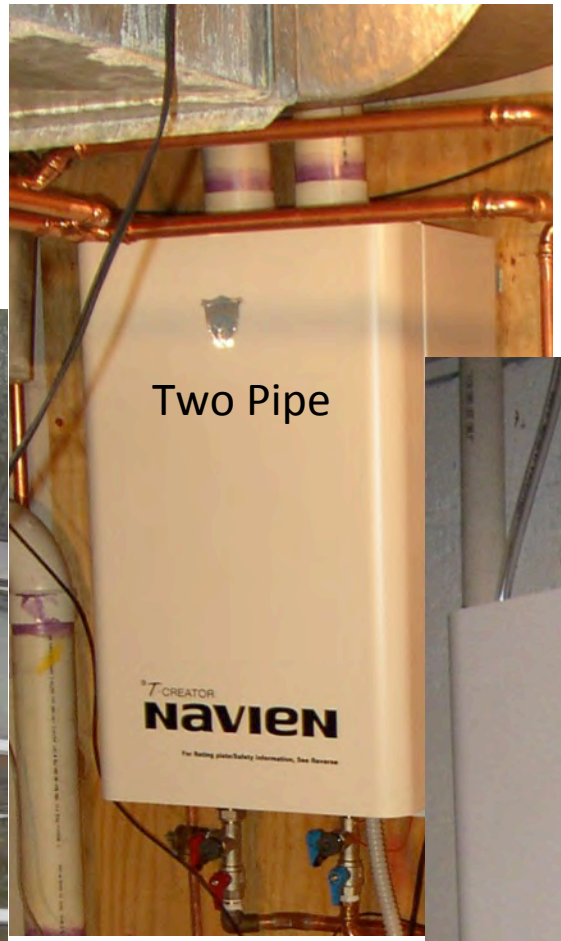
- Equipment
  - Coil characteristics and heat transfer rates
  - Fan characteristics
  - Pump characteristics

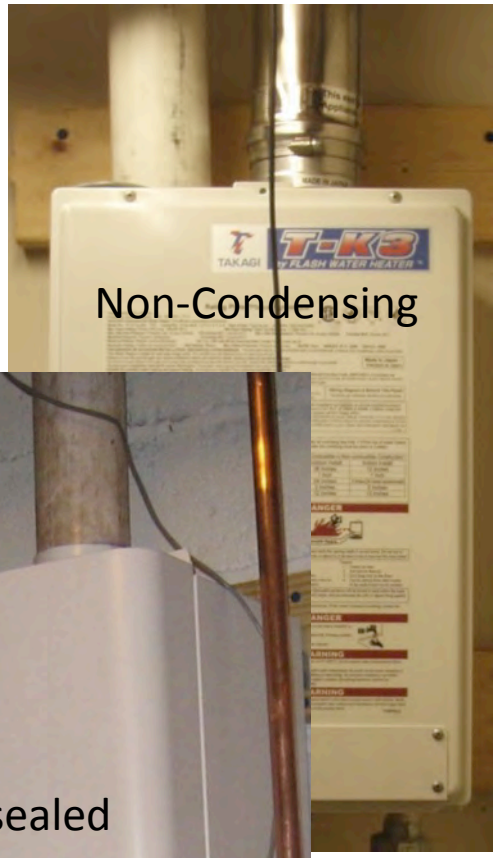
Heating Plant Sizing



Venting

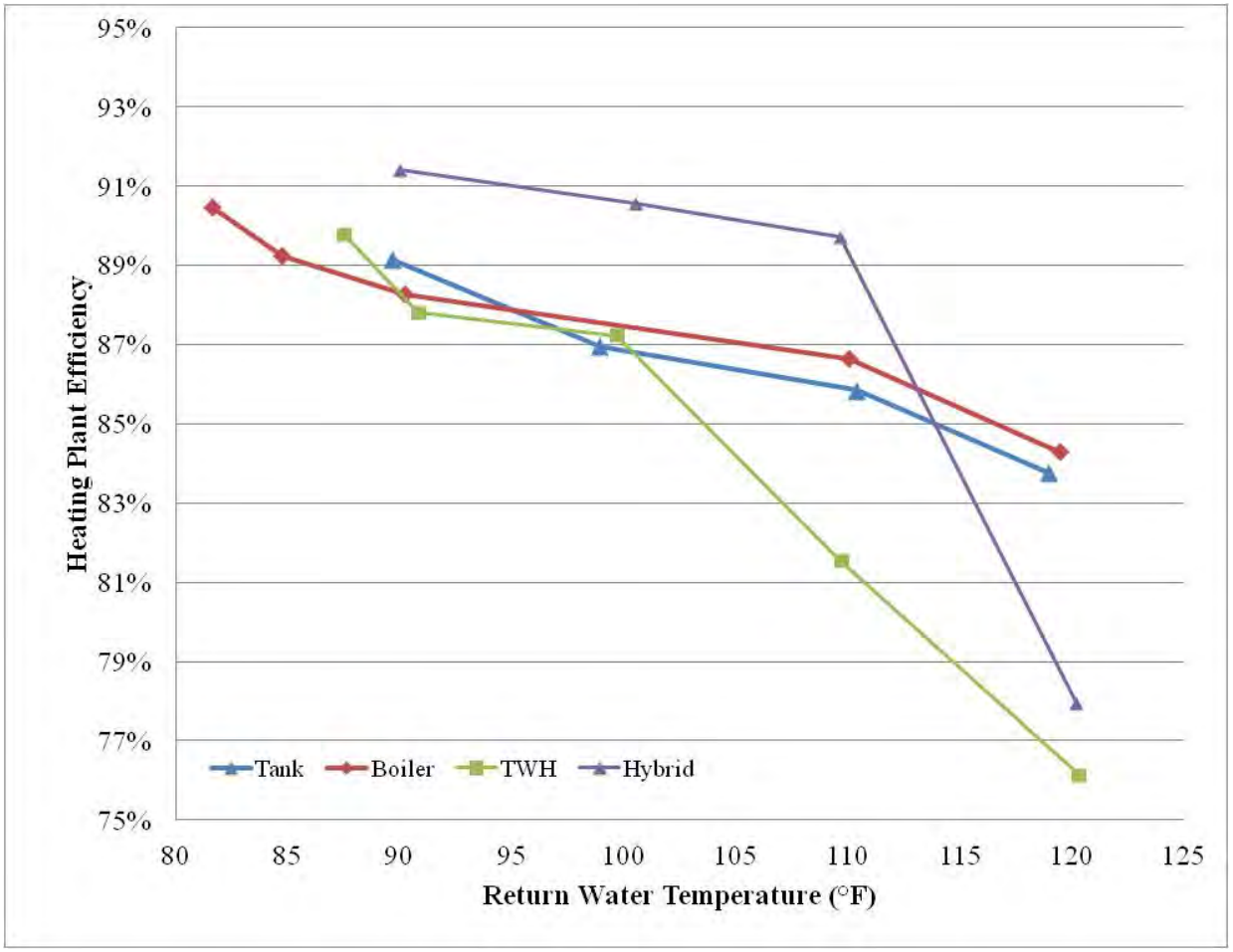

Concentric


Two Pipe
CREATOR
NAVIEN


TAKAGI
T-K3
Non-Condensing

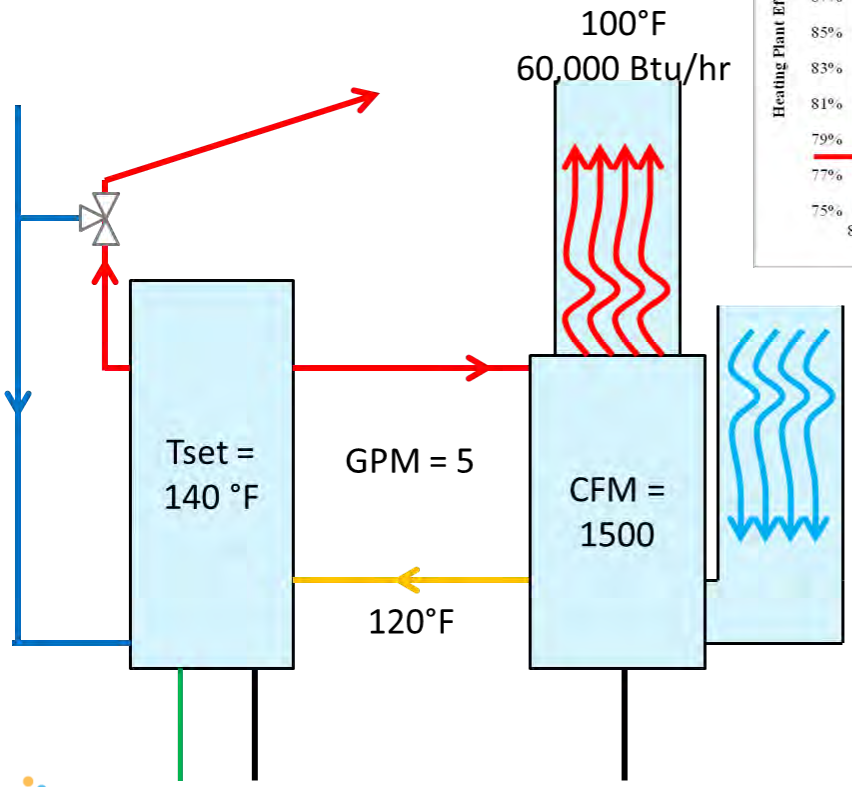

Non-sealed

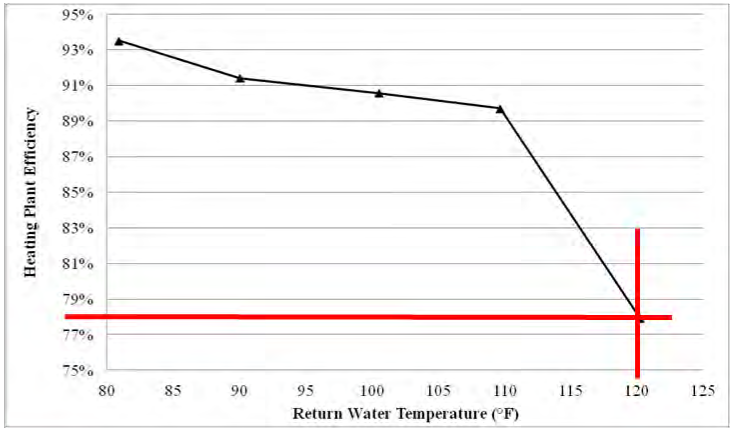
Optimizing Efficiency



No Optimization

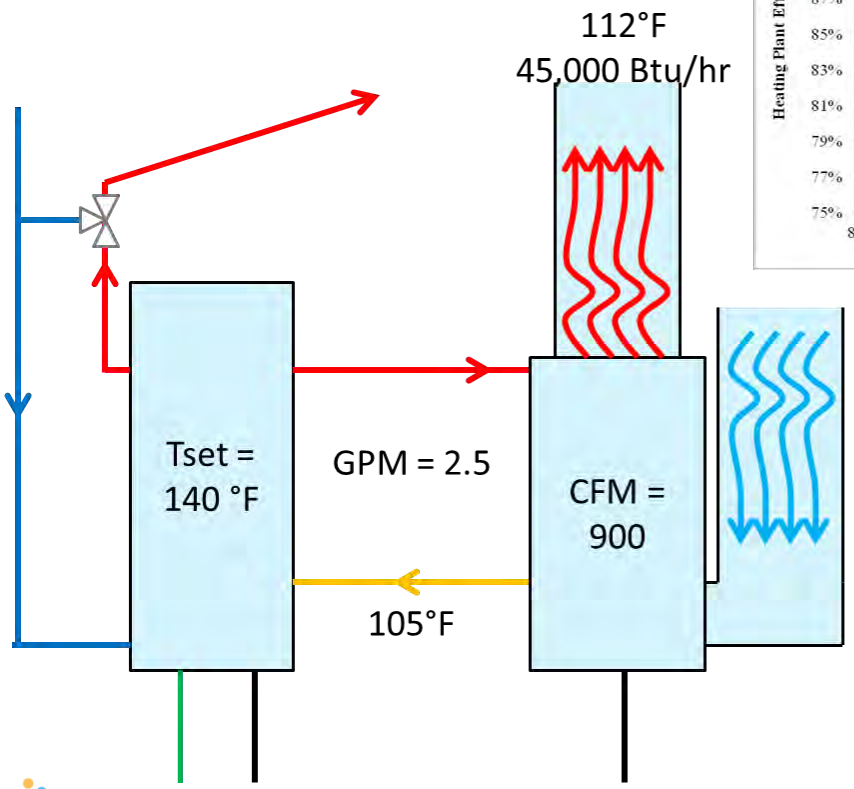
(for a 40,000 Btu/hr design load)

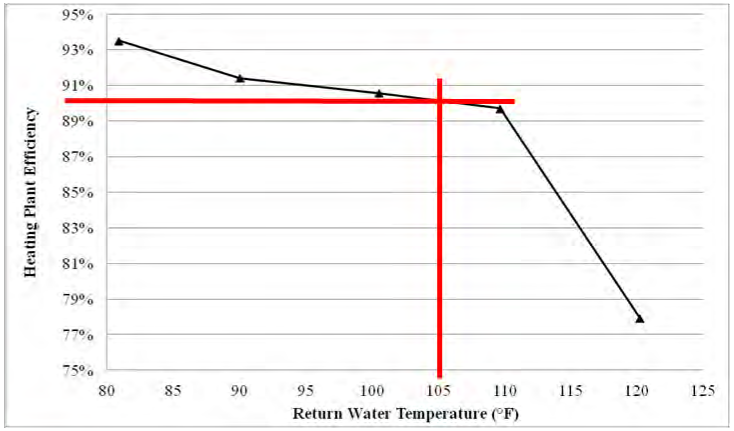




Improved Installation

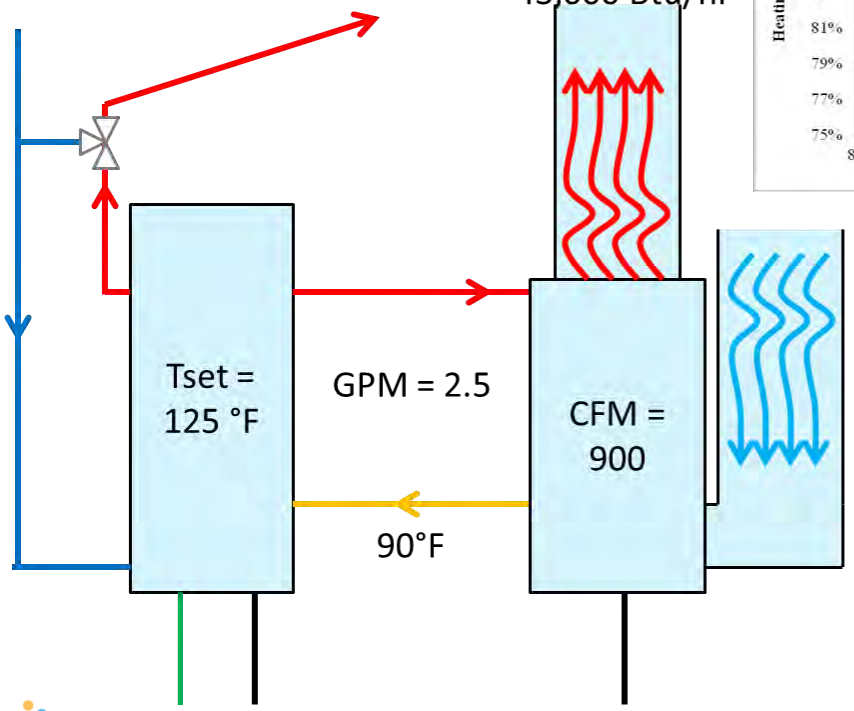
(for a 40,000 Btu/hr design load)

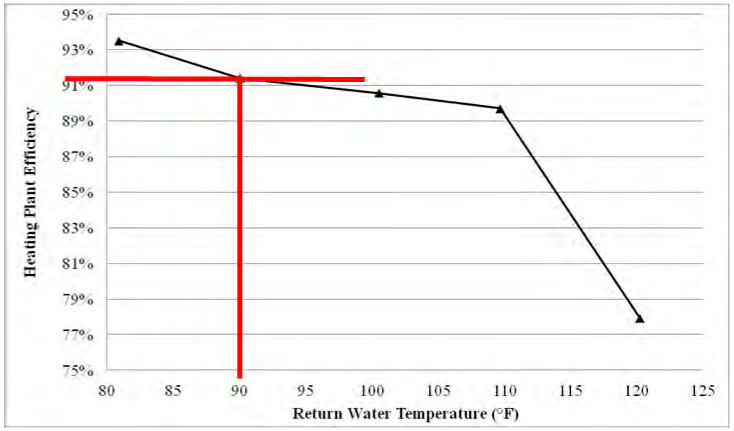




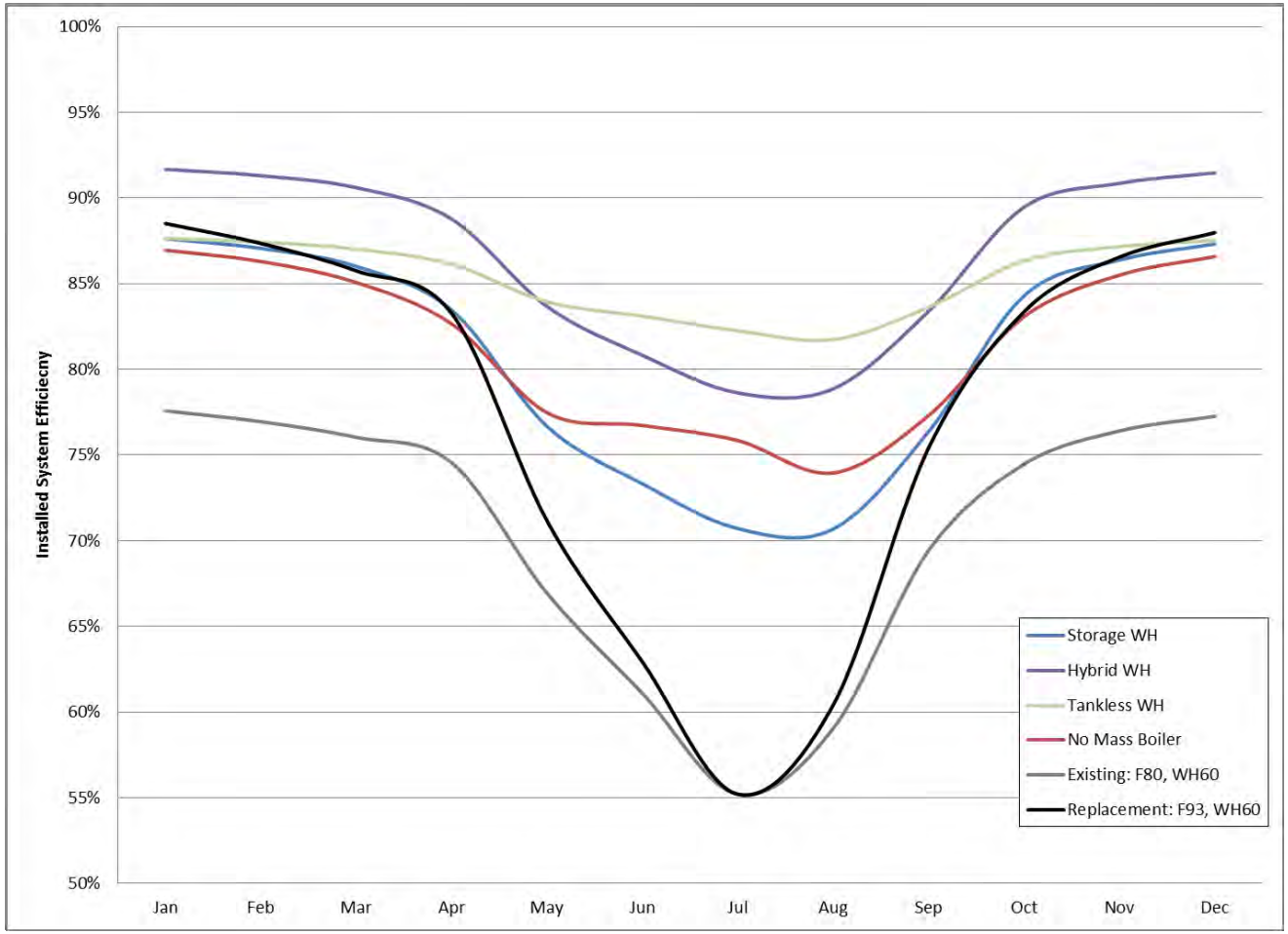
Fully Optimized

(for a 40,000 Btu/hr design load)

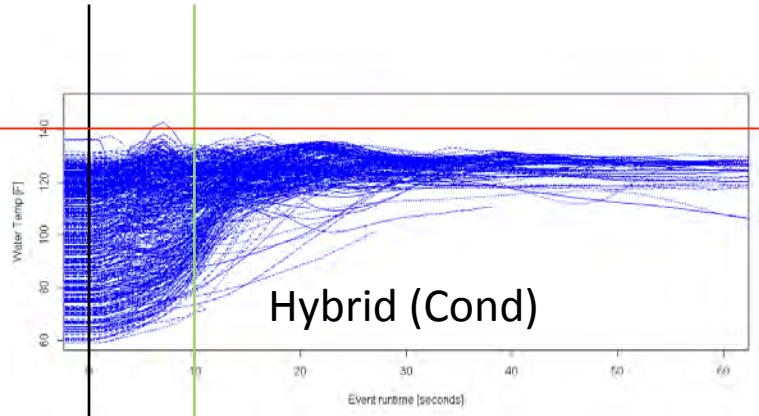


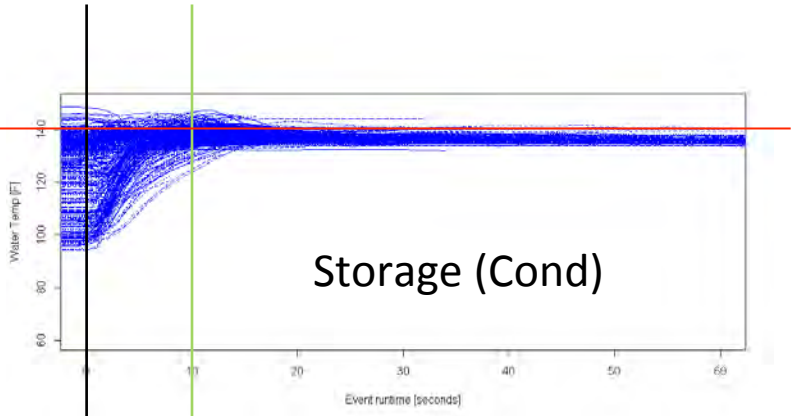


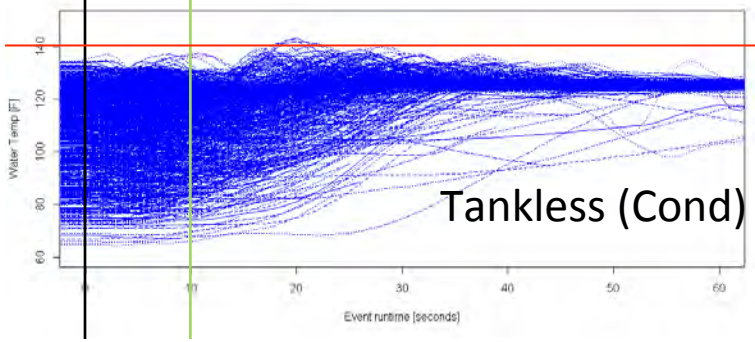
Installed Performance

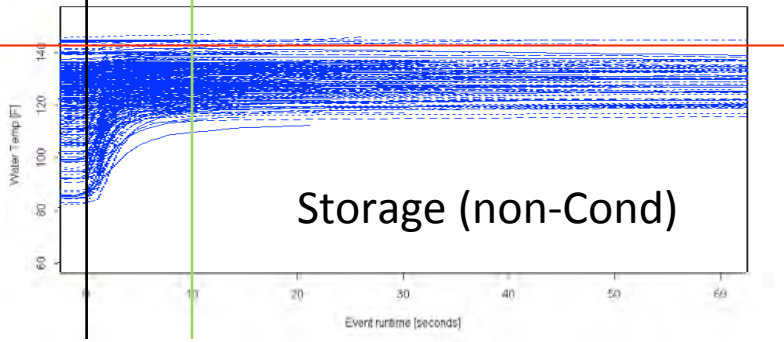


Water Temperature Delivery

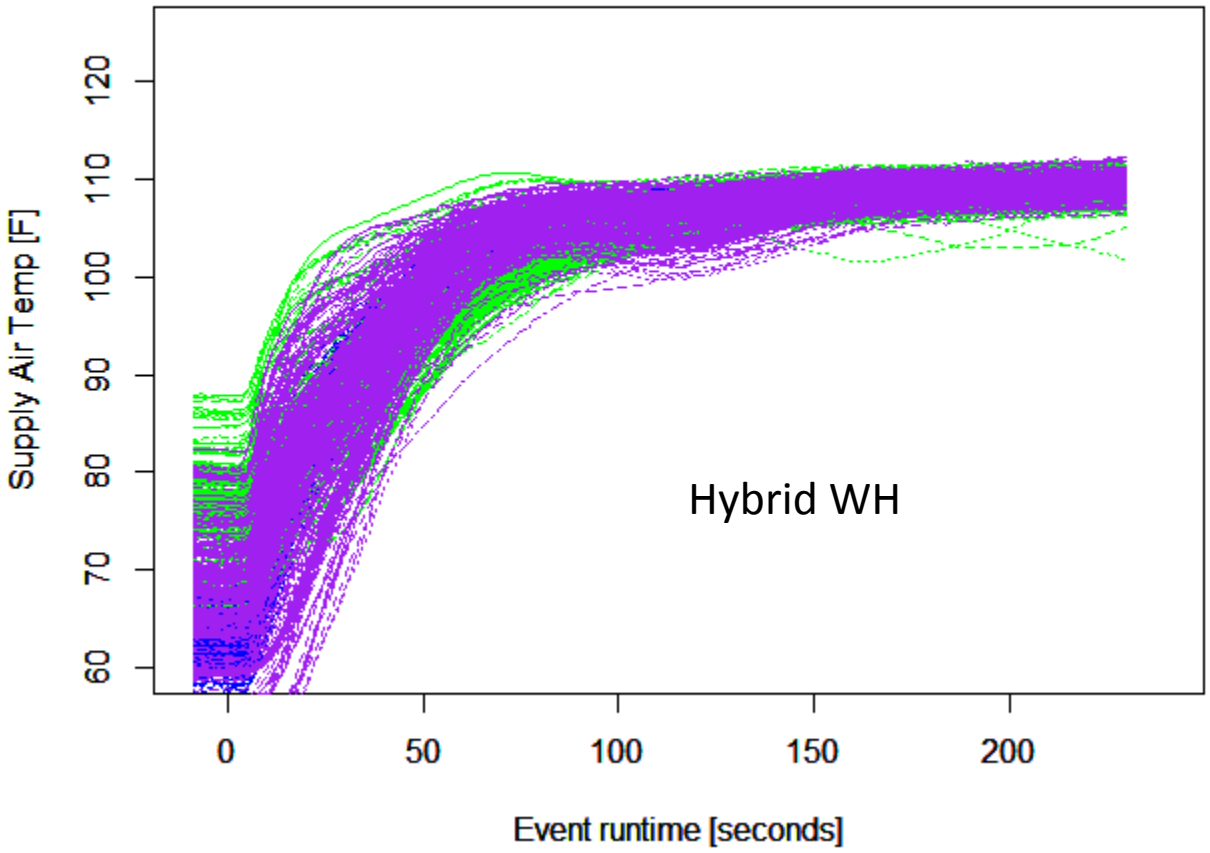




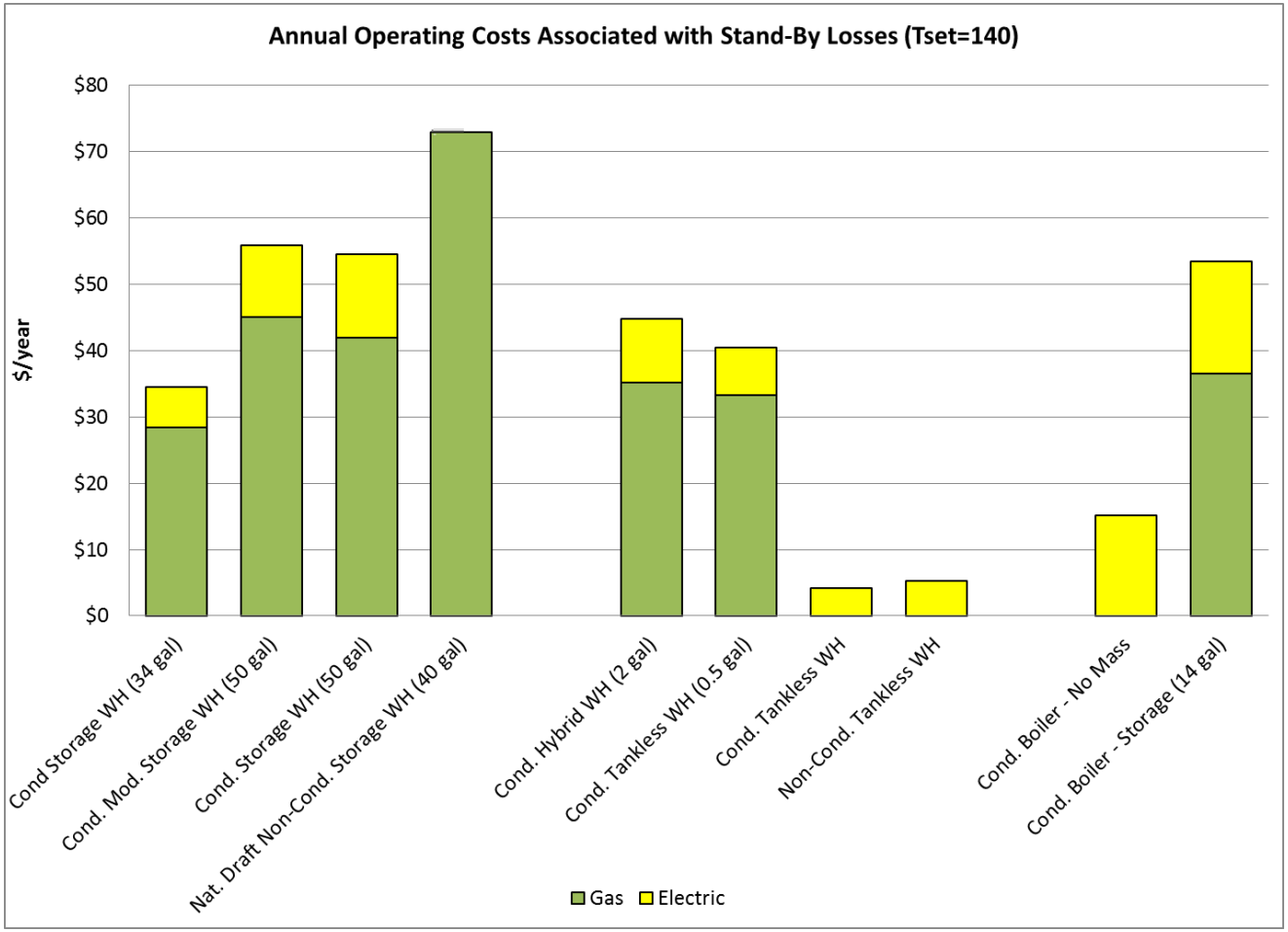




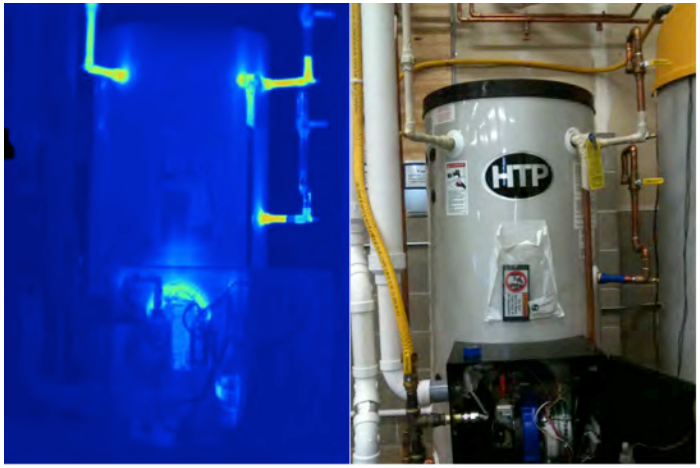
Delivered Air Temperature

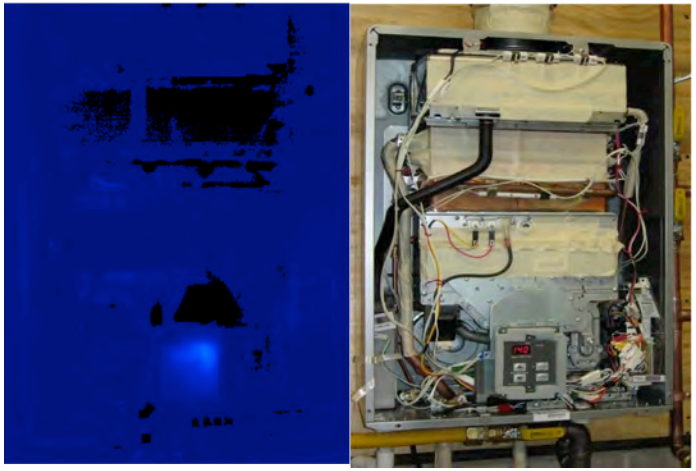


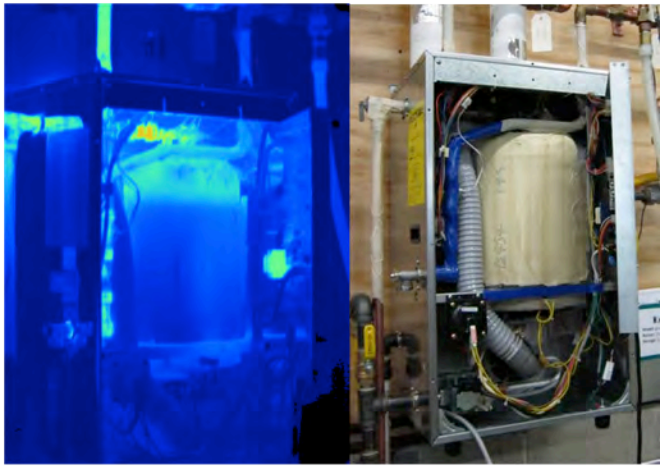
Stand by Loses



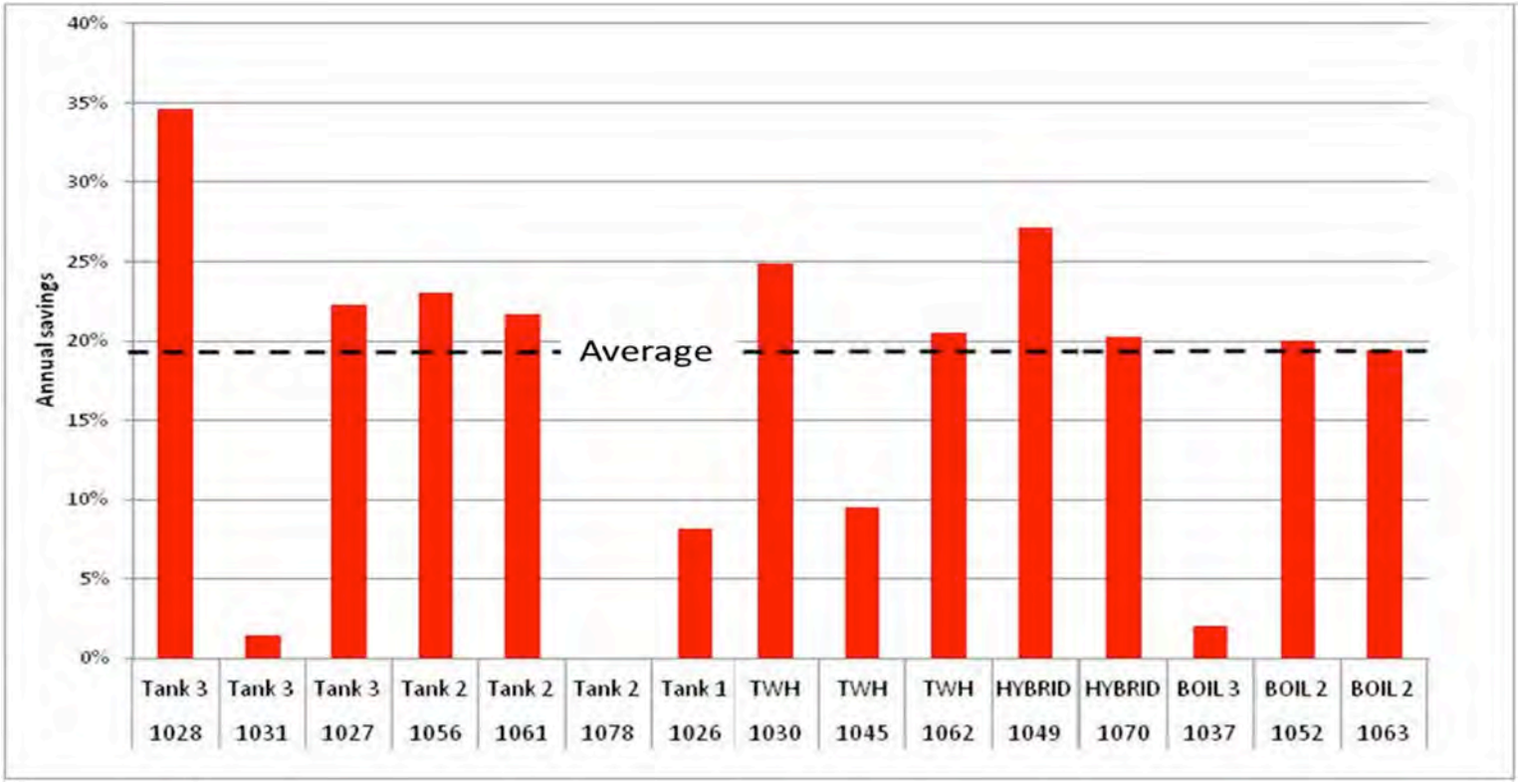
Stand-by Loses





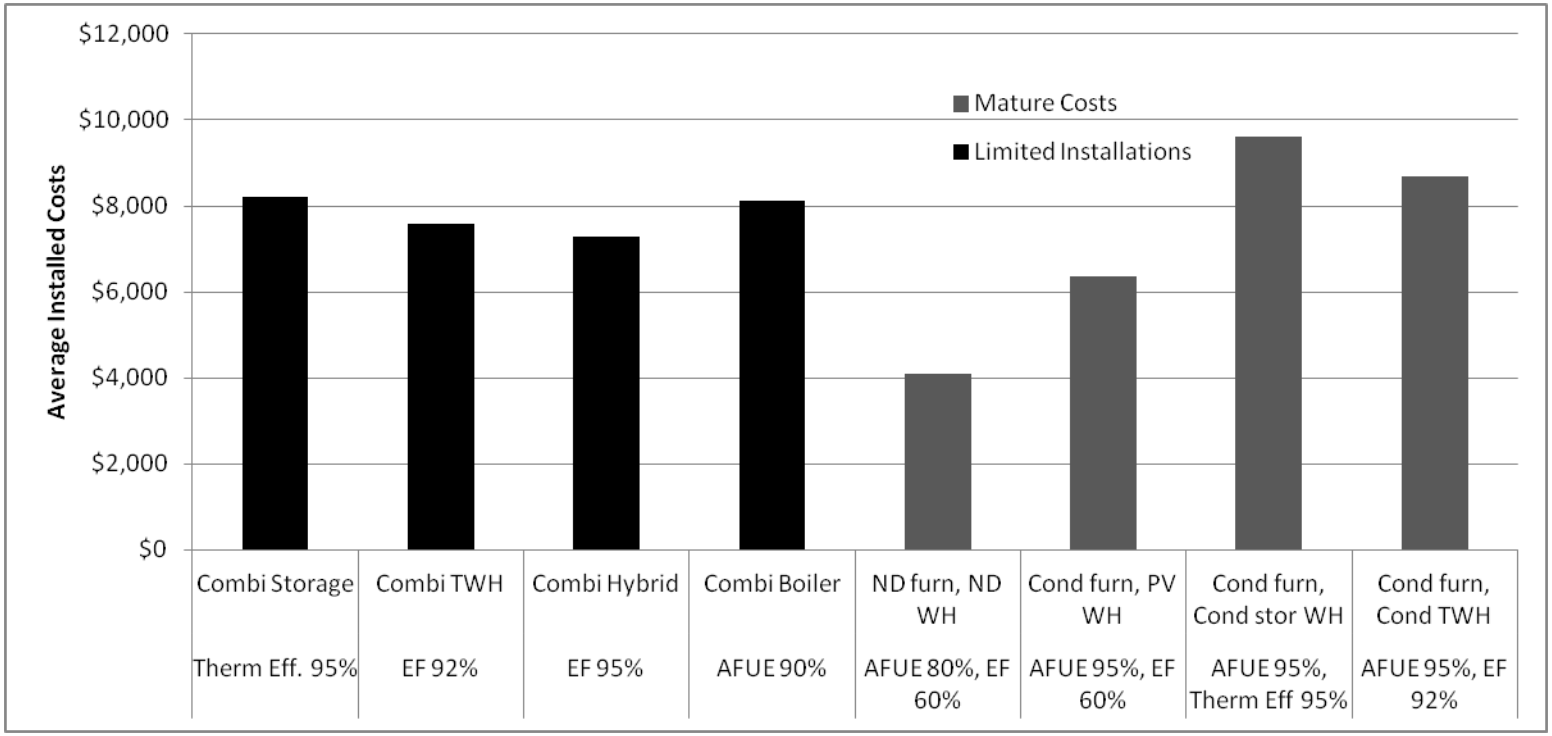


Savings



- From field monitoring

Cost


$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$0
Average Installed Costs
Mature Costs
Limited Installations
Combi Storage
Therm Eff. 95%
Combi TWH
EF 92%
Combi Hybrid
EF 95%
Combi Boiler
AFUE 90%
ND furn, ND WH
AFUE 80%, EF 60%
Cond furn, PV WH
AFUE 95%, EF 60%
Cond furn, Cond stor WH
AFUE 95%, Therm Eff 95%
Cond furn, Cond TWH
AFUE 95%, EF 92%

Controls

- Outdoor reset
- Air handler fan modulation
- Air handler pump modulation
- Load matching
- Set back control for both space and DHW systems

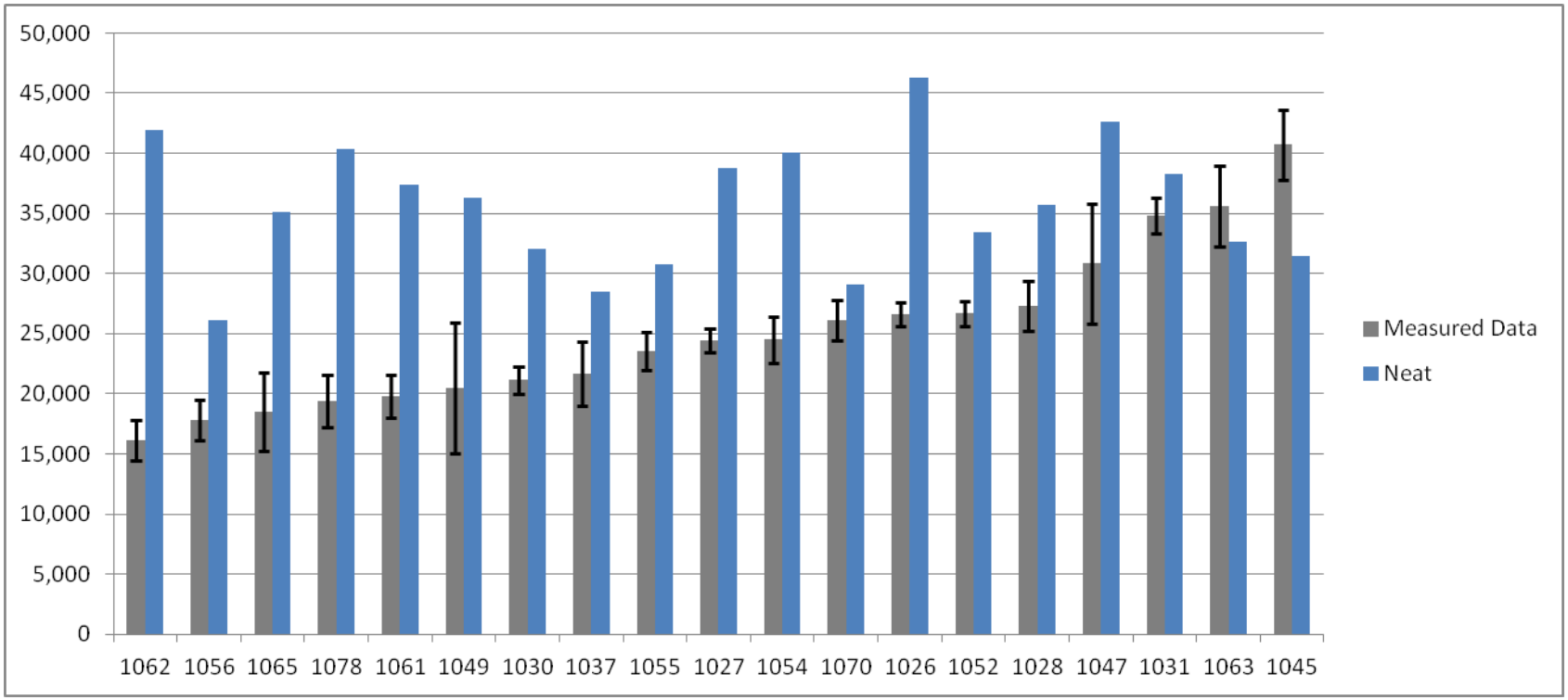
Programs: Lessons Learned

- Assessing the needs of the home and letting that inform the system that is installed
  - number people and showers and how that effects comfort
  - water quality
  - thermostat set points and setbacks
- Code officials
  - ask first, install second!
- Having good contractors
  - learning curve
  - training

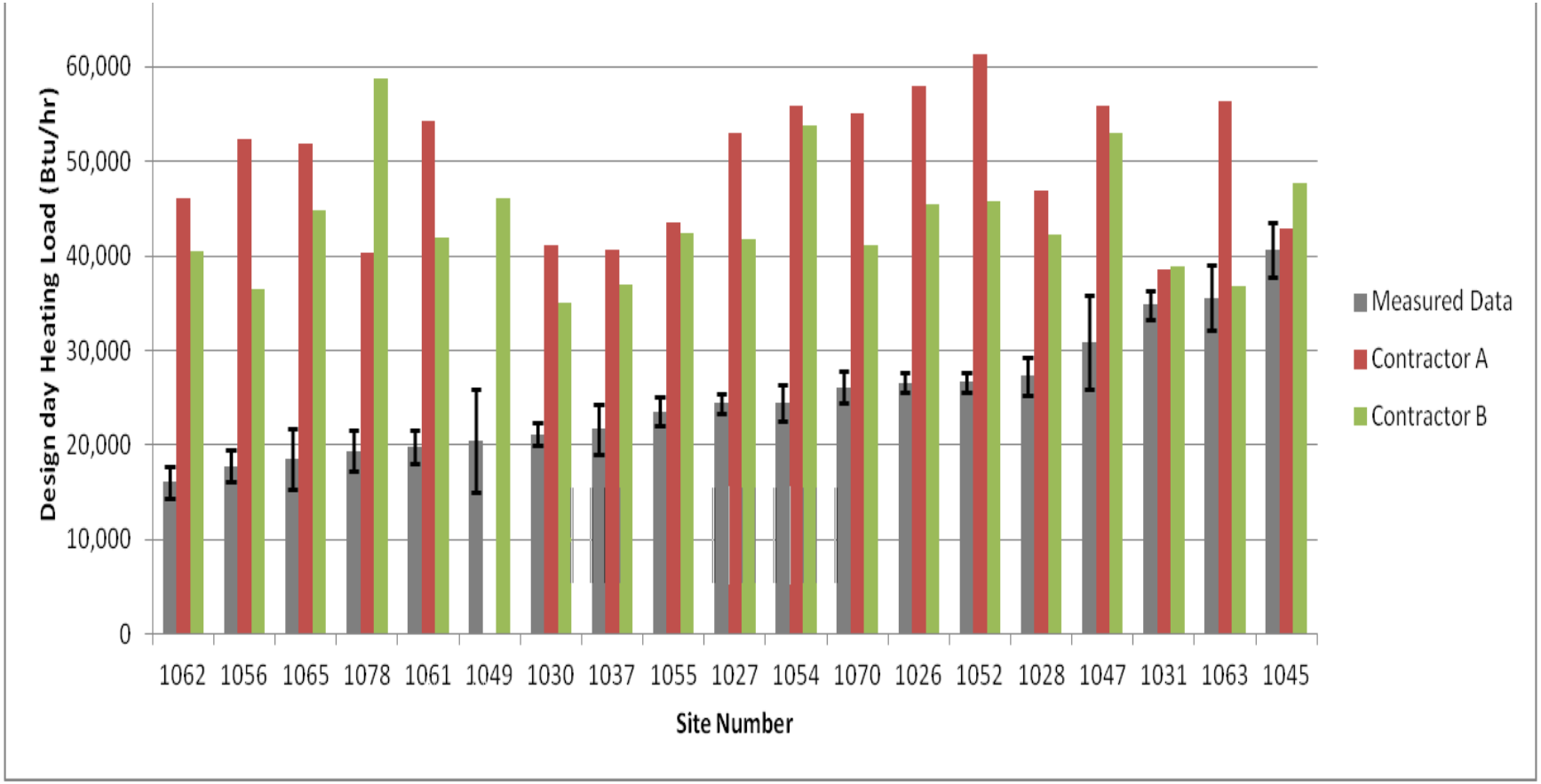
Programs: Lessons Learned

- Bids
  - when do they work?
  - retrofit vs. new build
- The roll of product reps
  - distribution of products
  - technical and warranty assistance
- Ensuring quality of installation
  - equipment specific requirements
  - field verification of installation
  - optimization and maintenance

Calculated versus Actual Load



Calculated versus Actual Load



Conclusions

- These systems can be economically installed with homeowner satisfaction and safety as well as good performance
- Hydronic systems are more common, but high efficiency performance is often overlooked
- Simplicity and durability are key for forced air systems
  - *Storage tanks and oversized air handlers*
- More information available at
  - www.mncee.org/dia

THANK you!

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