FSA 2.0

The New NORA Fuel Savings Analysis Calculator
Energy Efficiency at Your Fingertips!

Dr. Tom Butcher / NORA / BNL
Roger Marran: Energy Kinetics

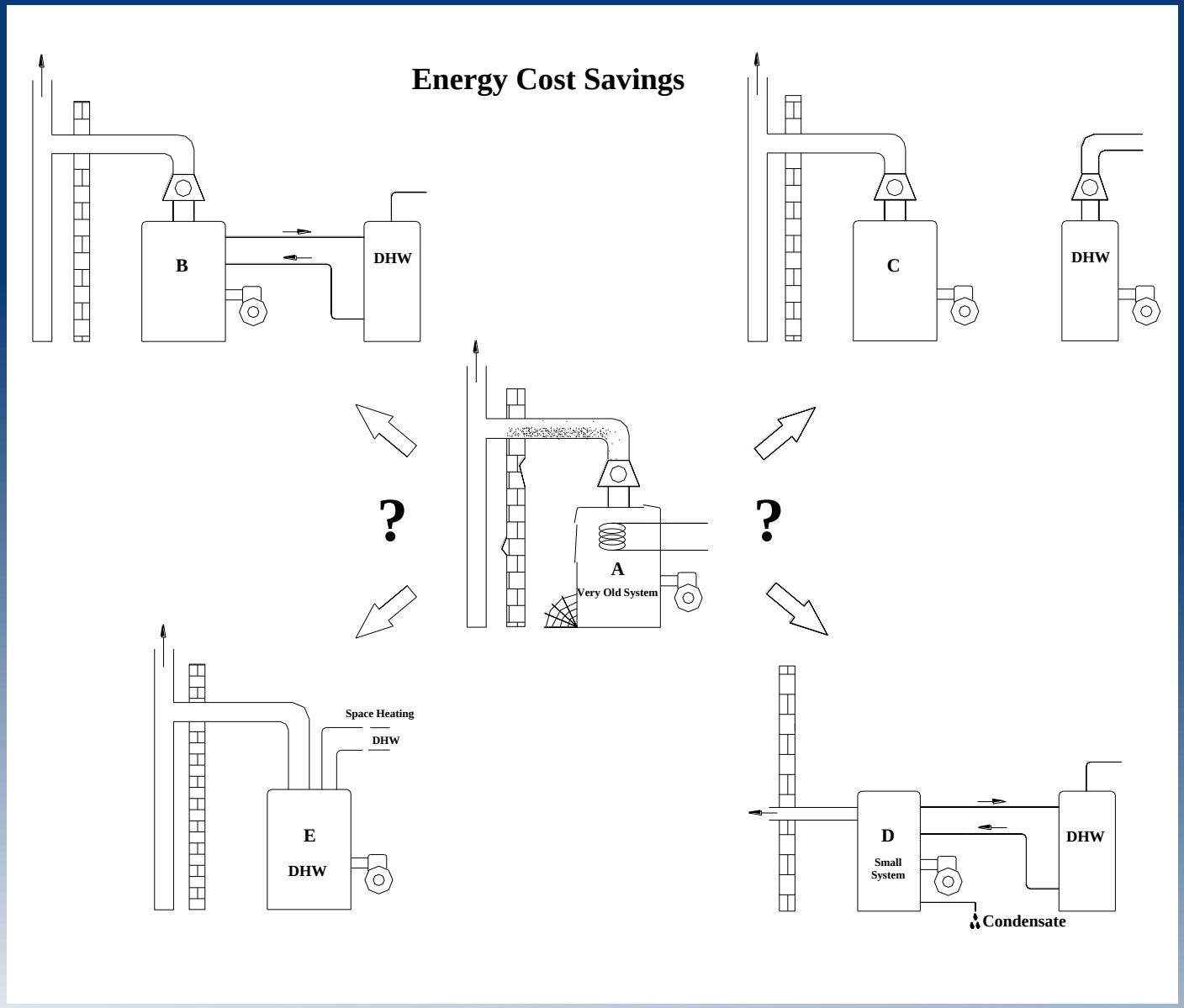
NORA™
NATIONAL OILHEAT RESEARCH ALLIANCE

FSA CALCULATOR 2.0
Fuel Savings Analysis

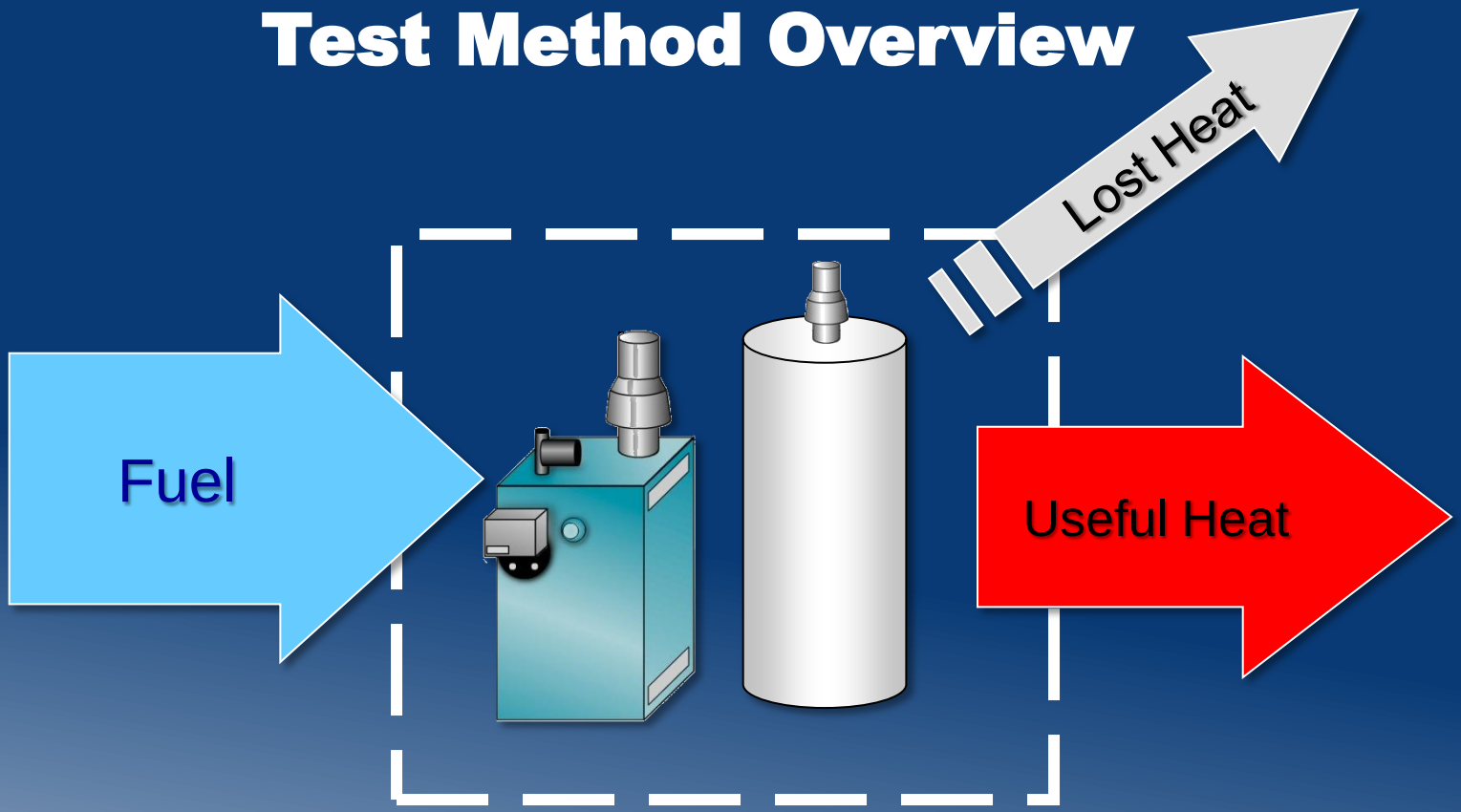
The Science Of Efficiency

- Original motivation – manufacturers of integrated hydronic heating systems were interested in offering improved features, including controls and better insulation, but could not share with consumers the energy savings benefits.
- Experience showed that achieved fuel savings in the field were greater than AFUE (heating only) showed.
- In growing field of energy audits and home energy performance, heating system opportunities were being overlooked.

Goal of the BNL Measurement Project



Test Method Overview



Intermittent through Full Load Testing

$$\text{Delivered Efficiency} = \frac{\text{Useful Heat}}{\text{Fuel Consumed}}$$

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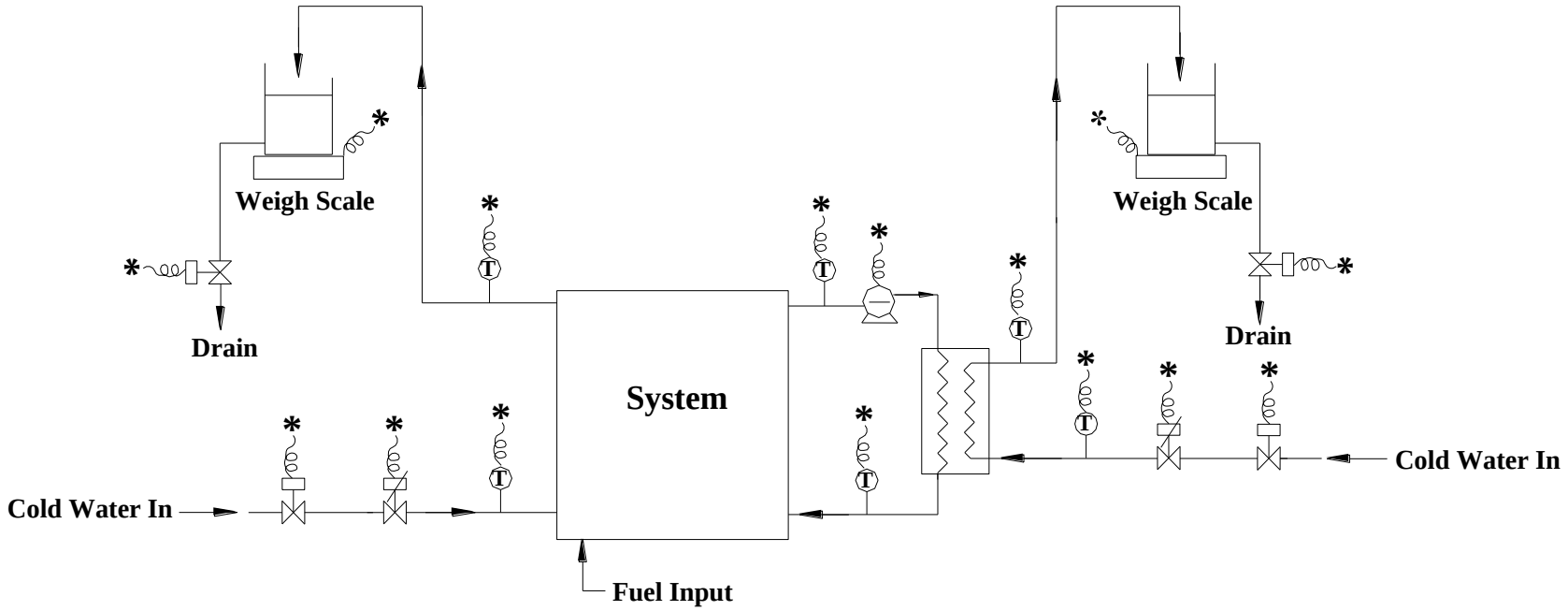
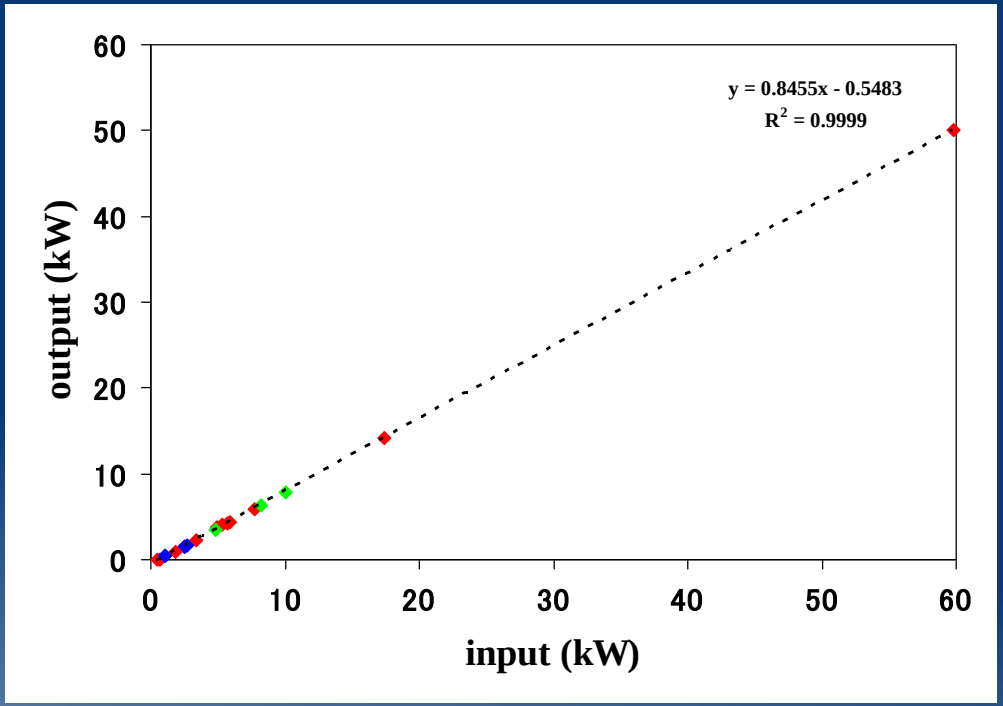
Test Method



* To Data Acquisition / Control System

Output results

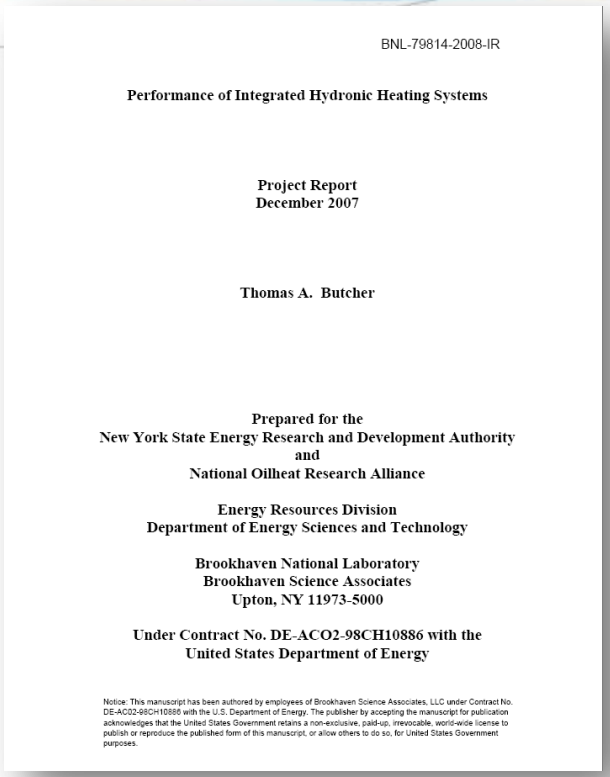


Key Results:

- Idle Loss
- Steady State Thermal Efficiency

Performance of Integrated Hydronic Heating Systems

DECEMBER 2007



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Performance of Integrated Hydronic Heating Systems

Project Report
December 2007

Thomas A. Butcher

Prepared for the
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and
National Oilheat Research Alliance

Energy Resources Division
Department of Energy Sciences and Technology

Brookhaven National Laboratory
Brookhaven Science Associates
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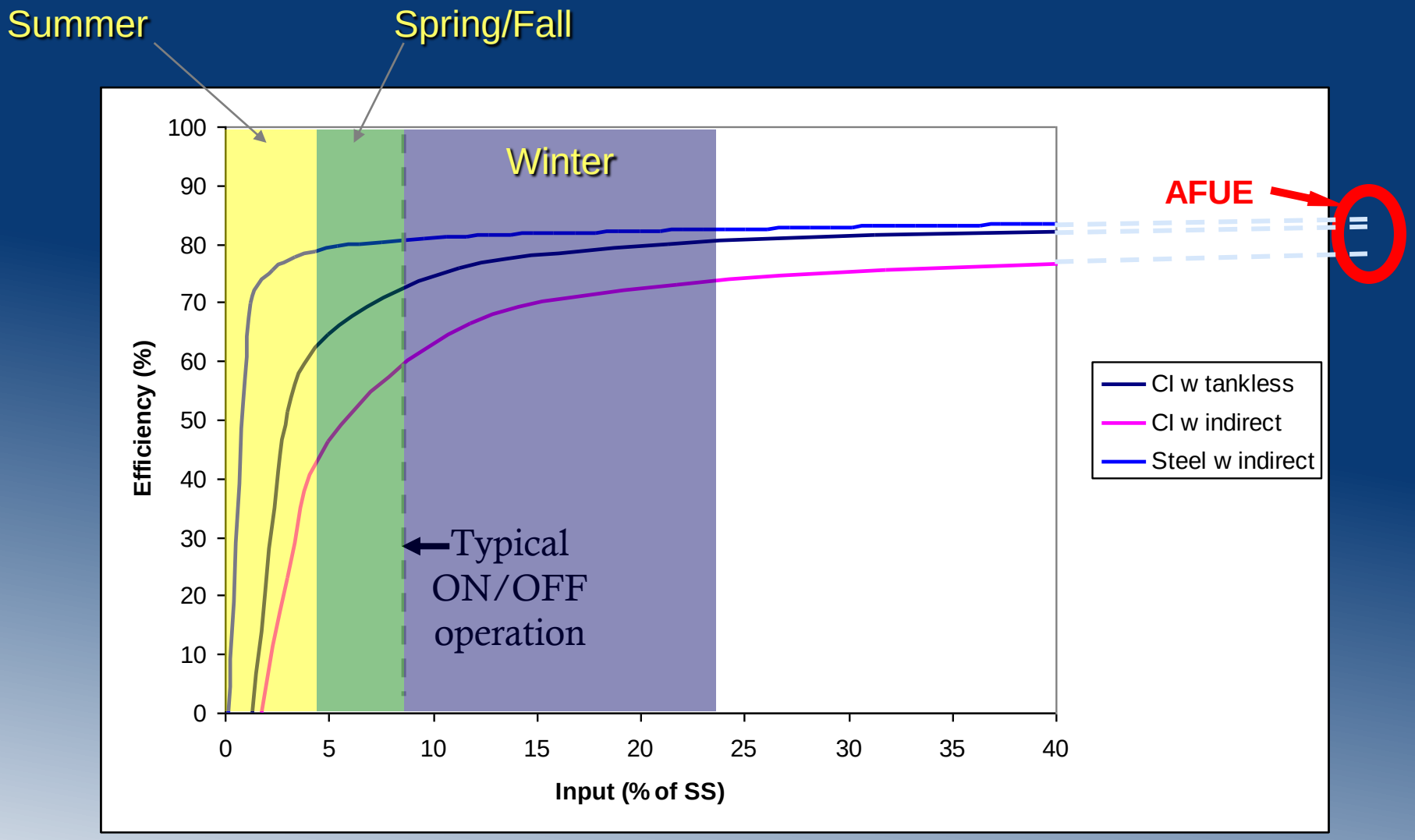
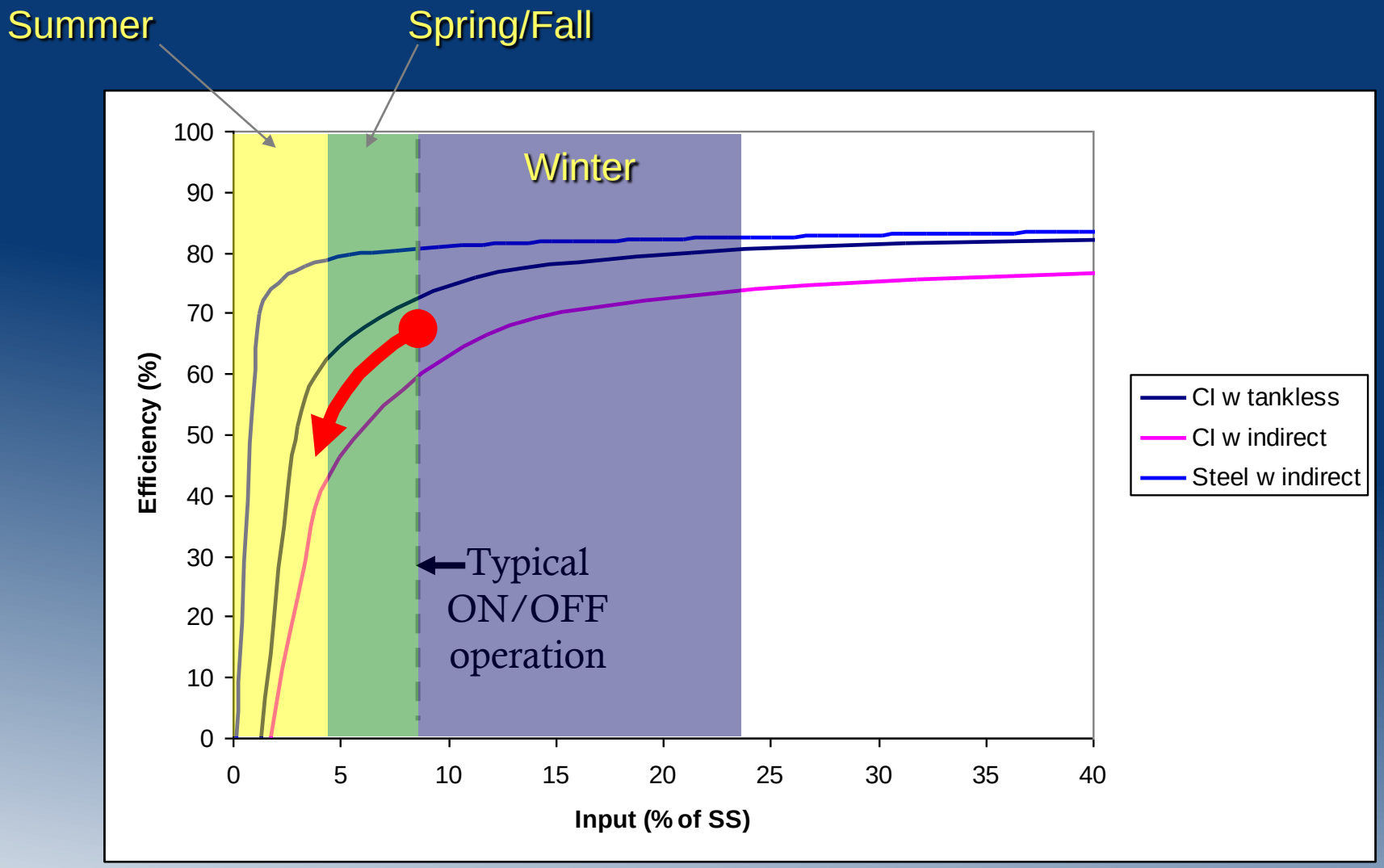
http://www.osti.gov/bridge/purl.cover.jsp?purl=/924431-kio3fU/

Three Systems With Comparable AFUE



Three Systems With Comparable AFUE



Oversizing virtually eliminated.

Table of Results

Table 3. Results of Analysis of Annual Performance with Each Unit

Unit	Description	Steady State Thermal Efficiency (%)	Idle Loss (%)	Annual Efficiency[1] (%) Oversize = 2	Annual Efficiency[1](%) Oversize = 3	Summer DHW oil use (gal) Oversize = 2	Annual Oil Use (gal)[2] Oversize =2
1	Oil, cast iron boiler with tankless	83.7	1.2	77.9	74.9	.54	897
2	Oil, cast iron boiler with indirect	78.4	2.1	72.9	65.1	.74	1007
3	Oil, steel boiler with purge control	86.5	.15	85.7	85.3	.36	816
4	Oil condensing boiler	92.0	1.5	84.2	80.3	.54	830
5	Oil, well insulated cast iron	87.5	.69	84.4	82.7	.42	828
6	Oil, water heater used also for heating	81.5	1.2	75.9	73.0	.56	921
7	Oil, combi System	79.5	.8	75.8	73.8	.51	923
8	Gas atmospheric with tankless	72.5	1.7	65.6	62.2	.72	1065
9	Gas atmospheric water heater	74.5	.65			.51	976
8+9	Gas boiler + separate gas water heater			66.6	64.7	.51	1081
10	Old cast iron boiler	72.8	2.1	64.5	60.4	.79	1085
11	Gas cond. modulating	88.5	.60	85.3	83.6	.42	819
12a	tankless mode	78.0	4.87	60.0	52.9	1.22	1165
12b	indirect mode	78.0	1.16	72.8	70.1	.57	960

1. Based on oversize factor stated, not actual firing rate tested.

83.5 AFUE tankless coil (poorest performing)

87.5 AFUE steel boiler with purge control (best performing)

Upgrade from 52.9% to 85.3% yields 38% savings

Dept. of Energy NODA oversizing analysis:
Oilheat: 3x oversized
Natural Gas: 4x oversized

Additional savings not addressed in these figures may result from sealed combustion systems without draft regulators or draft diverters, and from upgrades from systems with greater oversizing to systems with lower idle loss.

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4	Oil cond boiler						
5	Oil, well in cast iron						
6	Oil, water used also heating						
7	Oil, combi S						
8	Gas atmosph with tankless						
9	Gas atmos water heater						
8+9	Gas boile separate gas heater						
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These results reveal an untapped potential for consumers and our industry

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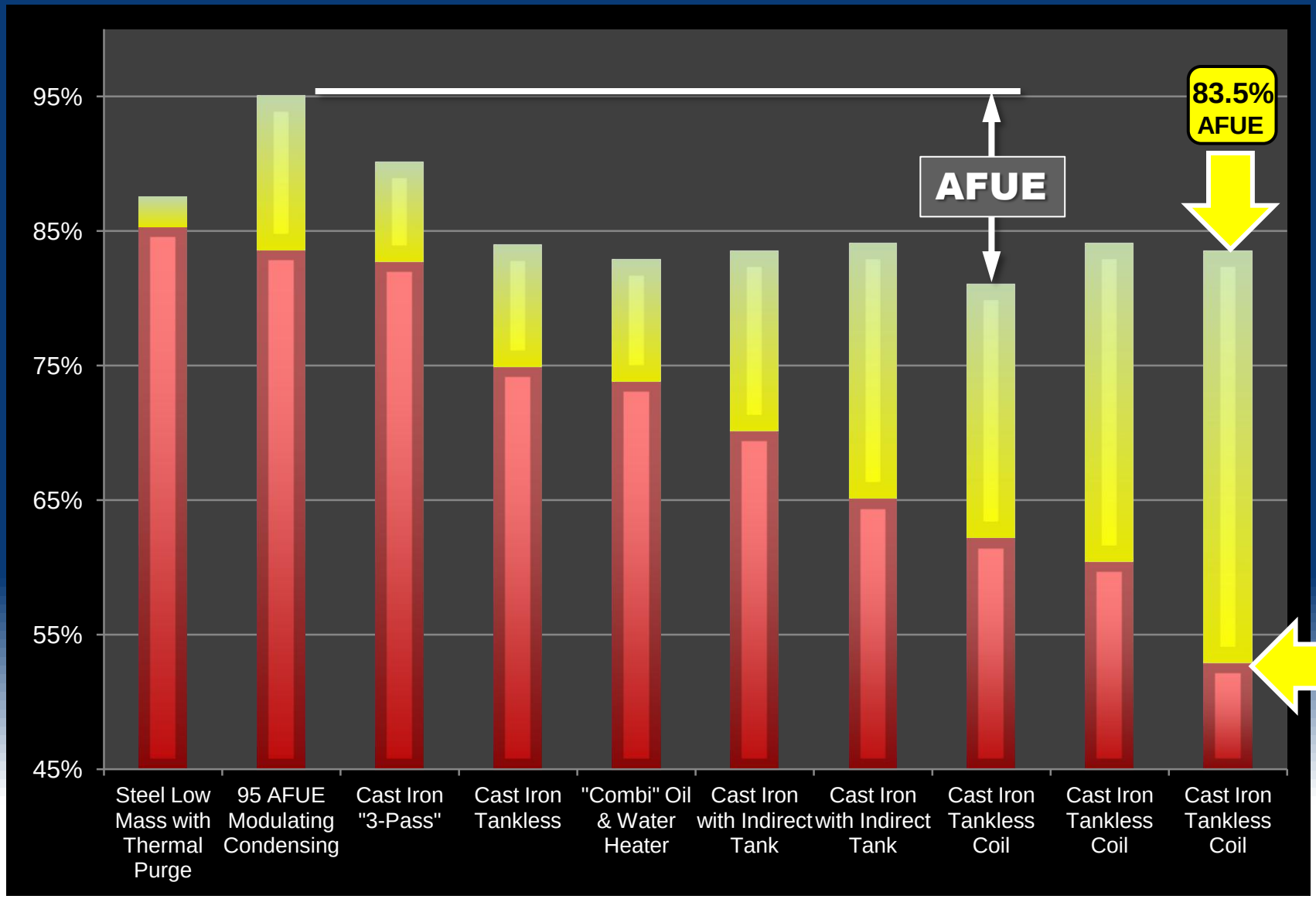
NYSERDA interest in a Better Way to Identify Idle Loss

Field Characteristics Existing Equipment New Equipment

Energy Kinetics CSG NYSERDA BNL

A Field Approach: Estimate Idle Loss Using Equipment Characteristics

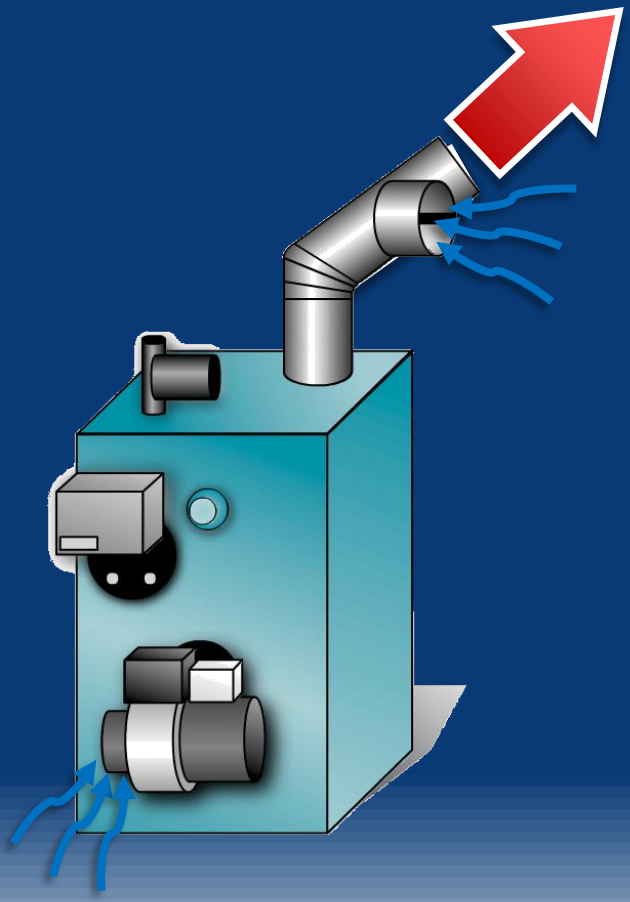


Systems with Similar AFUE and Combustion Efficiency may have very Different Annual Efficiency

A practical example demonstrating idle loss impact:

Outdoor Reset Controls

Idle Loss vs. AFUE and Combustion Efficiency



Stack loss measure based on:

1) Temperature
2) CO_2 or O_2

For example:

500 pounds
12 gallons of water
Cold start to 180ºF
Heats up in ~15 minutes

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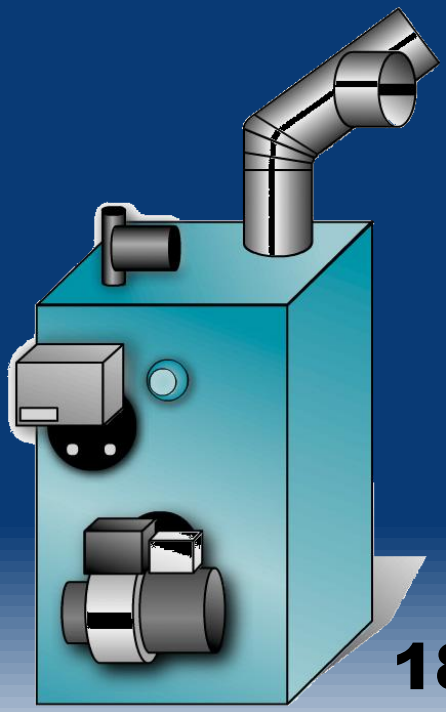
What Is The Combustion Efficiency?



NET STACK TEMPERATURE °F													
200	250	300	350	400	450	500	550	600	650	700	750	800	%CO2
89.6	88.4	87.3	86.2	85.1	84.0	82.9	81.7	80.6	79.5	78.4	77.3	76.2	14.7
89.4	88.2	87.0	85.9	84.7	83.6	82.4	81.2	80.1	78.9	77.7	76.6	75.4	14.0
89.2	87.9	86.7	85.5	84.3	83.1	81.9	80.7	79.4	78.2	77.0	75.8	74.6	13.2
88.9	87.7	86.4	85.1	83.8	82.6	81.3	80.0	78.7	77.5	76.2	74.9	73.6	12.5
88.7	87.3	86.0	84.6	83.3	82.0	80.6	79.3	77.9	76.6	75.3	73.9	72.6	11.7
88.4	87.0	85.5	84.1	82.7	81.3	79.9	78.5	77.0	75.6	74.2	72.8	71.4	11.0
88.0	86.5	85.0	83.5	82.0	80.5	79.0	77.5	76.0	74.5	73.0	71.5	70.0	10.3

About 1% better efficiency?

Temperature reset controls can save because of reduced idle loss

180° F Supply

400° F Stack

11% CO_2

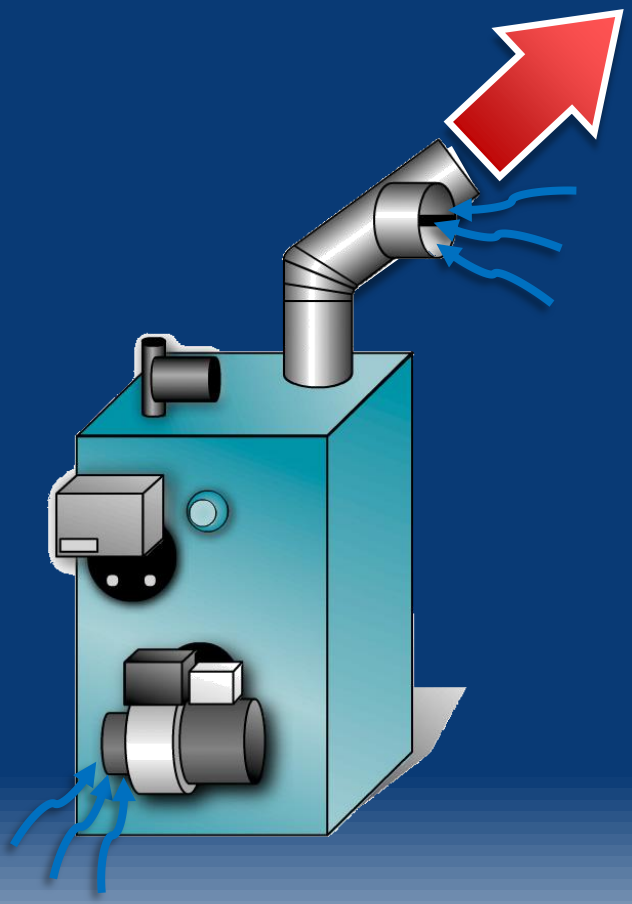
Temperature Reset

130° F Supply

350° F Stack

11% CO_2

Idle Loss



Temperature reset can save 5% to 10% by reducing idle loss

15 minutes to 180˚ F
10 minutes to 130˚ F

Up to five minutes less burner run time ‘Idle Loss’

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Modeling Idle Loss based on System Test Results In BNL Study

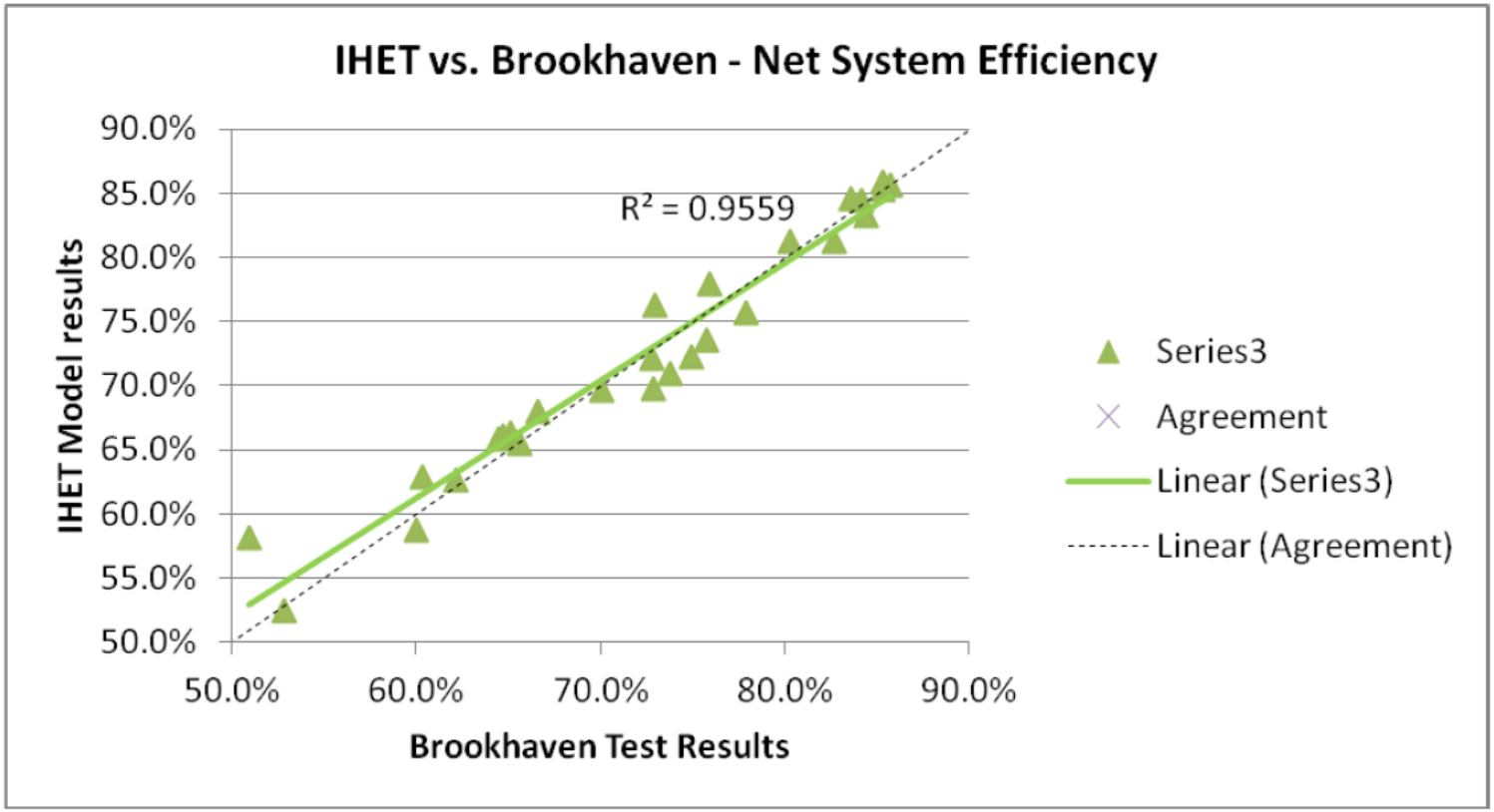


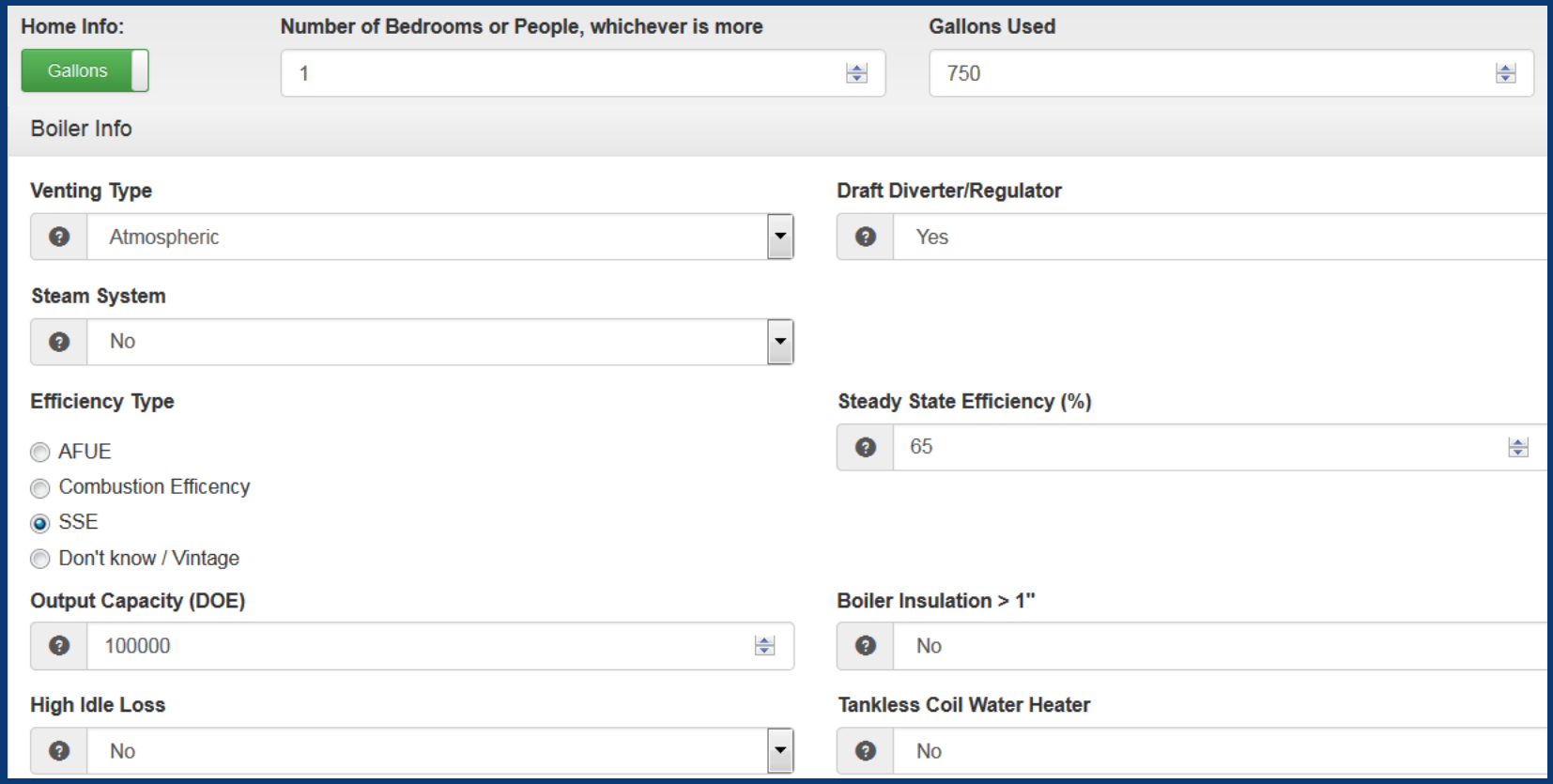
Figure 1. Comparison of IHET to Brookhaven lab test results

The mean absolute error of the group is 2.3% using a series of questions to characterize the systems tested.

Questions are Easy for Tech to Answer

FSA 2.0 shown using IHET Tool Engine

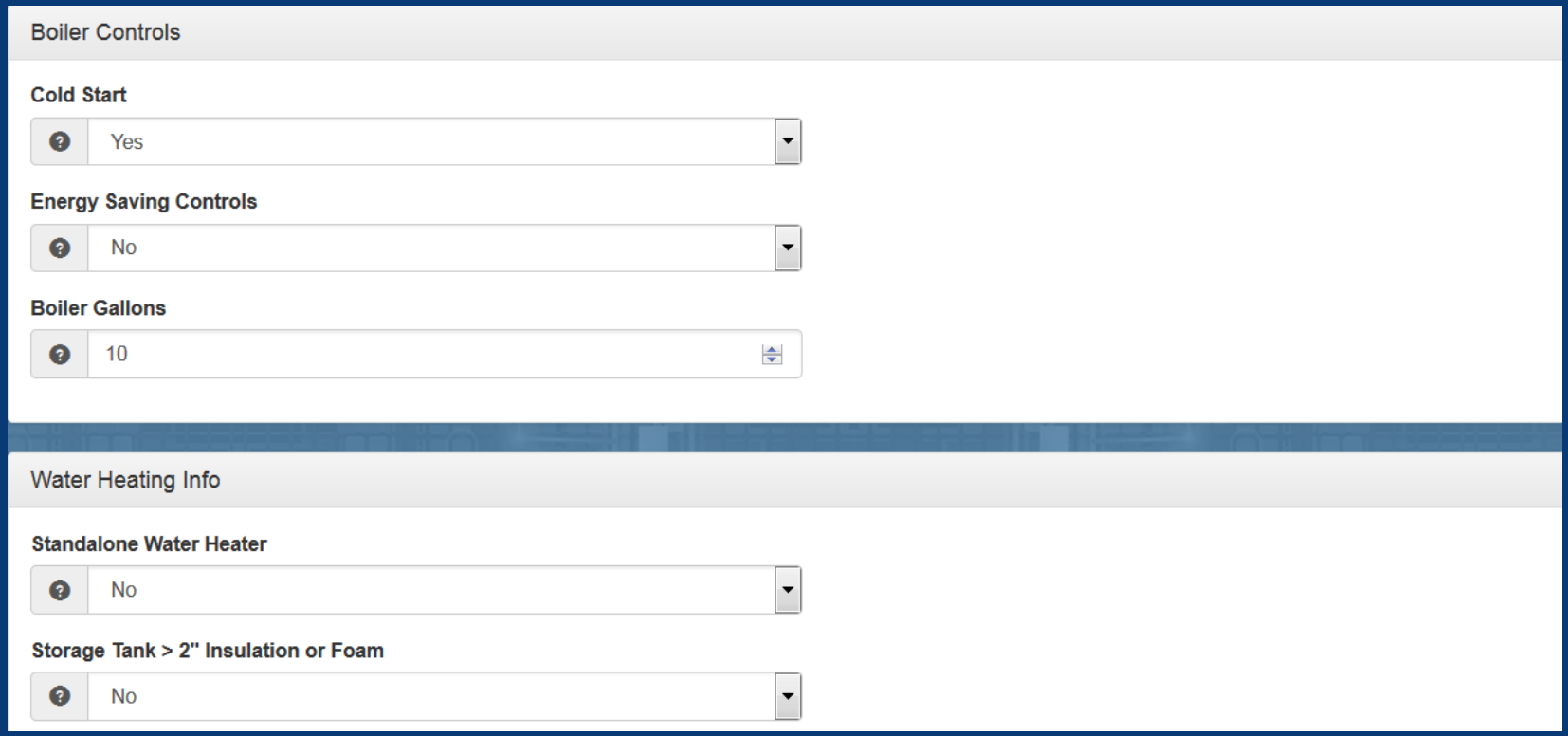
- Home Information
- Boiler Information



Tankless Coil Boilers consuming a firing rate per day in summer usually have the high idle loss characteristic.

Additional Questions

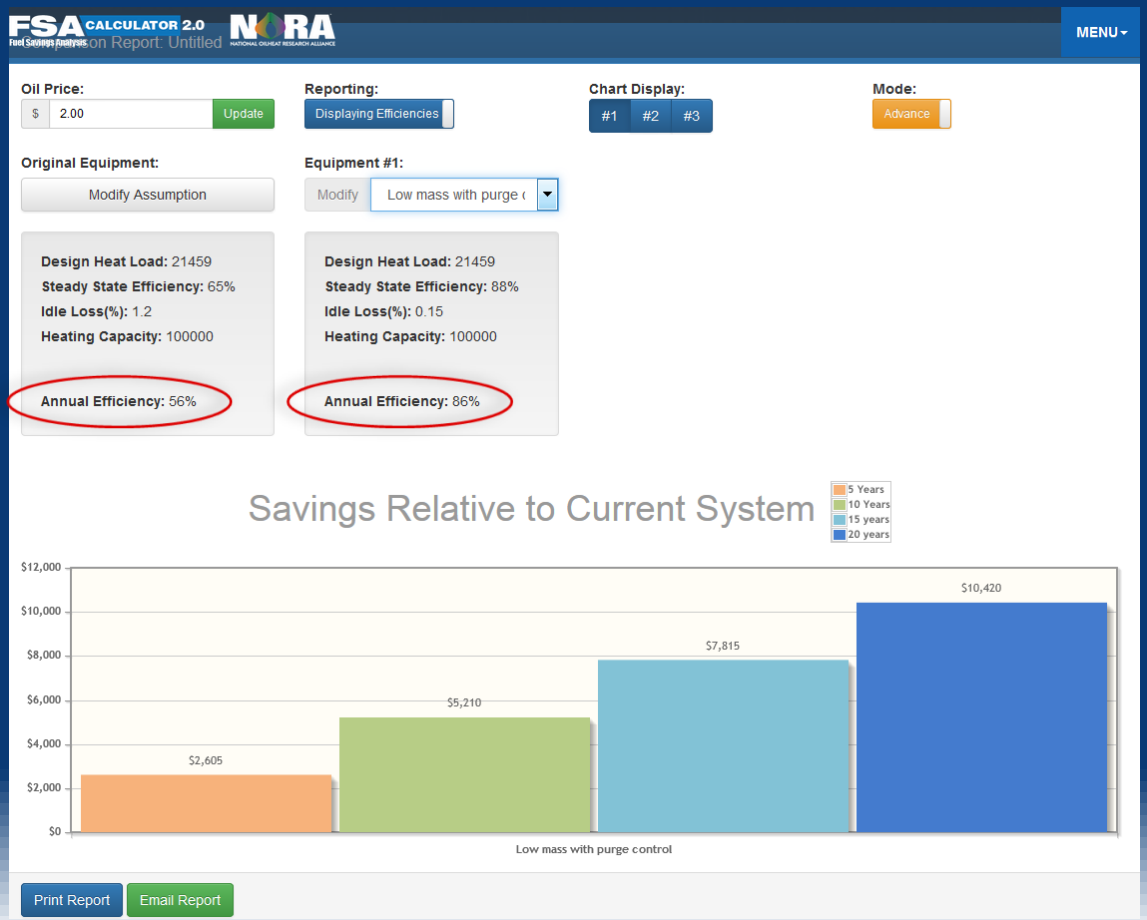
- Boiler Controls
- Water Heating Information



Answering the Questions Models Efficiency

A direct load emulation approach based on the TMY3 weather site, and a bin analysis is used to determine the annual performance.

Existing 65% Combustion Efficiency: 56% Annual Efficiency
Low Mass Thermal Purge 88% AFUE: 86% Annual Efficiency



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Q&A

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