Potential to Reduce Building Heating Energy Use

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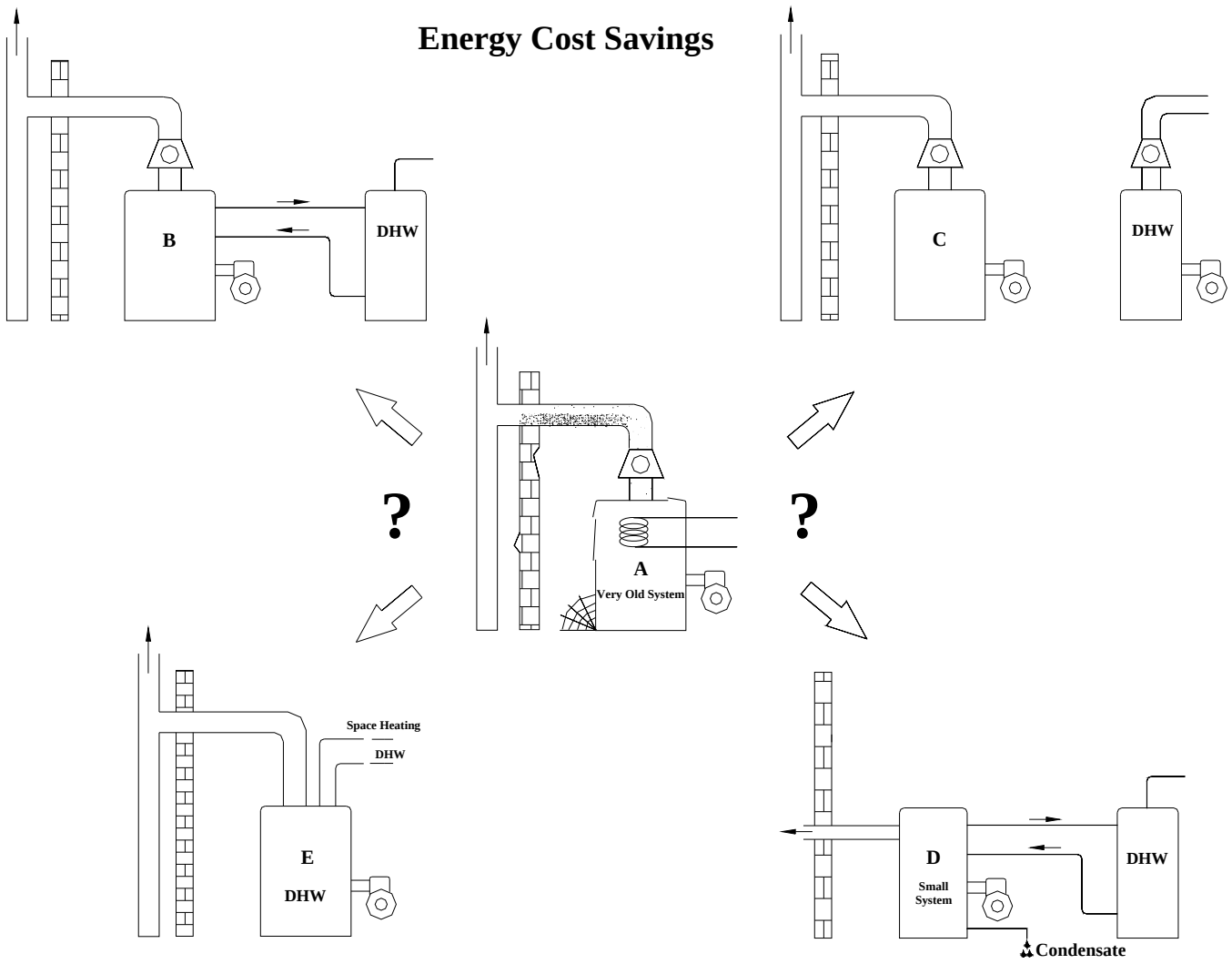
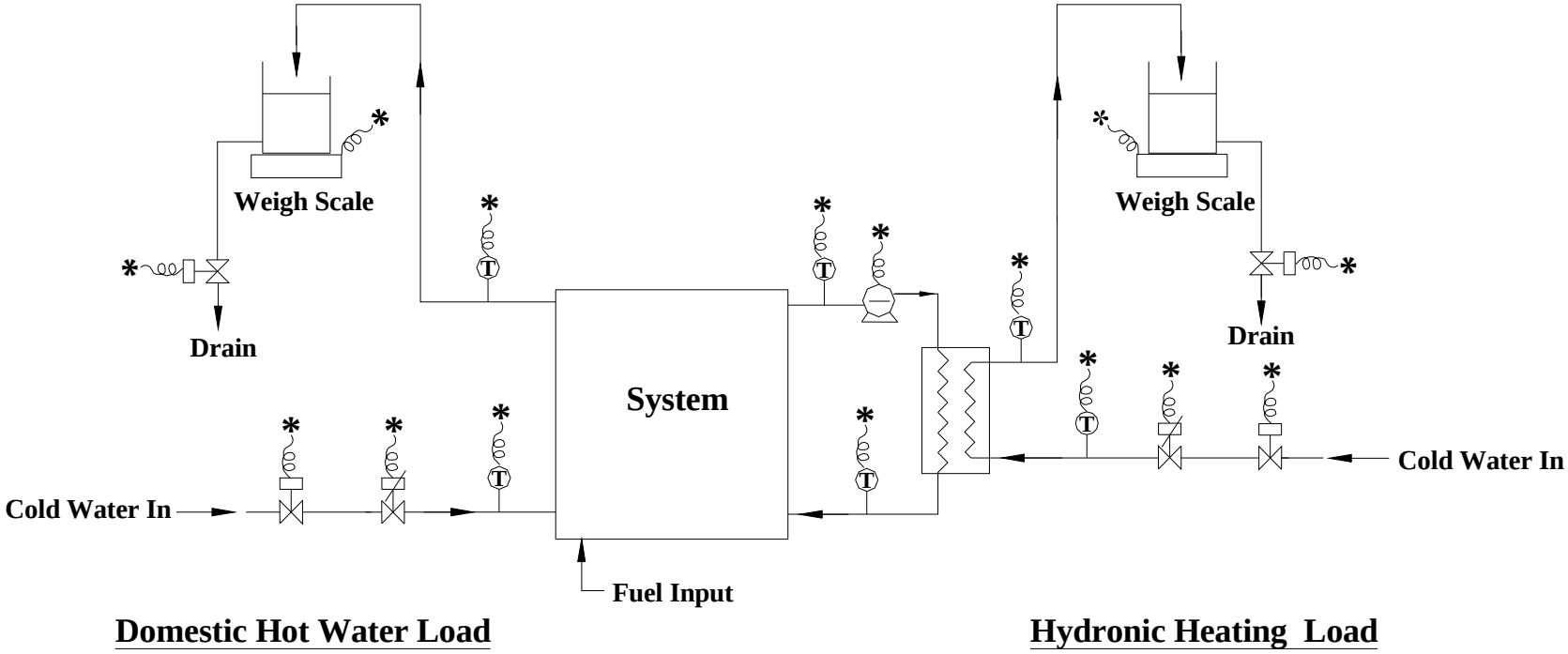
BROOKHAVEN NATIONAL LABORATORY
a passion for discovery

Office of Science
U.S. DEPARTMENT OF ENERGY

Integrated Hydronic Heating Systems

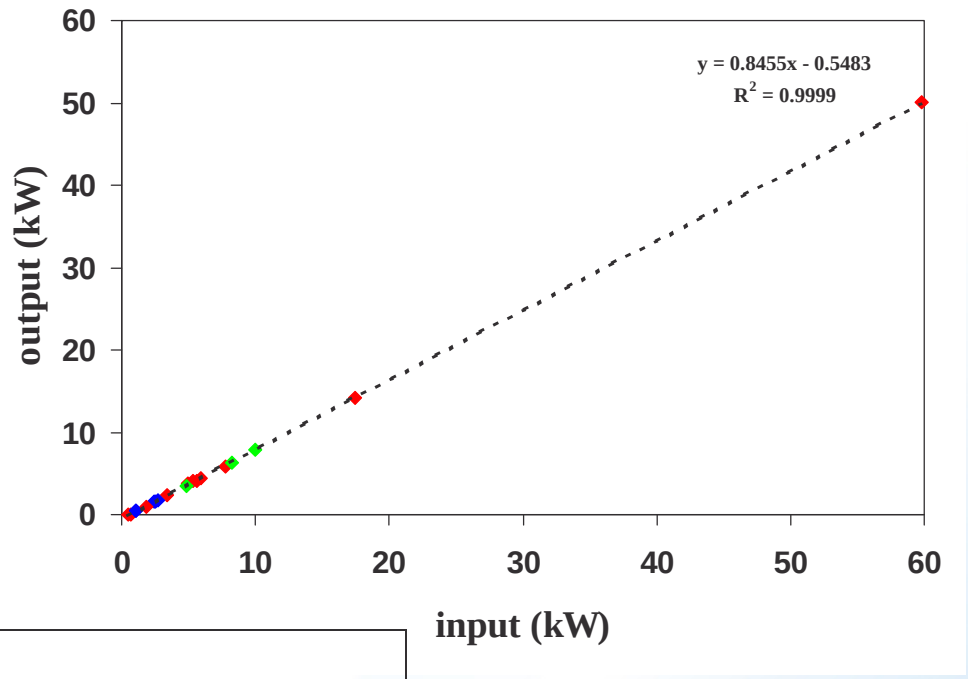


Test Method



* To Data Acquisition / Control System

Output results



Key Results:

idle loss

steady state thermal efficiency

Summary of Basic Results (1/2)

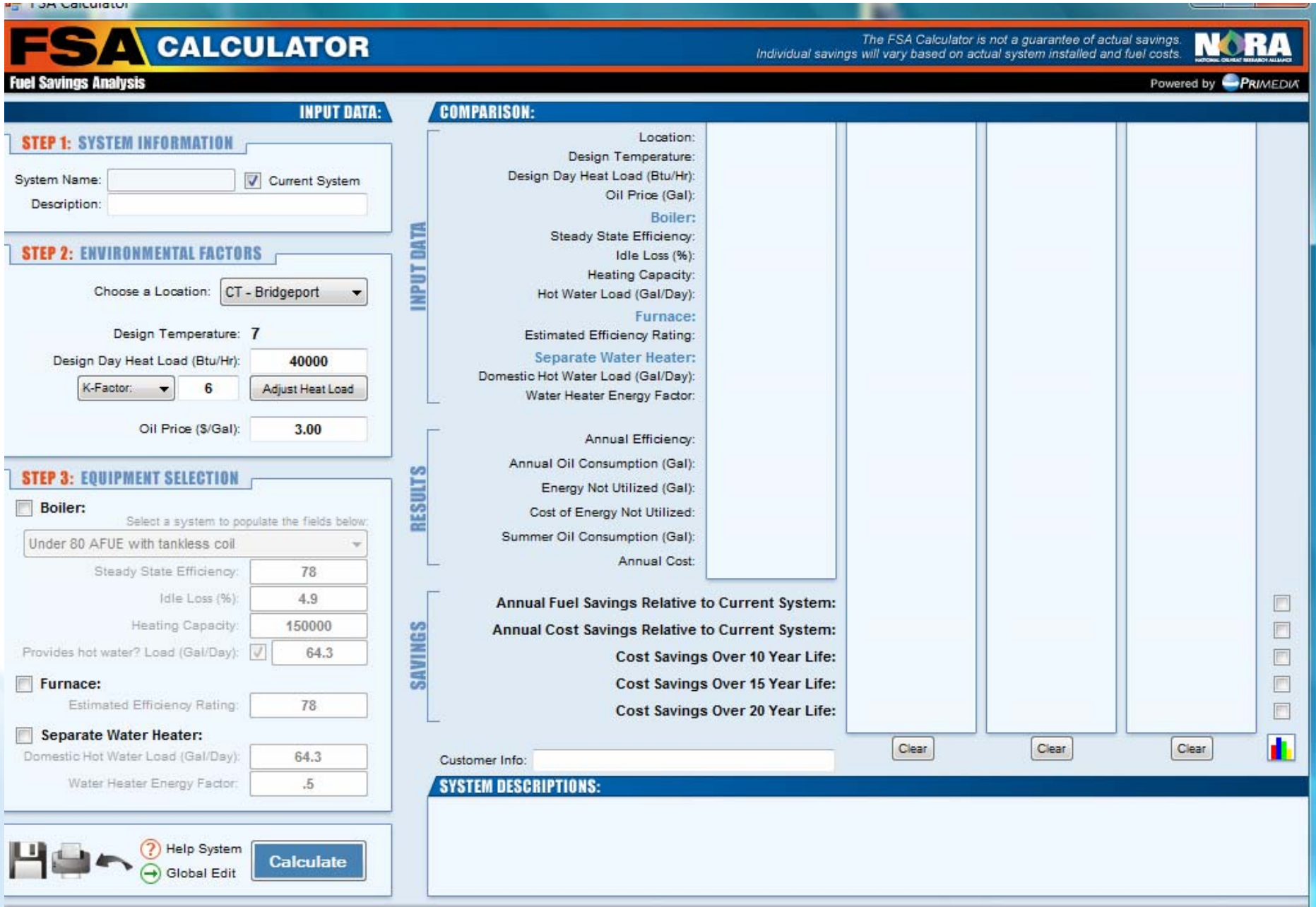
Summary of all basic test results. Part 1

Unit	Description	Steady State Thermal Efficiency (%)	Combustion Efficiency (%)	Idle Loss (%)	Summer domestic hot water efficiency (%)
1	Oil, cast iron boiler with tankless	83.7	85.5	1.2	40.6
2	Oil, cast iron boiler with indirect	78.4	84.6	2.1	38.3
3	Oil, steel boiler with purge control	86.5	88.1	.15	74.9
4	Oil condensing boiler	92.0	95	1.5	55.4
5	Oil, well insulated boiler	87.5	88.3	0.60	68.3
6	Oil, water heater used also for heating	81.5	83.9	1.2	57.1

Range of Results

- Thermal Efficiency – 72.8 –93.6%
- Idle Loss – 0.15 to 4.9 %

Calculator Tool



Example Results for Long Island

Thermal Efficiency	Idle Loss	Annual Efficiency	Annual Oil Use	Reduction from baseline
(%)	(%)	(%)	(gal)	(%)
78	2	58.7	1068	-

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88	.15	80.8	776	27.3

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84	2	63.2	991	7.2
88	2	66.2	946	11.4
88	.15	80.8	776	27.3
93	.15	85.3	735	31.2

Summary of Field Test Results

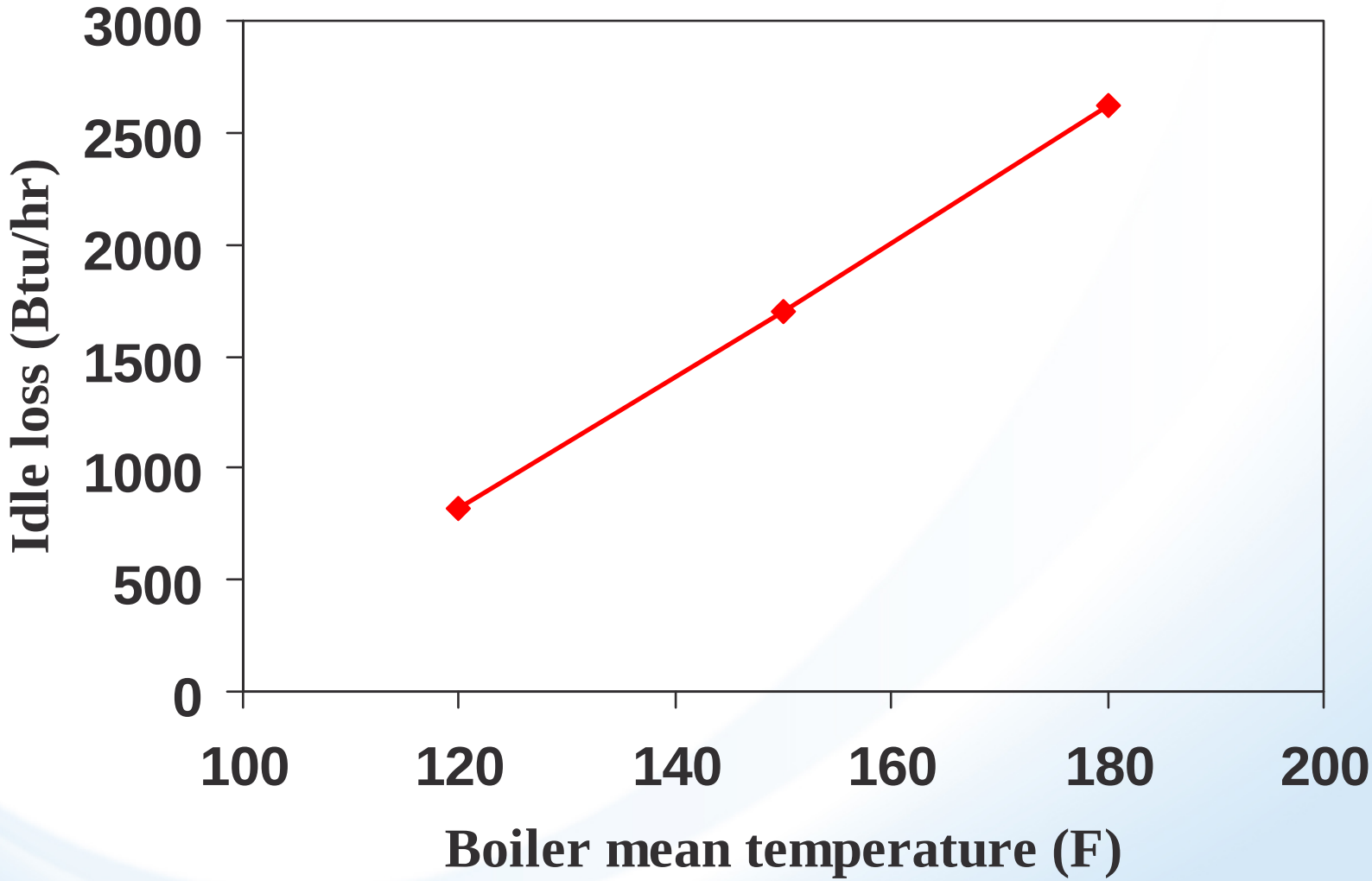
	% Saved
Test house 1	27.3
Test house 2	34.4
Test house 3	22.6
Test house 4	14.7
Test house 5	32.8
Test house 6	18.3
Test house 7	17.8
Test house 8	48.3
Test house 9	30.0
Test house 10	13.1
AVERAGE	**25.9**

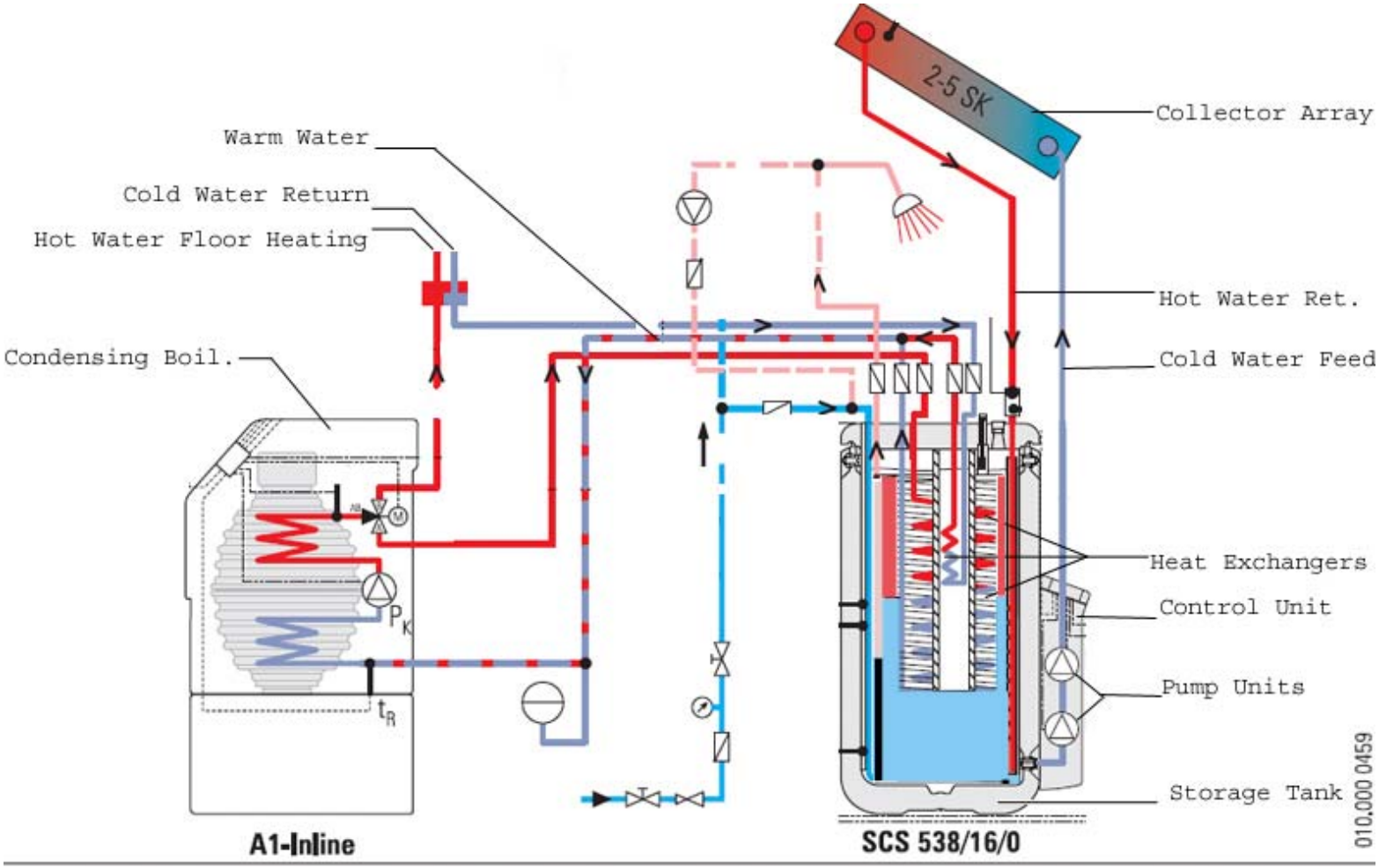
Existing Tankless Coil Boilers

Possible areas for improvement:

- Steady state stack loss
- Heating season cycling loss
- Summer idle energy

Example Idle Loss




2-5 SK
Collector Array
Warm Water
Cold Water Return
Hot Water Floor Heating
Hot Water Ret.
Cold Water Feed
Condensing Boil.
Heat Exchangers
Control Unit
Pump Units
Storage Tank
A1-Inline
SCS 538/16/0
010.000 0459

Solar Demo

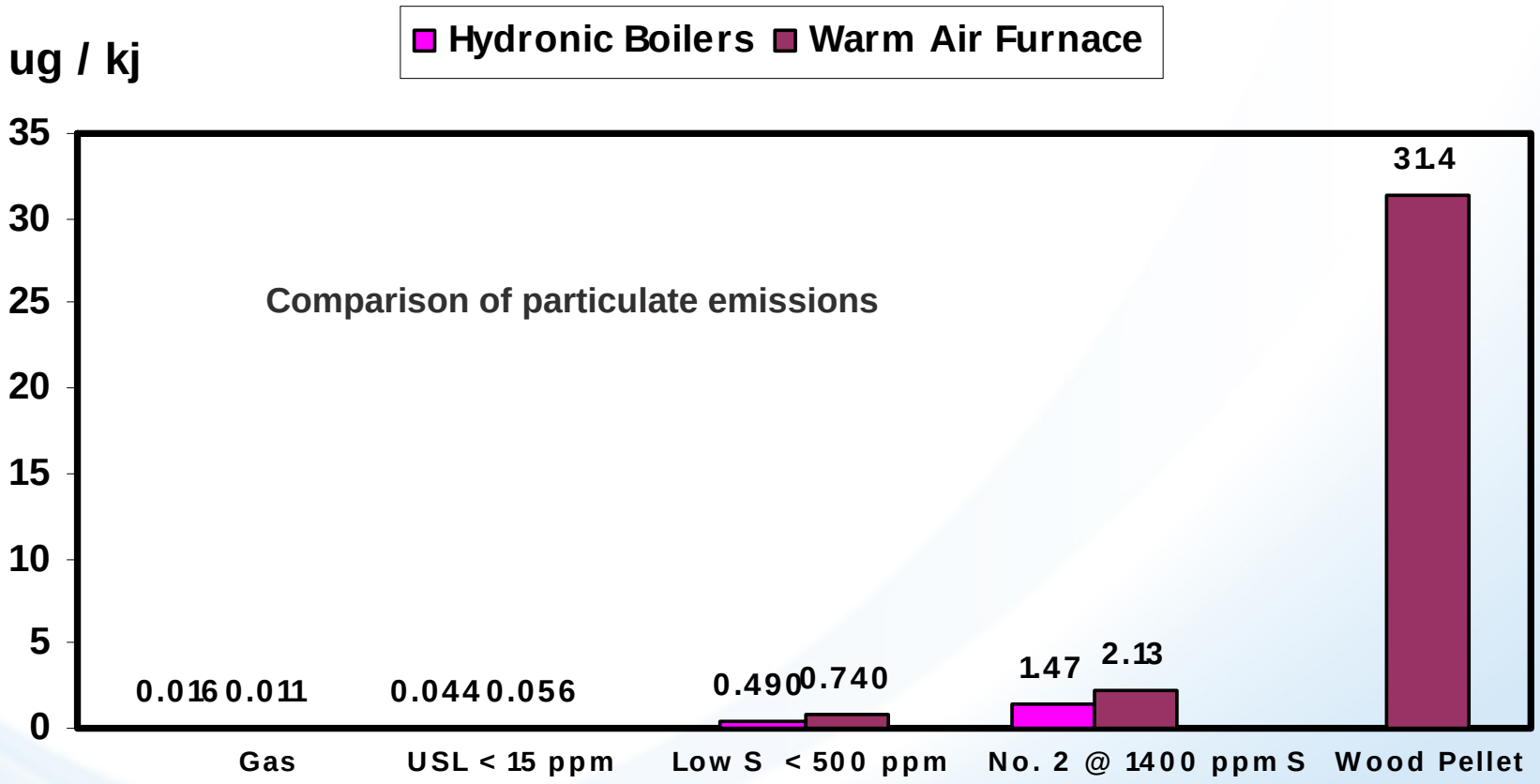
Key features:

Biodiesel fired, condensing boiler

integrated hot water and low temperature heating

Evaluation of residential application

The wood option



microCHP

- home heating systems that produce electric power
- heat led
- very active development world-wide
- generally will not run grid-independent
- 1 kW electric output very common
- several field trials done
- potential primary energy savings ~ 20%

microCHP Technologies

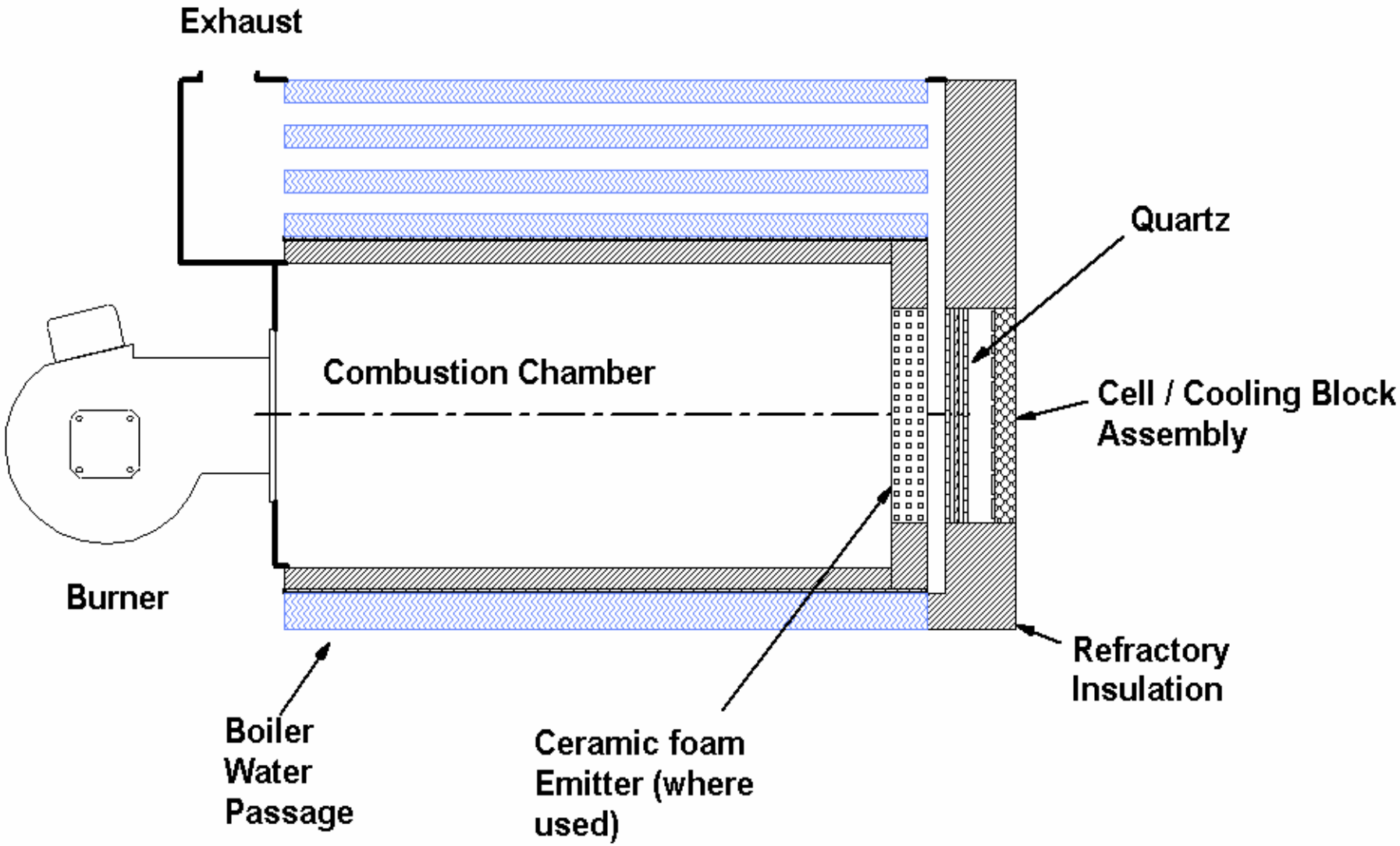
- Internal combustion engines
- Stirling engines
- Rankine engines
- PEM fuel cells
- Solid oxide fuel cells
- TPV/TE

Example system

BNL TPV Project

- Thermophotovoltaic power generation
- Direct flame radiation or radiation from ceramic emitter
- GaSb photocells
- Unfiltered – direct cooled

Full system test arrangement



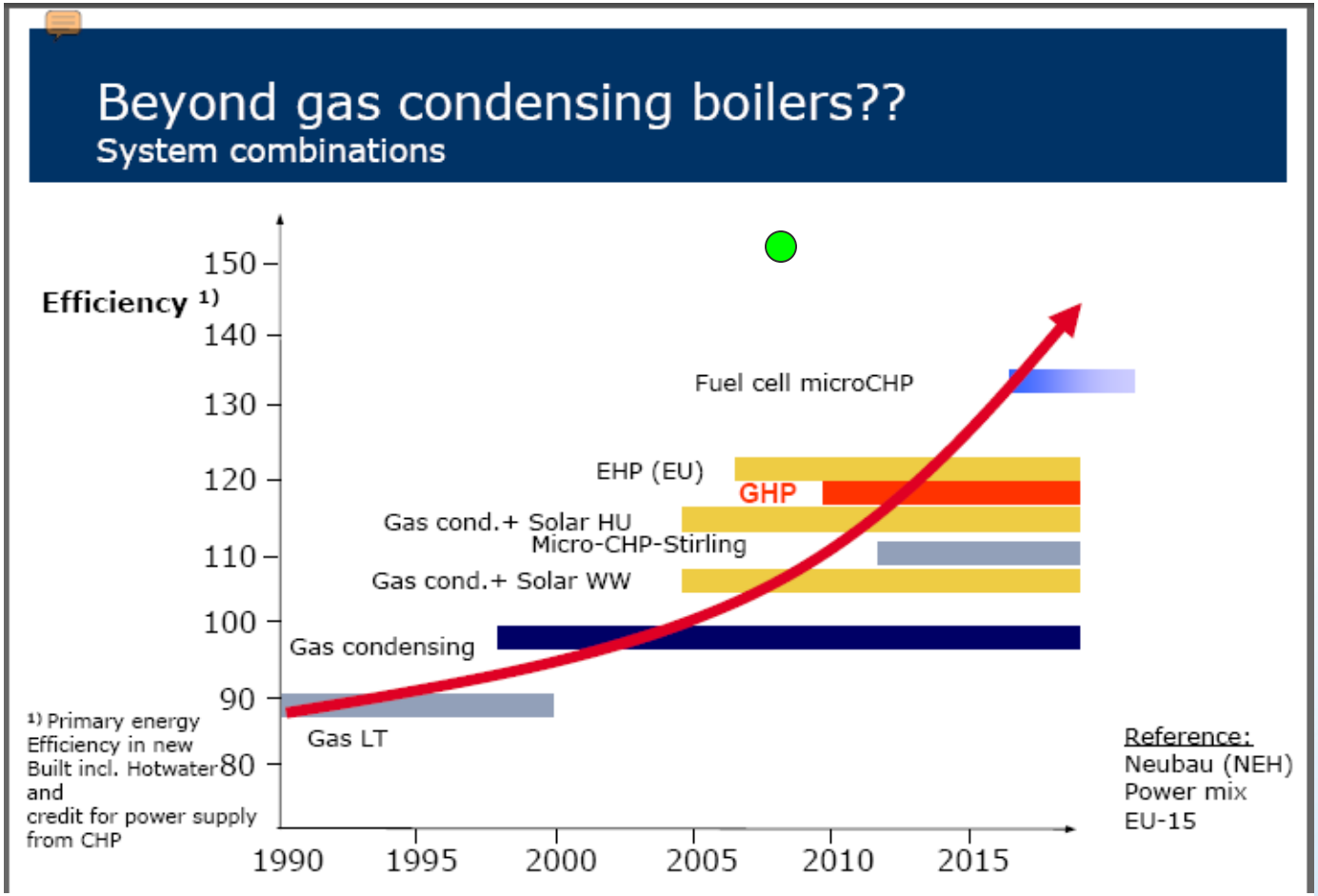
BNL HCCI microCHP Engine Project

- Biodiesel blends
- Single cylinder, compression ignition engine
- Fuel vaporization prior to ignition (homogeneous charge)
- Fixed speed and load
- Ultralow emissions based on prior work
- Thermal atomization technology

Fuel-fired Heat Pumps

- Air or water source. European developments focused on hydronic delivery of heating or cooling
- Outstanding heating performance, poor cooling performance
- Current: >1.2 heating, 0.68 cooling, Next: 1.6 heating
- High level of current development activity, multiple technologies
- In Northeast climate weak cooling performance expected to be outweighed by heating performance.
- Opportunity for investment in one, multifunction piece of equipment
- Hydronic potential for integration with solar, DHW, pool heating
- Low temperature delivery, radiant floor or oversize baseboard

Fuel-Fired Heat Pumps – offer potential for huge conversion efficiency gains



BNL Fuel-Fired Heat Pump Project

- Development of an oil- and biodiesel-fired generator that can meet demanding heat flux uniformity requirements.

Energy Efficiency – Other projects

- Water Heater Efficiency – New Test Standards
- Water Heater Field Study
- Condensing Boilers – Low Cost Distribution
- Field Study of Advanced Controls for Tankless Coil Boilers
- Corrosion in high efficiency, condensing, biodiesel-fired boilers

Thank you.

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