

Heat Recovery

What types of heat recovery are in the market?

- Boiler Based heat recovery
 - Economizers
 - Flash tank recovery
 - Blow down heat recovery
- Process Heat Recovery
 - Regenerative/Recuperative Thermal Oxidizers
 - Food process heat recovery
 - Transport Membrane Condenser
- Energy Recovery Ventilators (ERV's)

Boiler Stack Economizer

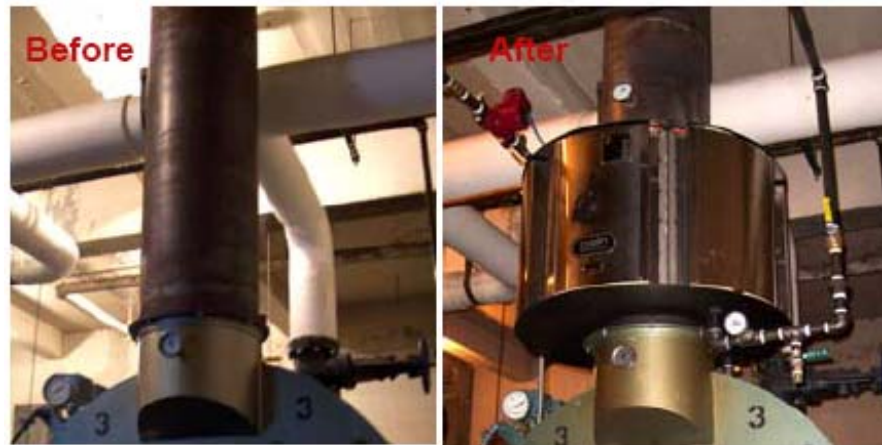
Potential Economizer Applications

A feedwater economizer is appropriate when insufficient heat transfer surface exists within the boiler to remove combustion heat. Boilers that exceed 100 boiler hp, operating at pressures exceeding 75 psig or above, and that are significantly loaded all year long are excellent candidates for an economizer retrofit.

Exhaust Gas Temperature Limits

The lowest temperature to which flue gases can be cooled depends on the type of fuel used: 250°F for natural gas, 300°F for coal and low sulphur content fuel oils, and 350°F for high sulphur fuel oils. These limits are set to prevent condensation and possible corrosion of the stack.

- Economizers – Pre-Heat Feedwater & Combustion Air
- Dependent on Exhaust Gas Temperature, Feedwater Flowrate & Boiler Operating Hours
- Exhaust Gases typically exit from 450°F-650°F
- Rule-of-Thumb – 1% Increase for each 40°F Decrease
- Fuel Usage Reduction of 4%-10% Common
- Paybacks of ~0.5-3 Years on Economizers

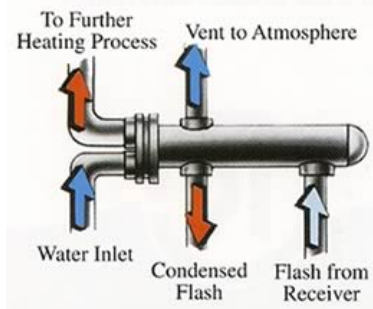


Blowdown Heat Recovery

- Blowdown rates are typically 4%-8% of total steam generated, but can be as high as 10% where incoming water has high solids content.
- If a 150 psig steam boiler generates 10,000 PPH of steam at a blowdown rate of 10%, the heat recovery potential is ~220,000 Btu/H.
- At \$12/MMBtu and 80% combustion efficiency, the potential savings is ~\$25,200/Y.



Flash Steam Heat Recovery



High-Pressure Condensate Flashing				
High Pressure Condensate (psig)	Percent of Condensate Flashed, lb Steam/lb Condensate			
	Low-Pressure Steam (psig)			
	50	30	15	5
200	10.4	12.8	15.2	17.3
150	7.8	10.3	12.7	14.9
100	4.6	7.1	9.6	11.8
75	2.5	5.1	7.6	9.9

◆ Example

In a plant where the cost of steam is \$4.50 per million Btu (MMBtu), saturated steam at 150 pounds per square inch gauge (psig) is generated, and a portion of it throttled to supply 30-psig steam. Assuming continuous operation, determine the annual energy savings of producing low-pressure steam by flashing 5,000 pounds per hour of 150-psig condensate. The average temperature of the boiler make-up water is 70°F.

From the table above, when 150-psig condensate is flashed at 30 psig, 10.3% of the condensate vaporizes.

Low-Pressure Steam Produced = 5,000 lbs/hr x 0.103 = **515 lbs/hr**

From the ASME Steam Tables, the enthalpy values are:

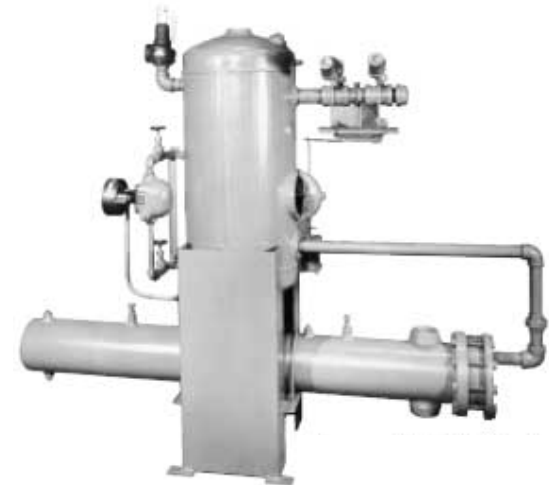
For 30-psig saturated steam = 1171.9 Btu/lb

For 70°F makeup water = 38.0 Btu/lb

Annual savings are obtained as follows:

Annual Savings = 515 lb/hr x (1171.9–38.0) Btu/lb x 8,760 hours/year x \$4.50/MMBtu

Savings = \$23,019



Customer Profile



- Decas Cranberry – Process Steam Customer installed
 - Combustion Controls
 - Flash Tank Recovery
 - Stack Economizer
- Estimated Savings \$ 58,191
- National Grid Incentive \$75,578
- Simple Payback 1.3 years

Customer Profile – Thermal Oxidizer Heat Recovery

- Auto parts Manufacturer Rockland MA looking to reduce their natural gas usage
 - Thermal Oxidizer was used to destroy volatile organic compounds that result from the manufacturing process
 - Heat Recovery system was installed to recover heat and re-use in process
- Installed Cost cost = \$ 778,550
- Annual Savings = \$94,000
- EE Incentive = \$250,000
- Net Payback = 5.6 years



Insulation Improvements

Insulation Improvements – What fits into EE Programs

- New Construction Improvements – Can be difficult as code is very stringent (IECC 2009)
 - Lower savings and high incremental costs in many applications lead to long paybacks and no EE funding
 - New Roofs and windows can be gray
- Retrofit Improvements – Great opportunities for pipe insulation, roofs (see above), attic insulation, blown in wall
 - Generally good paybacks and good EE incentives
 - Air sealing - depends

Insulation Incentive Overview

- New Construction Projects - MA
 - Incentives up to 75% of project cost, down to a 1 year payback, or \$1.50/therm saved. Whichever is first
- Retrofit Projects - MA
 - Incentives up to 50% of project cost, down to a 1 year payback, or \$1.50/therm saved. Whichever is first
- New Construction and Retrofit in RI – similar incentive structure, EE funding for gas is forthcoming.

New Construction Insulation Improvements – Where it worked

- New Newton North High School
 - Improved Wall & Roof Insulation above code
 - Incremental cost = \$ 212,000
 - Annual Savings = \$14,500
 - EE Incentive = \$33,570
 - Net Payback = 12 years
 - Why it worked
 - Building systems were relatively easy to add additional insulation



New Construction Insulation Improvements – Where it worked

- HVAC manufacturer in Rockland MA building a new wing on their facility
 - Improved Wall & Roof Insulation above code
 - Incremental cost = \$ 40,000
 - Annual Savings = \$3093
 - EE Incentive = \$20,000
 - Net Payback = 6.5 years
 - Why it worked
 - Building systems were relatively easy to add additional insulation



Retrofit Insulation Improvements

– Where it worked

- Large Church in Hingham
 - Blown in Cellulose Insulation in Walls and Attic
 - Total cost = \$ 6,595
 - Annual Savings = \$1,485
 - EE Incentive = \$3,248
 - Net Payback = 2.25 years
 - Why it worked
 - Blown in Insulation in Walls and roof was low cost



Retrofit Insulation Improvements

– Where it worked

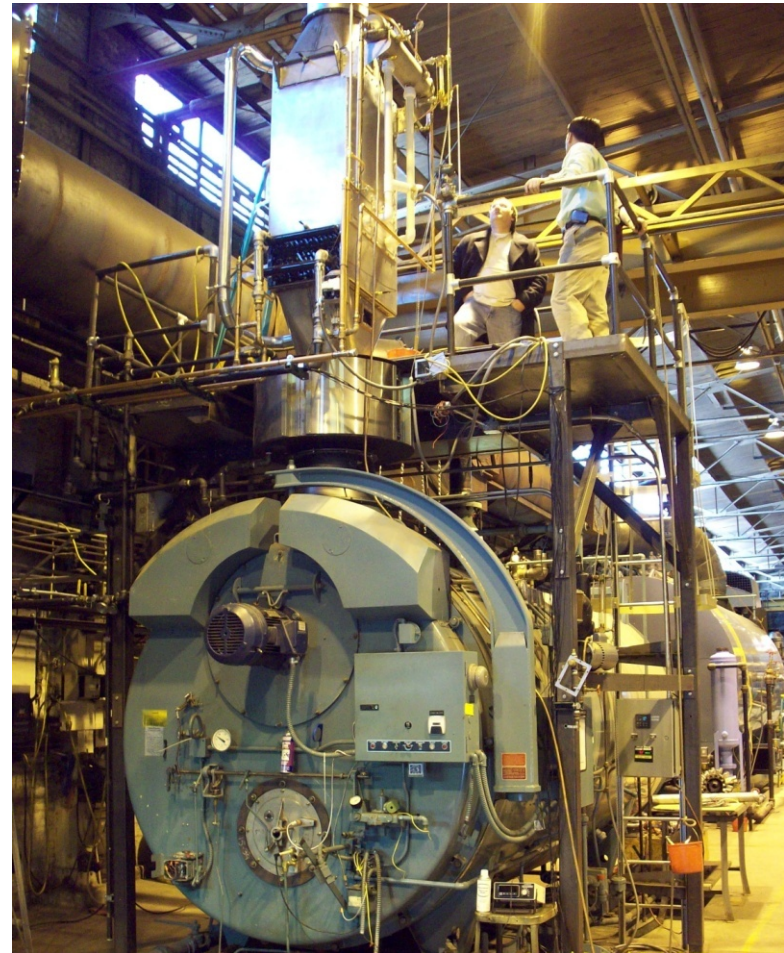
- Food Manufacturer in Clinton
 - Pipe Insulation for process steam
 - Total cost = \$ 95,000
 - Annual Savings = \$22,301
 - EE Incentive = \$47,500
 - Net Payback = 2.1 years
 - Why it worked
 - Good return on pipe insulation projects



Natural Gas Emerging technologies, initiatives, and processes

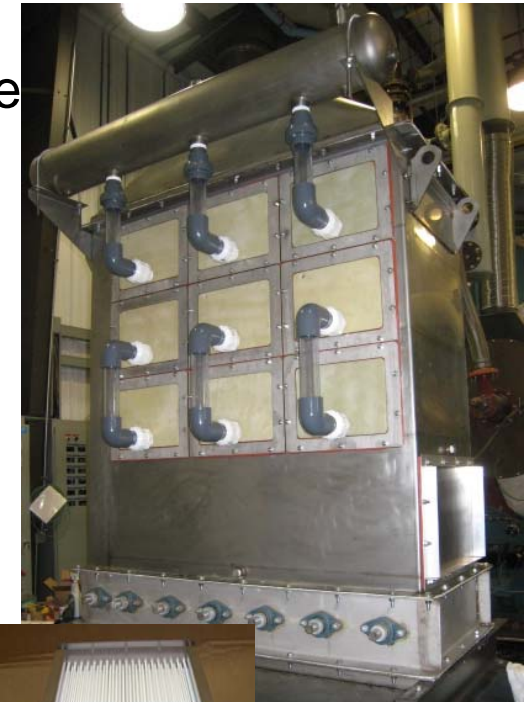
Advanced Boiler Technology

- Maximizing steam generation efficiency for commercial and industrial boilers
 - Up to 95% fuel to steam efficiency with novel heat and water recovery device
 - 15% carbon emission reduction
 - Ultra low NO_x (sub 9 ppmv)
 - Target: < 2 year payback
 - Multiple field tests underway



Transport Membrane Condenser (TMC)

- Tubes with nanoporous membrane that selectively removes water through low-pressure drop capillary condensation
- Simultaneously captures waste heat and pure water (from combustion products)
- Applicable to wide range of applications
 - Industrial and commercial boilers
 - Steam power plants, engines and turbines
 - Industrial drying and dewatering processes



Ultra-High Efficiency Boiler

Advanced Heat Recovery System at RBC



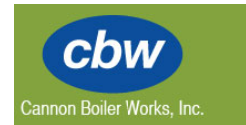
- Over 15% savings in steam production costs
- Up to 20% less make-up water consumed
- Lower NO_x and CO₂ emissions



Ultra-High Efficiency Boiler

Advanced Heat Recovery System at Baxter Healthcare

- 13-15% energy and carbon savings
 - Total efficiency of 93-95%
- Over \$35,000 annual savings at Baxter
 - Over \$80,000 at higher hours & firing rates
- Over 250,000 gallons annual water savings
- Cannon Boiler Works
www.cannonboilerworks.com



Baxter



A Sempra Energy company



Solar Thermal/Hybrid Energy Systems

- **Reduced-cost domestic hot water and hydronic heating systems** for residential and commercial buildings
 - > Push natural gas equipment above 100% efficiency using hybrid solar thermal/natural gas energy solutions
- **Higher-temperature concentrated solar thermal** for steam generation, absorption cooling, process heating
 - > Commercial buildings
 - > Industrial plants



EQUINOX Heating System

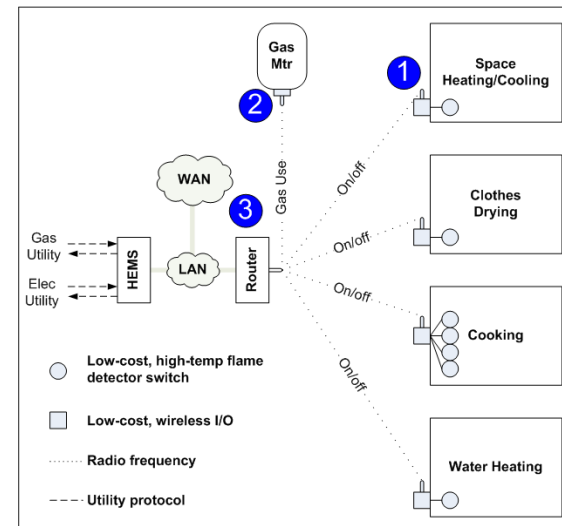


- System design
 - Evacuated tube array; plastic, unfired hot water storage tank; natural gas-fired tankless water heater
 - Reduce capital & installation costs
 - High initial investment inhibits use
 - Suitable for hot water and space heating service
 - Residential and commercial (schools, hospitals, hotels, etc)



Advanced Natural Gas metering

- Natural gas metering lags electric metering capabilities
 - Both at point of use and utility level
- Supporting wireless technology development to incorporate Natural gas point of use metering data into building energy management systems



New Initiatives

- Steam Trap Survey Initiative – aligned closely to Compressed Air O&M Initiative
- Looking for customers
 - Process loads
 - Hospitals
 - Laundry facilities

Steam trap Survey Initiative

Overview

National Grid will provide....	The Participating customer will....
<ul style="list-style-type: none">■ Financial Support for complete steam trap survey and system technical review■ Recommendations for low cost O&M improvements■ National Grid will pay up to 50% of all costs for steam trap repair/replacement or other low cost O&M improvements■ Other assistance may include a follow up system assessment and staff training	<ul style="list-style-type: none">■ Issue the initial Purchase Order for steam trap survey. National Grid will reimburse customer following steam trap repairs/replacements■ Pay 50% of the cost for steam trap repair/replacements or other O&M improvements■ Repair identified steam trap deficiencies within 90 days or system survey review with National Grid staff■ Provide periodic steam system operating data to National Grid or designated service providers■ Implement on-going steam trap repair/replacement program within the facility

Additional Points to know

- Vendors must demonstrate ability to complete trap surveys, qualification documentation to National Grid is needed before starting a project
- Customer has to sign a Memorandum of Understanding (MoU) in order to participate
- If customer doesn't elect to make repairs within 90 days, National Grid will only pay 50% of the survey cost
- Customers can access survey every 12 months
- National Grid doesn't take any position on orifice type traps. Trap survey program is intended to provide customer information on the status of their steam traps and make necessary repairs in order to maximize system efficiency.

Fuel Switching

- What is fuel switching?
 - Increasing one fuel source at the expense of another
- Historically not part of EE programs
 - As part of legislative plans in MA and RI, “all cost effective measures” are included in EE programs
 - Utilities are fully decoupled
- Energy efficiency funds are available for customers to switch fuels to a more cost effective source (i.e., electric heat to natural gas heat)
- Electric heat to gas heat fuel switching scenario
 - Electric company supports the electric demand and kWh reduction
 - Gas company supports any gas savings above code
 - Customer gets incentive from electric company for fuel switch and gas company for incremental improvements above code

Other new technologies

- **Natural Gas street lamp controls**

- Thousands of gas street lamps in northeastern US, most burn 24/7. Photocell based technology is being deployed to only operate lamps based on light levels

- City of Boston has 2800 gas street lamps

- **Commercial Food Service**

- High Efficiency Wok

- **Advances in Package Roof Top Units**

- Condensing heat exchangers

- **Heat Recovery from compressed air systems**

- Atlas Copco Energy Recovery Control Unit

What's upcoming

- Electric Commercial Kitchens measures
 - Roll out late fall in RI and NY
 - 2012 roll out for MA
- Looking at a similar initiative for insulation improvements
- Labs 21 in Providence