5. High Efficiency Systems for Large Boilers
Terminology

> Economizer
  – Captures exhaust heat to warm feedwater

> Heat Recovery Heat Exchanger
  – Heat exchanger in the flue gas to warm some other load entirely

> Possible loads
  – Domestic hot water
  – Hydronic (hot water) space heating
  – Separate in floor space heating
  – Even outdoor sidewalk ice melting
Efficiency Improvement

> Economizer
  - Improvement for low temperature water boilers only 2-4%
  - Improvement potential rises for higher pressure steam boilers
    • Function of the return condensate temperature and the boiling point

> Flue Gas Condenser
  - Efficiency improvement depends on finding and isolating a lower temperature load
Economizers

> Additional heat exchanger added onto larger boilers to enhance efficiency

> Newer technology for intermediate sized steam boilers
  – Pressures to 250 Psig (or so)
  – 10-40 MMBH
  – Most commonly fire-tube
Economizer

Fig. 3.4.3 A shell boiler with an economiser

Picture Courtesy of Spirex Sarco and Cleaver Brooks
Generic Economizer

> Used to preheat feedwater before it enters boiler

> Adds efficiency to the extent feedwater requires pre-heating

> May allow condensation or not

Picture Courtesy of Spirex Sarco
Economizers

> Market development

- PAST: economizers for smaller boilers were produced by secondary equipment supplier
- NOW: large boiler manufacturers are now producing their own economizers
- SHOWN: Cleaver Brooks Economizer on CB Boiler

Picture Courtesy of Cleaver Brooks
Exhaust Issue

Gases Must Be Hotter than Boiling Water in All Locations Including at the Exit

Hot Gases are Passing Heat to Boil Water

Flue Gas is Typically 80-100°F Hotter than Water’s Boiling Point
Economizer

Flue Gases will Leave Somewhat Above Condensate Return Temp

Flue Gases Pre-Heat Returning Condensate

Burner

Blowdown

Feedwater

Condensate Return

Make-Up Water

Massachusetts Energy Efficiency Partnership
Economizer Operation

Picture Courtesy of DOE
Economizer DA Conflict

De-aerator Must Preheat Water before Economizer

Condensate Pre-Heated To ~215°F At Boiler Pressure

Make-Up Water

Condensate

Feedwater

Boiler Pump

De-aerating Feedwater Heater
An Overall System

Complete Layout Best Left to an Expert

Heat Recovery with a Continuous Blowdown System

---

Massachusetts Energy Efficiency Partnership
Economizers
Non-Condensing

> This economizer will not handle condensation
Economizers

How the ByPass Damper Works

Stainless steel hinged access doors allow for rapid and easy inspection and maintenance of the FTR, which in turn lowers your operating costs.
Economizer
Mounting for Smaller Units

> Economizer supported by boiler
> Limitation on the weight boiler can support

Picture Courtesy of Cleaver Brooks
Economizer

**Mounting for Larger Units**

> Weight of larger economizers will require supports and rigging

> Both horizontal and vertical mounting is possible

[Diagram of economizers with support structures for both horizontal and vertical units.]
Economizer Efficiency with High Make-Up Water Levels

CBLE & 4WI Boiler Efficiency with 2-stage economizer
Natural Gas, Operating 80-125 psig

Efficiency %

% Makeup water

Makeup water @50°F

Picture Courtesy of Cleaver Brooks
# Economizer Efficiency with Non-Condensing Economizer

<table>
<thead>
<tr>
<th>BOILER HP</th>
<th>LOAD %</th>
<th>ECONOMIZER MODEL NO.</th>
<th>EFF W/O ECON</th>
<th>% FUEL SAVED</th>
<th>EFF WITH ECON</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 hp</td>
<td>100</td>
<td>CCE-16A6AL</td>
<td>82.05</td>
<td>2.50</td>
<td>84.55</td>
</tr>
<tr>
<td>125 hp</td>
<td>100</td>
<td>CCE-18D6AL</td>
<td>80.76</td>
<td>3.84</td>
<td>84.6</td>
</tr>
<tr>
<td>150 hp</td>
<td>100</td>
<td>CCE-18D7AL</td>
<td>81.81</td>
<td>3.04</td>
<td>84.85</td>
</tr>
<tr>
<td>200 hp</td>
<td>100</td>
<td>CCE-18E6AL</td>
<td>82.40</td>
<td>2.34</td>
<td>84.74</td>
</tr>
</tbody>
</table>

**NOTES:**
1. Feedwater temperature to Economizer 227 °F (Deaerated).
2. Selections are based on best Btu savings per dollar costs.
3. Boiler is firing natural gas.
4. Boiler operating pressure is 125 psig (acceptable tolerance ± 5 psig).
5. Contact your local Cleaver-Brooks representative for sizing detail.
Third-Party Economizers
Economizer
Condensing

> This CB factory built economizer WILL handle condensation

Picture Courtesy of Cleaver Brooks
Condensing Economizers

Condensing Temperatures

Figure 1. Indirect contact condensing economizer

Stack Temperature 100-120°F

Temperature Controller

Flue gas 325°F from boiler after heat exchange in feed-water economizer

Boiler make-up water or hot process water load

200°F

45-85°F

Pump

Picture Courtesy of DOE
Economizer
Condensing

> TWO Water Passes

Condensing Section

Non-Condensing Section
Economizer
Condensing

> TWO Water Passes

Picture Courtesy of Cleaver Brooks
The System

Condensing Steam Boiler
The System

Alternative Layout

Make-Up Water Temp. Usually ~50°F

- Burner
- Blowdown
- Feedwater
- Make-Up Water
- Pre-Heated Make-Up
- Returning Condensate
- Boiler Pump
- De-aerating Feedwater Heater
- Low Temp. Economizer
- Condensate Pre-Heated To ~215°F At Boiler Pressure
- High-Temp Economizer
New Concepts in Industrial Steam Boiler Systems
New Internal Economizer

2 PASS

3 PASS

Picture Courtesy of Hurst Boiler
Direct Contact Economizers

Flue gas outlet
100°F

Spray

Water inlet

95°F

Packed bed of stainless steel pall rings

Flue gas inlet
325°F

Boiler make-up water or other hot water load

Heat Exchanger

90°F

140°F

Blow-down

135°F

Pump

Picture Courtesy of DOE
For Larger Boilers

> Very large boilers, high pressure boilers, and boilers built for power generation will come equipped with economizers as standard equipment
Large Boiler Economizer

> Uses left over heat in the exhaust gases to pre-heat feedwater
Large Boiler Economizer

Superheater
Steam Drum
Boiler Bank
Furnace
Bark Bin
Economizer
Air Heater
Start-Up Burners
Particulate Collection
ID Fan
ONE-DRUM DESIGN
III. Industrial Scale High Eff. Water Heating
Learning Objective

> Understand new options for improving the efficiency of large scale commercial and industrial water heating
Overview

- Understanding efficiency in water heating systems
- Tankless water heaters
- Condensing water heaters
- Savings potential
- High efficiency pool heaters
- Industrial Scale Water Heating
Understanding Efficiency in Water Heating Systems
Understanding Efficiency Measurements

Review from Fundamentals of Gas Technology Course

> Steady State Efficiency
> Recovery Rating
> First Hour Rating
> EF-Energy Factor
Efficiency Measurements are Based on Conventional Water Heaters

> Residential ~40,000 Btu/h
> Commercial <250,000 Btu/h
> Storage tank, gas burner, combustion gases vent through middle of tank

Picture Courtesy of Natural Resources Canada
Recovery Rate

> Steady State Efficiency = Efficiency at which a water heater will heat a continuous flow of water

> Recovery Rate = Rate (in gallons/hr.) at which a certain size burner will generate hot water on a continuous basis

> If the water draw is less than or equal to the Recovery Rate – the water heater will never run out of hot water
Recovery Rate

> Recovery Rate indicates the amount of water in gallons that can be heated in 1 hour

> Recovery Rate (gallons per hour) =

\[
\text{Gas Input} \times \text{Steady State Efficiency} \\
\text{(Temperature Rise} \times 8.34\text{)}
\]

> Efficiency for a Gas Water Heater \(\sim 0.75\) (75%)
  — Do NOT use the Energy Factor on the rating label

> Typical temperature rise is 80°F
  — (40°F in – 120°F out)
Recovery Rate Calculation in Units

\[
\text{Recovery Rate} = \frac{\left( \frac{\text{Gas Input} \ Btu}{\text{hr}} \right) \times \text{Steady State Efficiency}}{(\text{Temperature Rise}) \left[ 8.34 \frac{\text{lb}}{\text{gal}} \right] \left[ \frac{1 \text{ Btu}}{\text{lb} \ 0^\circ \text{F}} \right]}
\]

For a 40,000 Btu/Hr Burner

\[
\text{Recovery Rate} = \frac{\left( \frac{40,000 \ Btu}{\text{Hr}} \right)(0.75)}{\left( 120^\circ F - 40^\circ F \right) \left[ 8.34 \frac{\text{lb}}{\text{gal}} \right] \left[ \frac{1 \text{ Btu}}{\text{lb} \ 0^\circ \text{F}} \right]} = 45 \frac{\text{Gallons}}{\text{Hr}}
\]

> This means that the water heater could produce 45 gallons per hour of 120°F water FOREVER
Water Heater Efficiency Measurements

> Steady State Efficiency (more exact)
  – Efficiency of the water heater when heating an infinitely prolonged water stream running at the water heaters recovery rate

> Energy Factor
  – A residential efficiency measurement
  – Efficiency of water heating when the water heater is producing 64 gallons of heated water per 24 hour period
Maximum Output Based on Recovery Rate

For a 40,000 Btu/Hr Burner:

\[
\text{Recovery Rate} = 45 \frac{\text{Gallons}}{\text{Hr}} = 1,080 \frac{\text{Gallons}}{\text{Day}}
\]

> Water heater could produce 1,080 gallons / day to meet a steady 45 gallon / hour load that occurs all 24 hours of the day

> Unlikely to ever happen in a real application
Storage Efficiency

> Effect of stacking
> Only a portion of the water is at a useful temperature
> Upon draw – water is consistently hot until usable water runs out
> Then promptly cold

Tank Efficiency (%) = \frac{\text{Usable Storage}}{\text{Volume of the Tank}}
First Hour Rating

Most customers do not want to produce hot water forever. They want to know how much hot water they can draw at one time before the heater runs out. The First Hour Rating is useful:

First Hour Rating

\[ \text{First Hour Rating} = (\text{Recovery Rate})(1\text{hr}) + (0.7)(\text{Tank Volume}) \]
First Hour Rating

First Hour Rating = (Recovery Rate)(1 hr) + (0.7 \times \text{Tank Volume})

> If for the example, the tank was 40 gallons

\[
\text{First Hour Rating} = 45 \frac{\text{gallons}}{\text{hr}} (1 \text{ hr}) + 0.7 \times 40 \text{ gallons}
\]

First Hour Rating = 73 Gallons

 Indicates that the water heater can produce 73 gallons over the first hour
Why is This Important?

> First hour rating depends on power input and tank size

> Gas water heaters have much higher power input than electric water heaters

> Therefore, a smaller gas heater can have a HIGHER first hour rating and usually do
  — This means the customer can take more showers, wash more clothes, and so on with a smaller gas water heater than a larger electric heater

> MORE convenience while using LESS space
### Right from the State Water Heater Catalog

<table>
<thead>
<tr>
<th>Gallon Capacity</th>
<th>Input Per Hour Natural/Propane</th>
<th>First Hour Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>52,500</td>
<td>84</td>
</tr>
<tr>
<td>50</td>
<td>40,000</td>
<td>80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gallon Capacity</th>
<th>Wattage 240 VAC</th>
<th>First Hour Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>Upper 4500</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Lower 4500</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>4500</td>
<td>62</td>
</tr>
</tbody>
</table>

Picture Courtesy of State Industries
Efficiency Based on Recovery Rate

Reversing the Recovery Rate Calculation

\[
\text{Efficiency} = \left( \frac{\text{Recovery Rate}}{\text{hr}} \right) \left( \text{Temperature Rise} \ 0^\circ \text{F} \right) \left[ \frac{8.34 \text{ lb}}{\text{gal}} \right] \left[ \frac{1 \text{ Btu}}{\text{lb} \ 0^\circ \text{F}} \right]
\]

\[
\frac{\text{Gas Input}}{\text{hr}} \frac{\text{Btu}}{\text{gal}}
\]
Efficiency Based on Recovery Rate

For a 52,500 Btu/Hr Burner:
Recovery Rate = First Hour Rating − 0.7(Capacity)

Recovery Rate = 84 − 0.7(40) = 56 \frac{\text{gal}}{\text{hr}}

\begin{align*}
\text{Efficiency} &= \left(56 \frac{\text{gal}}{\text{hr}}\right)(80^\circ \text{F})\left[8.34 \frac{\text{lb}}{\text{gal}}\right]\left[1 \frac{\text{Btu}}{\text{lb} \ 8^\circ \text{F}}\right] \\
&= \frac{52,500 \ \text{Btu}}{\text{hr}} \\
\text{Efficiency in Constant Recovery} &= 71.17\%
\end{align*}

<table>
<thead>
<tr>
<th>Gallon Capacity</th>
<th>Input Per Hour Natural/Propane</th>
<th>First Hour Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>52,500</td>
<td>84</td>
</tr>
</tbody>
</table>
Effective Efficiency for a Standard Residential Heater

> A 40 gallon gas water heater could produce a large amount of water (1080 gal/day)

> Realistic residential load is much lower
  — Standard load assumed at 64 gal/day
  — The remainder of the time, the heater is keeping the tank warm
  — Keep warm energy is lost to the home
  — DOE rating procedure measures this
Effective Efficiency for a Standard Residential Heater

- Larger Commercial Load – Anywhere on This Line
- Steady State or Recovery Efficiency
- Energy Factor Efficiency

Hot Water Flow in Gallons per Day

- 64.00
- 1080.00
- Effective Efficiency
Tankless Water Heaters
Tankless Water Heaters

> What are they?
> Why would a standard tankless water heater be more efficient?
Tankless Gas-Fired Water Heaters

- Residential input is 125,000 Btu/h
- Commercial input <725,000 Btu/h
- Best suited to constant HW demand
- No storage
- Higher capital cost
- Compact
**Tankless Gas-Fired Water Heaters**

**The Process:**

1. A hot water tap is turned on.
2. Water enters the heater.
3. The water flow sensor detects the water flow.
4. The computer automatically ignites the burner.
5. Water circulates through the heat exchanger.
6. The heat exchanger heats the water to the designated temperature.
7. When the tap is turned off, the unit shuts down.

Picture Courtesy of Takagi
Why Would a Tankless Water Heater be More Efficient?

- Eliminated Tank Loss
- Tankless
- Steady State or Recovery Efficiency
- Energy Factor Efficiency

Hot Water Flow in Gallons per Day:
- 64.00
- 1080.00

Effective Efficiency
**Why Would a Tankless Water Heater be More Efficient?**

> Without the storage tank – the tank loss is removed

<table>
<thead>
<tr>
<th>Hot Water Flow in Gallons per Day</th>
<th>Energy Factor Efficiency</th>
<th>Steady State or Recovery Efficiency</th>
<th>Tank Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>64.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1080.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Normal Situation

Typical Usage Range

Tank Type

Tankless

Effective Efficiency

Hot Water Flow in Gallons per Day

40% 45% 50% 55% 60% 65% 70% 75% 80%
Issues with Tankless Systems

> Larger burner is required
  ─ First hour and recovery rates are the same
  ─ One shower will require a 125 MBH burner
  ─ More sophisticated safety controls

> Electric components
  ─ Needs power connection

> Overall – more expensive
  ─ Power burner
  ─ More controls
# Sizing Tankless Systems

## Right Model?

<table>
<thead>
<tr>
<th>Model</th>
<th>Cold Water Temperature</th>
<th>40°F</th>
<th>55°F</th>
<th>70°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR - 180 CC - 180</td>
<td></td>
<td>4.6 GPM</td>
<td>5.9 GPM</td>
<td>8.5 GPM</td>
</tr>
<tr>
<td>CR - 210 CC - 210</td>
<td></td>
<td>5.3 GPM</td>
<td>6.9 GPM</td>
<td>9.8 GPM</td>
</tr>
<tr>
<td>CR - 240 CC - 240</td>
<td></td>
<td>6.0 GPM</td>
<td>7.8 GPM</td>
<td>11.1 GPM</td>
</tr>
</tbody>
</table>

Above GPM rates and shower capabilities are based on a standard 2.5 GPM shower head and a shower temperature of 105°F. The cold water supply temperature may change with the seasons. Use your winter water temperatures to make your selection.
Tankless Gas-Fired Water Heaters

Traditional tank water heater

Takagi tankless water heater

Picture Courtesy of Takagi
Tankless Gas-Fired Water Heaters
Also Applied to In Floor Space Heating
Also Applied to Warm Air Space Heating

picture courtesy of Rheem
Applied to Heating
Issues with Tankless Systems

> Overall combustion process is no more efficient than a standard tank system
  – Similar exhaust temperatures

> Why not a condensing unit?
Condensing Water Heaters
Condensing Water Heaters

> Substantial increase in efficiency and heater first cost

> Condensing heat exchangers are elaborate and must be built of high grade stainless

> Best applications are systems that require large quantities of hot water
New Technology in Water Heating – Condensing Water Heater

- Stainless steel tank assures long life. No glass lining necessary.
- R-16 foam insulation minimizes heat loss.
- Stainless steel coiled flue transfers heat from flue gases to the water resulting in a 94% recovery efficiency.
- Power venting and sealed combustion avoid backdrafting hazards.

Picture Courtesy of American Water Heater
Condensing Water Heater

> Larger heat exchanger
> Combustion blower
> Requires electric connection
Condensing Water Heater

Alternative - Top Mounted Burner
Condensing Water Heater

> Combustion blower can power a longer more elaborate exhaust

> Typically sidewall exhausted

According to the table the maximum length is 20 metres and the allowed number of 90° bends is 5. Both requirements are met.
Condensing Water Heater

Sealed combustion is typical
Condensing Tankless System

> Very high efficiencies due to cold entering water

> In 98% range
  – Both recovery efficiency and energy factor
Navien Condensing 98% Tankless

Low exhaust gas temperature

113 °F

Money Saving Water Heater

Navien's stainless steel Condensing Heat Exchanger recovers heat from water vapor in the flue gas

Primary Heat Exchanger (Stainless steel)
Condensing Heat Exchanger (Stainless steel)

Up to 98.8%
(Thermal Efficiency)

Hot exhaust gas is recycled through the condensing heat exchanger, saving energy and money.

Conventional Tankless

High exhaust gas temperature

250 °F

Primary Heat Exchanger (Copper)

Average 82%
(Thermal Efficiency)

Hot exhaust gas is flown away, wasting energy and money.
Condensing Tankless System

Condensing efficiency, plastic venting
Savings Potential
Savings Potential in Residential Loads is Limited

In this case – the appropriate efficiency is the energy factor due to the low volume of water required per day.

### Economic Analysis of Water Heating

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Water Consumption</td>
<td>64 Gallons/Day</td>
<td>64 Gallons/Day</td>
</tr>
<tr>
<td>Cold Supply Water Temp.</td>
<td>42 Deg F</td>
<td>42 Deg F</td>
</tr>
<tr>
<td>Hot Water Temp. Desired</td>
<td>120 Deg F</td>
<td>120 Deg F</td>
</tr>
<tr>
<td>Effective Efficiency</td>
<td>55%</td>
<td>75%</td>
</tr>
<tr>
<td>Water Heater Gas Consumption/Year</td>
<td>27.63 MMBtu/Yr</td>
<td>20.26 MMBtu/Yr</td>
</tr>
<tr>
<td>Current Gas Cost</td>
<td>8 $/MMBtu</td>
<td>8 $/MMBtu</td>
</tr>
<tr>
<td>Total Water Heating Bill</td>
<td>$221.03 $/Yr</td>
<td>$162.09 $/Yr</td>
</tr>
<tr>
<td>Operating Cost Difference</td>
<td>$58.94 $/Yr</td>
<td></td>
</tr>
</tbody>
</table>

Current Gas Cost = 8 $/MMBtu

Hot Water Consumption = 64 Gallons/Day

Cold Supply Water Temperature = 42 Deg F

Hot Water Temperature Desired = 120 Deg F

Operating Cost Difference = $58.94 $/Yr
In this case – the appropriate efficiencies may be the steady state efficiency due to the much higher volume of water required per day.

### Economic Analysis of Water Heating

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Supply Water Temperature =</td>
<td>42 Deg F</td>
<td>42 Deg F</td>
</tr>
<tr>
<td>Hot Water Temperature Desired =</td>
<td>120 Deg F</td>
<td>120 Deg F</td>
</tr>
<tr>
<td>Effective Efficiency =</td>
<td>75%</td>
<td>95%</td>
</tr>
<tr>
<td>Water Heater Gas Consumption/Year =</td>
<td>633.17 MMBtu/Yr</td>
<td>499.87 MMBtu/Yr</td>
</tr>
<tr>
<td>Current Gas Cost=</td>
<td>8 $/MMBtu</td>
<td>8 $/MMBtu</td>
</tr>
<tr>
<td>Total Water Heating Bill =</td>
<td>$5,065.38 $/Yr</td>
<td>$3,998.99 $/Yr</td>
</tr>
<tr>
<td>Operating Cost Difference =</td>
<td>$1,066.40 $/Yr</td>
<td>$1,066.40 $/Yr</td>
</tr>
</tbody>
</table>
High Efficiency Pool Heaters
Pool Heaters

> Related to boilers in construction
> Generally a specialized industry
> Need to handle pool water chemistry, high flows, and low delivery temperature
  ─ Low delivery temperature should make condensing technology practical
Pool Heaters

> Added first cost makes condensing operation more attractive to large loads with long operating seasons – commercial or community pools
Condensing Pool Heaters
Condensing Pool Heaters
Pool Heaters

Pool Heating or Low-temperature System (primary/secondary) piping shown
Smaller Condensing Pool Heaters
Industrial Scale Water Heating
Common Hydronic Boiler-Fired Industrial Water Heating

Picture Courtesy of Natural Resources Canada
Common Steam-Fired Industrial Water Heating

Picture Courtesy of Natural Resources Canada
Indirect Boiler Heat Recovery
Water Heating
New Technology in Water Heating – Commercial Direct Contact Water Heater

Direct Contact Gas Fired Water Heater
1-25 MMBtu/Hr

- Burner
- PVC Vent
- Controls
- Vent Gas in 80-120°F Range
- Very High Efficiency Operation
- Gas Train
- Water Drips Over Packing Material and Contacts Hot Burner Gases – Which Heat Water
- Water Collector
- Water Level Controls
- Small Footprint

Picture Courtesy of Armstrong
Direct Contact Water Heaters

> Drops of water are sprayed directly thru exhaust gases
  - Droplet surface is the heat exchanger
  - Spray of drops produces huge surface areas
  - Large capacity in small packages

> Pipeline quality gas has little tendency to contaminate water
  - Minor sulfur content
  - However, water should not be re-circulated
Direct Contact Water Heaters

The QuikWater 99% Efficient Water Heater

- Stack Temperature only a Few Degrees Above Inlet Water Temperature in Normal Operation
- Low NOx (<30ppm) Heater Packages Available
- Stainless Steel Packing Promotes 99% Efficient Heat Transfer
- ETL Listed Control Panels, Burners and Gas Trains Comply With UL-795 and Internationally Recognized Codes
- Optional Combustion Air Inlet Plenums, Filters, and Silencers Available
- Exclusive Water Jacketed “Clean Burn” Dry Combustion Chamber, U.S./Canadian Patent #4,773,390
- Totally Automated Operation, Using Natural Gas, Propane, #2 Oil Fired Burner
- Combustion chamber Cooling and Recirculation Pump
- Integral Storage Tank Included—No External Tank Needed
- Access Ports for Inspection and Servicing
- Optional Discharge Stacks Available

Picture Courtesy of Custom Thermal
Direct Contact Water Heaters
Direct Contact Economizers

Diagram of a Direct Contact Economizer system:
- Preheated Water
- Stack to Atmosphere
- Heat Reclaimer
- 4-Way Valve
- Cold Water Inlet
- Cooled Wastewater to Sewer
- Hot Wastewater
- Process Heat Water Recovery
- Flue Gas Heat Recovery
- Gas Fired Steam Boiler
- Preheated Water to Heater

Picture Courtesy of Kemco
Direct Contact Economizers

Picture Courtesy of Thermal Engineering of Arizona
Summary

Understanding efficiency in water heating systems

Tankless water heaters

Condensing water heaters

Savings potential

Booster water heaters

Direct contact water heaters

High efficiency pool heaters
Summary

>Savings from more expensive higher efficiency equipment depends on the size of the water load

>Larger commercial loads make paybacks shorter

>However, greater premium to “green image” in the residential market
IV. On-Site Generation and CHP
Learning Objectives

> The electric generation and delivery industry is undergoing changes and significant strains

> Only by understanding the current situation and future outlook can we understand drivers for gas fired on-site generation

> Develop familiarity with new distributed generation equipment by understanding the technical advantages, limitations, and the marketable features
Overview

> The current market conditions
> The emergency generator market
> What is distributed generation/cogeneration?
> Cogeneration
> Existing and emerging distributed generation equipment
  – Microturbines
  – Fuel cells