

High Efficient Natural Gas Technologies

FUPWG

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Presented by:

Eric Burgis

Energy Solutions Center

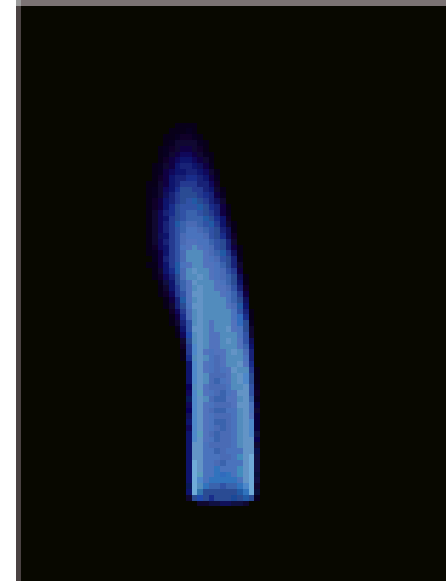
610-796-1946

eburgis@escenter.org



Presentation Outline

- Heating Technologies
- Water Heating
- Gas Cooling
- Humidity Control
- Combined Heat & Power
- Natural Gas Vehicles



A close-up photograph of a furnace burner assembly. Three circular burners are visible, each with a bright blue flame. The burner in the center is the most prominent, with its flame extending downwards. The surrounding metal components are silver and show signs of wear and discoloration. The background is dark, making the blue flames stand out.

Natural Gas Heating

Natural Gas Heating

■ Forced Air Systems

- The most common heating system is a forced-air system or furnace that uses a natural gas burner to heat air
- Cool air is drawn into the system and moved into a heat exchanger where it is warmed by the gas burner and then circulated by a blower or fan through ductwork to the space being heated
- Forced air system can also include items such as electronic air filters, electric cooling equipment and a humidifier or dehumidifier

Natural Gas Heating

- Heat Pump Systems
 - Instead of warming the air by direct application of heat, a heat pump moves heat from the air, water or ground and transfers it to areas of cooler air
 - Uses a refrigerant gas or fluid that runs through pipes between two sets of coils
 - A heat pump works like an air conditioner in reverse

Natural Gas Heating

- Infrared Heaters
 - Has either a glowing panel or tube distribution system that warms people and surfaces in its direct path
 - Warms objects (not air) which then radiate heat upwards
 - Very energy efficient

Available Heating Technologies



- Forced Warm Air Systems
- Make-Up Air Systems
- Unit Heaters
- Gas Heat Pumps

Rooftop Units



- Natural gas rooftop units are commonplace
- Usually purchased with gas heat and electric air conditioning in one unit
- New high efficiency designs employ modulating and condensing technology for higher efficiency

Conventional Rooftop Units

- Conventional gas-fired rooftop heaters often have efficiency ratings between 78 and 82 percent
- Heating capacities range from under 100,000 to over 500,000 BTU/hr.

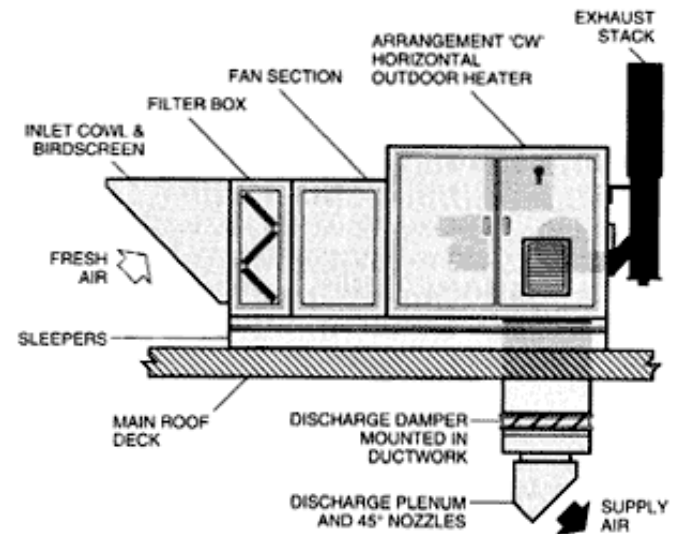


High Efficiency Rooftop Units

- Condensing natural gas rooftop units provide comfort and **efficiency (89-97%)** offering:
 - Fast morning warm-up and response times
 - Lower operating and maintenance costs
 - Longer equipment life than heat pump units
 - Easily maintainable and replaceable systems

Make Up Air Systems

- Cost effective way to provide fresh tempered air to “make up” air leaving the building
- Sizes available 900 – 1,200,000 CFM
- Up to 100% outdoor air



Unit Heaters

- Unit Heaters – 150,000 to 400,000 BTU/Hr
 - Forced Hot Air Systems
 - Standard Efficiency 78-80%
- High Efficiency Unit Heaters
 - **Up to 93% AFUE**
 - Power Vented Exhausts
 - Integrated Direct Spark Control



Gas Heat Pumps

- Absorption and Engine Drive units available
- Wide range of cooling and heating capacities and temperatures with capacities from 5 to 300 tons
- Engine Drive systems are variable speed for efficient partial load operation
- Absorption units available as air or water cooled systems

Engine Driven Heat Pumps

- Similar to electric heat pumps
- Electric motor replaced with a natural gas driven engine
- Can be Variable Refrigerant Flow
- Excellent part load efficiencies
- Multiple zone capable
- Heating efficiency equivalent to 140%



IntelliChoice Energy

- 8, 11 & 15 Ton units available
- Ducted or Ductless Options
 - Ductless Units ideal for Zoning
- Air-cooled condensing in packaged unit
- Cooling COP of 1.23
- Heating COP of 1.40



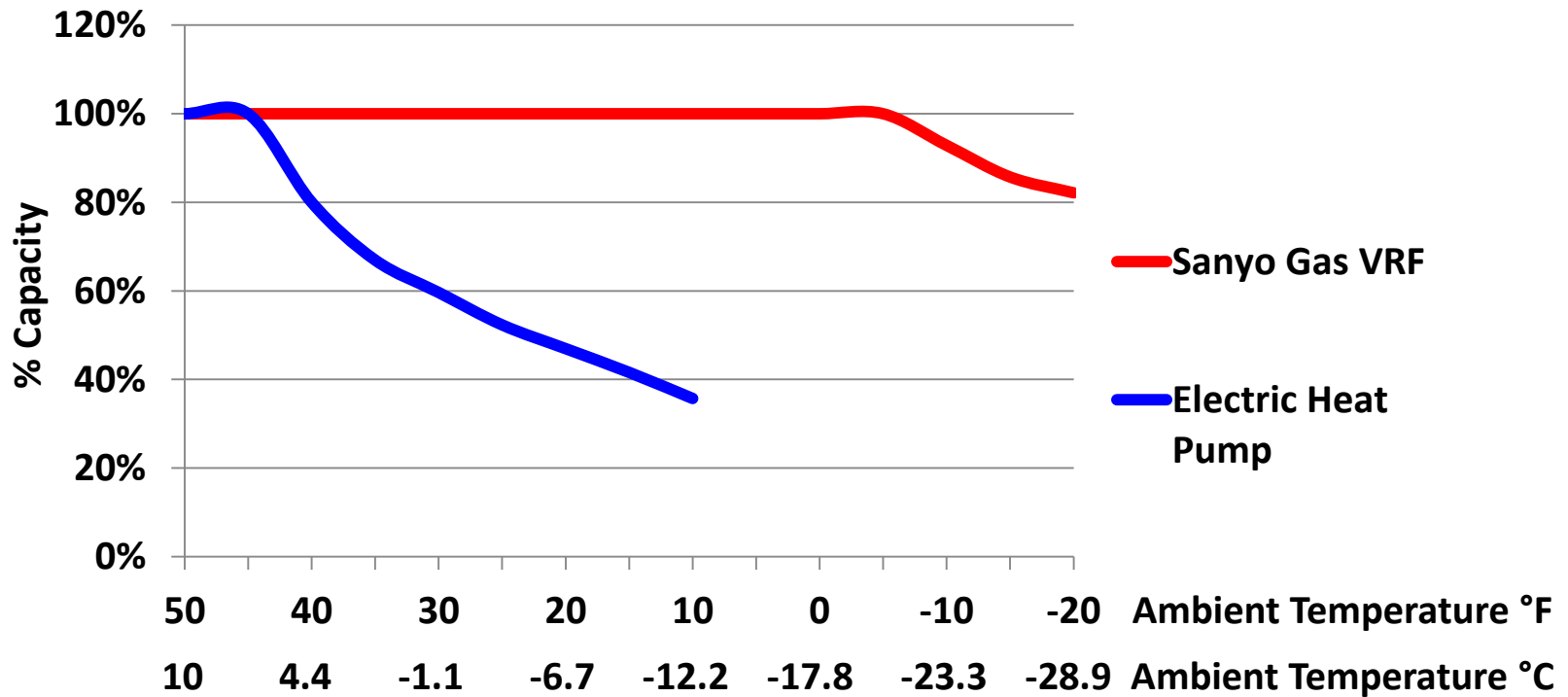
INTELLI CHOICE
ENERGY

SANYO Engine Driven Heat Pumps



- 16 & 24 Tons
- Variable Refrigerant Flow
- Simultaneous Heating and Cooling
- Some models also generate electricity
- No emergency heat needed when very cold
- Up to 393 feet (120 meters) of piping between the outdoor unit and the water heat exchanger

SANYO Gas Heat Pump Low Temperature Performance



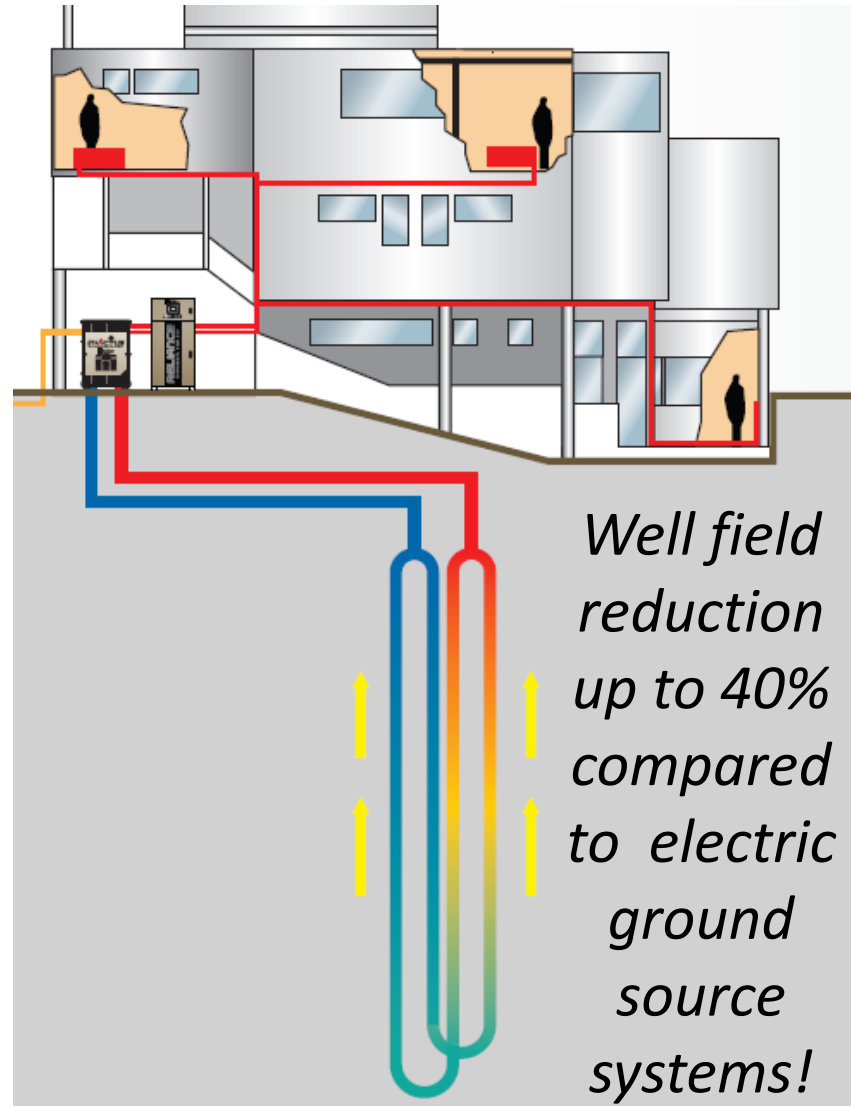
Typical of other Gas Heat Pumps

Gas Absorption Heat Pump

- Small gas fired boiler (traditional combustion)
 - 95,500 BTU/HR input
- Produces **HOT** up to 149°F (65°C) or **COLD** water down to 37°F (2.8°C)
- Hydronic product
 - Piped into hydronic loop just like a hydronic boiler
- Up to 149% Heating Efficiency



Ground or Water Source



Recent GSHP Study for Schools

- Recent study by UIC on Ground Source Heat Pumps compared to conventional systems in schools.
 - Found that building is tight, school is full of children adding heat to space and ERV's on new schools save a lot of heat energy.
 - Found the school uses 3X more cooling than heating in a cold climate.
 - Economics for GSHP very poor compared to rooftop units or boiler/chiller system.



Natural Gas Water Heaters

Natural Gas Water Heating Options



Atmospheric Storage



Boiler



Tankless



Booster Water Heater



Solar/Gas Hybrid



High Efficiency Storage

Fire-Tube Condensing



Tank Water Heaters



- Commercialized versions of traditional residential unit
- Input ratings $\leq 199,999$ BTUs/hour as many codes change at 200,000 BTUs/hour and above
- Storage capacity of about 100 gallons (378.5 liters)
- Heat water to about 180°F (82.2°C)
- Direct or power venting options

Intelligence for Tank Water Heaters

- Microprocessor controls
 - Tank maintain consistent temperatures
- Integrated mixing devices
 - Allows for storage of hotter water – increasing amount of usable hot water available
- Set back controllers
 - Similar to programmable thermostat
- Leak detection devices
 - Shuts off water if tank leak is detected
- Atmospheric flue dampers
 - Reduces standby losses

Future Water Heater Efficiency – U.S.

2015 Standards (Residential): GAS – Common Sizes

	<= 55 Gallons				> 55 Gallons		
Calculation	EF = 0.675 – (0.0015 x V)				DF = 0.8012 – (0.00078 x V)		
Rated Storage Volume	Tankless	30	40	50	60	65	75
Current Standard	.62	.61	.59	.58	.56	.55	.53
2015 Standard	.82	.63	.62	.60	.75	.75	.74

* 2015 DOE (Department of Energy) Final Rule Effective April 16th, 2015

* Applies to residential water heaters, but these are used in small commercial applications as well.

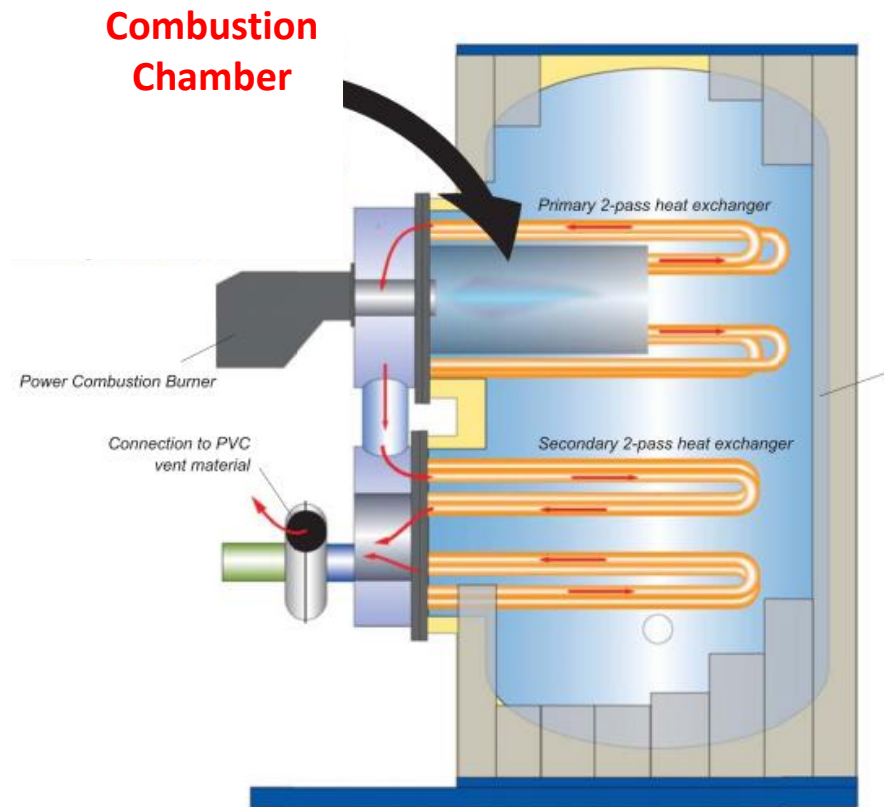
High Efficiency Storage Water Heater



- 399,000 – 2,000,000 BTU Input
- 125, 250, and 300 (473, 946, and 1,135 liters) Gallon Tanks
- Up To 99% Efficiency (low fire)
- Full Modulation with 10:1 Turndown
- Programmable Electronic Control with Digital Temperature Control
- Category IV Venting with CPVC Vent Material
- 10 Year Tank Warranty
- 3 Year Scale Warranty

Commercial Fire Tube Condensing

- Removable dual heat exchangers
- Four passes of combustion gases through the water
- PVC venting
- Low NOx burners available



Tankless Water Heaters



- Have no storage tank
- Heat water on demand with no standby-losses from a tank
- Standard efficiency units – 80-85%
- High efficiency units – 97-98%
- Sizing done by GPM required but under 200,000 BTU input per unit
- Higher first cost – savings comes from elimination of standby losses

Hybrid Systems – Solar/Gas



- Solar water heater with natural gas-fired back-up heat exchanger
- Internal solar heat exchanger for a solar panel
- Combines with a highly efficient all in one storage tank
- Provides approximately ½ of the water heating from solar

Booster Water Heaters



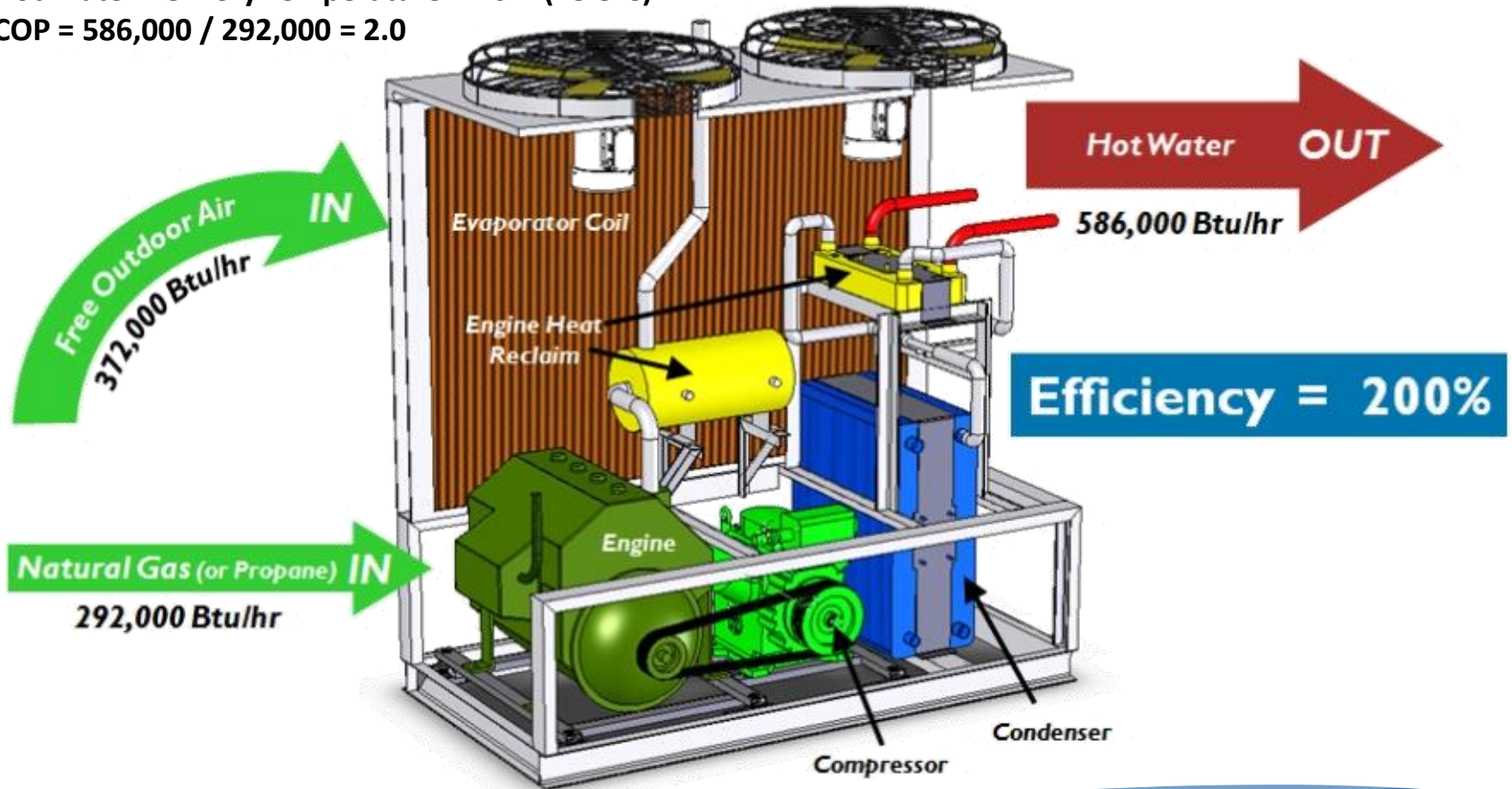
- Designed to heat rinse water for better cleaning with fewer spots – especially on glassware
- Heats hot water from 120°-140° up to 180°F (48.8°-60° up to 82.2°C) water
- Improves cleaning and sanitizing of dishes
- Shortens drying time
- Eliminates need for chemical rinse aids

Commercial Heat Pump Water Heater

Ambient Outdoor Temperature: 75°F (23.8°C)

Hot Water Delivery Temperature: 120°F (48.8°C)

COP = 586,000 / 292,000 = 2.0



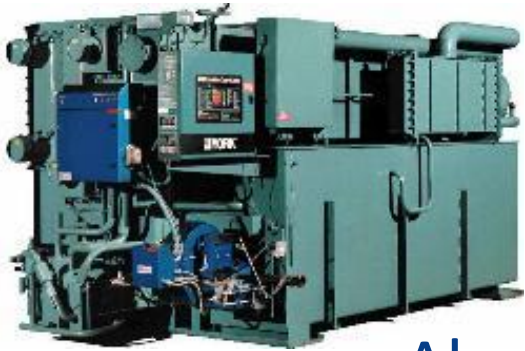
Gas Heat Pump Water Heater Specifications

- 400,000-600,000 BTU/Hour (4-6 Therms)
- Ford 2.3 L 4 Cylinder Engine (<50 bhp)
- Ultra Low Emissions
- Small 5 kW generator for parasitic load
- Next-generation control system – Internet-Based
- Touch-screen display
- Advanced communications (CAN)
- Efficient, low-pressure, HFC-134a refrigerant
- Open-drive reciprocating compressor
- Custom evaporator coil design
- Compact brazed plate condenser



Natural Gas Cooling

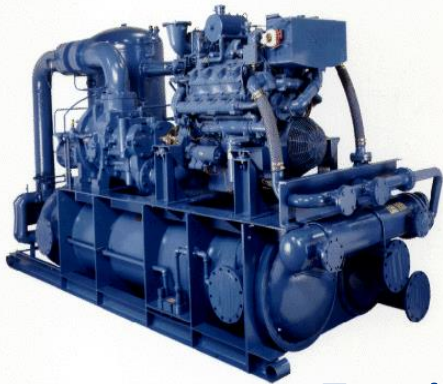
Natural Gas Cooling Options



Absorption
Chillers



Heat
Pumps



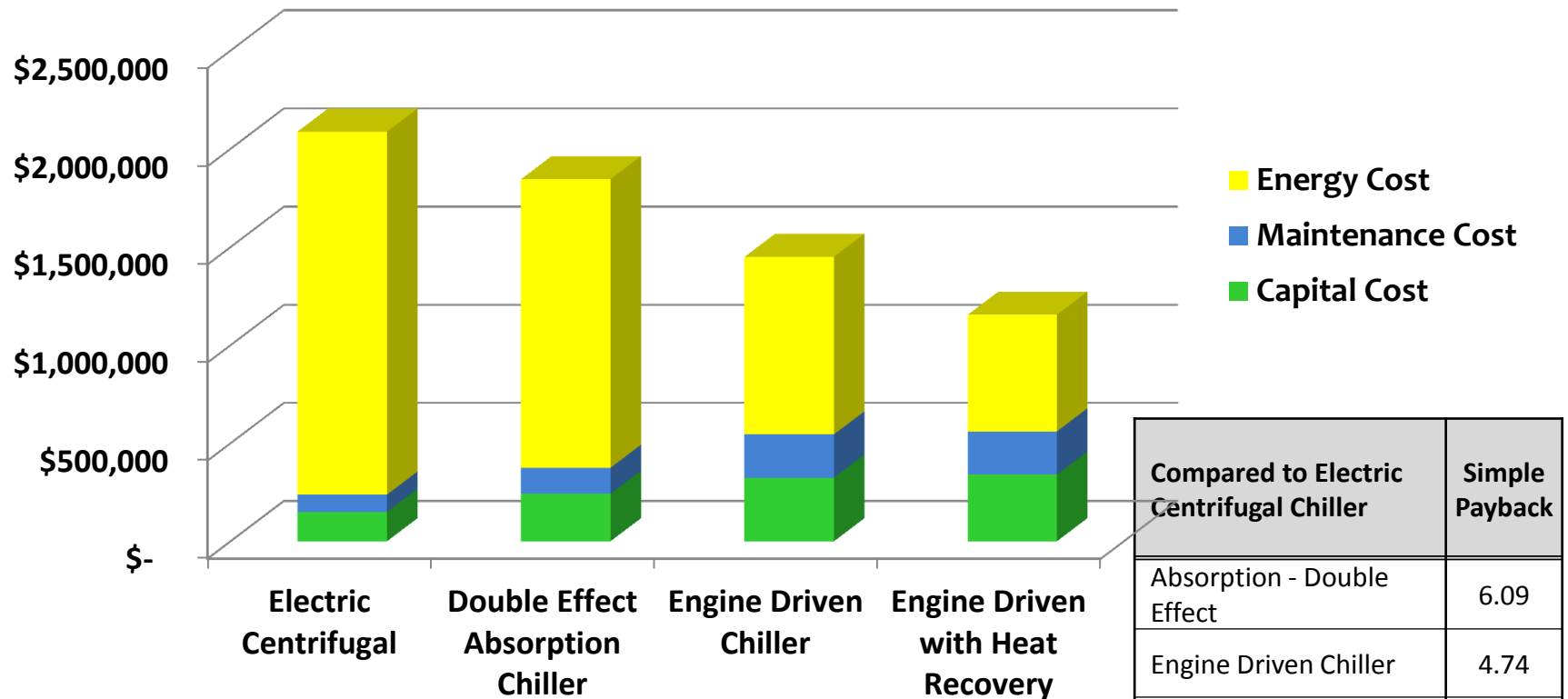
Engine Driven
Chillers



Steam Turbine
Driven Chiller

20 Year Life Cycle Cost Analysis

Gas Cooling Life Cycle Cost Analysis



Compared to Electric Centrifugal Chiller	Simple Payback
Absorption - Double Effect	6.09
Engine Driven Chiller	4.74
Engine Driven w/ Heat Recovery	3.73

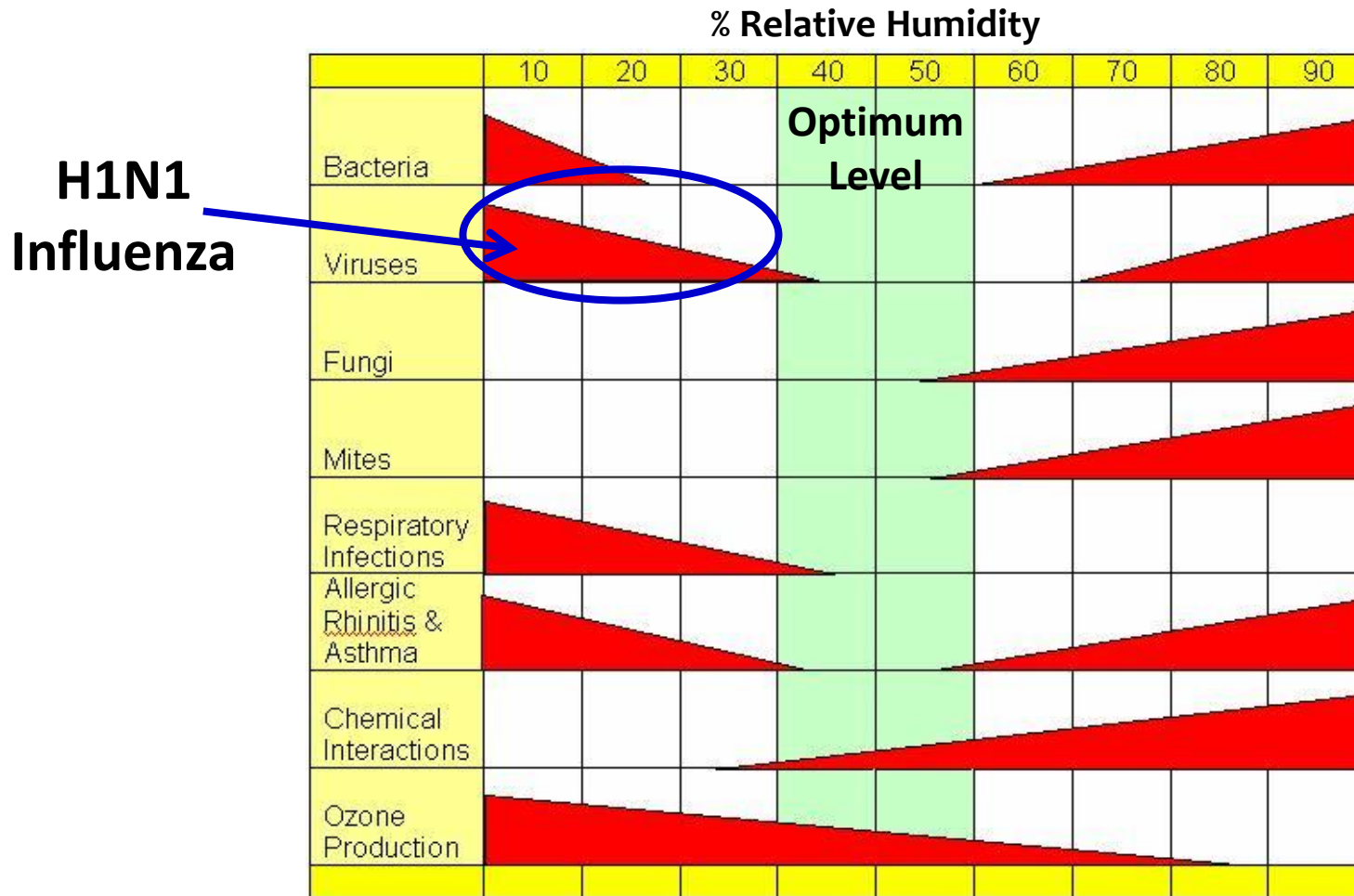
Example Only –500 Tons Cooling, 2000 operating hours/yr.

Energy Prices –Electricity @ \$0.12 / KWH & Natural Gas @ \$7.00 / MCF

Humidity Control

- Dehumidification and
- Humidification

Health Impact of Uncontrolled Humidity



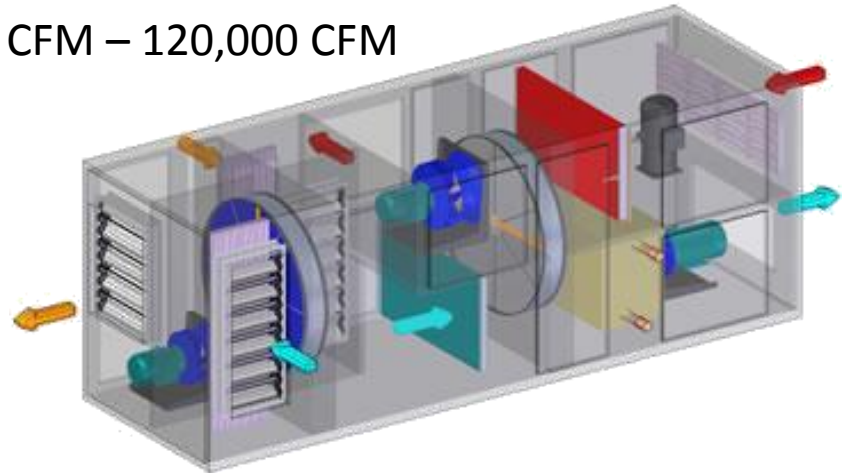
Desiccant Dehumidification

- Residential through Industrial sizes available
- Dry desiccant wheel or liquid desiccant systems



300 CFM – 400 CFM

300 CFM – 120,000 CFM

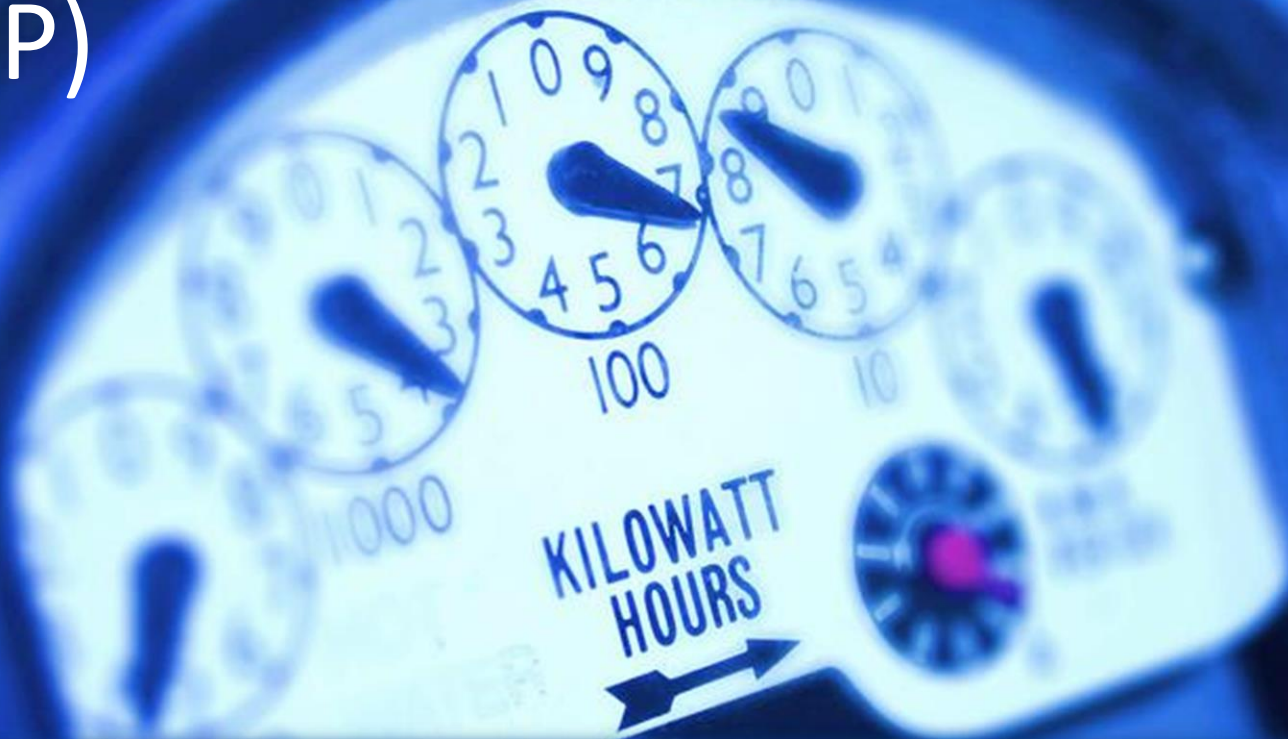


Humidifiers

- Steam humidifier
 - Uses a boiler
- Direct-Fired humidifier
 - Cost-effective when boiler not available
 - Boil water to steam and distribute via air handling system or remote blower



Combined Heat & Power (CHP)



Combined Heat & Power

Power Generation Equipment Options



Reciprocating Engines
(80 KW - 8 MW)



Microturbines
(30 – 250 KW)



Turbines
(1,000 KW – 40 MW)



Fuel Cells
(10 – 200 KW)

Reciprocating Engine Driven CHP

- High fuel efficiency
- Sizes ranging from a few kilowatts to over 5 MW
- Lower Initial costs vs. larger turbines
- Best for variable load applications
- More tolerant to high ambient conditions and high elevations
- Lower fuel pressure requirement
- Accept low BTU fuels
- On line in less than 30 seconds
- May offer “black start” opportunity

Combustion Turbine CHP

- Large heat to ekW ratio
- Sizes from 100s of kW to 100s of MW
- High exhaust temperatures: 480°C / 900°F
- Low weight & minimal space requirement
- Very simple design
- Lower emissions capabilities
- Ideal for 24/7 operation
- Accept high or low BTU fuels

Microturbine CHP

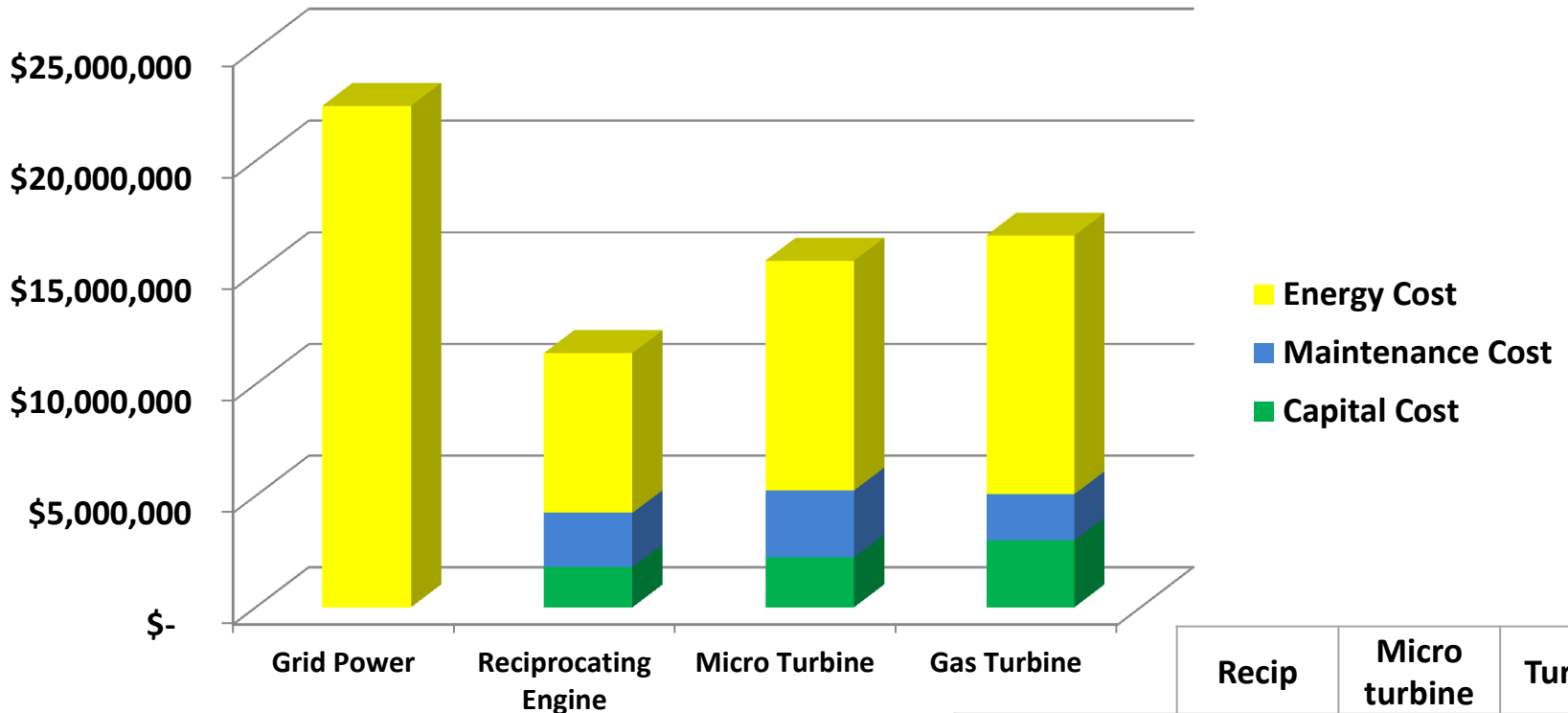
- 30 – 250 kW sizes available
- Lightweight & small footprint
- Multi-fuel capability
- Air cooled
- Ultra low emissions
- High reliability
- Minimal scheduled maintenance
- Accepts various fuel sources

Fuel Cell CHP

- Grid-independent operation
- Sizes from 5kW to 400 kW
- Electric load following
- Multi-megawatt capacity
- Will operate on low pressure natural gas fuel
- Low noise and vibration
- Ultra-low emissions
- 10 year cell stack life

Life Cycle Cost Analysis

1,000 kW CHP Life Cycle Cost Analysis



	Recip	Micro turbine	Turbine
Simple Payback	3.1 yr	5.4yr	7.5 yr
Internal Rate of Return	30%	13%	6%

Example Only –1000 kW CHP plant, 8760 hours per year

Energy Prices –Electricity @ \$0.12 / KWH & Natural Gas @ \$7.00 / MCF

Small Scale CHP vs Renewables

Summary of study by NGTC 4/17/14

12,000 Sq Ft - 10 KW DE System¹	Solar - PV	Wind	CHP
Installed Cost (\$/KW)	\$5,300	\$6,000	\$7,280
Annual Savings (/KW installed) ²	156	216	592
Space Required (Sq Ft/KW installed)	76	785	1.4
CO2 Saved (/KW installed) ³	1,871	2,588	6,502
Ave. hours /year at max power ⁴	1,550	2,175	8,311

75,000 Sq Ft - 65 KW DE System¹	Solar - PV	Wind	CHP
Installed Cost (\$/KW)	\$4,600	\$3,300	\$2,250
Annual Savings (/KW installed) ²	\$157	\$161	\$583
Space Required (Sq Ft/KW installed)	76	121	0.28
CO2 Saved (/KW installed) ³	1,878	1,933	6,369
Ave. hours /year at max power ⁴	1,550	1,595	8,322

- 1 Fitness Center = 10KW IC Engine, Elder Care facility = 65KW Micro-Turbine
- 2 Average annual energy savings across all 4 regions divided by size of DE system
- 3 Average annual CO2 reduction across all 4 regions divided by size of DE system
- 4 Average annual electric generated across all 4 regions per year divided by size of DE system



Natural Gas Vehicles (NGVs)

Available Natural Gas Vehicles



NGV Facts

- Natural gas ranges in cost from \$1.50–\$2.00 less per gasoline gallon equivalent (GGE)
- In the U.S. alone, NGVs offset the use of nearly 360 million gallons (1,362 million liters) of gasoline in 2011
- NGVs meet the strictest emission standards, including California's AT-PZEV standard
- NGVs are as safe as or safer than traditional gasoline or diesel vehicles

NGV Benefits

- Environmentally friendly
- No loss in performance
- Cost savings – CNG vs. other fuel(s)
- Extended maintenance intervals
- Operational flexibility
 - Extended driving range with dual fuel system

Questions?

Eric Burgis
Energy Solutions Center
610-796-1946
eburgis@escenter.org