

Microgrid Absorbers Designed for Maximizing Waste Heat Recovery

Combined cooling heating and power.

Modern Absorption. CHP

Case Studies:

Pinellas County Jail & Montgomery County Micro grid



Keywords: Combined cooling heating and power. Modern Absorption. CHP

This presentation will cover the absorber design as well as few additional types of absorbers that are available and specifically designed to recovery heat from internal combustion engines.

As engines are being designed to higher and higher electrical efficiencies absorber now can recovery these larger delta T's and send back even lower temperature to the radiator block.

Double lift & Triple lift as well as steam and exhaust fired combination units to fully capture waste heat steams and improve overall plant COP.

Outline

- CHP & Microgrid
- Modern Absorption Chiller
- Case Studies
- Q & A

CHP / CCHP & Microgrid

Cogeneration or combined heat and power (CHP) is the use of a heat engine or power station to generate electricity and useful heat at the same time.

Trigeneration or combined cooling, heat and power (CCHP) refers to the simultaneous generation of electricity and useful heating and cooling from the combustion of a fuel or a solar heat collector.

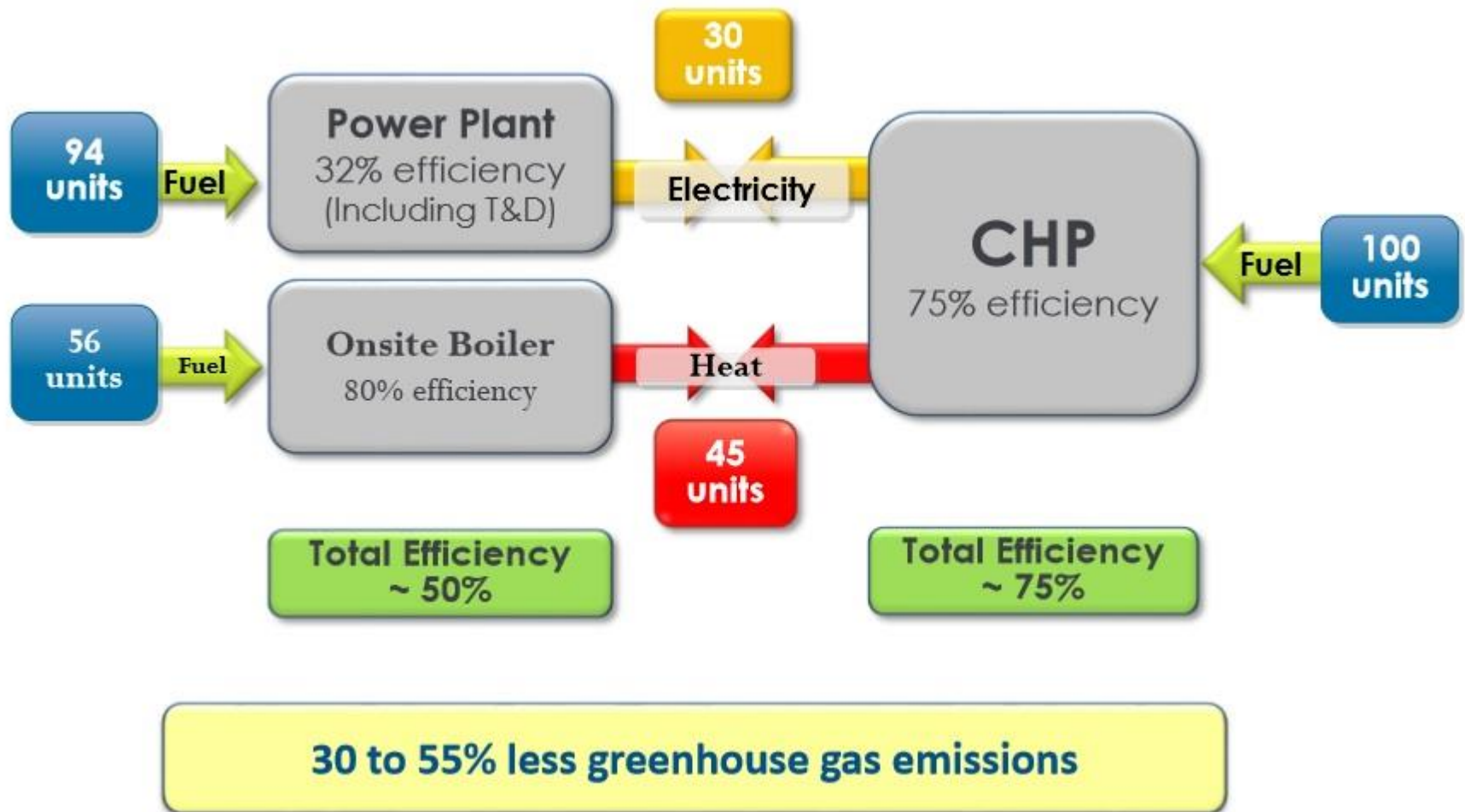
Microgrid -- A local power system (a power system on its own), Can operate in interconnected or/and isolated states. Can take part of a Smart grid or not, but it can be smart too. Scalability.

CHP / CCHP : The Foundation of a Microgrid

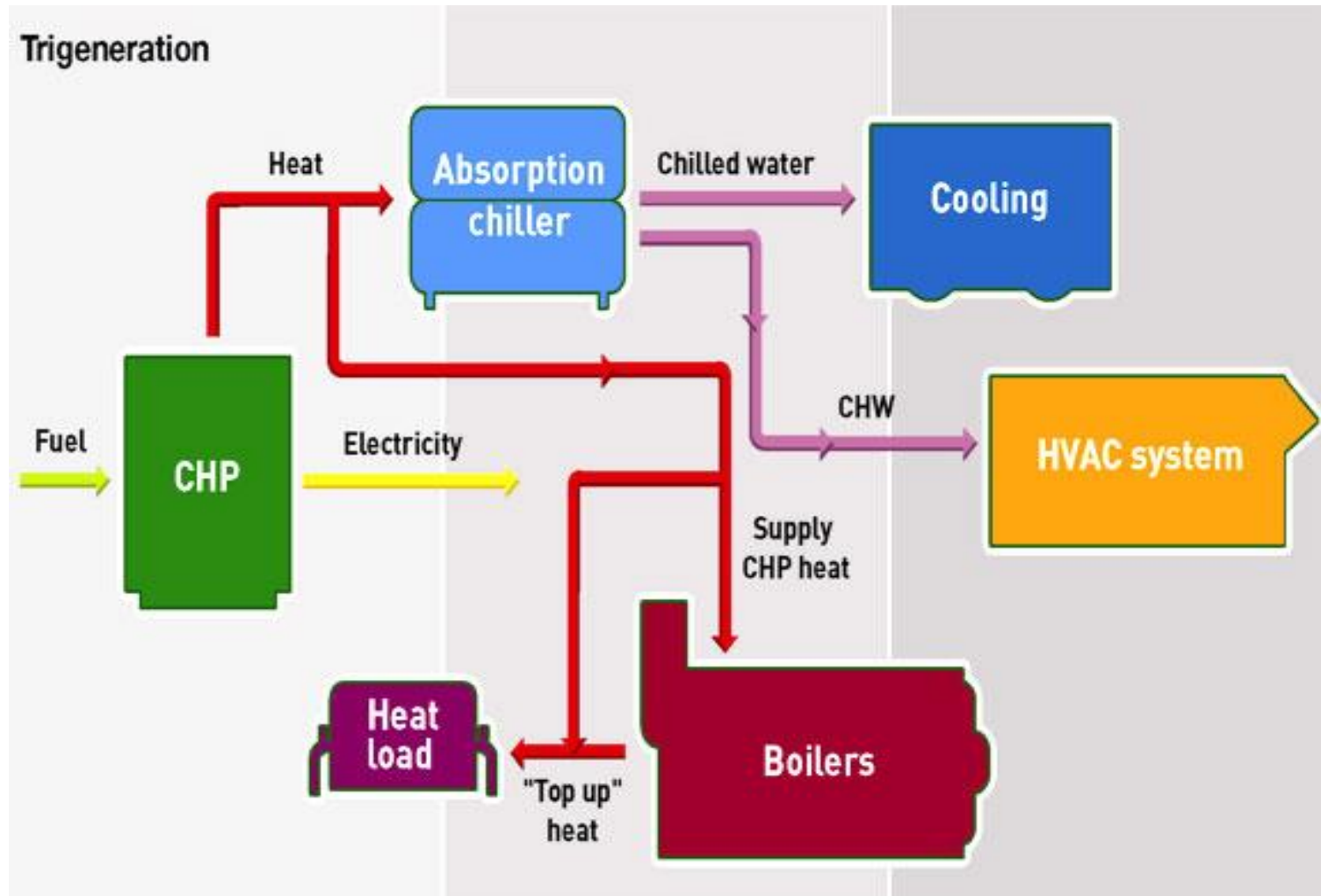
- Form of Distributed Generation (DG)
- An Integrated System
- Located at or near a building / facility
- Provides at least a portion of the electrical load and
- Uses thermal energy for: Space Heating / Cooling or Process Heating / Cooling or Dehumidification

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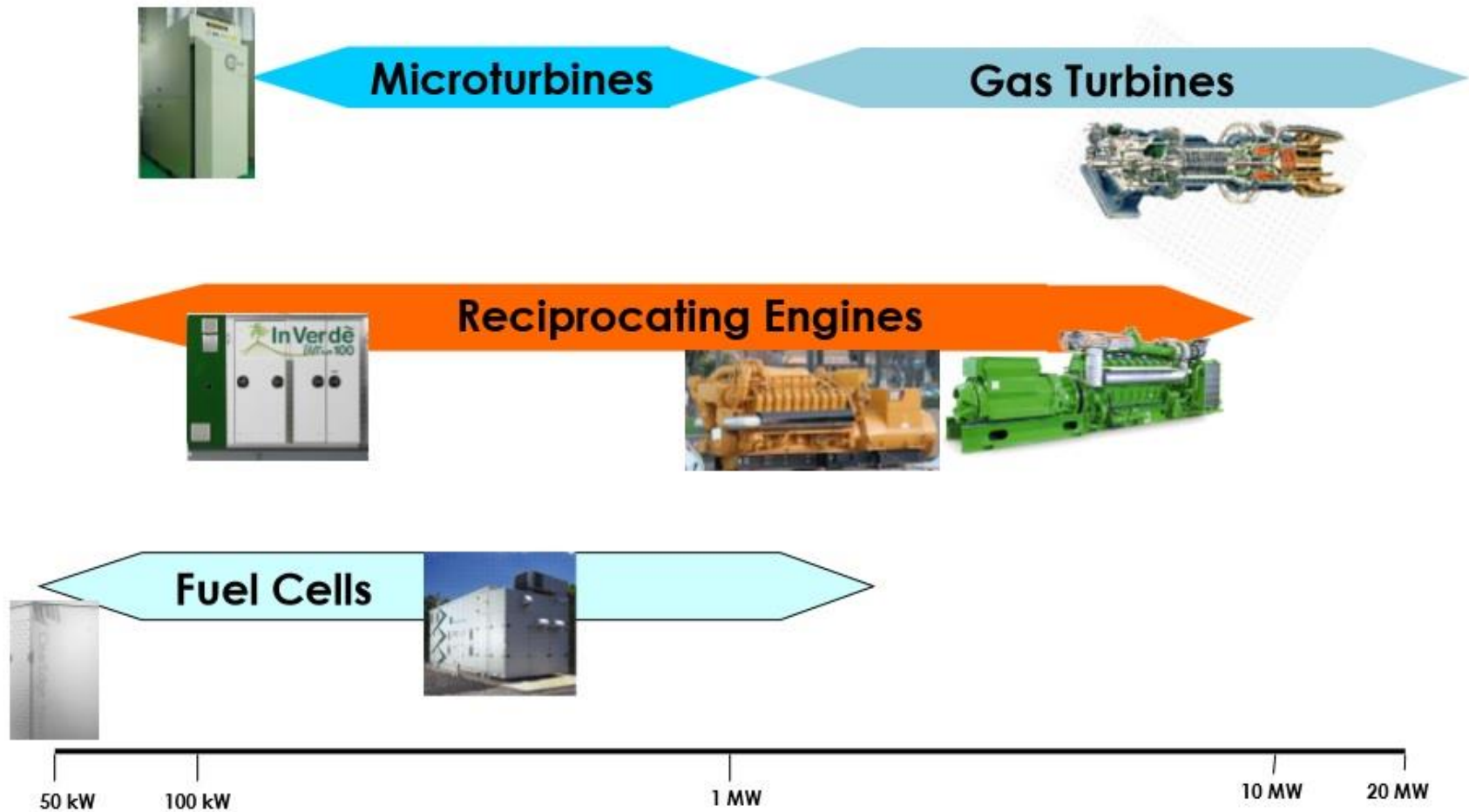
CHP Recaptures Heat of Generation, Increasing Energy Efficiency, and Reducing GHGs



CCHP (Trigeneration) System Schematic



Common CHP Technologies

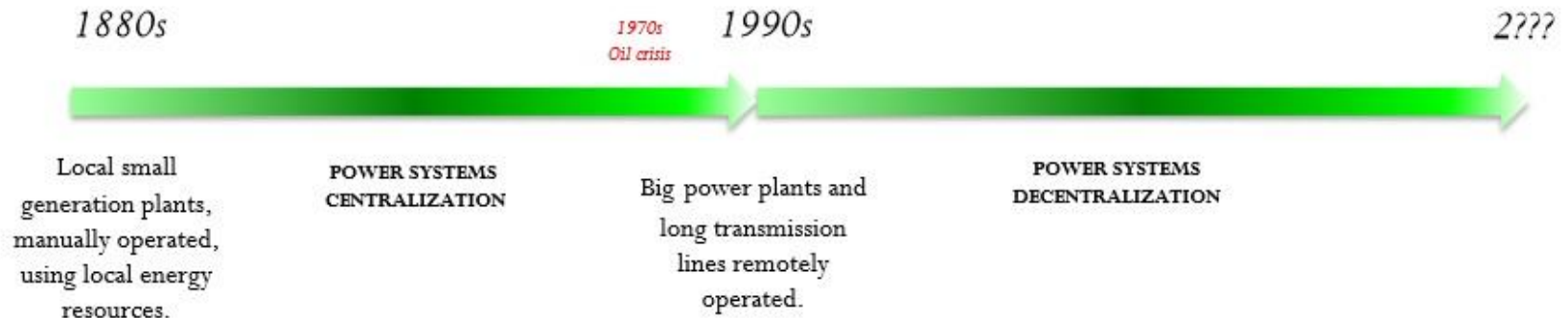


Benefits of CHP?

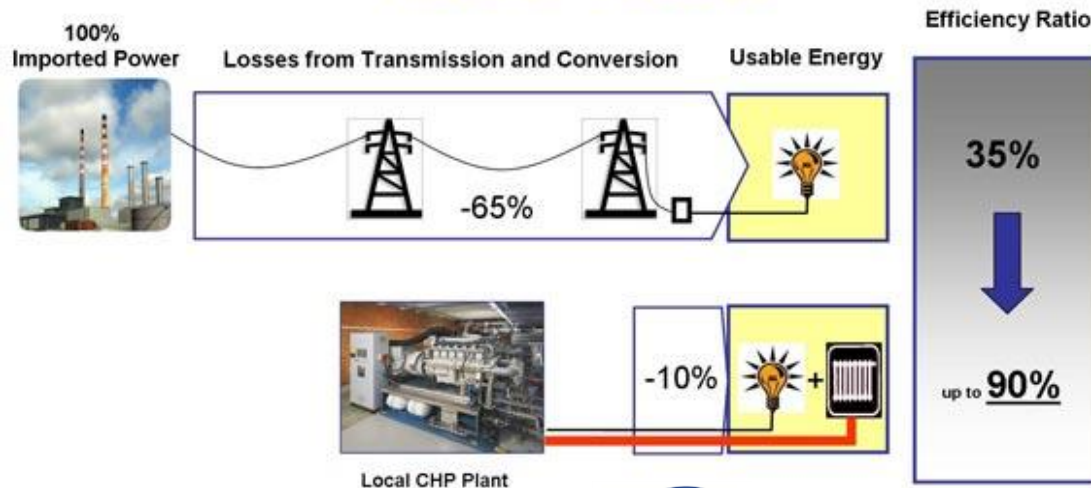
- CHP is **more efficient** than separate generation of electricity and heating/cooling ☐
- Higher efficiency translates to **lower operating costs** (but requires capital investment) ☐
- Higher efficiency **reduces emissions** of pollutants ☐
- CHP can also increase **energy reliability** and enhance power quality

Why Microgrids ?

An existing concept updated by technological advances and market conditions ☐



The CHP Process



Modern Absorption Chiller

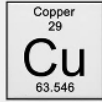



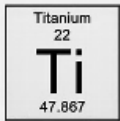


- 30 to 3300 ton
- COP = 1.4-1.52
- Auto vacuum Purge
- 24/7 monitoring
- Multi energy driven (above 180F)



Modern Absorption Chiller - Titanium Tubes



| Tube Materials | Pure Copper | Copper-Nickel | Stainless Steel | Titanium |
|----------------------|---|--|---|---|
| Solution Media |  |   |  |  |
| Chlorine | Resist corrosion under low temp& low concentration | Resist corrosion under low and medium temperature | Resist corrosion differs by types of stainless steel | No corrosion |
| salt water (speed) | 1.2 m/s | 3.6m/s | 5-7m/s | No limitation |
| Ammonia | Serious corrosion | Corrosion | No corrosion | No corrosion |
| Polluted air & water | Corrosion | Slight corrosion | No corrosion | No corrosion |

Modern Absorption Chiller - Stainless Steel Plate Heat Exchangers

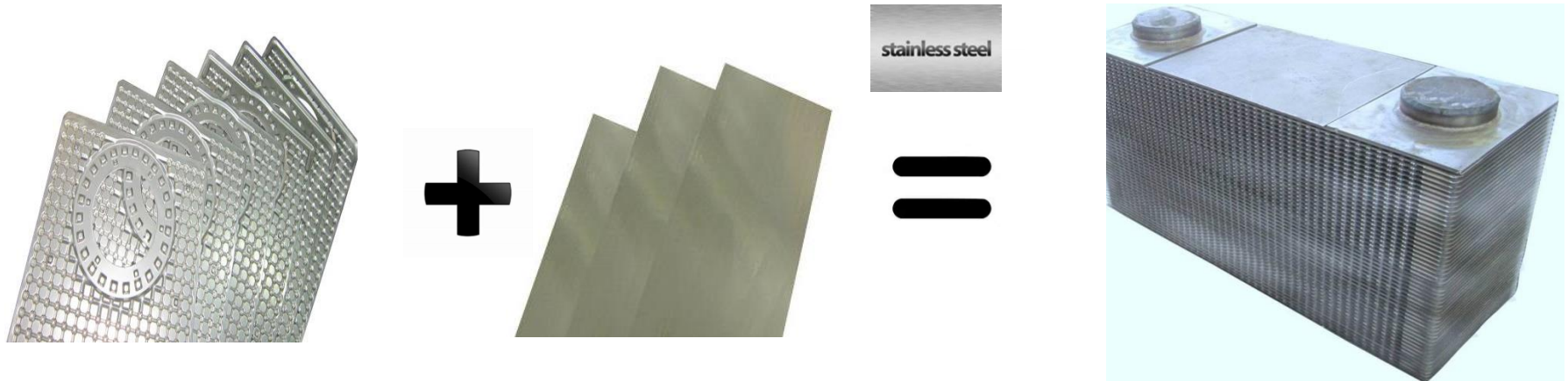


Plate Heat Exchanger for economizers
316L Plates, Nickel alloy is solder.

- No copper in plate heat exchanger, no corrosion.

Modern Absorption Chiller – 100% performance test

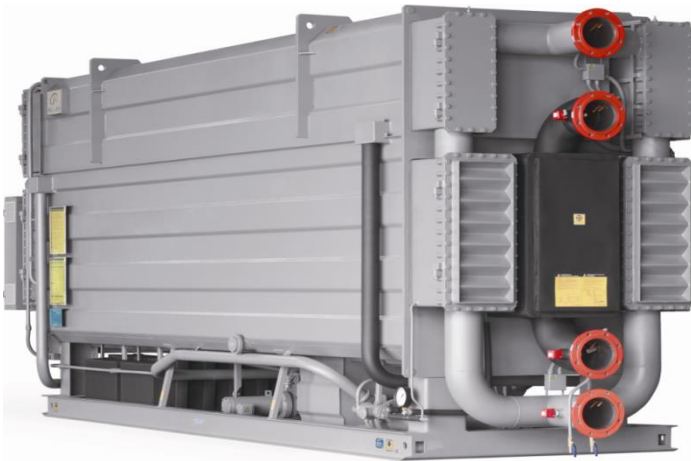


Modern Absorption Chiller – 24/7 monitoring

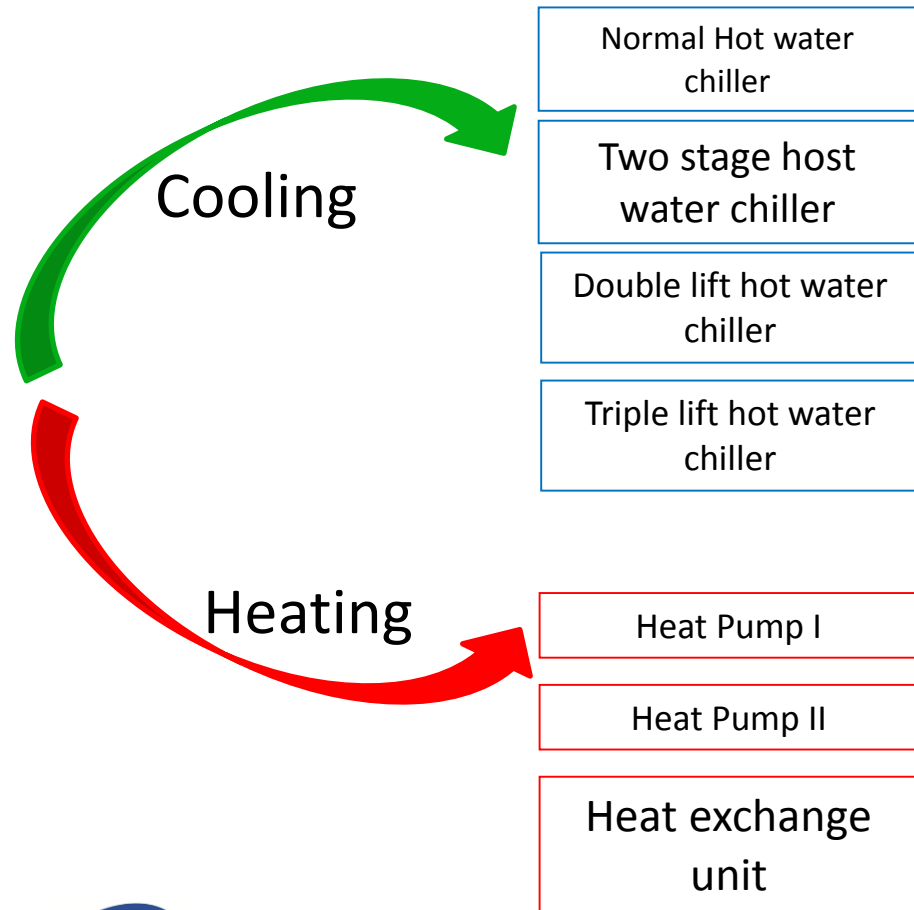


The Absorbers are monitored by the Central Control System which automatically alerts the service center/executives in the event of a fault with full diagnosis capability.

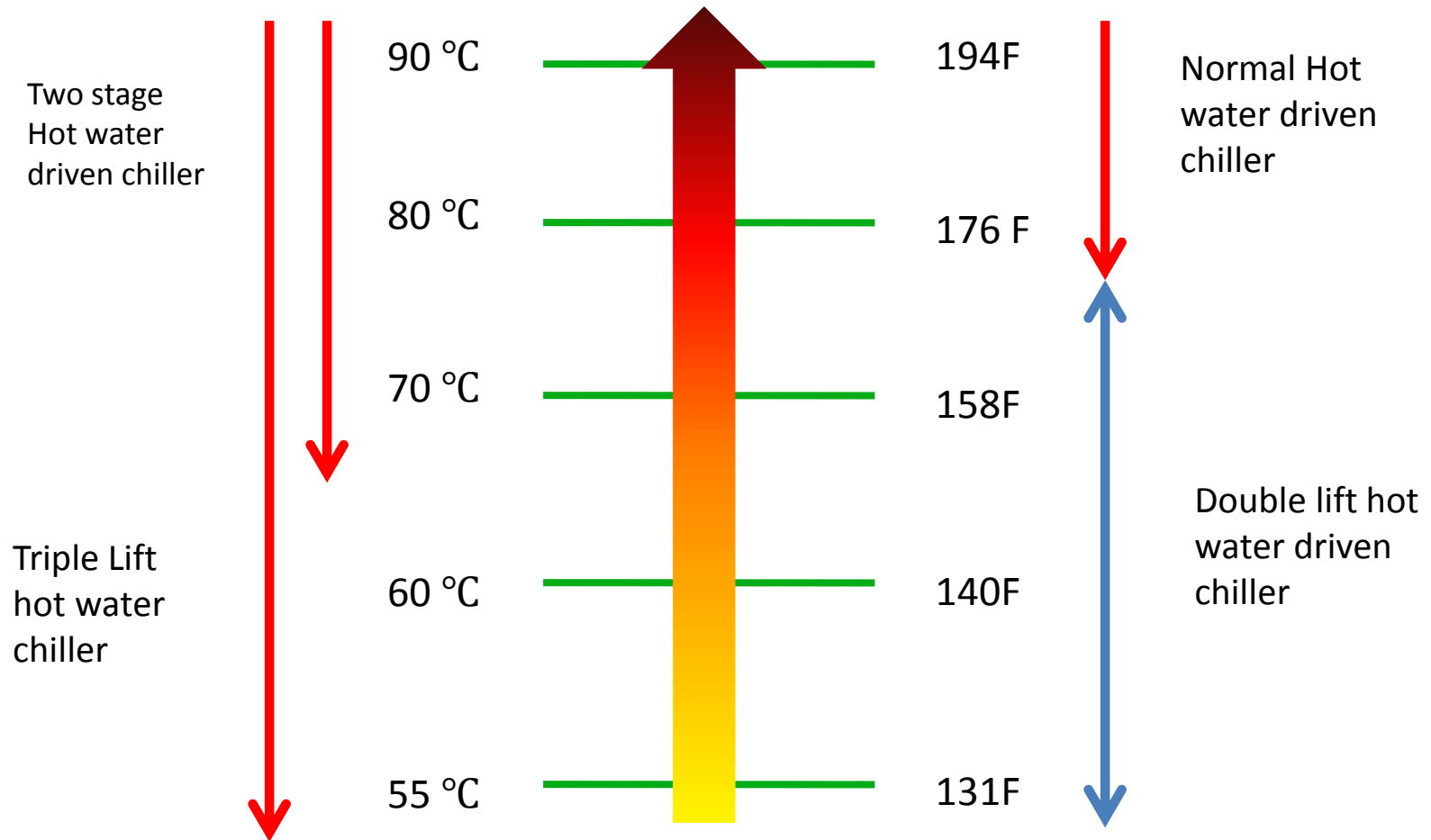
Modern Absorption Chiller – The magical of hot water



Hot water
driven chiller



Modern Absorption Chiller – The magical of hot water



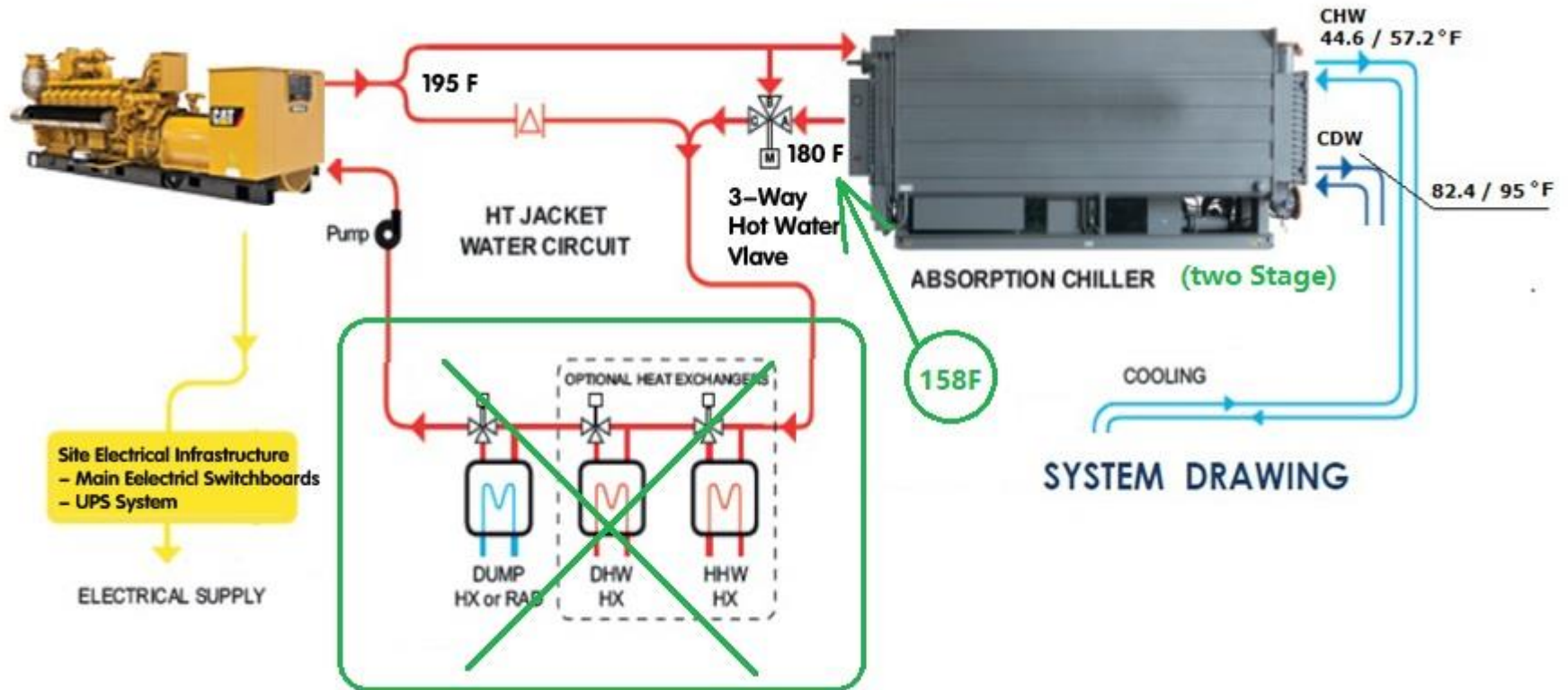
Modern Absorption Chiller – The magical of hot water

| NO. | Type | Structure | COP | Hot Sauces In/Out | Price |
|-----|-------------|--------------------------------|------|-----------------------|----------------|
| 1 | Normal Type | Normal Single stage | 0.76 | 208/190 °F (98/88°C) | Standard Price |
| 2 | Two Stage | Identical on Left & right | 0.7 | 194/158 °F (90/70°C) | 1.5 more |
| 3 | Double Lift | Add One generator and absorber | 0.45 | 167/131 ° F (75/55°C) | 1.66 more |
| 4 | Triple Lift | Add Two generator and absorber | 0.55 | 194/131 ° F (90/55°C) | 1.95 more |

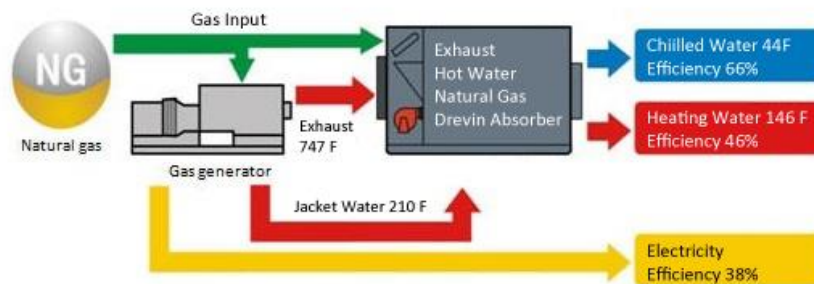


Nashville Tennessee....North Americas first triple lift single stage hot water industrial heat recovery from tire manufacturing 185 to 127 F hot water

Modern Absorption Chiller – The magical of hot water



Case Studies - Pinellas County Jail



Case Studies - Pinellas County Jail

System Info:

LOCATION: Pinellas County, Florida

Generator

Model: CAT G3516H

Maximum Continuous Rating: 2027 kW

Fuel Type: Natural Gas

Maximum Electrical Efficiency: 44.70%

Frequency: 50 / 60 Hz

RPM: 1500 / 1800 rpm



Absorption Chiller

Model: BZHE300

Cooling capacity (CHP) only : 479 ton

Cooling capacity (NG Max ton) : 992 ton

Exhaust Temp. : 747F

Exhaust Heat Input : 231,151lbr/hr

Cooling Capacity in Exhaust: 299 ton

COP on Exhaust Heat: 1.33

Hot Water Temp. : 210F

Hot Water Flow Rate: 322 GPM

Cooling Capacity in Hot Water: 180 ton

COP on Hot water: 0.76

Fuel Type: Natural Gas

Gas Consumption: 8383MBH

Cooling Capacity : 992 ton

COP on Hot water: 1.42



Case Studies - Pinellas County Jail

Installed in 2018, the CHP system is comprised of one CAT G3516H engines (2 MW) with a 1000-ton BROAD absorption chiller. The recovered heat energy (Exhaust & Jacket Water heat) from the engines goes to power the absorption chiller. The BROAD unit has total 479 -ton capacity operating on the heated jacket water (180 ton) and exhaust heat (299 ton) from the engines. BROAD chiller also loaded with a gas burner system to produce maximum 1000 ton cooling.

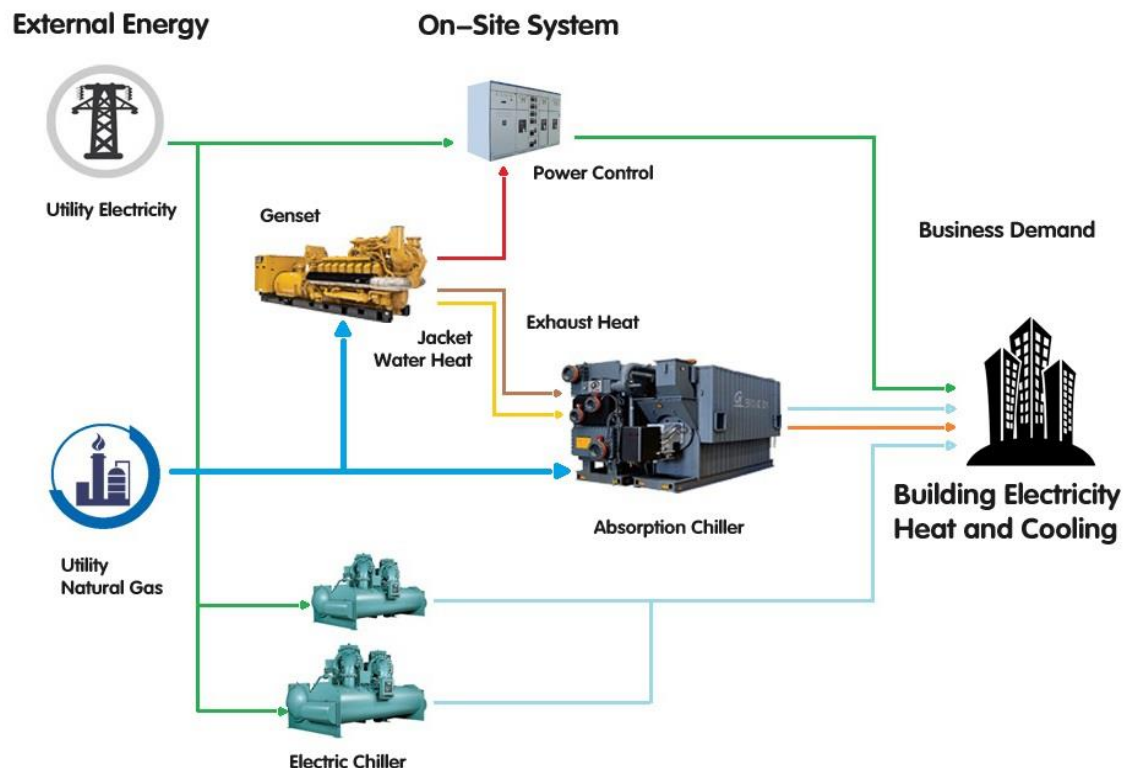
During normal business hours, the system operates at full capacity, providing approximately 2 MW for the building's electrical loads and the absorption chiller supplying a portion of the building's cooling requirements. A chilled water plant, composed of two additional electric chillers (total of 2,000 tons), supplies the remaining building cooling needs.

The CHP system produces a combined electrical and thermal efficiency of approximately 78%. During the day, the absorption chiller is able to meet 80-100% of the building's requirement, thereby allowing the electric chillers to be turned off. Night time overall system efficiency is approximately 65%.

ANNUAL ENERGY SAVINGS: \$700,000-\$800,000

PAYBACK: 5 years

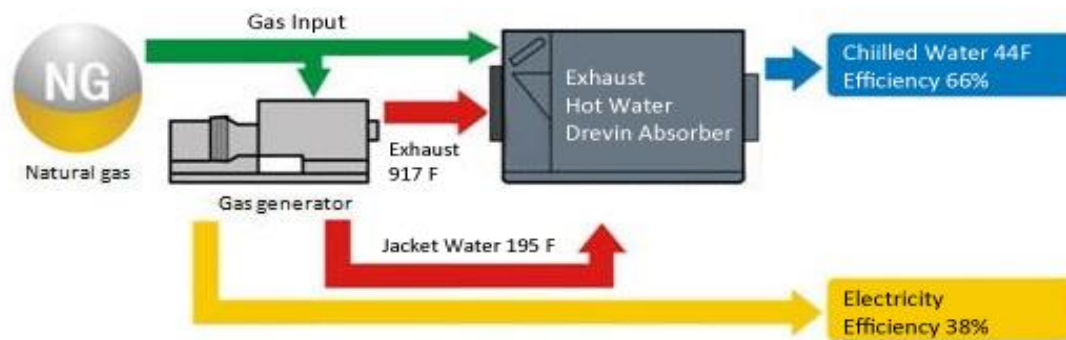
CHP IN OPERATION SINCE: 2018



Case Studies - Pinellas County Jail



Case Studies - MGM National Harbor



Case Studies - MGM National Harbor

MGM National Harbor is the premiere entertainment destination located on the banks of the Potomac just outside of Washington DC. Featuring a 3,000 seat Theater, 308 luxurious hotel rooms, restaurants from acclaimed chefs and a gaming floor bigger than the White House. MGM installed combined heat and power (CHP) in 2016 and an estimated 4.5-year payback.

Why use Cogeneration — Casinos require simultaneous heating, hot water and cooling for HVAC. The CHP provides additional economic savings by using the recovered heat for building heat in the winter and to power an absorption chiller for cooling in the summer.

- 1) More affordable to operate the facility than an electric Grid Supplied power system
- 2) CCHP will typically use 35% less energy.
- 3) Significantly Lower CO2 emissions
- 4) Resiliency: CCHP system typically can keep facility open during an electric Grid power outage with standard emergency generators
- 5) Capital Investment can be paid back within a few years of operation and easily financed

The Chiller system is comprised of 6 magnetic bearing chillers and one 250 ton multi energy (exhaust + jacket water) absorption chiller. Building installed four 2.5MW engines running on natural gas and one of engine's exhaust / jacket water loop connected to exhaust boiler and a 250 ton absorption chiller. During the summer, partial recovered heat is used to power the absorption chiller, providing space cooling.

MGM started CHP operation in July 2017, and now runs the system 24/7. CHP supplies 2.5MW to the facility. The CHP system operated in island mode for few months, until a 3-way exhaust damper failure on November of 2017. MGM's goal is to generate close to 100% of the facility's electrical needs, operating in parallel and synchronized to the utility.

Case Studies - MGM National Harbor

System Info:

LOCATION: 101 MGM National Avenue Oxon Hill, MD 20745

Generator

Model: CAT 3516C

Maximum Continuous Rating: 2500 kW

Fuel Type: Natural Gas

Maximum Electrical Efficiency: 44.70%

Frequency: 60 Hz

RPM: 1800 rpm



Absorption Chiller

Model: BHE77

Cooling capacity (CHP) : 258 ton

Exhaust Temp. : 917F

Exhaust Heat Input : 9,795 lbr/hr

Cooling Capacity in Exhaust: 181 ton

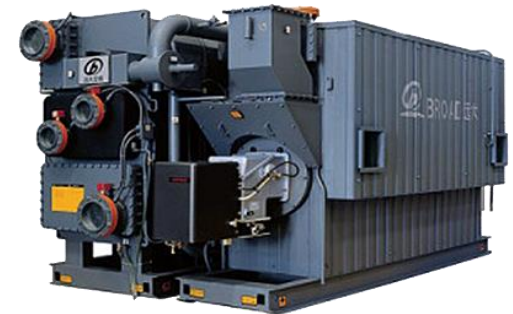
COP on Exhaust Heat: 1.41

Hot Water Temp. : 195F

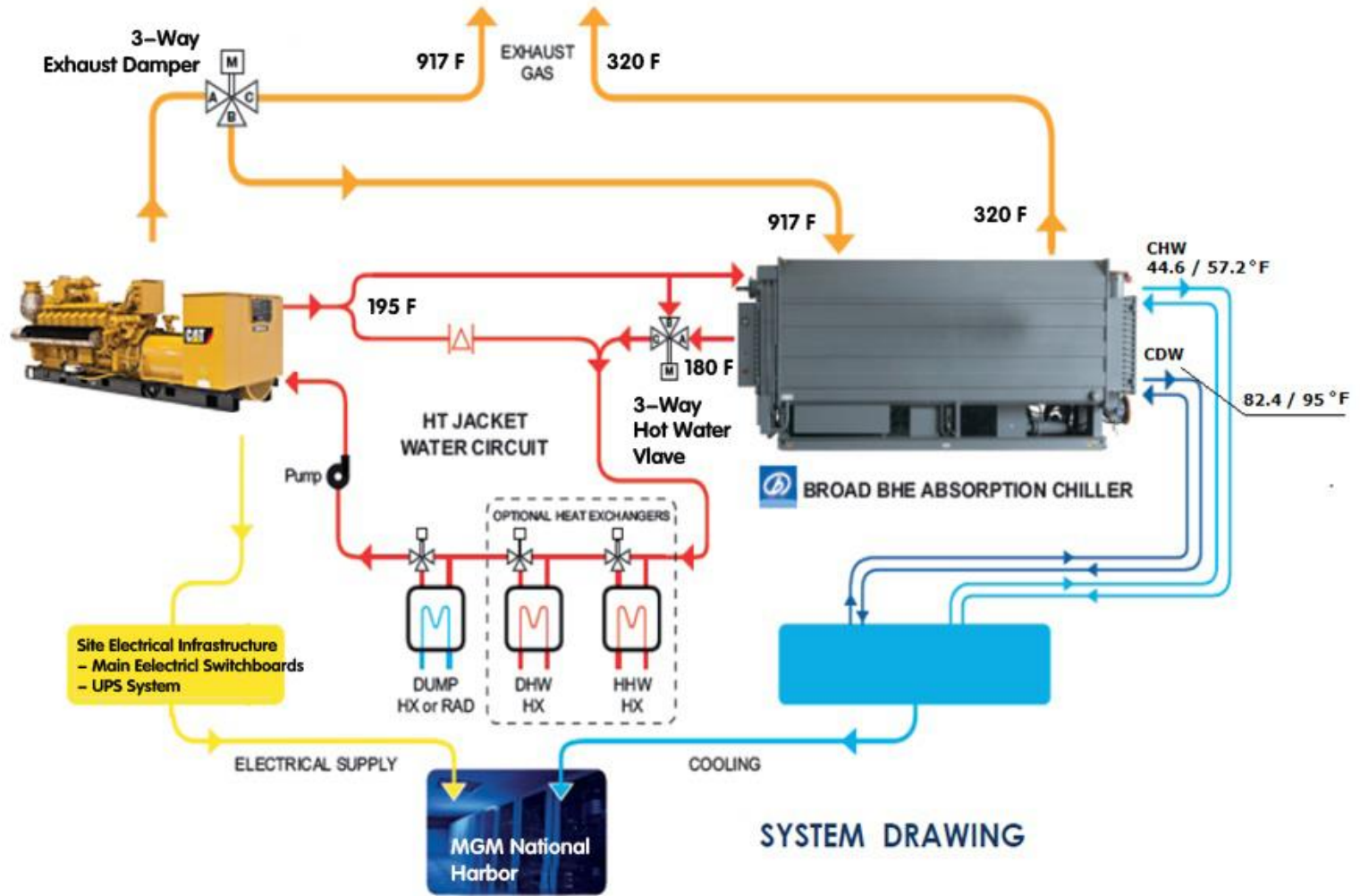
Hot Water Flow Rate: 175 GPM

Cooling Capacity in Hot Water: 77 ton

COP on Hot water: 0.72



Case Studies - MGM National Harbor



Case Studies - Pinellas County Jail

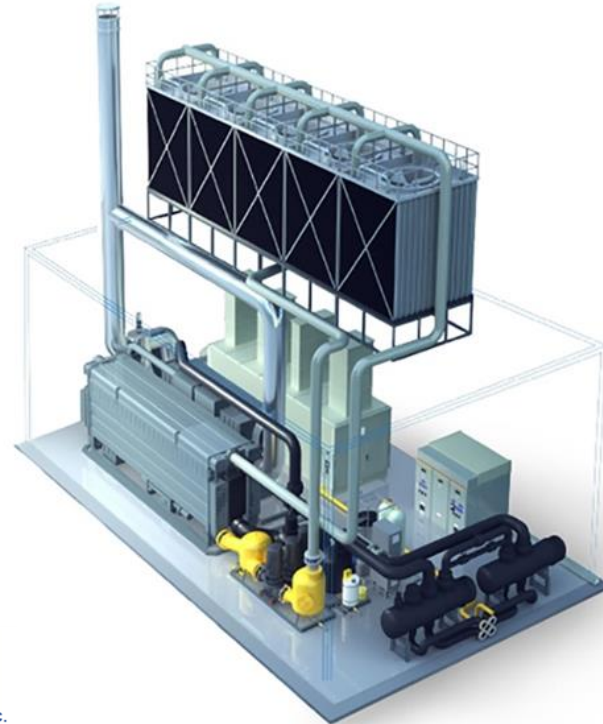


Summary of Absorption Chiller Attributes for CHP Systems

| | |
|-------------------------|---|
| Size range | 5 to 3,300 refrigeration tons |
| Input Heat | Hot water, steam, or prime mover exhaust |
| Configuration | <p>Available in single (double or triple lift) and two stage designs.</p> <p>Single stage machines can be driven with hot water (167-240°F) or low pressure steam (15 psig) and are often used with reciprocating engine CHP installations.</p> <p>Compared to single stage chillers, two stage machines require higher temperature hot water (e.g., 280 - 350°F) or higher pressure steam (e.g., 115 psig) and are often used with combustion turbine CHP installations.</p> <p>In addition to hot water and steam, absorption chillers can also be exhaust fired (required exhaust temperatures typically above 650°F).</p> |
| Refrigerant / Absorbent | <p>For 39°F and higher chilling fluid temperatures (e.g., building air conditioning), a common mixture is water (refrigerant) and lithium bromide (absorbent).</p> <p>For chilling fluid temperatures below 39°F (e.g., cold storage), a common mixture is ammonia (refrigerant) and water (absorbent).</p> |

Lessons to Share

- 1) Negotiate utility contracts including natural gas supply (preferably long term), natural gas delivery, standby rates, and interconnection contracts.
- 2) Picking a contractor for operation and maintenance is important. On-site engineering staff should have been better trained in the operations of the CHP system.
- 3) Space to locate the absorption chiller close to the engine units
- 4) CHP + Absorption chiller good for base load . Absorption chillers has significant space conditioning requirements or year-round cooling loads. Sites that may require steady year-round cooling include manufacturing plants with process cooling needs, cold storage warehouses, data centers, and district energy plants



Q&A

Thank You For Your Precious Time

Kevin Fu

Vice GM

BROADUSA INC.,

Tel: 646.425.7499

Email: Kevin@broadusa.com



About BROAD U.S.A.

BROAD U.S.A. is a privately held company Headquarter in New Jersey supporting the sales and service to our Customers in North America. BROAD Absorbers are currently operating successfully in over 80 countries with over 35,000 installations worldwide. Broad is the world largest manufacturer of absorption chillers ranging in size up to 3300 tons.

