
LEADING THE WAY
CampusEnergy2022
Feb. 15-18 | Westin Boston Seaport District Hotel | Boston, Mass.
INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Absorption Chillers in District Cooling Plants

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District Cooling Plants

➢District Cooling Plants mostly have Cogen to meet Electricity, Cooling and Heating demands of their clientele.

➢Cogen offers great economics with electricity cost lower than utility and as a by product provides steam too.

➢Heating BTUs are provided directly by steam

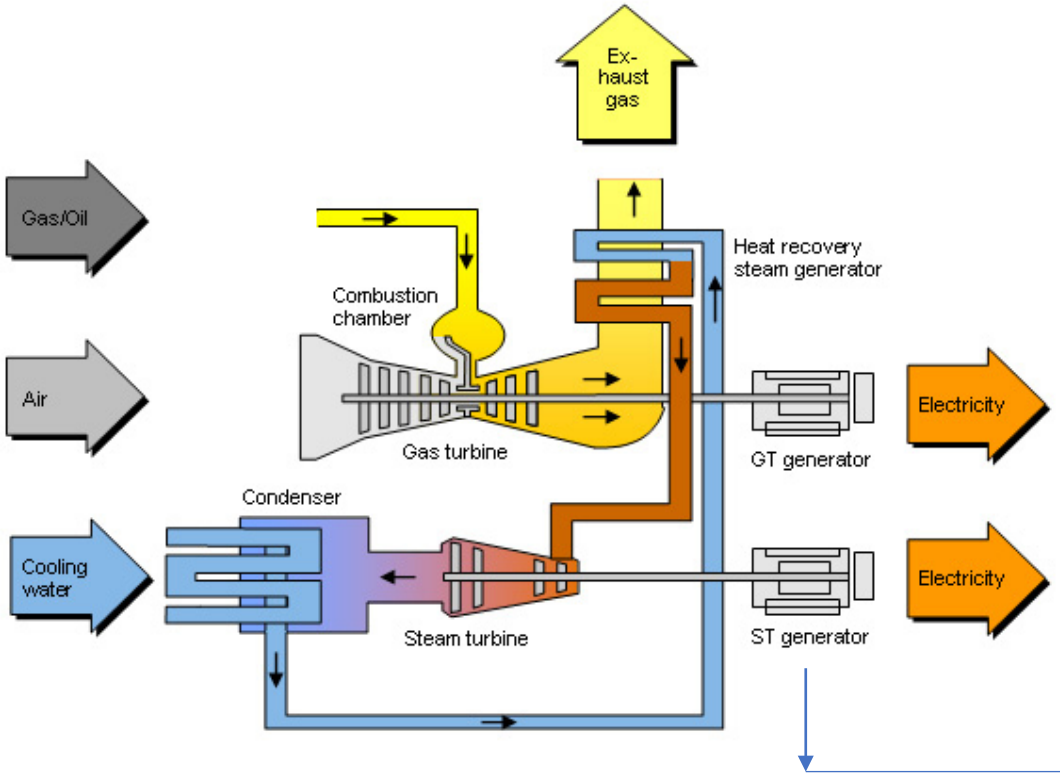
➢Cooling BTUs can be generated from steam in different ways:

- Single Effect Steam Absorbers [if there is a combined cycle plant]
- Double Effect Steam Absorbers [in case of Cogen with L.P/H.P HRSG]
- Steam Turbine driven Centrifugal chillers [in case of Cogen with H.P HRSG]

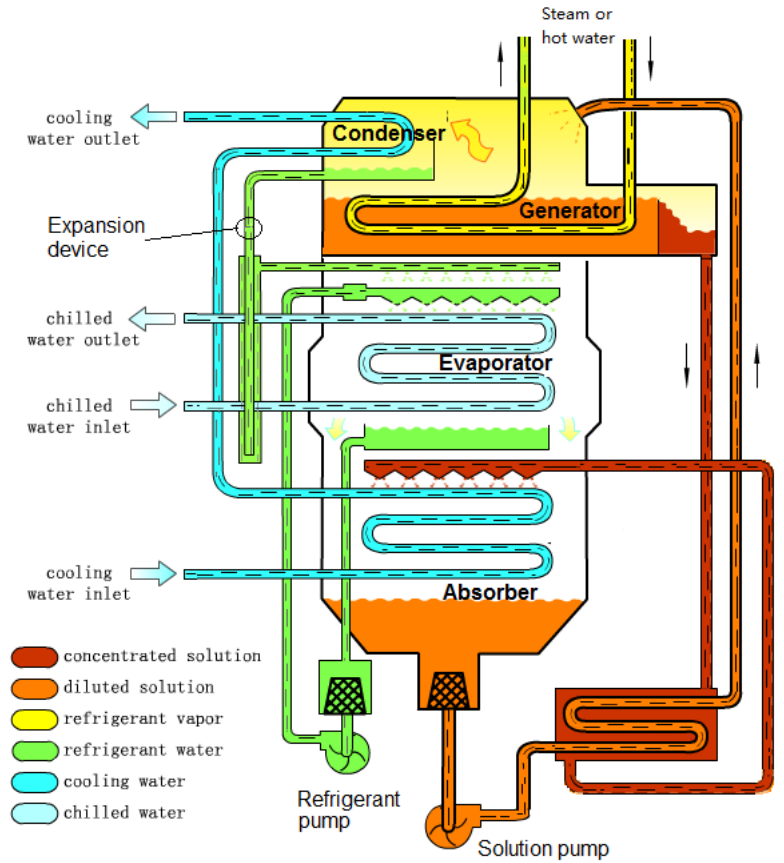
[HRSG: Heat Recovery Steam Generator, L.P: low pressure, H.P: high pressure]

1. Single Stage Absorption Chillers in Dis. Cooling Plant

- Combined Cycle Power Plant
  (condensing turbine)

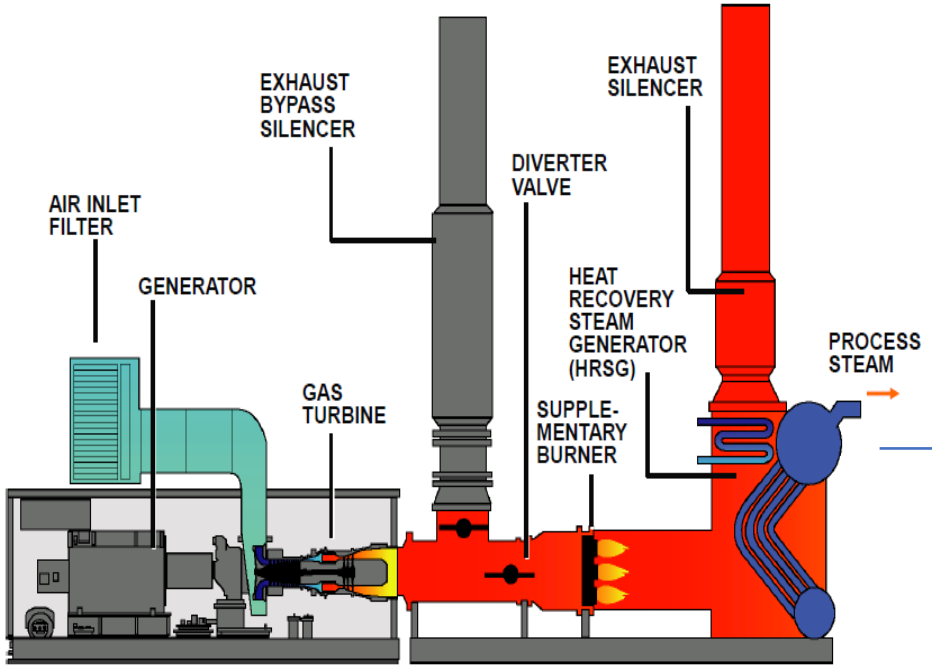


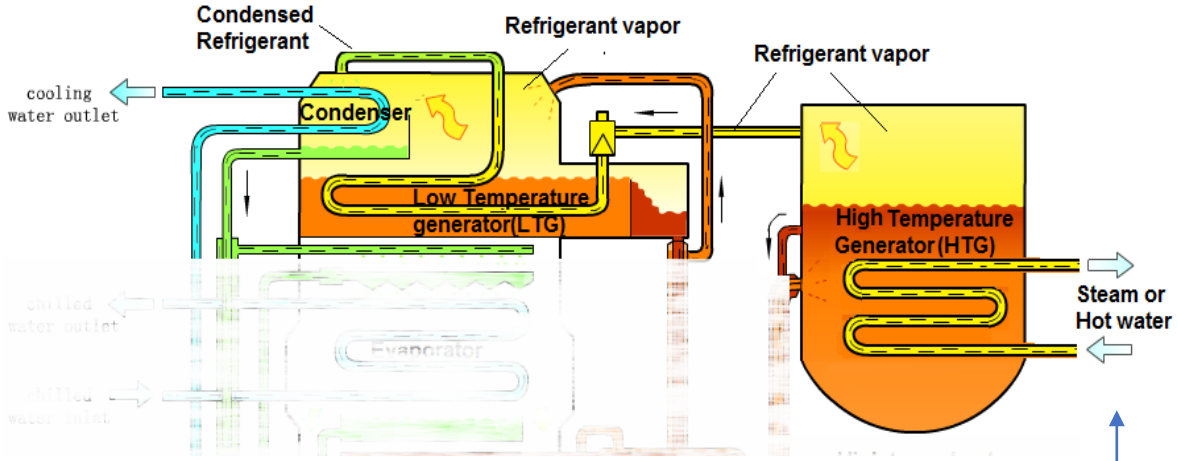
5-15 psi Steam



2. Two Stage Absorption Chillers in Dis. Cooling Plant

- Cogen with L.P HRSG

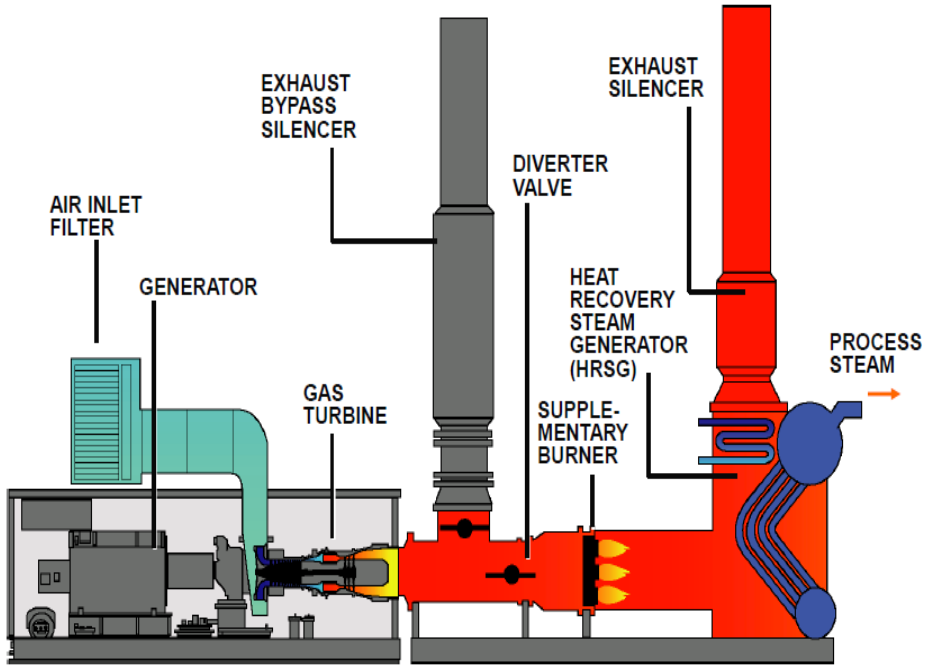


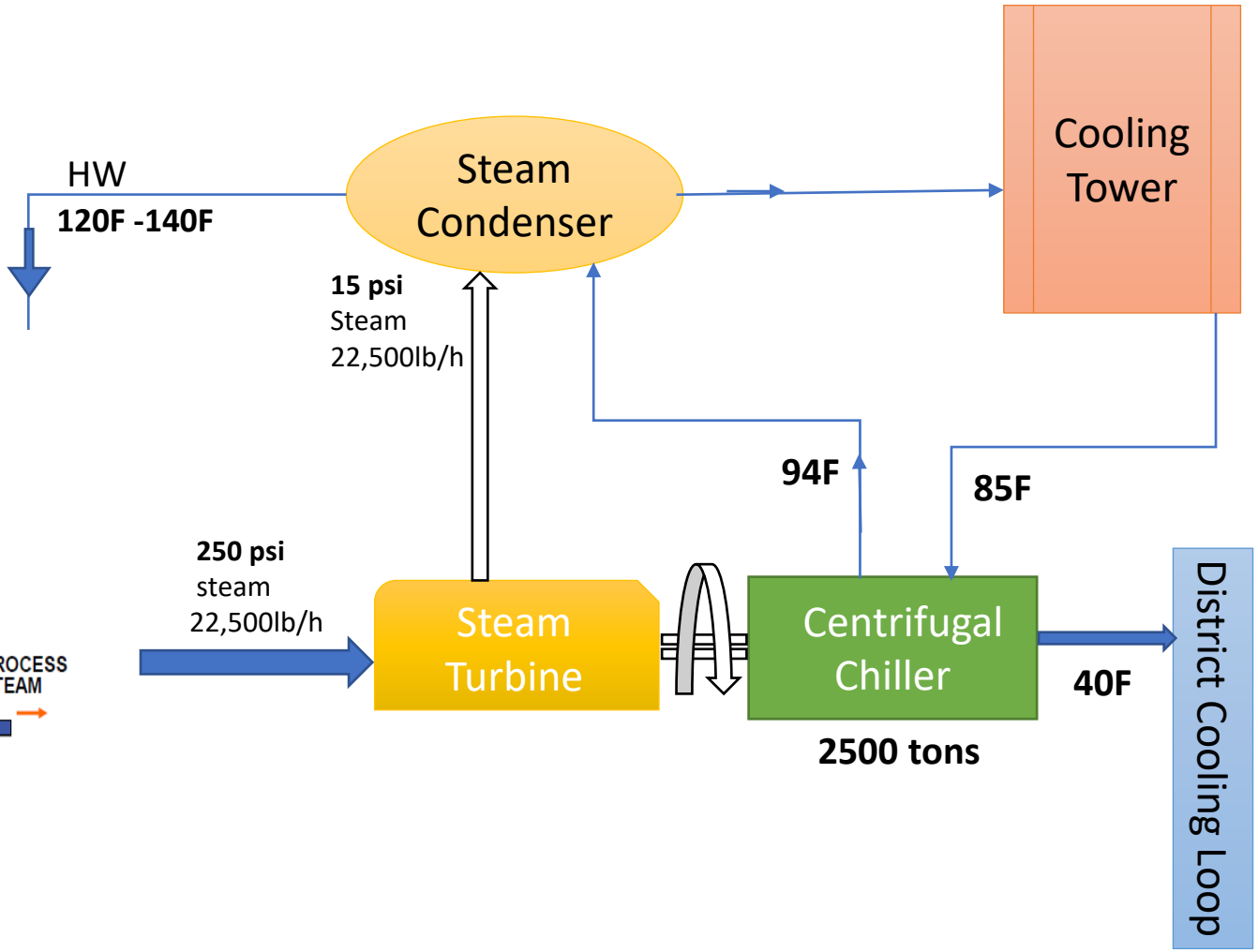


60 -115 psi Steam

3. Turbine Centrifugal in Dis. Cooling Plants

- Cogen with H.P HRSG





We focus today on the 3rd option:

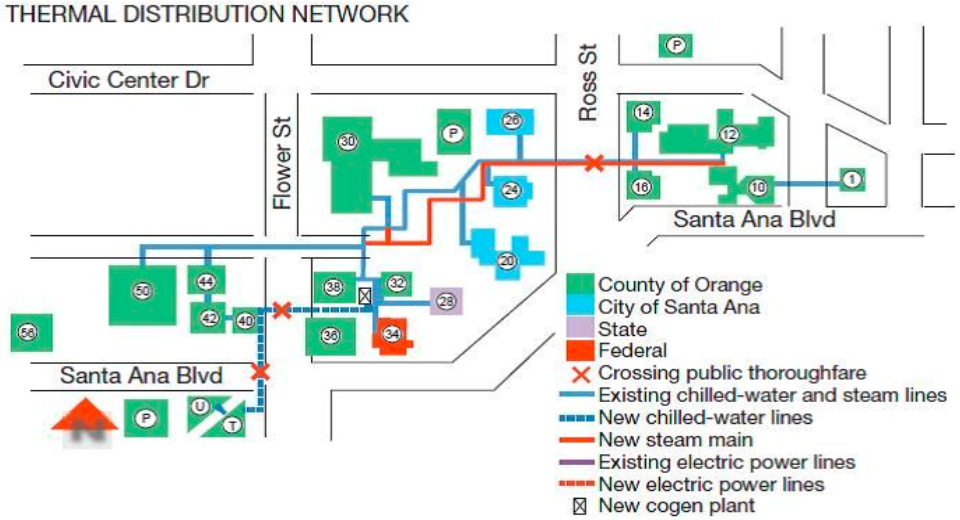
District cooling Cogen plant with Steam Turbine driven Centrifugal:

- Demands steam to run the centrifugal compressor: **250 psi/ ~9 lbs./hr/ton**
- Delivers low chilled water to the loop: **40F**
- Saves Electricity: **560kw/1000 tons**
- Reduces Co2 emissions: **900lbs/mWh saved**
- Turbine's backpressure steam **is condensed** for HRSG' optimum efficiency

This steam energy could be used to drive a Single Stage Absorber!

Case Study: Santa Ana (OC) CUF, California

Pictures Courtesy: OC website



- Central Utility Facility (CUF) is owned & operated by Orange county since 1968 in Santa Ana.
- Distributes electricity, steam and chilled water 24x7 to various government office buildings in the sprawled Civic Center area.
- Serves 215 facilities comprising 9 mill. sq. ft area including County Courts and Jails vide several miles of underground piping network.
- On-site electricity and high-pressure steam generations from 2x 5.2 MW COGEN and imports grid electricity too. *Total Steam: 128,000 lbs./hr at 265 psi.*
- Maintains its peak grid electricity demand using thermal heat source driven cooling technology.
- Peak Cooling Load is around 10,000 Tons.

Energy Savings: District Cooling Plant's priority

- Cooling Load: 10,000 Tons
- Installed: Steam Turbine Centrifugal @ 2500 Tons x 3 *[on Cogen steam]*

Options for adding balance 2500 tons

- 2500 Tons Turbine Centrifugal: 22,500 lbs./hr. extra steam at 150 psi
  [HRSG In-duct firing required; extra gas cost]
  [Condenser cooling will require extra water]
- 2500 Tons Electric Centrifugal: 1.4 mWh extra grid connection
  [Electricity infra update; extra investment]
- 1250 Tons x 2 Single Stage Steam Absorption chillers

Target and Challenges

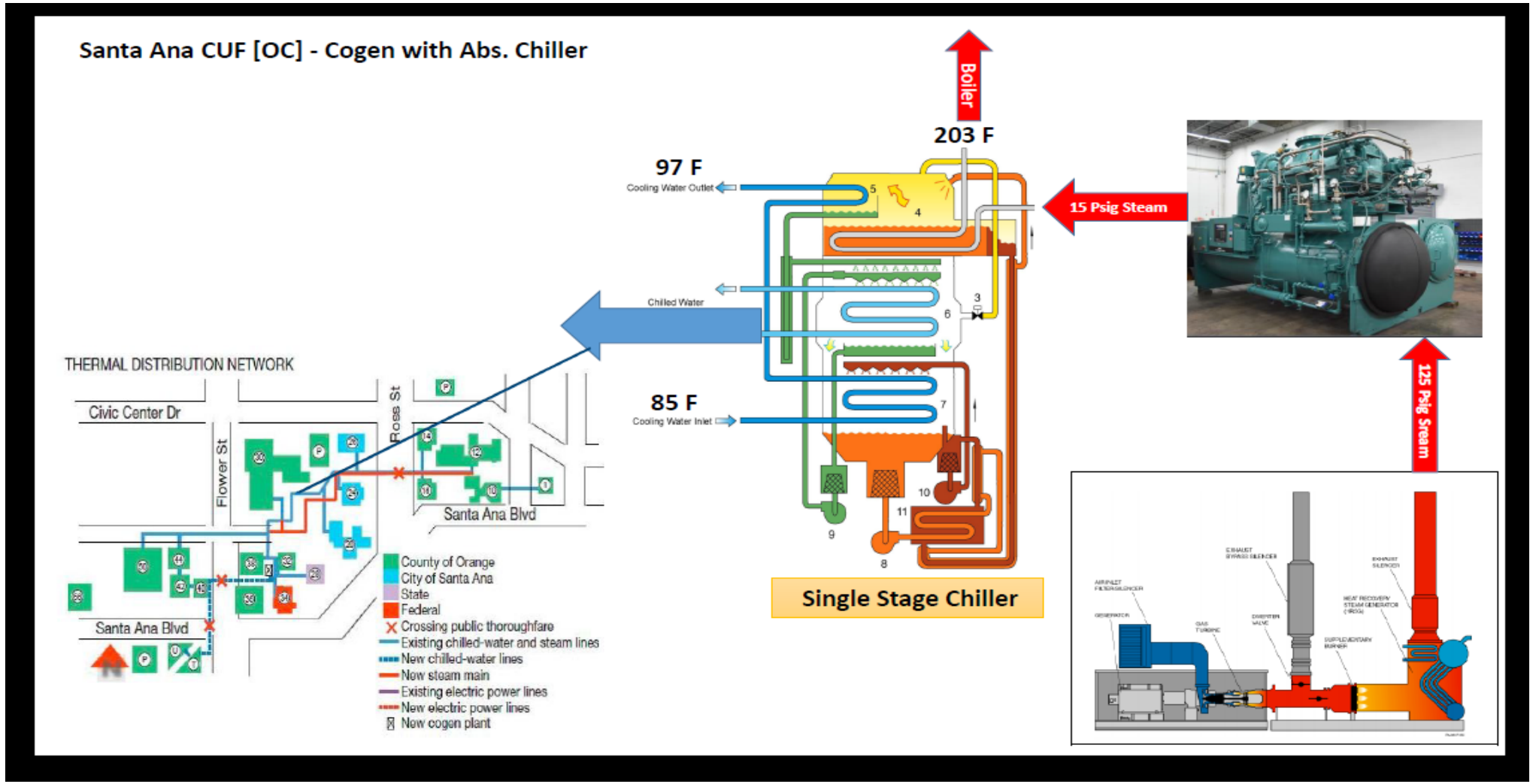
Target

Add 2500 Tons

Challenges

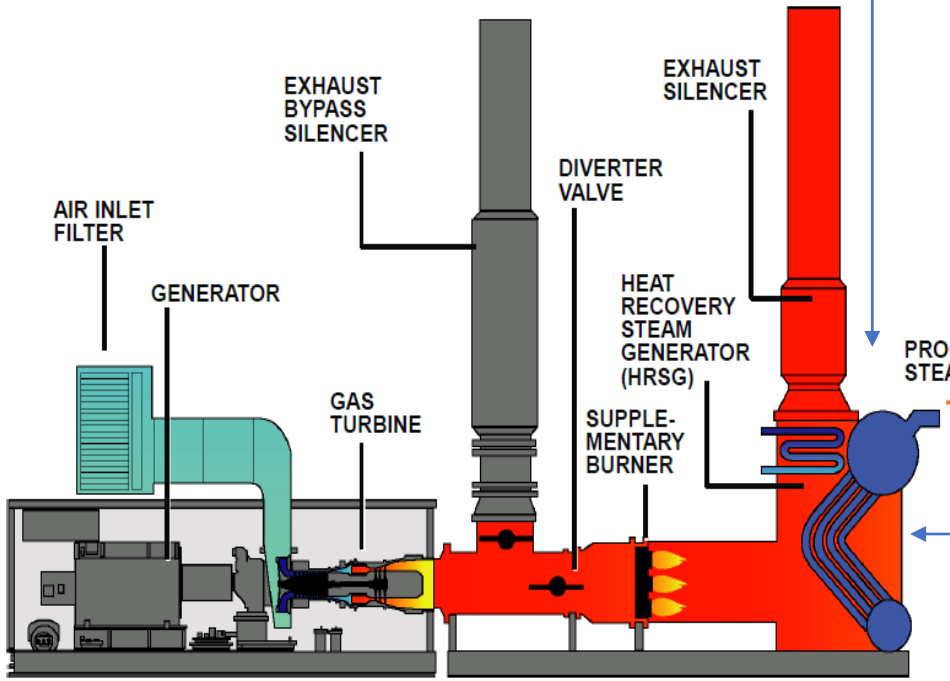
- Avoid extra grid connection
- Avoid in-duct gas burning
- Justify any extra water usage

Solution- Single Stage Absorber on the Back Pressure Turbine



Solution

Installed in duplicate with 2 such sets of Turbine Centrifugal



Picture Courtesy: Solar Turbine

- *Pressure* = 15.0 *psig*
- *Temperature* = 249.0 *°F*
- *Specific Enthalpy* = 217.6 *btu/lbm*

[*Inlet Energy Flow* = 4.9 *MMBtu/hr*]

4.9MMBTU/h
Steam Energy loss

Steam Condenser

HW
120F

99F

Cooling Tower

15 psi
Steam
22,500lb/h

94F

85F

PROCESS STEAM

250 psi
steam
22,500lb/h

Steam Turbine

Centrifugal Chiller

40F

2500 tons

District Cooling Loop

HW
203F

15 psi
Steam
22,500lb/h

Single Stage Absorption Chiller

40F

85F

97F

1250 tons

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Result

- **Electricity savings:** 4.2 gWh /year by each Steam Absorber
- **Co2 emission reduction:** 1831 Metric Ton / year* per set
- **Water savings:** Condenser cooling of steam avoided. Tower make-up water justified with extra cooling addition
- **Gas savings:** Auxiliary gas firing avoided as extra steam not required

**436gm Co2/kWh emitted by Gas Turbine with HRSG/COGEN. Citation: iopscience.iop.org;*

Project Owners and Engineers: *Jacobs were the MEP Engineers of the CUF Upgradation Project. West Coast Air Conditioning were the GCC & Mechanical Contractors. Project is owned and funded by Orange County.*

Questions?

Thank You !

Amit Vatsa

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