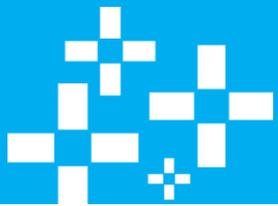


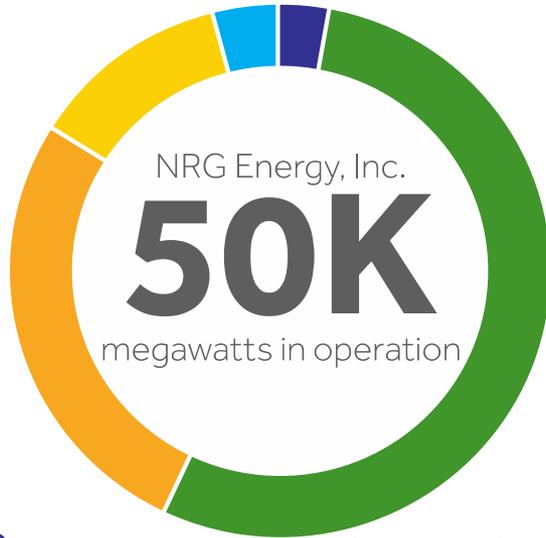
Challenges of Constructing and Operating a Multi-Phase Chilled Water Plant Under a City Street



IDEA 2017 June 28th



NRG by the Numbers

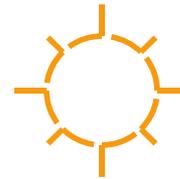


Global, diverse energy



3,000,000

recurring customers within NRG retail brands



One of the nation's largest

SOLAR

power generators

Ownership interest in nearly **140**
power-generation facilities across 29 states



Largest independent
power producer in U.S.



Fortune 200

District Heating & Cooling and Combined Heat & Power



San Francisco, CA

- Two 250 kW Engines
- 2.6 MMBTU/hr
- Steam: 454 MMBtu/hr
- 175 customers



Minneapolis, MN

- Steam: 1,100 MMBtu/hr
- Chilled Water: 40,000 tons
- 150 customers



Omaha, NE

- Steam: 735 MMBtu/hr
- Chilled water: 29,250 tons
- 120 customers



Dover, DE

- 103 MW
- 70 MLB/hr



Pittsburgh, PA

- Steam: 295 MMBtu/hr
- Chilled water: 12,935 tons
- 50 customers



Harrisburg, PA

- 4.1 MMBTU/hr
- Electricity: 12 MW
- Steam: 370 MMBtu/hr
- Chilled water: 3,600 tons
- 145 customers



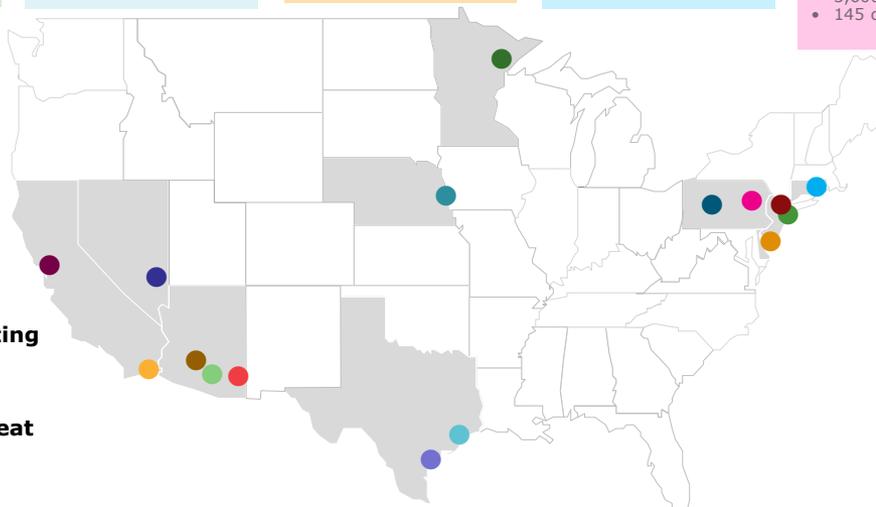
Bridgeport U, CT

- 1.4 MW fuel cell power plant
- Capacity to deliver 4 MMBTU/hr of heat



San Diego, CA

- 1.5 MW Recip Eng
- 2,000 ton Gas Turbine Chiller
- 940 tons (waste heat to chilled water)
- Chilled water: 8,825 tons
- 16 customers



District Heating and Cooling



Combined Heat and Power



Plainsboro, NJ

- 4.6 MW
- 34.1 MMBTU/hr
- 72.3 MLB/hr of boilers
- 3700 tons chilled water
- 1,000,000 gallon thermal storage



Princeton, NJ

- Single 248 KW Reciprocating Engine
- 1.45 MMBTU/hr
- 45 tons of chilled water



Phoenix, AZ

- Chilled water: 38,100 tons
- 35 customers



Tucson, AZ

- 1.6 MW Reciprocating Engine
- 4,120 tons chilled water
- 12.5 Mmbtu/hr hot water



ASU-Tempe, AZ

- 8.3 MW
- 80 MLB/hr steam
- 10,000 tons chilled water



Henderson, NV

- 90 MW CC
- 140 MLB/hr



San Jacinto, TX

- 176 MW
- 1200 MLB/hr



Corpus Christi, TX

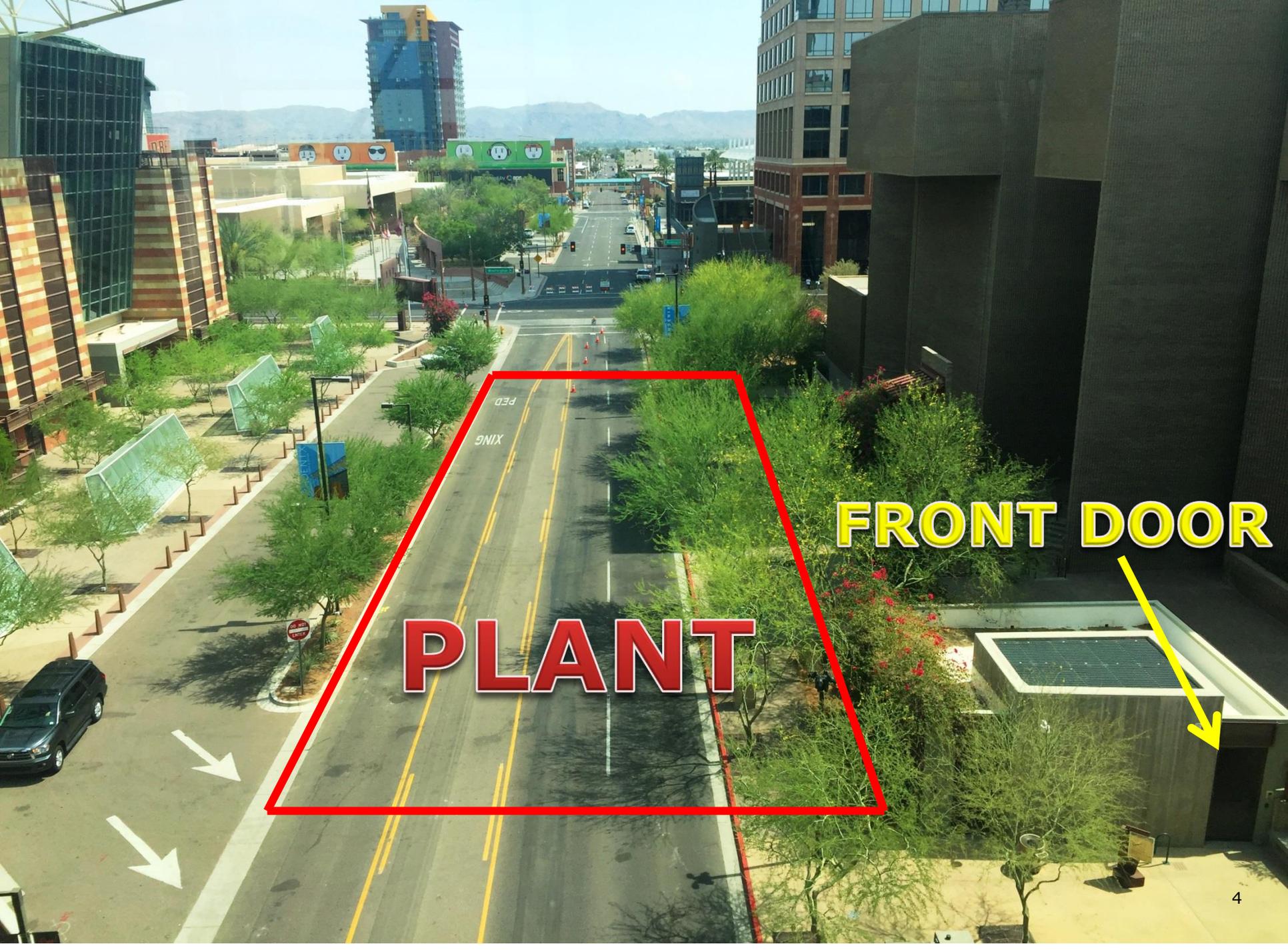
- 560 MW
- 1 MLB/hr steam





PLANT OVERVIEW

- **Phase 1 of the plant was initially constructed with the expansion of the Convention Center and began producing chilled water in 2006. NRG is a tenant of the City of Phoenix who owns and operates the Convention Center.**
- **Phase 1 consisted of 2 chillers, one 1,000 ton centrifugal water chiller and one 2,000 ton dual mode compound centrifugal chiller for chilled water and ice production. Phase 1 also included 20,000 ton hours of thermal ice storage.**
- **Future phases added 6 more chillers along with associated pumps and cooling towers, and the last phase added 40,000 ton hours of thermal ice storage.**
- **Plant is now fully built out with:**
 - **8 Chillers, 15,000 tons of chilled water capacity, 8,000 tons available for ice making, with associated chilled water and condenser water pumps**
 - **6 District Pumps**
 - **4 Glycol Pumps**
 - **9 Cooling towers on top of Convention Center roof**
 - **60,000 tons hours of thermal ice storage**



PLANT

FRONT DOOR



**Cooling
Towers**



Plant



Why under the street?

It's the only piece of dirt they were willing to give up. And there were no utilities.



Challenges of Phased Construction and Operations under a City Street

- **ACCESS**

- **Access for Future Phased Construction**
- **Access for Maintenance Services**
- **Access for Chemicals & Supplies**
- **Access for Emergency Personnel**



PLANT

**FRONT
DOOR**

Back Door Access





From the Convention Center Looking into Plant





**Inside the Plant
Looking Out**



ACCESS

- **Access for Future Phases**
 - **Provide extra space early in the design**
 - **Confirm manufacture dimensions before ordering any equipment. Returns are not an option**
 - **Make full size mock-ups for a fit test if in doubt**

Staged Ice Coils



Each ice coils is 10 ft. wide x 20 ft. long and weighs 10,000 lbs. There were 80 coils for this last phase Scheduled Time – Monday after Thanksgiving until January 7th.



Mockup of ice coil



Staging Mockup into ice Tank



Staging Equipment into Ice Tank



Note the transition in rigging



New Ice Coils and Piping In Ice Tank



ACCESS

- **Access for Future Phases**
- **Access for Maintenance Services**
 - **Motors & Pumps are dirty. Crossing the carpet with them has challenges and opportunities for trouble (damage to carpet, very expensive one-off design)**
 - **Mobilizing contractors into and out of the plant must be planned well in advance and in many cases during nighttime hours to coordinate with scheduled events**
 - **Operations considered back of house**
 - **Cooling Towers of roof by Hyatt Hotel**



ACCESS

- **Access for Future Phases**
- **Access for Maintenance Services**
- **Access for Chemicals & Supplies**
 - **Deliveries can be a challenge**
 - **Utilize Concentrated Chemicals**
 - **Manufacture Biocide Onsite**

Bulk Concentrated





Biocide made onsite with Mixed Oxidant Generator

Product

Brine

Generator
38 gal/hr.



ACCESS

- **Access for Future Phases**
- **Access for Maintenance Services**
- **Access for Chemicals & Supplies**
- **Access for Emergency Personnel**



ACCESS

- **Access for Emergency Personnel**

- **The City of Phoenix owns the structure and access for emergency personnel is coordinated with the 24/7 Security Operations Group.**
- **Any 911 Calls to the Convention Center are guided by Security Operations.**
- **Orientation for new security employees includes plant tours.**
- **First Responders are provided tours of the plant for accessibility.**



NRG Energy Center Phoenix

Questions - ?