Better Buildings®
U.S. DEPARTMENT OF ENERGY

CHP is Everywhere! Success Stories and Best Practices

Tuesday

May 16, 2017

11:15 to 12:30

U.S. DEPARTMENT OF ENERGY

Panelists

- Devon Rock, Aberdeen Proving Ground
- Jeremy Scharfenberg, Columbia Association, Maryland
- Ollie Veasey, City of Los Angeles
- Cliff Haefke, DOE Midwest CHP TAP, University of Illinois, Chicago
- Moderator: Patti Garland, Contractor to US DOE, Advanced Manufacturing Office, Energy Efficiency & Renewable Energy

Devon Rock

Aberdeen Proving Ground

U.S. DEPARTMENT OF ENERGY

US Army Garrison
Aberdeen Proving Ground

Better Buildings Summit
CHP is Everywhere!

16 May 2017

Installation Management Command integrates and delivers
base support to enable readiness for a globally-responsive Army

We are the Army's Home
Serving the Rugged Professional

Installation Overview

Geographic Area:

- Total Acres – 72,000
- Cantonment Area – 6,900 acres
- Range Area – 30,600 land acres
- Water – 34,500 acres or 58 sq miles and 144 miles of shoreline

Developed Infrastructure:

- Test Facilities – 57
- Surety Labs – 13
- Buildings – 2,410
- Road network – 210 Paved Miles
- Leased Area – 1,015 Acres

Installation Facts

- Fifth largest employer in MD
- 17M SF Building Space - 27% over 50 years old
- 2 Airfields
- 90+ Tenants
- Army's Premier Chem/Bio Surety Mission
- Major Range and Test Facility Base (62,000 acres)
- Growing MD National Guard Presence
- Army's Largest Enhanced Use Leasing (EUL) Site (415 acres)
- Unique facilities for National Research and Development
  - Sample Receipt Facility (SRF)
  - Underwater Explosives Pond (UNDEX)
- Environmental Challenges
  - One of the Largest Restoration Programs in the Army
  - Fragile Chesapeake Bay Ecosystem
- FY 2015 Contracts
  - $8.254B total contracts awarded
  - $765M contracts awarded to Maryland businesses

Innovation and Opportunity

APG Provides Significant Contributions to the Nation

- ***6 Centers of Excellence; 3 Separate Installations***
- ***Home to 1 of 12 SHARP Resource Centers Army wide***
- ***Over 19,000 Military, DA Civilians & Contractors***
- ***$8.2B Economic Impact on the Region (potential $15B)***
- ***$2.4B to Small Business in Fiscal Year 15***
- ***11 major commands and 92 tenant organizations***

Research & Development

C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance)

Public Health Sciences

Test & Evaluation

ChemBio (Chemical and Biological)

PSI (Personnel Security Investigation)

Alternative Energy Sources

History:

- Waste-to-Energy plant built in 1986 by the Northeast Maryland Waste Disposal Authority
- $3.79M annual contract for steam with the NMWDA ended in March 2016 after 30-year contract life
- Combined Heat and Power (CHP) project was awarded as an ESPC contract in August 2014 with the Huntsville COE and Johnson Controls Inc. (JCI)
- Long awaited opportunity to use the existing Canal Creek Treatment Plant to re-utilize non-potable water for steam generation
- CHP was sized to replace the WTE generated steam and provide Edgewood with 7.9 MW of base load electricity
- ~$9M Edgewood Area electric bill was estimated to be reduced by approximately half (in 2014)
- Increased use of natural gas for the plant is ~ $1.9M per year
- Assisting Federal Facilities with Conservation Technologies (AFFECT) is a Dept. of Energy Grant (Applied Feb 2014)
- Baltimore Gas & Electric (BGE) offered significant CHP rebates through the Smart Energy Savers incentive program

Harford County - Waste-to-Energy

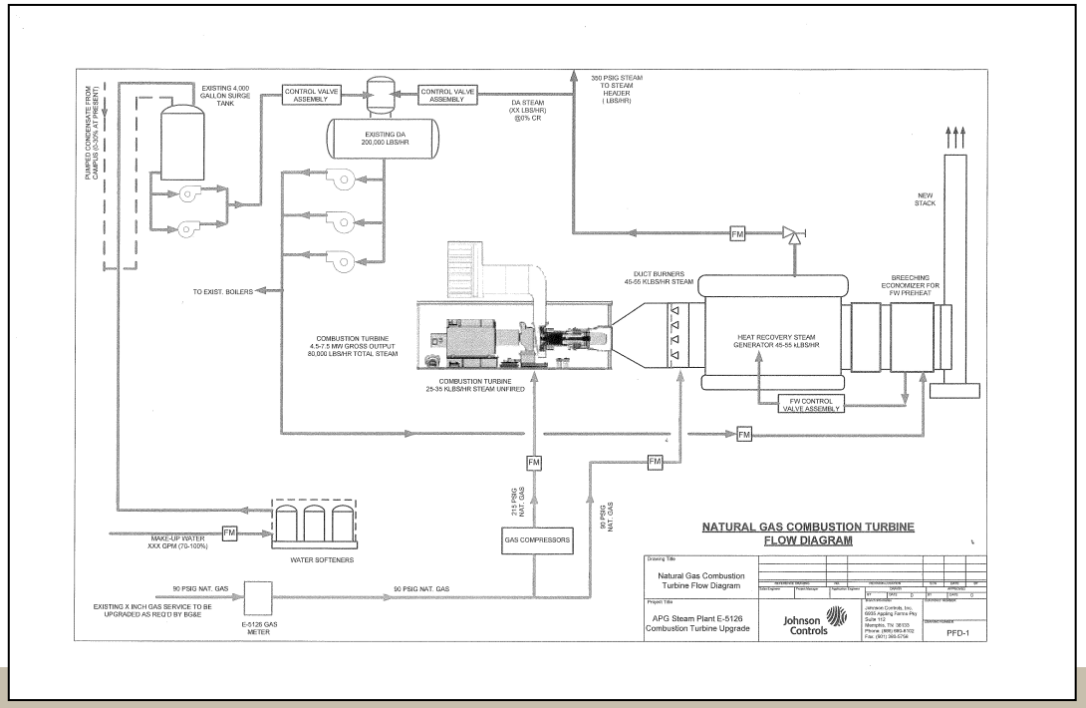
CHP Groundbreaking – 27 May 2014

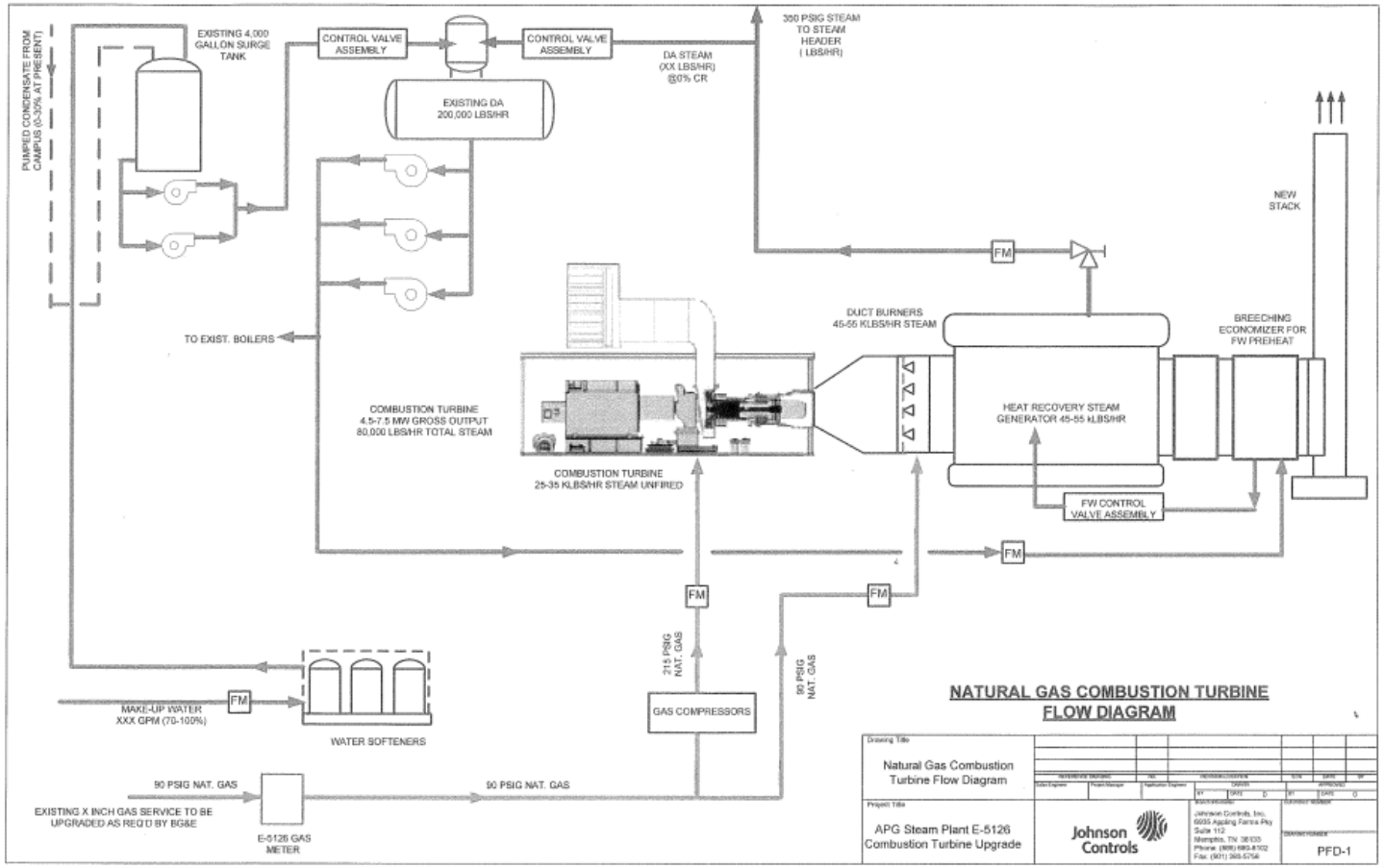
Energy Savings Performance Contract

Energy Saving Performance Contract (ESPC) Project #8 provided APG with a thermal energy solution for Edgewood by implementing a CHP plant and steam system modifications that ensure redundancy. This solution is vital to replace the capabilities of the local Waste-to-Energy (WTE) Plant, which generated 70% of Edgewood's steam requirements.

The CHP plant is located at Building E-5126, the Army's primary existing boiler plant. Natural gas is burned in a turbine and the waste heat generates steam in the Heat Recovery Steam Generator (HRSG). A nominal 7.9 MW turbine was the most cost effective design – generating more steam than the WTE plant.

This project will also generate approximately 50% of the Edgewood Area's electricity. This improves APG's energy security posture for both electricity and steam and can be quantified by $4.4M in guaranteed electrical savings.




PUMPED CONDENSATE FROM CAMPUS (0-30% AT PRESENT)
EXISTING 4,000 GALLON SURGE TANK
CONTROL VALVE ASSEMBLY
CONTROL VALVE ASSEMBLY
EXISTING DA 200,000 LBS/HR
DA STEAM (XX LBS/HR) @0% CR
350 PSIG STEAM TO STEAM HEADER (LBS/HR)
NEW STACK
FM
TO EXIST. BOILERS
DUCT BURNERS 45-55 KLBS/HR STEAM
BREECHING ECONOMIZER FOR FW PREHEAT
COMBUSTION TURBINE 4.5-7.5 MW GROSS OUTPUT 80,000 LBS/HR TOTAL STEAM
HEAT RECOVERY STEAM GENERATOR 45-55 KLBS/HR
COMBUSTION TURBINE 25-35 KLBS/HR STEAM UNFIRED
FW CONTROL VALVE ASSEMBLY
FM
FM
FM
215 PSIG NAT. GAS
90 PSIG NAT. GAS
GAS COMPRESSORS
FM
MAKE-UP WATER XXX GPM (70-100%)
WATER SOFTENERS
90 PSIG NAT. GAS
90 PSIG NAT. GAS
EXISTING X INCH GAS SERVICE TO BE UPGRADED AS REQ'D BY BG&E
E-5126 GAS METER
NATURAL GAS COMBUSTION TURBINE FLOW DIAGRAM
Natural Gas Combustion Turbine Flow Diagram
APG Steam Plant E-5126 Combustion Turbine Upgrade
Johnson Controls
PFD-1

Combined Heat and Power (CHP)

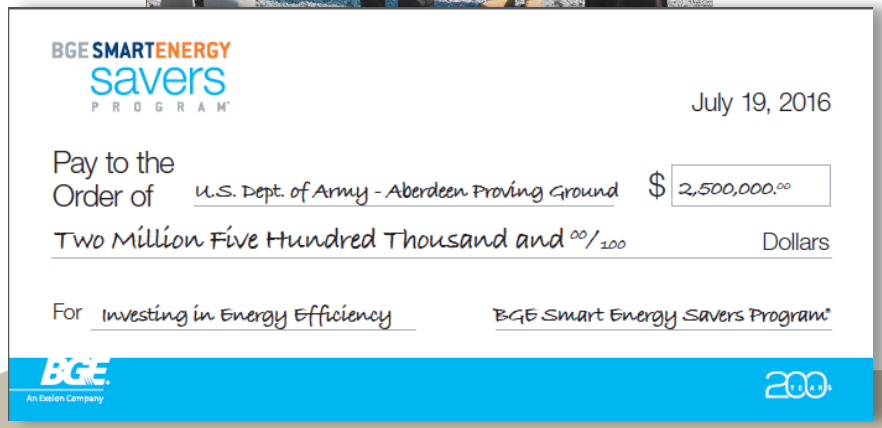
Economics:

- Total ESPC Financed Amount = $39.689M
- Guaranteed Savings = $4.486M per year
- Contract Performance Period = 22.7 years
- $682,770 obtained from Dept. of Energy Grant
- BGE CHP Incentive Rebates = $2.5M (maximum allowable by the program)

Involved Partners:

- Johnson Controls Inc
- Huntsville Corps of Engineers
- City Light & Power
- Baltimore Gas & Electric
- Defense Logistics Agency – Energy
- Concord Engineering
- Maryland Department of the Environment
- Federal Energy Management Program (Dept. of Energy)

CHP Ribbon Cutting – 19 July 2016



BGE SMARTENERGY savers PROGRAM

July 19, 2016

Pay to the Order of U.S. Dept. of Army - Aberdeen Proving Ground $ 2,500,000.00

Two Million Five Hundred Thousand and 00/100 Dollars

For Investing in Energy Efficiency BGE Smart Energy Savers Program

BGE An Exelon Company

Photo by Molly Blosse, APG News

APG Senior Commander Maj. Gen. Bruce T. Crawford talks about future innovations and maintaining a state of readiness on Aberdeen Proving Ground during the opening ceremony for the new Combined Heat and Power plant at APG South (Edgewood), July 19. A ceremonial "chain-cutting" following his remarks signified the plant's official opening.

Net Zero Water

Canal Creek Ground Water Treatment Plant Optimizations

Beneficial Re-Use of Treated Effluent:

- Past activities at APG have resulted in a groundwater plume primarily contaminated with volatile organic compounds.
- These compounds include 1,1,2,2-tetrachloroethane (PCA), trichloroethylene (TCE), and their breakdown products.
- The groundwater was treated in a treatment facility and then discharged into Canal Creek.
- The Department of Public Works has completed a project for the beneficial reuse of treated contaminated groundwater.
- This water, previously released to surface waters, is now piped to E5126 for CHP process water
- On-line in July 2015 as part of an Energy Savings Performance Contract
- Usage is planned to increase to 150,000 – 170,000 gallons per day with a projected water cost savings of $207,000 per year
- Being a Research, Development, Test and Evaluation (RDT&E) installation presents significant life, health and safety factors that make APG missions very water intensive.
- Water efficiency efforts and implementation of Net Zero initiatives are necessary to ensure APG's mission.

Questions?

APG Installation Energy Manager

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Jeremy Scharfenberg

Columbia Association, Maryland

U.S. DEPARTMENT OF ENERGY

Small Scale Cogeneration

Lessons Learned from a 60kW CHP Installation

JEREMY SCHARFENBERG
ENERGY MANAGER

DOE BETTER BUILDINGS SUMMIT 2017

Columbia Association

CHP Lessons Learned

Agenda

- Site Description
- Proposed CHP System
- Incentive Programs
- Feasibility Study
- Permitting & Interconnection
- Procurement
- Construction
- Commissioning
- Operation
- Final Thoughts

Site Description

Supreme Sports Club

- 100,000 square feet
- 24 hr/day operations

Electricity Demand:

- Space conditioning, lighting, pump, and plug loads

Natural Gas Demand:

- Space conditioning, pool water heating, DHW

Proposed CHP System

Reciprocating CHP System

- Natural gas engine generates electricity onsite
- Free “waste” heat is recovered

  - Transferred to water/space heating systems
- Estimated Annual Savings = $25,000
- 7 SPP with BGE rebate program

CHP
EPA COMBINED HEAT AND POWER PARTNERSHIP

Incentive Programs

- Met with BGE account rep early 2014 – online early 2016

- BGE Support:

  - Design incentive

  - Installation incentive

  - Electricity generation incentive $0.07/kWh

BGE SMARTENERGY savers PROGRAM®

Incentive Programs

- Engage utility incentive and grant programs at the earliest stage of CHP project exploration
- Maintain regular contact with utility and grant program staff throughout the CHP project lifecycle

Feasibility Study

- CHP systems selected based on many factors:

  - Power needed, space constraints, thermal load, fuel availability, utility prices

- Tecogen CM-60

  - 60kW Capacity

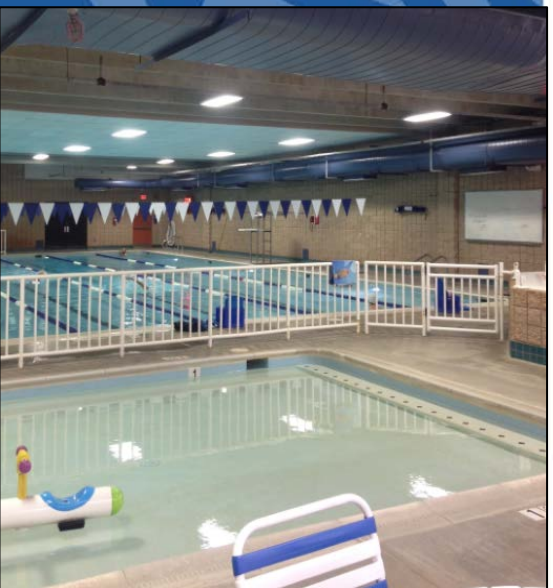
  - 440 MBH thermal output

  - 28% electrical capacity; 53% thermal capacity

  - Estimated Efficiency: 90% (LHV) or 81% (HHV)

  - Ultra low NOx reciprocating engine generator with waste heat recovery

Feasibility Study



- Know your existing thermal loads
  - Especially temporal variability
- Explore all prime mover types
  - “Apples to apples” comparison
  - Differing efficiencies
  - Gas pressure requirements
- Ensure electricity rates and gas costs in economic simulations are as accurate as possible
  - Economic simulations

Project Design

- Detailed site survey

  - Electrical, gas, and thermal load interconnections

- Thermal load management – pool and hot water

  - Existing broiler heat exchange system and existing DHW recirculation loop modified

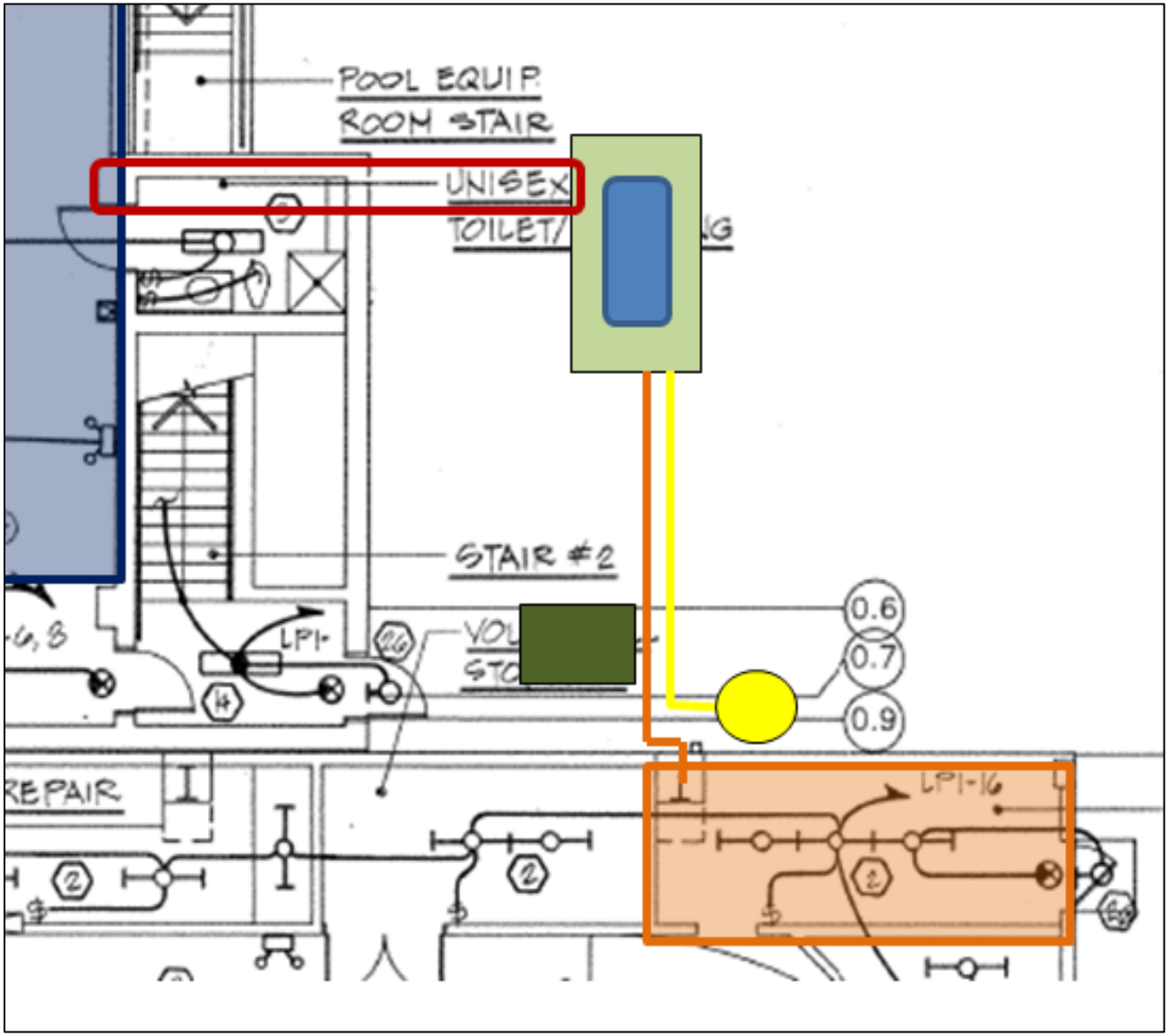
- Team coordination critical

  - Coordinate between design engineer and the vendor representatives

  - Provide facility operating Details

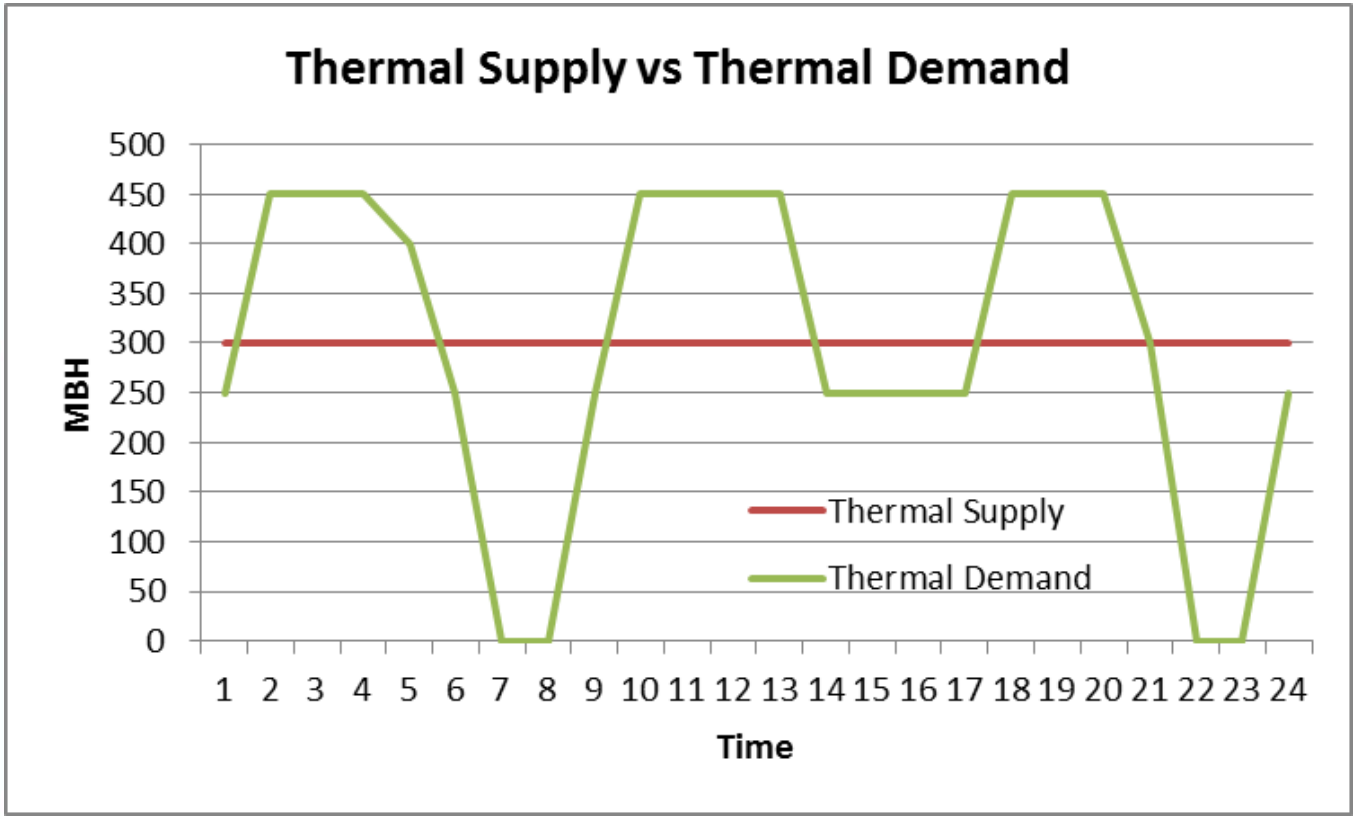
  - Integrating design considerations

Project Design



Project Design

Key design challenge – variable thermal demand sync with ~constant thermal supply from cogeneration unit



Project Design

- Design engineer familiar with CHP
- Ensure that CHP system and existing heating system controls are thoroughly explored and appropriate modifications made
- Back-up power provision with CHP systems at existing buildings can be cost prohibitive.

Project Design

- Provide prime mover vendor with technical review at several stages during the design process
- Allow for modifications

  - Utility gas and electrical interconnection review
- Do NOT overlook communications aspects

  - Meter data

  - Generator remote monitoring

  - Reverse power relay controls

Permitting and Inter-connection

- Required electrical and natural gas interconnection reviews by BGE
- Upgraded gas service
- Reverse power relay
- Local county jurisdiction permitting review
- DHW code requirements

Permitting and Inter-connection

- Numerous approvals

  - e.g., gas, electric, metering, air quality

  - Smaller systems may be below AQ permitting thresholds

- Local permitting authorities may have no familiarity with CHP systems

  - Confuse with back-up electric generators

- Plan for time requirements associated with interconnection direction and local inspections when planning for start-up

Procurement

- Generator procured from vendor

  - Long-term maintenance agreement

- Project scope:

  - MEP design documents

  - Literature on prime mover

  - Broad scope language to encompass activities associated with coordinating install with the prime mover vendor and commissioning activities

Procurement

- Marginal costs can have greater impact on small-scale installations

  - 3% increased construction cost with addition of reverse power relay

  - Unexpectedly high installation prices and additional costs increased overall project from $2,900/kW to $4,500/kW

- Forced to absorb $50K cost premium due to bid response issue (low bid rejected and fixed installation window)

Procurement

- Leverage the local utility program staff and other resources to identify contactors with CHP experience
- Have a contingency fund for unexpected project costs identified during construction or commissioning
- Consider sourcing the prime mover from the vendor directly

  - Save on mark-up costs

Construction

- Scheduled during building maintenance shut-down
- Interconnection aspects:

  - Gas service

  - Main electrical room (200A)

  - Thermal load connections
- Site work included maintenance pad and screen fence
- Actual site conditions uncovered during the installation process resulted in design modifications

Construction

- Deficiencies in existing building systems may be uncovered

  - Increase scope and cost

- Novel nature of CHP systems:

  - Close coordination and oversight of the installing contractor and subcontractors is essential

- Plan for installation modifications to be identified in the commissioning phase

Commissioning

- It is likely that commissioning will require significant time

- CA's commissioning phase spanned several months

  - Thermal loads more variable than expected

  - DHW system modifications

  - Control integration with existing heating systems

Commissioning

- Avoidance of impacting critical service areas can slow the commissioning process

- Prime mover representatives working with the installation contractor will likely suggest changes to the installation during this phase to further optimize operation

Operation

- Overall CHP system operates efficiently
- Steady electricity generation and thermal output

Operation

Shoulder Seasons

- Weather had larger impact than anticipated

Maintenance Contract

- Vendor has provided exceptional service
- Full motor replacement in four hours in November 2016

Final Thoughts

- CHP systems offer immense potential to promote distributed generation, highly efficient use of energy, and greenhouse gas emission reductions
- A single Project Manager is needed to drive project forward
- Learning curve for all parties involved

Columbia Association

Ollie Veasey

City of Los Angeles

U.S. DEPARTMENT OF ENERGY

ZERO WASTE ONE WATER

environment LA SANITATION
CITY OF LOS ANGELES

OUR MISSION IS TO PROTECT PUBLIC HEALTH AND THE ENVIRONMENT

Enrique C. Zaldivar, P.E.
Director and General Manager

Ollie Veasey
Assistant Plant Manager City of Los Angeles
LA Sanitation Hyperion Water Reclamation Plant

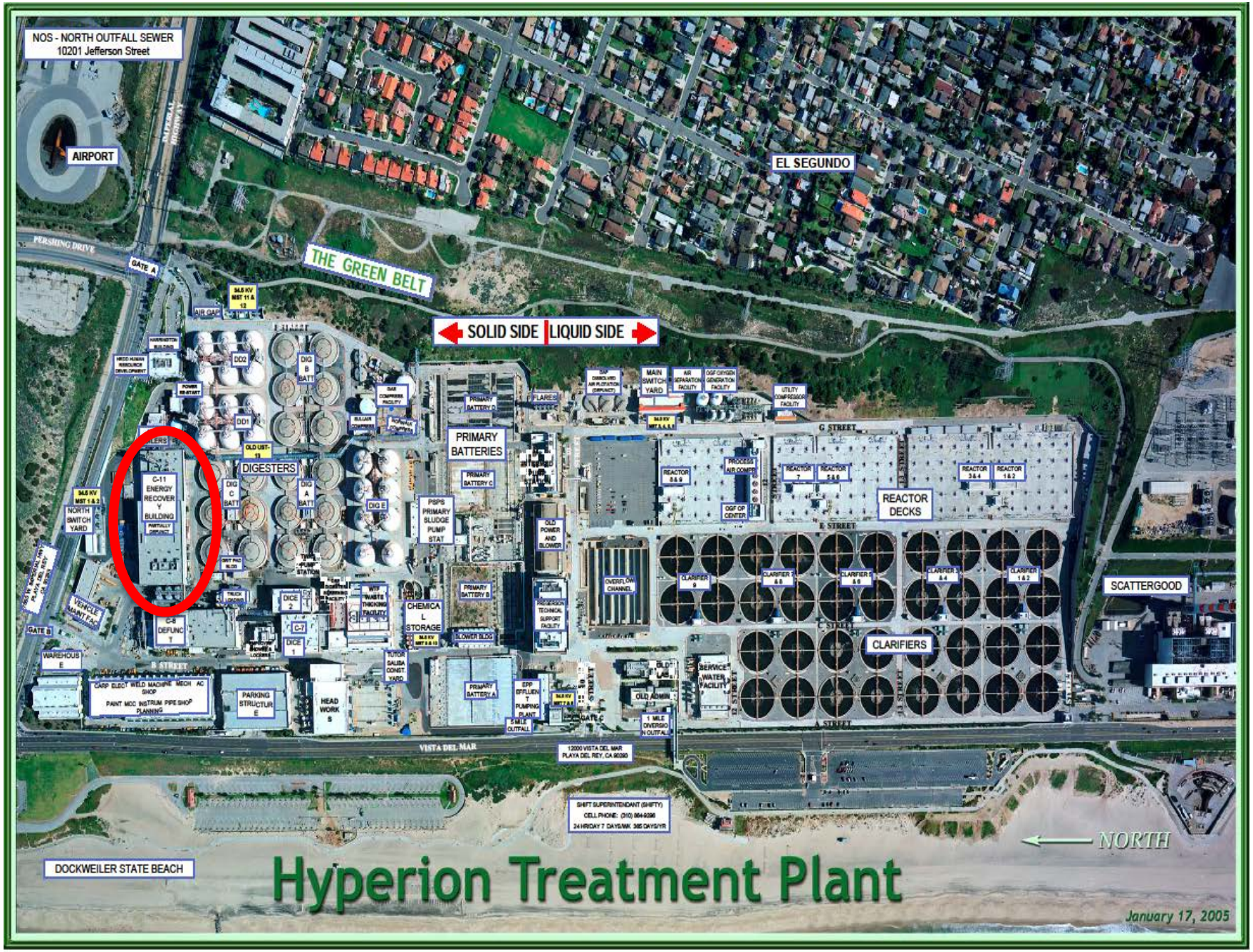
LASAN

HYPERION DIGESTER GAS UTILIZATION PROJECT DGUP

ZERO WASTE ONE WATER

LASAN

ZERO WASTE ONE WATER



LASAN

ZERO WASTE ONE WATER

In the late 1990's it was determined that Hyperion's (HWRP) Biosolids digestion process would be converted from Mesophilic to Thermophilic operation.

HWRP goes on to successfully produce Class A Biosolids, meeting the Biosolids Class A requirements detailed in EPA Rule 40 CFR, Part 503. Class A Biosolids provide flexible and economical re-use options for the City's beneficial use program.

LASAN

ZERO WASTE ONE WATER

In 2001HWRP entered into a contract with the Los Angeles Department of Water and Power (DWP). The agreement allowed for HWRP to provide biogas to the Scattergood Steam Generation Station (SGS) to fuel their gas turbines. In return, SGS would provide steam to heat HWRP's digesters as well as provide electricity at a reduced rate.

LASAN

ZERO WASTE ONE WATER

In January 2010, DWP issued a memorandum to LASAN that SGS would undergo a major remodel and would no longer use HWRP's biogas as a source of fuel. At that time the decision was made to build a generation station at HWRP and LASAN negotiated with DWP to extend the agreement until December 2016. Subsequently, a ground breaking ceremony was held on November 17,2015.

LASAN

ZERO WASTE ONE WATER

The DGUP is a design-build contract currently in the commissioning phase. This project includes the reuse of the existing Energy Recovery Building to house a combined-cycle cogeneration system to provide the steam and electricity requirements of HWRP, with the use of HWRP's biogenic digester gas as the primary fuel source

LASAN

ZERO WASTE ONE WATER

The DGUP converts 7.1 million cubic feet/day of digester gas produced at HWRP to electricity and steam which is used to meet the plant's power and heating demands, moving the plant toward full sustainability with this renewable energy source and reducing the carbon footprint.

LASAN

ZERO WASTE ONE WATER

TWO COMBUSTION TURBINE GENERATORS 11MW EACH

ONE STEAM TURBINE GENERATOR
7MW

PLANT POWER CONSUMPTION
18-20 MW

INFLUENT: 270 MGD AVE.
~374 MGD DUE TO RAIN

INTEND TO GENERATE POWER TO BE SELF SUFFICIENT PLUS ~1MW

LASAN

COMBUSTION TURBINE GENERATOR 11MW

ZERO WASTE ONE WATER

LASAN

ZERO WASTE ONE WATER

Each CTG is provided with a dedicated heat recovery steam generator (HRSG), producing high pressure superheated steam at 350°F. This superheated steam is fed to the steam turbine generator which produces up to 7 MW of electricity and provides steam to the digesters.

LASAN

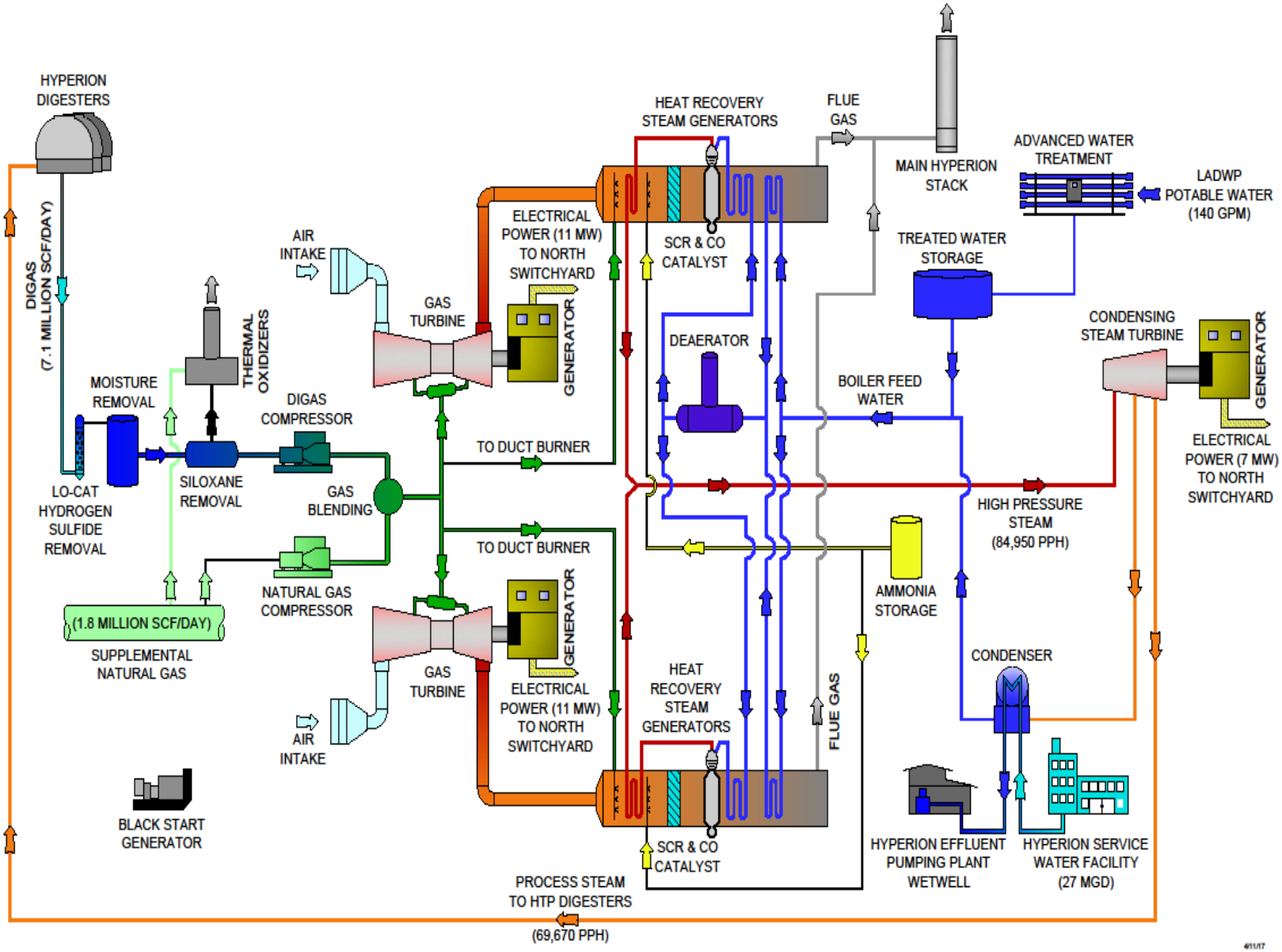
Electric Room

ZERO WASTE ONE WATER

LASAN

ZERO WASTE ONE WATER

HYPERION WATER RECLAMATION PLANT - DIGESTER GAS UTILIZATION PROJECT (DGUP)



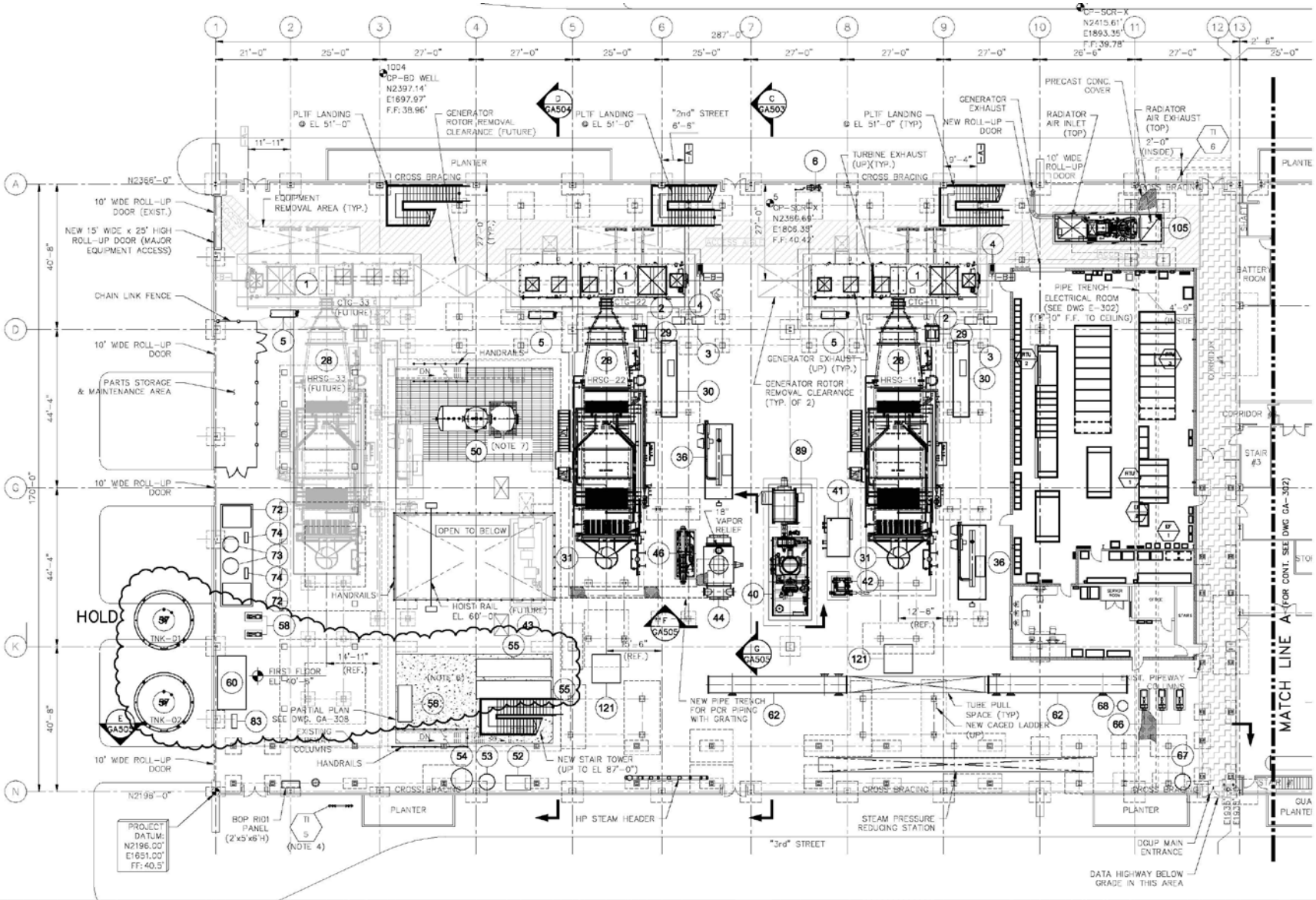
LASAN

DGUP DURING COMMISSIONING AND RELIABILITY TEST APR 2017

ZERO WASTE ONE WATER

LASAN

FUTURE COMBUSTION TURBINE GENERATOR 11MW



ZERO WASTE ONE WATER

LASAN

POWER CONSUMPTION AS RECORDED ON MARCH 28, 2017

From Importing 18 MW to Exporting 8 MW

ZERO WASTE ONE WATER

LASAN

ZERO WASTE ONE WATER

24-HOUR CUSTOMER CARE CENTER

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LASAN

Cliff Haefke

Midwest DOE CHP TAP, University of Illinois, Chicago

U.S. DEPARTMENT OF ENERGY

Technical Assistance with the US DOE CHP Technical Assistance Partnerships (CHP TAPs)

US DOE 2017 Better Buildings Summit

CHP is Everywhere! Success Stories and Best Practices

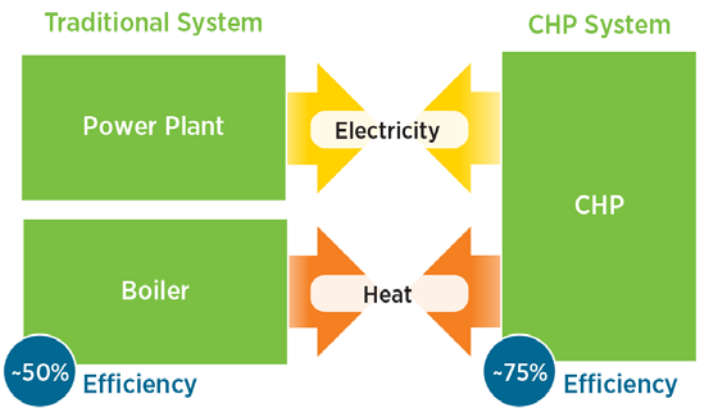
May 16, 2017

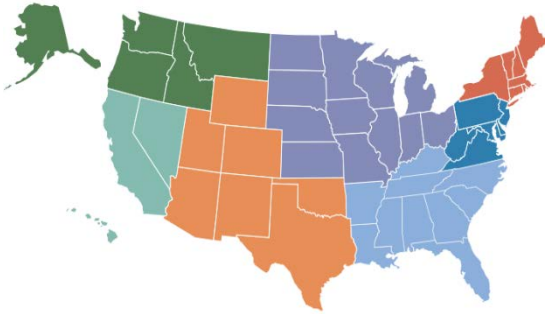
U.S. Department of Energy
CHP Technical Assistance Partnerships
MIDWEST

DOE CHP Technical Assistance Partnerships (CHP TAPs)

DOE's CHP TAPs promote and assist in transforming the market for CHP, waste heat to power, and district energy or microgrid with CHP throughout the United States. Key services include:

- **Market Opportunity Analysis**
  Supporting analyses of CHP market opportunities in diverse markets including industrial, federal, institutional, and commercial sectors
- **Education and Outreach**
  Providing information on the energy and non-energy benefits and applications of CHP to state and local policy makers, regulators, end users, trade associations, and others.
- **Technical Assistance**
  Providing technical assistance to end-users and stakeholders to help them consider CHP, waste heat to power, and/or district energy or microgrid with CHP in their facility and to help them through the development process from initial CHP screening to installation.





U.S. Department of Energy
CHP Technical Assistance Partnerships
MIDWEST

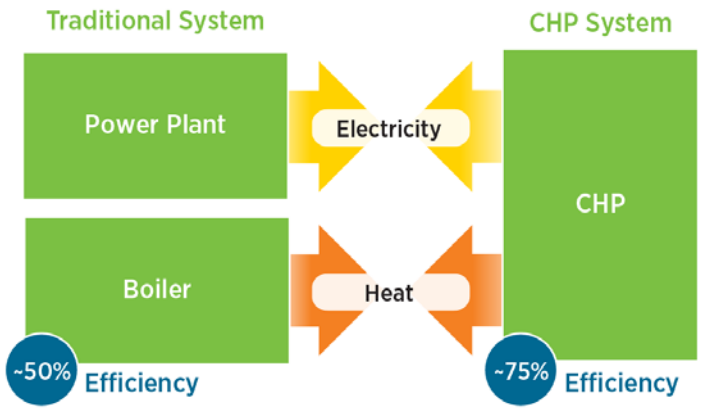
www.energy.gov/chp

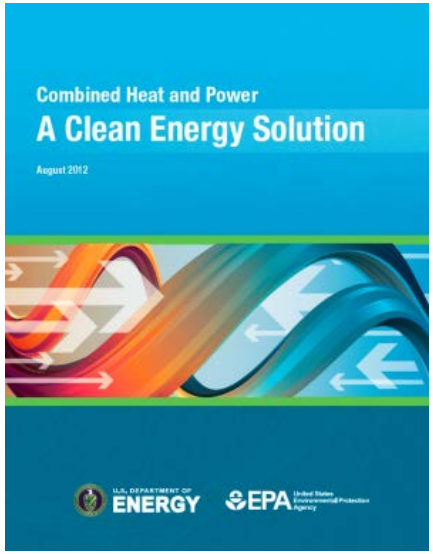
Benefits of CHP

- CHP is *more efficient* than separate generation of electricity and heat
- Higher efficiency translates to *lower operating cost,* (but requires capital investment)
- Higher efficiency *reduces emissions of all pollutants*
- CHP can also *increase energy reliability and enhance power quality*
- On-site electric generation *reduces grid congestion and avoids distribution costs*

Combined Heat and Power (CHP) Emerging Drivers

- Benefits of CHP recognized by policymakers
  - State Portfolio Standards (RPS, EEPS, Tax Incentives, Grants, standby rates, etc.)
  - CHP recognized as an energy efficiency technology in more states (e.g. Illinois, Minnesota, Ohio)
- Favorable outlook for natural gas supply and price in North America
- Opportunities created by environmental drivers
- Utilities finding economic value
- Energy resiliency and critical infrastructure





Finding the Best CHP Candidates:

Some or All of These Characteristics

- High and constant thermal load
- Favorable "spark spread"
- Existing central plant

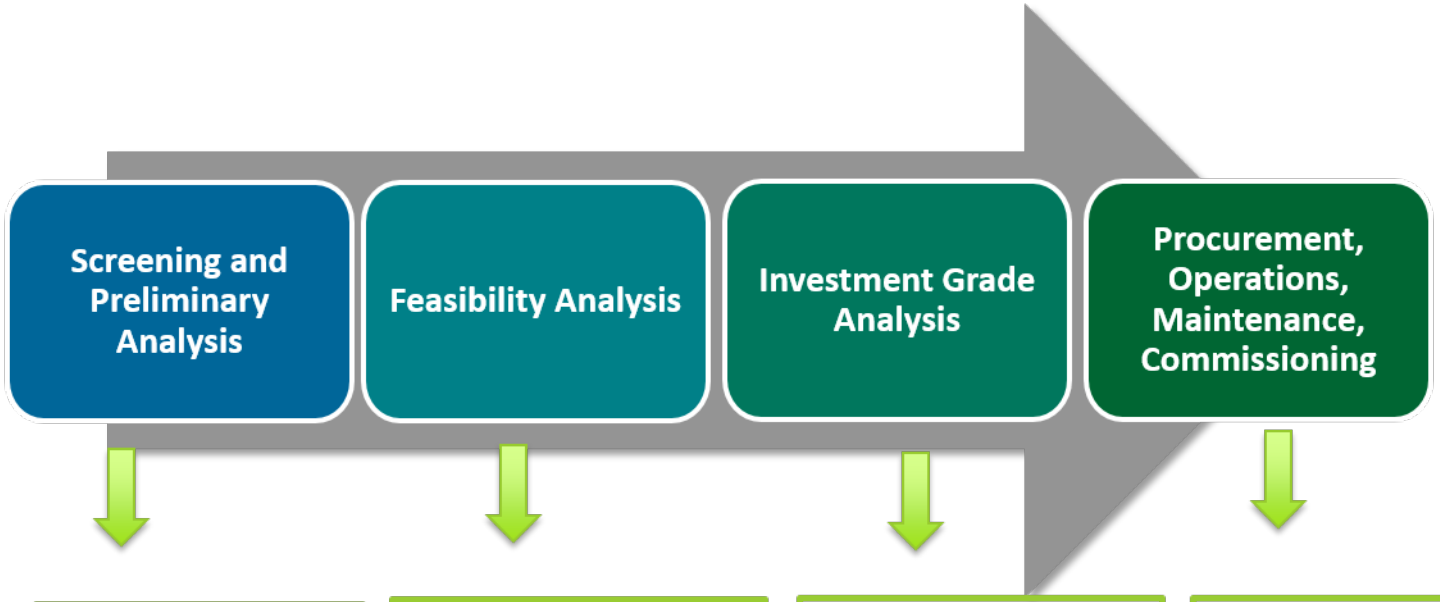
- Planned facility expansion or new construction in next 3-5 years
- Equipment replacement in next 3-5 years

- Power quality or resiliency concerns
- Sustainability goals
- Available utility programs, incentives, rebates, etc.

- Facility "Champion"

CHP Project Development Steps

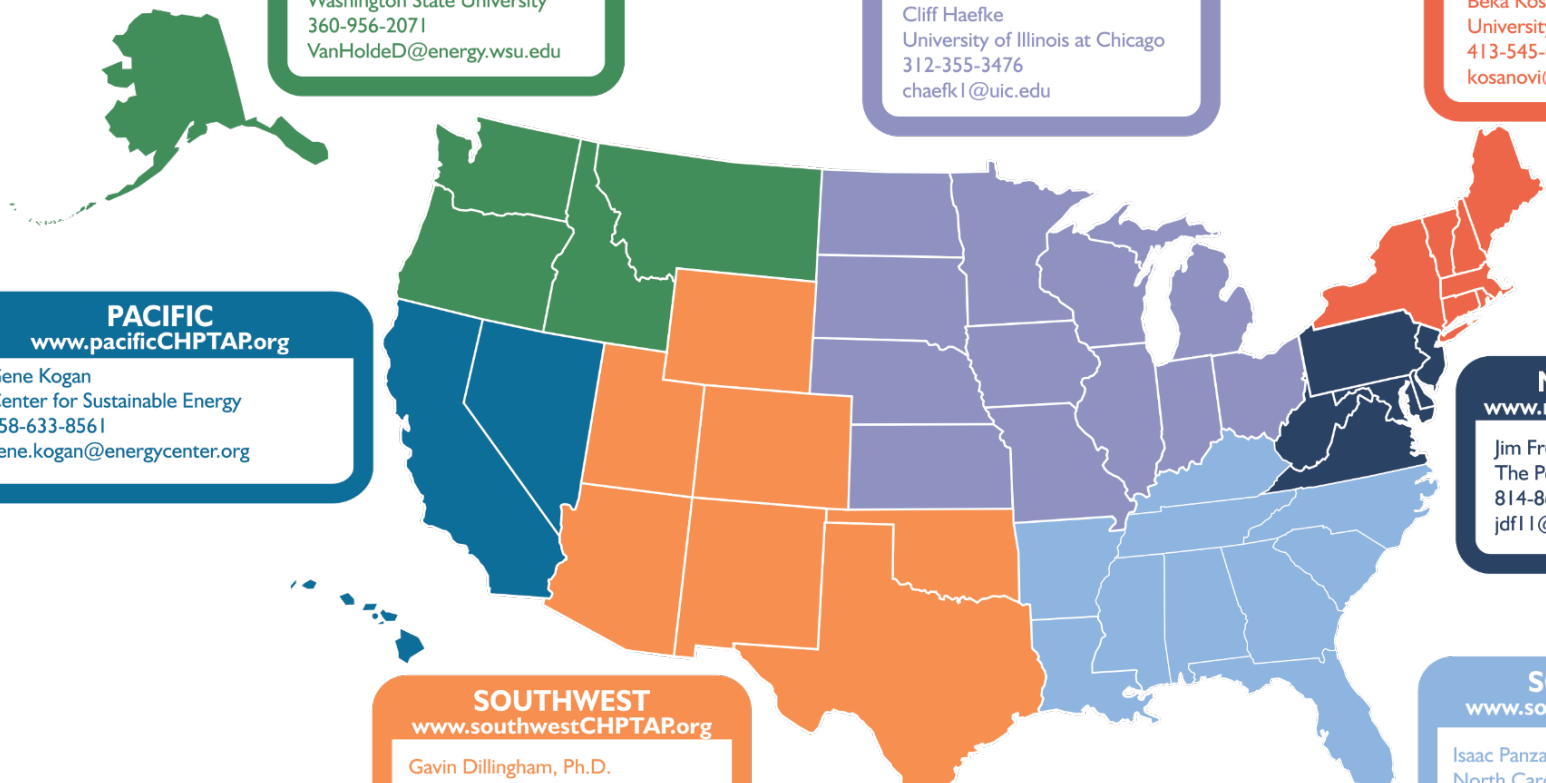
CHP TAP Technical Assistance



US DOE CHP TAP Services:

- Quick screening questions with spreadsheet payback calculator.
- Uses available site information. Estimate: savings, Installation costs, simple paybacks, equipment sizing and type.
- 3rd Party review of Engineering Analysis. Review equipment sizing and selection.
- Review specifications and bids. Limited operational analysis

DOE CHP Technical Assistance Partnerships (CHP TAPs)



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Next Steps

Contact your regional CHP TAP for assistance if:

- Interested in having a Qualification Screening performed to determine if there is an opportunity for CHP at your site
- If you already have an existing CHP plant and interested in expanding it
- Need an unbiased 3rd Party Review of a proposal

Thank You

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U.S. Department of Energy
CHP Technical Assistance Partnerships
MIDWEST

www.MidwestCHPTAP.org

Thank You

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