Better Plants
U.S. DEPARTMENT OF ENERGY

Combined Heat & Power
Virtual INPLT Training & Assessment

Session 3 Project Implementation
Tuesday – Dec 6, 2022
10 am – 12:30 pm

U.S. DEPARTMENT OF ENERGY

CHP Project Implementation

December 6, 2022

Dr. James Freihaut, Director, Mid-Atlantic CHP TAP
Bill Valentine, Assistant Director, Mid-Atlantic CHP TAP
Richard Sweetser, Sr. Advisor, Mid Atlantic CHP TAP
Gearoid Foley, Sr. Advisor, Mid Atlantic CHP TAP

Safety and Housekeeping

- You are welcome to ask questions at any time during the webinar
- When you are not asking a question, please MUTE your mic and this will provide the best sound quality for all participants
- We will be recording all these webinars and by staying on-line and attending the meeting you are giving your consent to be recorded
  - A link to the recorded webinars will be provided, afterwards

Session 3 – CHP Project Implementation

- Part 1: Project Financing Options
  - Grants, Tax Credits, Loans, Leases, 3rd-Party
  - Project Development Options
- Part 2: Project Implementation & eCatalog
  - Engineering, Planning, Permitting
  - Procurement, Construction, O&M
  - DOE CHP eCatalog
- Part 3: Microgrid/Utility Integration
  - CHP & Microgrids in the U.S.
  - Example Microgrids

Speakers

Session 3: Part 1. Project Financing Options

Richard Sweetser

Session 3: Part 2a. Project Implementation

Gearoid Foley

Session 3: Part 2b. Packaged Systems and eCatalog

Richard Sweetser

Session 3: Part 3. Microgrid/Utility Integration

Dr. James Freihaut

Richard Sweetser, DOE's Mid-Atlantic CHP TAP

Experience

- 50 years in energy system design, with experience in industrial refrigeration, CHP, on-site power integration, energy resilience and microgrid development.
- Senior Technical Advisor to the Mid-Atlantic CHP TAPs
- Clients include US Department of Energy, Air Conditioning and Refrigeration Institute, American Gas Association, DuPont, Gas Technology Institute, IntelliChoice Energy, Ingersoll-Rand, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, MVGas, National Renewable Energy Laboratory, Propane Education and Research Council, Southwest Gas, Technova, United Technologies Corporation, World Alliance for Decentralized Energy (for the US Department of State)
- Collaborated with state agencies throughout the Northeast and Mid-Atlantic regions including the NJ BPU, NJ EDA, PA PUC, PA DCED, NYSERDA, NY DEC, MD MEA, MD PSC, VA Department of Energy and DE DNREC, and has provided testimony and educated stakeholders in the development of energy efficiency, combined heat & power and resilience programs.
- Member of ASHRAE TC1.10 and past Chair of TC1.10 Programs Subcommittee

Gearoid Foley, DOE's Mid-Atlantic CHP TAP

Experience

- 30 years in energy plant design, on-site power integration, energy resilience and microgrid development including project implementation as owner's representative.
- Senior Technical Advisor to NY/NJ and Mid-Atlantic CHP TAPs
- Clients include US Department of Energy, RWJBarnabas Health, Cooper UH, Mack-Cali RE, Dresser-Rand, Johnson Controls, BEA Systems, Lawrence Berkeley National Labs, Penn State University, Princeton University and the Electric Power Research Institute
- Collaborated with state agencies throughout the Northeast and Mid-Atlantic regions including the NJ BPU, NJ EDA, PA PUC, PA DCED, NYSERDA, NY DEC, MD MEA and DE DNREC, and has provided testimony and educated stakeholders in the development of energy efficiency, combined heat & power and resilience programs.
- Voting member of ASHRAE TC1.10 and Chair of TC1.10 Programs Subcommittee

Dr. James Freihaut, DOE's Mid-Atlantic CHP TAP

Experience

- 40 years in energy system design, with experience in central power plant combustion systems, aircraft and aeroderivative gas turbine combustors, CHP, on-site power integration, commercial fuel cell systems, building system HVAC components and integration, microgrid development, industrial manufacturing site environmental remediation. 22 years in industrial research at former United Technologies Research Ctr (Pratt & Whitney, Carrier HVAC, Fuel Cells); 20 years at Penn State University, Dept. of Architectural Engineering
- Director of DOE Mid-Atlantic CHP TAP Ctr.
- Collaborated with state agencies Mid-Atlantic regions including the PA PUC, PA DCED,PA DEP, PA Climate Change Advisory Committee, NYSERDA, MD MEA,W VA Energy Office, Philadelphia Energy Authority, VA Department of Energy and DE DNREC, and has provided testimony and educated stakeholders in the development of energy efficiency, combined heat & power and resilience programs.
- Spoken at multiple State, regional and national events

Project Finance Options

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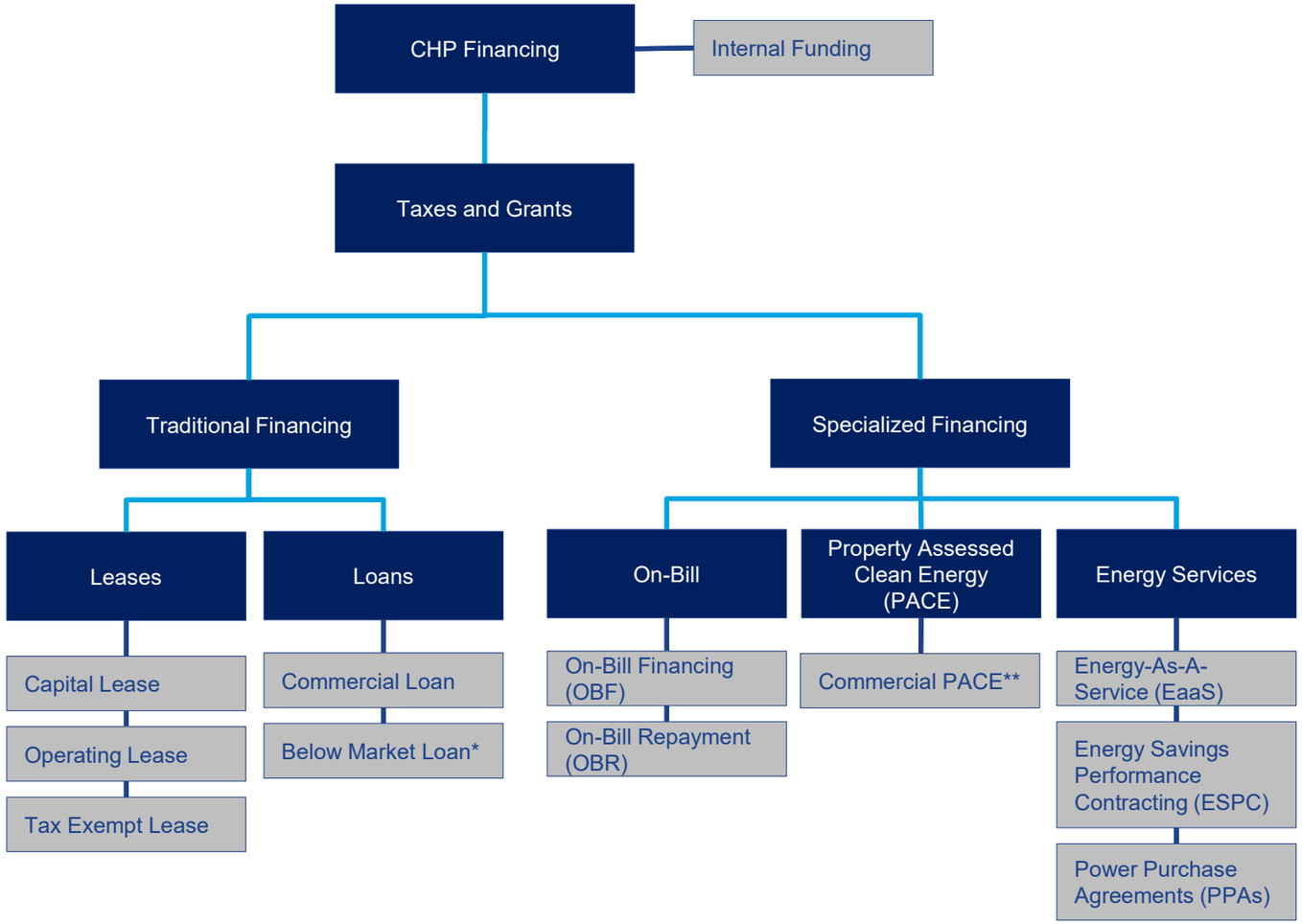
Project Financing Needs

- Capital Cost
- Owner Costs
- Engineering
- Procurement
- Construction
- Grants and Tax Credits
- Bridge financing

Project Financing Options



* Various entities including green banks, state government and other clean energy funds can provide loans at favorable rates with minimal requirements
** C-Pace provided low interest loans and attaches loan to property

Incentive and Grant Programs

- Generally legislative controlled
- Fixed or custom programs
- Subject to change
  - Legislative

EPA United States Environmental Protection Agency

Environmental Topics ∨ Laws & Regulations ∨ Repo

Combined Heat and Power (CHP) Partnership

Database of CHP Policies and Incentives (dCHPP)

The Database of CHP Policies and Incentives (*d*CHPP) is an online database that allows users to search for CHP policies and incentives by state or at the federal level. *d*CHPP has two primary purposes:

- Policy makers and policy advocates can find useful information on significant state/federal policies and financial incentives affecting CHP.
- CHP project developers and others can easily find information about financial incentives and state/federal policies that influence project development.

The database is updated annually with input from the DOE TAPS. A dCHPP glossary (pdf) (131.55 KB) contains definitions for the policy and incentive types included in dCHPP.

Please select one or both of the search filters to return the desired results. To select more than one option in a search filter (e. g., New York and Texas in the "Search by State" filter), hold down the Control key on the keyboard while selecting the options. You can then sort the results by selecting the desired column heading. To start over, select "Reset Filters."

DOE CHP Policy Profiles

DOE's CHP Technical Assistance Partnerships (TAPS) develop profiles describing current policies and programs covered in dCHPP. Examples include financial incentives, portfolio standards, and interconnection standards. These profiles highlight enabling policies and successful programs and best practices that can be used as models throughout the country.

Search by State: Show All, U.S./Federal, Alabama, Alaska, Arizona

Search by Policy/Incentive Type: Reset Filters »

Environmental Regulation, Feed-in Tariff, Gas Utility Rate, Grant/Rebate, Interconnection Standard

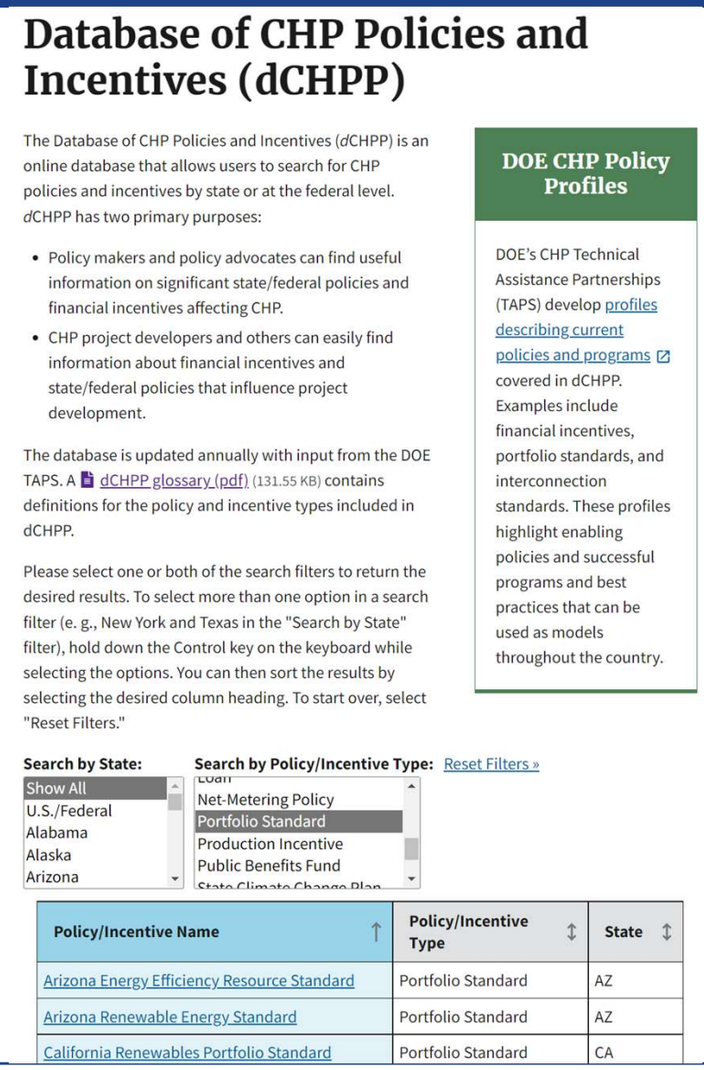
Policy/Incentive Name	Policy/Incentive Type	State
Alternative and Clean Energy Program	Grant/Rebate; Loan	PA
Ameren Illinois Combined Heat and Power Feasibility Study Incentive	Grant/Rebate	IL
Assisting Federal Facilities with Energy Conservation Technologies (AFFECT)	Grant/Rebate	U.S./Federal

Grant Programs

- Several states have CHP grant programs that are either utility administered, energy office administered or third party administered. Maryland, for example:
  - Maryland: electric utilities: Tiered grants ≤ 50kW - $2,000 per kW; Between 51kW and 200kW - $1,600 per kW; Between 201kW and 1MW - $1,200 per kW; Greater than 1MW - $800 per kW. Max incentive any project could receive is $2.5 million.
  - MEA CHP Grant: AOI 1: Resilient and Sustainable CHP Systems enhance operational resilience of the facility and/or utilize renewable fuels: < 60 kW) 50% of Net Total Project Cost or $100,000; whichever is lower 61 kW, 500 kW $600 per kW, 501 kW – 1,000 kW $550 per kW, and > 1,000 kW $500 per kW, not to exceed $650,000 total, AOI 2: Efficient CHP Systems: enhance the efficiency: < 60 kW) 40% of Net Total Project Cost* or $80,000 whichever is lower, 61 kW – 500 kW $500 per kW, 501 kW – 1,000 kW $450 per kW, and > 1,000 kW $400 per kW, not to exceed $400,000 total.

Portfolio Standards

- Generally legislative controlled
- Market value driven
- Subject to change
  - Legislative
  - Market changes



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Search by Policy/Incentive Type: Reset Filters » Net-Metering Policy, Portfolio Standard, Production Incentive, Public Benefits Fund

Policy/Incentive Name	Policy/Incentive Type	State
Arizona Energy Efficiency Resource Standard	Portfolio Standard	AZ
Arizona Renewable Energy Standard	Portfolio Standard	AZ
California Renewables Portfolio Standard	Portfolio Standard	CA

Portfolio Standards Use Case

PAPUC PENNSYLVANIA ALTERNATIVE ENERGY CREDIT PROGRAM

- Renewable-fueled CHP systems are eligible as a Tier I resource, and fossil-fueled CHP systems are eligible as a Tier II resource, with only electric output receiving credit.
- Both new and existing renewable resources are eligible as Tier I resources.
- Tier II resources include demand-side management and distributed generation systems, including CHP.
- Each electric distribution company to provide 18% of their electricity from alternative sources and 8% of electricity must come from Tier 1 sources and 10% must come from Tier II sources for 2021 and beyond.
- Compliance is based on accumulating alternative energy credits (AECs), and banking of excess credits is allowed for up to 2 years.
- CHP and other eligible technologies are credited at a conversion of 1 MWh = 1 AEC.

PA AEPS Historical Pricing

	Tier I			Tier II		
	Low	High	Weighted Average	Low	High	Weighted Average
2008	$1.00	$21	$4.48	$0.25	$3.00	$0.66
2009	$0.50	$23	$3.65	$0.20	$1.75	$0.36
2010	$0.50	$24	$4.77	$0.01	$1.75	$0.32
2011	$0.14	$50	$3.94	$0.01	$20.00	$0.22
2012	$0.20	$23	$5.23	$0.01	$5.00	$0.17
2013	$0.13	$100	$8.31	$0.01	$20.00	$0.22
2014	$1.25	$41	$9.78	$0.01	$18.87	$0.13
2015	$2.40	$285	$12.51	$0.01	$15.00	$0.12
2016	$0.20	$44	$14.56	$0.01	$15.50	$0.10
2017	$1.75	$79	$12.16	$0.01	$15.10	$0.16
2018	$0.10	$109	$10.15	$0.01	$18.43	$0.22
2019	$0.20	$115	$6.41	$0.01	$20.00	$0.31
2020	$2.50	$250	$7.87	$0.01	$6.25	$1.92
2021	$1.00	$115	$10.62	$0.01	$19.00	$5.76
2022	$1.27	$405	$17.68	$0.01	$32.70	$10.86

Ancillary Services

- Regulation is used to control small mismatches between load (the electricity being consumed) and generation (the electricity being produced), adjusting for small tips to either side of the scale.
- Reserves help to recover system balance by making up for generation deficiencies if there is loss of a large generator, resulting in a large tip in the scale.

IRA Tax Credits

- Inflation Reduction Act
  - Base & Bonus Rates
    - The base rate for the ITC is 6%.
    - The bonus rate for the ITC is 5 times the base rate (30%)
    - The base and bonus rates apply to the extensions of the PTC and ITC, the technology neutral credits, and other tax credits in the bill.
    - Taxpayers receive the bonus rate for meeting the prevailing wage and apprentice requirements.
  - Projects under 1 MW are exempted
  - Prevailing Wage Requirements
    - Taxpayers must ensure project workers are paid at prevailing locality wages.
  - Apprentice Requirements
    - Taxpayers must ensure the applicable percentages of labor hours are filled by qualified apprentices: Construction begins before Jan. 1, 2023: 10%, Construction begins in 2023: 12.5%, Construction begins in 2024 or later: 15%

IRA Tax Credits

- Plus 10% Points: Energy Community Bonus
  - Energy communities fall into three categories:
    - A brownfield site
    - An area with above average fossil energy employment with above average unemployment or local tax dependence on fossil energy
    - Within or adjacent to a census tract where a coal mine has closed after 1999, or a coal-fired electric generator closed after 2009
- Plus 10% Points: Domestic Content Bonus
  - To meet the domestic content requirement the facility must use 100% domestic iron and steel and a specified percentage of domestic manufactured products, which changes by year: 2023: 40%, 2024: 40%, 2025: 45%, 2026: 50%, 2027 and later: 55%

IRA Tax Credits

- Deadline for the sec. 48 ITC to January 1, 2025.
- Direct Pay
  - The bill allows direct pay for tax-exempt entities and new technologies.
    - Projects must meet the domestic content bonus credit requirements to get full direct pay (starting with 2024 construction starts) or get waivers. Domestic content requirements will be waived only if the use of domestic content raises overall project cost over 25% or sufficient materials (quantity or quality) are not available domestically.
  - The direct pay election is irrevocable.
- Transferability
  - Allows the transfer of eligible credits (or a portion of credits) from one taxpayer (the eligible taxpayer) to another unrelated taxpayer (the transferee taxpayer).

IRA Tax Credits

- Tech Neutral Credits (sec. 45Y, 48E)
  - Only zero-emissions facilities placed in service after December 31, 2024, are eligible for the technology-neutral PTC or ITC
  - The technology-neutral credits phase out as greenhouse gas emission reduction targets in the electric sector are reached.
  - The applicable year means the later of the calendar year in which electric sector greenhouse gas emissions are equal to or less than 25% of 2022 emissions or 2032.

Poll Q1

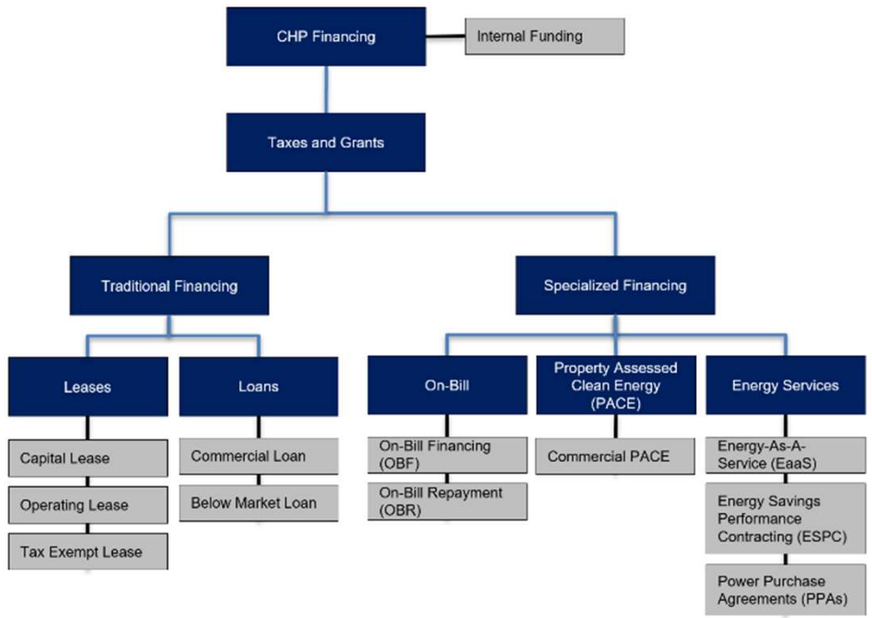
Would the availability of grants significantly impact the decision to implement a CHP project:

a. Yes

b. No

c. Maybe

Project Finance Questions



Structure the Development of a CHP project

Once financing options have been reviewed, a facility owner can determine their desired role in the project development process. The choices are to:

- Self-develop,
- Subcontract a “turnkey” project to an experienced company, or
- Find a developer or partner, and determine what kind of company best complements the owner and the project?

Develop the project internally

- Facility owner hires a consultant, plans and manages the design-construction effort, and maintains ownership control of the project.

- This approach maximizes economic returns to the owner, but also places most of the project risks on the owner (e.g., construction, equipment performance, financial performance) and requires a high level of oversight and project management from the owner.

Develop the project internally

- A facility owner with the following attributes is a good candidate for developing a project independently:
  - Willingness and ability to accept project risks (e.g., construction, equipment, permitting, financial performance).
  - Technical expertise with energy equipment and energy projects.
  - Funds and personnel available to commit to the construction process.
- Assuming the CHP project is viable, but the owner decides to use a project developer, then it is important to understand their roles and responsibilities.

Purchase a “turnkey” project

- Facility owner selects a qualified project development company to design, develop, and build the project on a “turnkey” basis, turning over ownership and operation of the facility to the owner after commissioning.

- This option shifts some risk to the developer, at a price, sometimes reducing the economic return to the facility owner or limiting the types of technologies or equipment considered.

Team with a partner

- For minimum risk, an Energy-As-A-Service (EaaS) company, an Energy Savings Performance Contracting (ESPC) company, companies offering Power Purchase Agreements (PPAs) would build, own and operate the CHP plant and purchase services required to operate and maintain the plant over a long-term agreement. The owner reduces owning and operating risks, but generally carries any energy price risk.

- Other partnerships are typically available such as teaming with an equipment vendor for major equipment financing and maintenance, teaming with an engineering/procurement/construction (EPC) firm, a utility or investor to develop the project and to share the risks and financial returns under various partnership approaches.

Project Implementation

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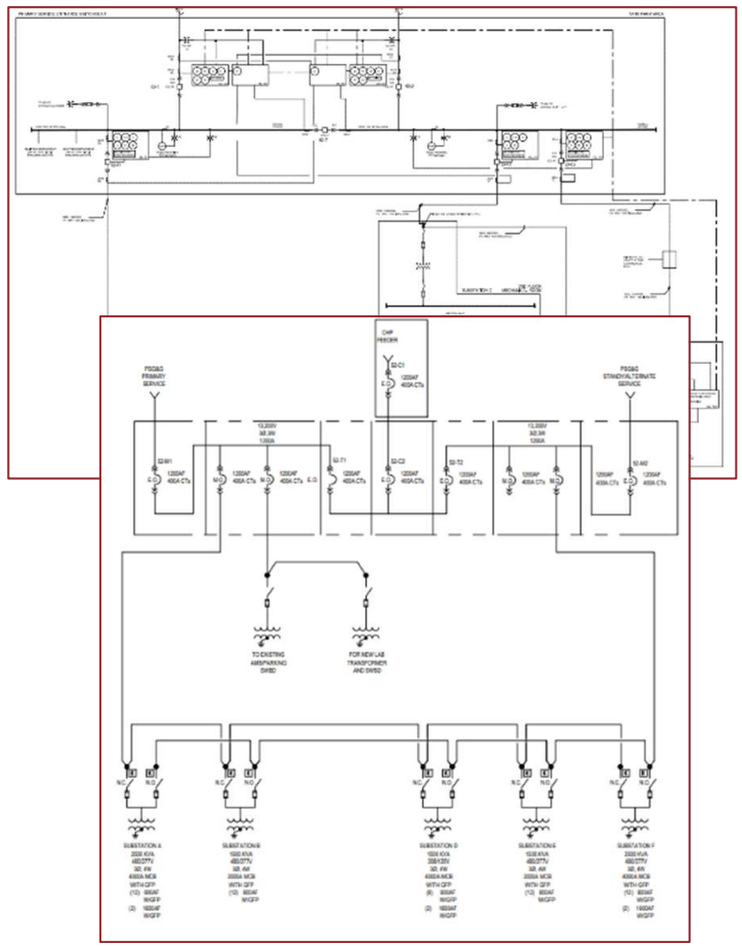
Project Implementation

- CHP Project Development is a multi-faceted and highly technical undertaking. Knowledgeable planning is the key to optimal project performance.
- At this point in the project, owner has typically decided on project goals and funding mechanism which may still leave more than one option open but is moving towards making a commitment and incurring some minor costs



Poll Q2

If installing a $20MM mechanical process system, would you:

a. Hire an external engineering company to design the system and bid out the install

b. Hire a 3rd-party installer who has responsibility for system design

c. Use the process manufacturer to do the installation

Project Development Tasks

- Carry out project scoping
- Conduct financial grade feasibility analysis
- Select CHP configuration
- Create a financial pro forma

- Obtain environmental and site permits
- Secure financing
- Contract with engineering, construction, and equipment supply firms
- Provide overall project management
- Deliver completed and commissioned CHP plant to the owner

Project Implementation

Project Implementation Skill Set Requirements

- CHP project development requires the services of:
  - mechanical, electrical, and structural engineers and contractors,
  - equipment suppliers,
  - a project manager,
  - environmental consultants,
  - lawyers, and
  - financiers.

Project Implementation Management

Discussed:

- Project Size & Scope / Contract Methods
- RFQ / RFP Process
- Siting & Permitting
- Utility Interconnection
- Air Permitting

Owner Project Management

Not Discussed:

- Engineering
- Procurement
- Construction

EPC

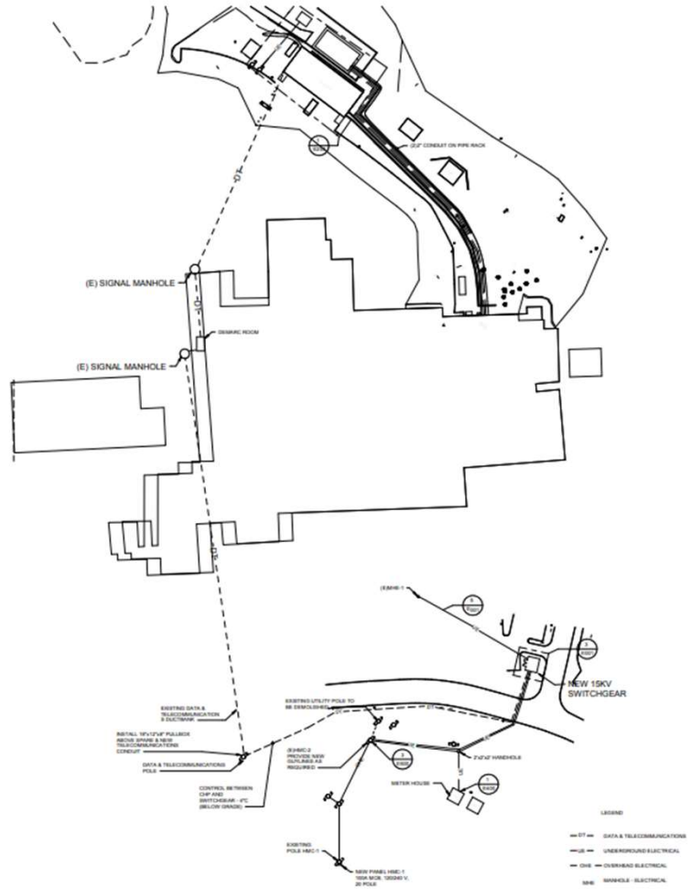
Project Development

Successful CHP projects share the following features:

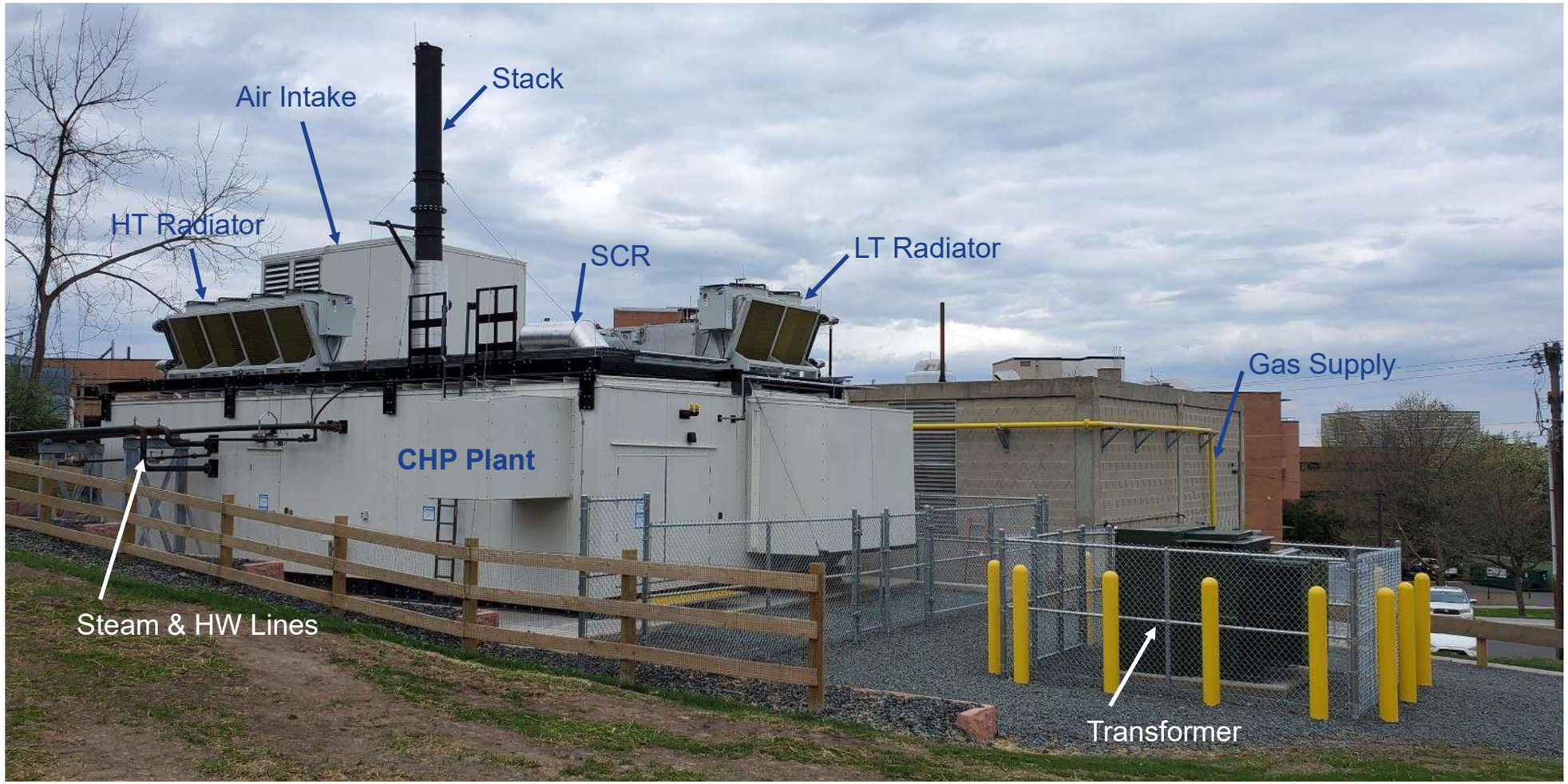
- Collaborative environment
- Independent review
- Clear procurement methods
- A Master Plan based on fact

CHP Project Scope

- Project complexity can vary widely from a single parallel interconnection located inside the facility with hot water heating to incorporate any or all of the following:
  - major electric infrastructure upgrades
  - zoning and planning changes
  - Significant civil/structural work
  - addition of cooling output
  - retrofitting into an existing facility
- Financing and contracting mechanism should be informed by size and complexity of project



Project Snapshot



Contractor/Partner Risk

Issuing a request for qualifications (RFQ) is often a good way to attract and evaluate partners early in the process. A request for proposals (RFP) can be issued when enough is known about financing and project parameters to RFQ approved, invited, or to all in an open bid.

A partner reduces risks to the facility owner by bearing or sharing the responsibilities of project development, although the amount of risk reduction provided depends on the type of partner chosen. For example, a "pure developer" partner will usually take the risk/responsibility of construction, equipment performance, environmental permitting, site permitting, and financing, whereas an equipment vendor partner may only bear the risks of equipment performance.

Selecting Project Partners

- **Pure developer**

  A firm primarily in the business of developing, owning, and/or operating energy projects. Some developers focus on onsite power projects, while others may be involved in a broad project portfolio of technologies and fuel types. Pure developers usually will own the completed CHP facility, but sometimes a developer will build a turnkey facility.

- **Equipment vendor**

  A firm primarily in the business of selling power or energy equipment, although it will participate in project development and/or ownership in specific situations where its equipment is being used. The primary objective of this type of developer is to help facilitate purchases of its equipment and services.

- **EPC firm**

  A firm primarily engaged in providing engineering, procurement, and construction services. Many EPC firms have project development groups that develop energy projects and/or take an ownership position.

Selecting a Turnkey Developer

- Selecting a turnkey developer to manage the development process is a way to shed development responsibility and risks, and get the project built at a guaranteed cost.
- In addition, the developer typically provides strong development skills and experience. Other reasons for selecting a turnkey developer include:
  - The developer's skills and experience may be invaluable in bringing a successful project online and keeping it operational.
  - Many developers have access to financing.
  - In return for accepting project risks, most turnkey projects cost more than self-built systems.

Poll Q3

When considering a new process line investment do you:

a. Bid out to multiple vendors

b. Work with favorite in-house vendor

c. Build the process in-house

Selecting Contractors/Consultants

- If the decision to develop a project internally is made, the facility owner should review the capabilities of individual contracting firms that meet the owner's general needs. When selecting a contractor, there are several qualities and capabilities that owner should look for, including:
  - Previous CHP project experience.
  - **Experience with similar industrial applications**
  - A successful project track record.
  - In-house resources (e.g., engineering, finance, operation), including experience with environmental permitting and siting issues.

Preparing a Request for Proposals

- The RFP process is a good way to screen proposals and focus on the best one(s) for further discussions and negotiation.
- An owner who plans on issuing an RFP should carefully examine the needs at the facility and ask respondents to propose ways to meet those needs or solve problems.
  - For example, if ability to secure financing or environmental permits is important, that should also be stated in the RFP. In this way, respondents will be encouraged to offer innovative proposals that meet the project's specific needs.
  - Provide a mechanism for bidders to also offer alternative technical or other approaches in order to improve the project.

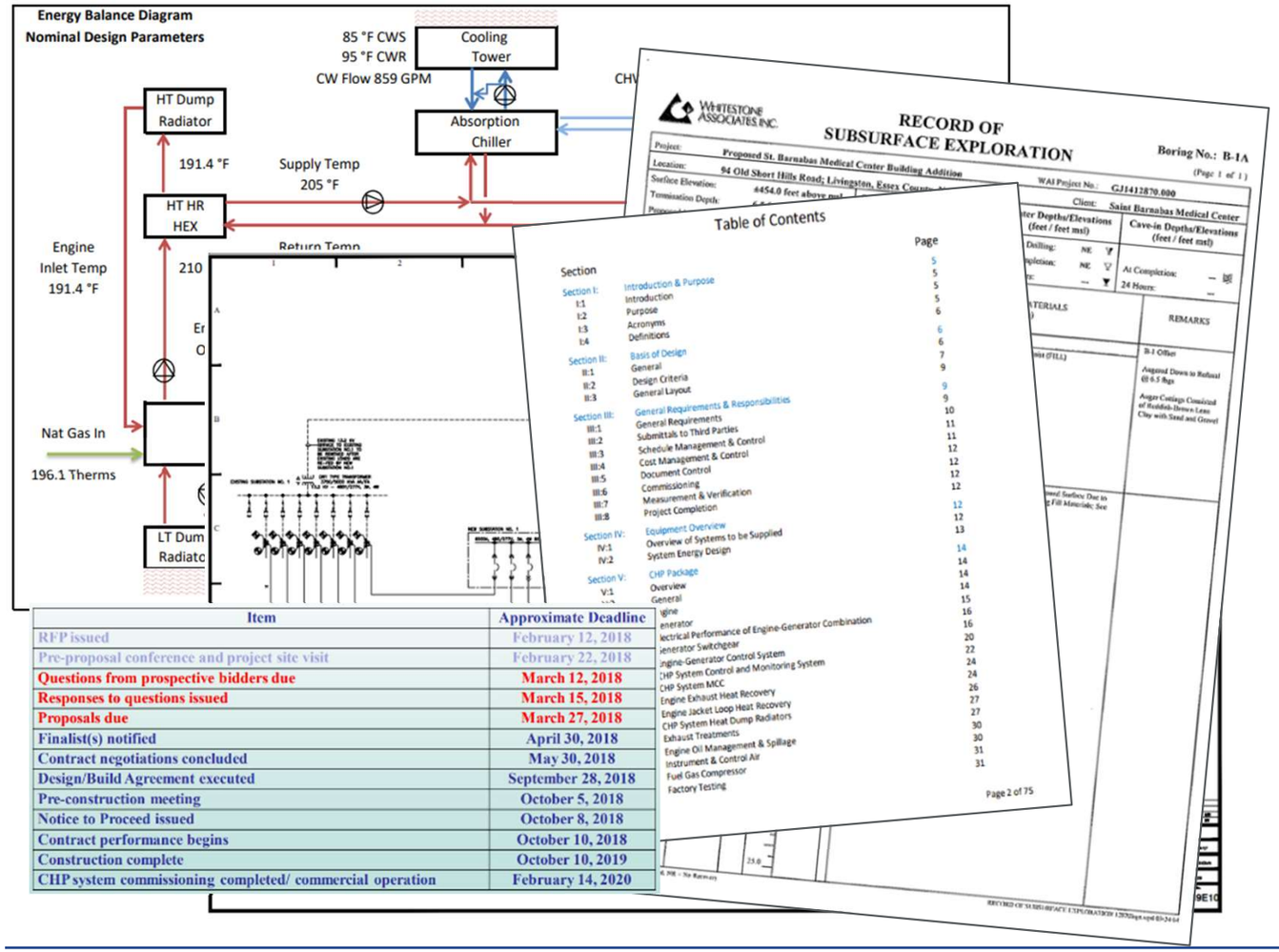
RFP Development

- In general, RFP respondents should be asked to provide the following information:
  - Description of the energy project and available options.
  - Scope of services being offered (e.g., developer, owner, operator).
  - Project development history and performance.
  - Turnkey facility bid (if appropriate).
  - Technology description and performance data.
  - Environmental permitting, interconnection, and site permitting plan.
  - Financing plan.
  - Schedule.
  - Operation and maintenance plan.

RFP Development

- The RFP should state that the owner reserves the right to select none, one, or several respondents for further negotiation, depending on the proposal's responsiveness to the owner's criteria.
- RFPs can be issued for various portions of the project development process, including:
  - Investment grade feasibility analysis
  - Equipment
  - Construction
  - Engineering (100% design)
  - Permitting
  - Maintenance

Project Snapshot



Item	Approximate Deadline
RFP issued	February 12, 2018
Pre-proposal conference and project site visit	February 22, 2018
Questions from prospective bidders due	March 12, 2018
Responses to questions issued	March 15, 2018
Proposals due	March 27, 2018
Finalist(s) notified	April 30, 2018
Contract negotiations concluded	May 30, 2018
Design/Build Agreement executed	September 28, 2018
Pre-construction meeting	October 5, 2018
Notice to Proceed issued	October 8, 2018
Contract performance begins	October 10, 2018
Construction complete	October 10, 2019
CHP system commissioning completed/ commercial operation	February 14, 2020

An RFP whether for design/bid/build or for complete 3rd party development, needs to be specific on performance, equipment parameters, integration with existing systems, existing conditions (Geotech), schedule, etc.

Preparing a Contract

- The contract should accomplish several objectives, including allocating risk among project participants.
- Some of the key elements of a contract include:
  - project schedule and milestones,
  - performance penalties and bonuses, and
  - potential remedies and/or arbitration procedures
- Each contract will be different depending on the specific nature of the project and the objectives and limitations of the participants.
- Because of this complexity, it is often useful for the facility owner to consult in-house counsel or hire a qualified attorney to serve as a guide through the contracting process.

Elements of a Project Development Contract

- Commercial operation date—Date on which the facility will achieve commercial operation. Trigger for liquidated damage penalties due to project delays.
- Milestones—Engineering completion, construction commencement, genset delivery, start-up.
- Cost, rates, and fees—Structures include fixed EPC or turnkey price, hourly labor rates, cost caps, fee amount or percentage.
- Performance guarantees—Specified output (kW, MMBtu/hr), heat rate, availability, power quality.
- Warranties—Output, performance degradation, heat rate, outage rates, component replacement costs.
- Acceptance criteria—Testing methods and conditions, calculation formulae.
- Bonus amounts and conditions—Bonus for early completion, exceeding specifications.
- Penalties and conditions—Damages for late completion, failure to meet specifications.
- Integration/impact of construction on facility operations—Schedules for power outages, limits to access, etc.

Siting and Permitting Requirements

- Local agencies must ensure that a CHP project complies with:
  - Local ordinances (e.g., noise, set-backs, general planning and zoning, land use, and aesthetics).
  - Standards and codes (e.g., fire safety, piping, electrical, and structural).
  - Air emissions requirements (e.g., NOx, CO, and particulate standards).


Existing


Rendering of Future

Siting and Permitting Requirements

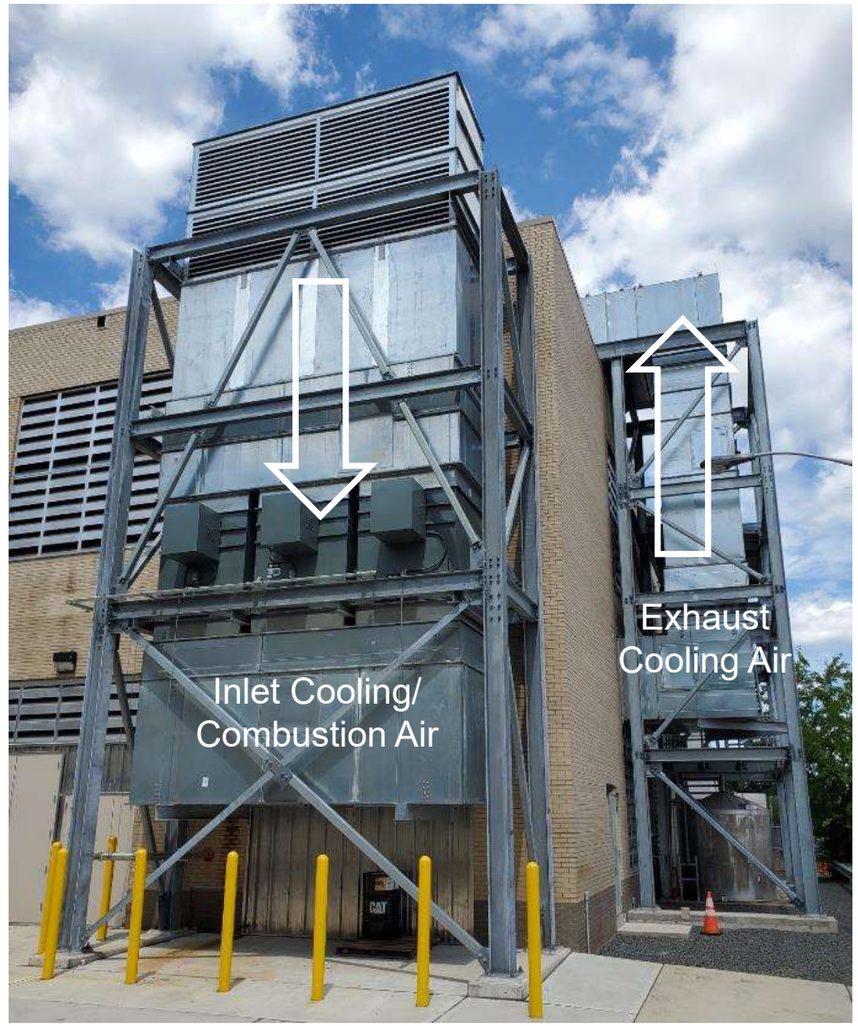
- Obtaining the required planning/zoning, utility interconnection, environmental compliance, and construction permits is an essential step in the CHP project development process.
- Permit conditions often affect project design, and neither construction nor operation may begin until all permits are in process or in place.
- The process of permitting a CHP system will typically take from 3 to 12 months to complete, depending on the location, technology, and site characteristics.

Local Zoning/Planning Requirements

- Project siting and operation are governed by a number of local jurisdictions. It is important to work with the appropriate regulatory bodies throughout all stages of project development in order to minimize permitting delays that cost both time and money. Applicable local agencies include:
  - County and city planning bureaus govern land use and zoning issues. They may conduct environmental impact assessments, including noise studies, and are responsible for compliance with local ordinances.
  - State and local building and fire code departments address CHP-related safety issues such as exhaust temperatures, venting, natural gas pressure, fuel storage, space limitations, vibration, gas and steam piping, and building structural issues. Most CHP projects require a building permit.

Project Snapshot

- Noise is a significant concern for any mechanical equipment and particularly for reciprocating engines.
- Noise from the engine unit itself is fairly easily contained behind sound proofing walls. Exhaust stacks, radiators and cooling/combustion air are also significant sources of sound.
- Duct size and silencers combined to mitigate noise from air movement.



Siting and Permitting Requirements

- There are also a number of pre-construction, construction, and operating approvals that must be obtained from a variety of local government jurisdictions for any CHP project.
- The more involved government approval procedures are those required by the local planning and building departments, fire department, and air quality district.
- One critical set of requirements are the approvals necessary for connection with the servicing utilities, both natural gas and electric.

Permitting Costs

- Siting and permitting can require significant investments of time and money in researching, planning, filing applications, meeting with officials, and paying fees.
- **Interconnection, environmental regulatory, and local government agency approval costs may approach 3 to 5 percent of project costs for smaller systems and need to be included in any CHP project economic evaluation.**
- Equipment needed to ensure compliance, such as air pollution control equipment or noise abatement equipment, would be in addition to these fees

Required Approvals

- CHP installations typically require the following types or approvals:
  - Local utility company approvals
  - Electric utility interconnection study and approval
  - Natural gas connection/supply
- Local jurisdiction pre-construction and construction approvals
  - Planning department land use and environmental assessment/review
  - Building department review and approval of project design and engineering (based on construction drawings)
  - Air quality agency approval for
  - construction
- Local jurisdiction post-construction and operating approvals
  - Planning and building department confirmation and inspection of installed CHP plant
  - Air quality agency confirmation that CHP emissions meet emissions requirements

Overall Permitting Process

- A typical basic pre-construction/ construction-phase permitting process for a CHP project within any given entity (utility company or government agency) involves three major steps:
  - The owner or developer completes and submits application forms, accompanied by fee payment(s), to the relevant entity.
  - The entity reviews the application for completeness. In this step, the entity and the developer may complete a number of rounds of information exchange before the application is considered complete and accurate.
  - The entity completes its review and issues the relevant approval/permit.

Overall Permitting Process

The approval process may also feature one or more meetings between agency or utility staff and the project developer or development team. More importantly, in some states and government agencies, public comment periods are added to Step 2 to allow interested parties to review and comment on the completed application. The comment periods are usually a minimum of 30 days in length. The agency then addresses the comments received, usually explaining why they did or did not incorporate or act on specific suggestions. Public review processes can add months to the approval process.

Overall Permitting Process

- The success of the permitting process relies upon a coordinated effort between the developer of the project and the various entities that must review project plans and analyze their impacts. There are a number of steps that the developer can take to facilitate the permitting process:
  - Hold preliminary meetings with key regulatory agencies.
  - Develop permitting and design plans early.
  - Understand procedure and submit timely permit applications to regulators.
  - Negotiate design changes with regulators in order to meet requirements. Permitting processes sometimes provide opportunities to negotiate with regulators.

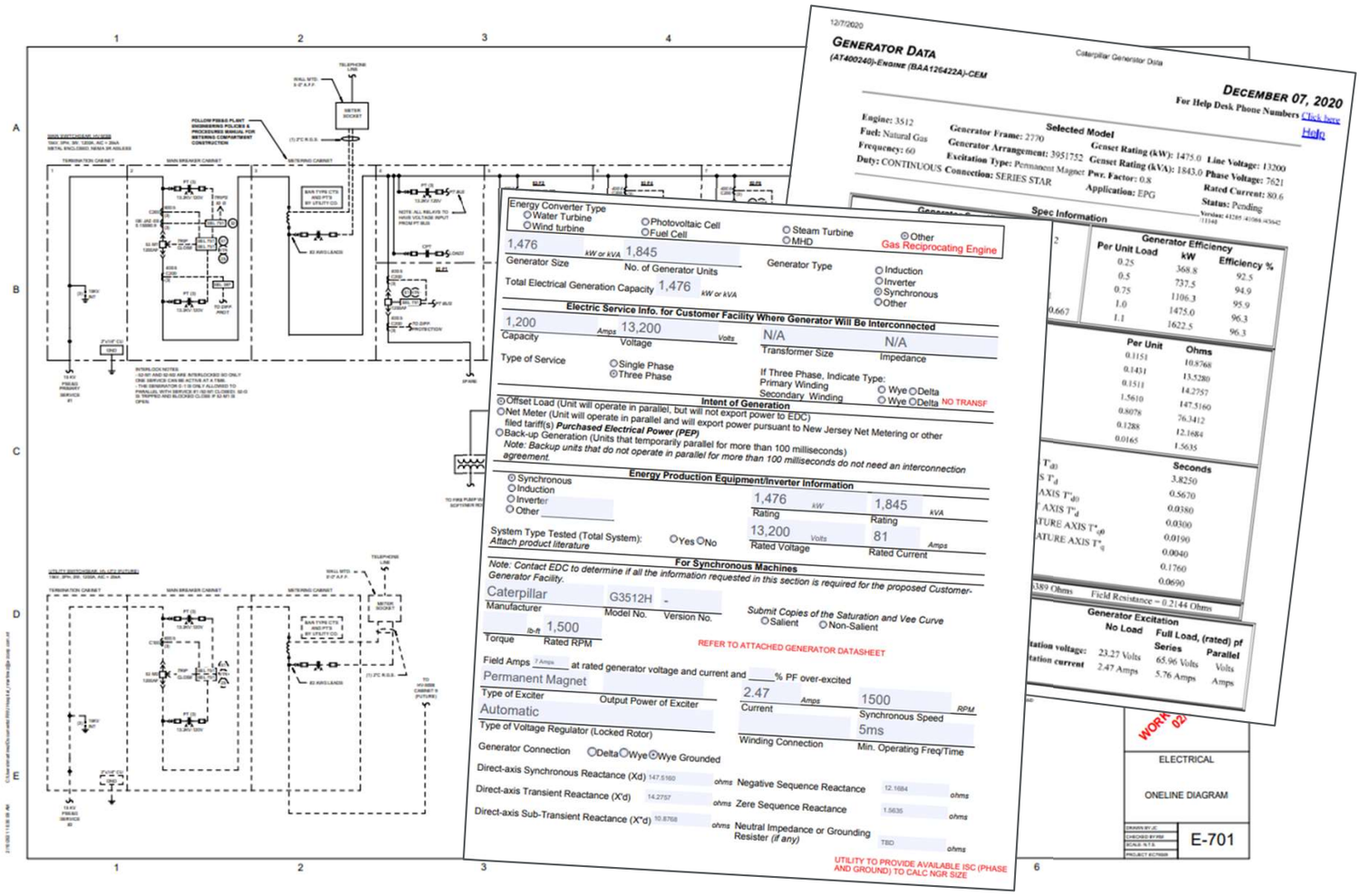
Utility Interconnection Requirements

- These include the technical and contractual requirements for interconnection to the local electricity grid for those systems that will operate in parallel with the utility.
- “Parallel with the utility” means the CHP system is electrically interconnected with the utility distribution system at a point of common coupling at the site (common busbar), and facility loads are met with a combination of grid and self-generated power. Interconnection requires various levels of equipment safeguards and utility approvals to ensure that power does not feed into the grid during grid outages.

Utility Interconnection Requirements

- Streamlining and standardization of interconnection is being promoted with the intent that small, low-impact CHP projects can be reviewed quickly and cost-effectively, and the technical and equipment requirements will be only as complex and expensive as required for safe operation. In some cases, ‘small’ can be up to 20 MW nominal electric output.
- Interconnections typically include natural gas load requirement approval by the local gas distribution company and should Include volume and pressure requirements.

Project Snapshot



- The electric grid interconnection is typically processed through the local distribution utility company.
- It requires design engineering work to provide the requisite information and field technical questions or interpret directives from the utility.

Utility Interconnection Requirements

- **Application**

  A formal application is filed with the servicing electric utility. This application usually asks for information on the location, technical and design parameters, and operational and maintenance procedures for the planned CHP system. The level of detail required and application fees can vary considerably from one utility to another.

- **Interconnection studies**

  There are a number of technical interconnection studies that might or might not be required, depending on the size and configuration of the CHP system and the specific requirements of the servicing utility.

Utility Interconnection Requirements

- Minimum engineering review.

  Designed to identify any adverse system impacts that would result from interconnection of the CHP system. Examples of potential negative impacts to the grid include exceeding the short circuit capability of any breakers, violations of thermal overload or voltage limits, and inadequate grounding requirements and electric system protection.

- System impact study.

  Required if any adverse impacts are identified in the minimum engineering review. Designed to identify and detail the impacts to the electric system operation and reliability of the proposed CHP system, focusing on the potential adverse system impacts identified in the engineering review.

- Facility study.

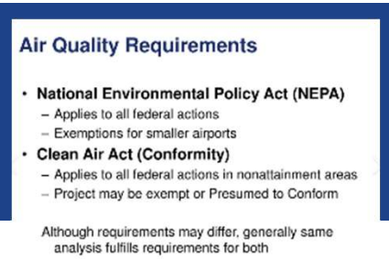
  Might be required if the system impact study indicates that grid system reliability would be adversely affected by interconnection of the CHP system. This study would identify and design any required facility or system upgrades that might be necessary to maintain grid integrity.

Utility Interconnection Requirements

- The costs of the studies are typically paid by the applicant, but can be negotiated with the utility. It is important to execute specific agreements with the utility if specific studies are required. These agreements should outline the scope of the study and requirements and include a good faith estimate of the cost to perform the study.
- The utility should establish a definitive period of time in which to process the application and studies, and provide cost estimates for utility study to be paid by the applicant and ultimately provide approval to interconnect, approval to interconnect with a list of prescribed changes to the CHP system, justification and cost estimate for prescribed changes to distribution systems that are required to accommodate the CHP system, or application rejection with justification.

Interconnection Agreement

There are also contractual issues that must be addressed in parallel to the technical requirements for interconnection. The interconnection agreement will cover such issues as back-up services, metering requirements, inspection rights, insurance requirements, and the responsibilities of each individual party.



Local Air Quality Requirements

- Air quality agencies/districts at the state and local levels are responsible for administering air quality regulations, with a primary focus on air pollution control.
- The primary criteria pollutants of concern include NOX, CO, SO2, particulates, and certain hazardous air toxics.
- These authorities issue construction permits based on their review of project design and performance objectives.
- After construction and installation is complete, projects receive operating permits based on emissions performance relative to applicable emissions thresholds.

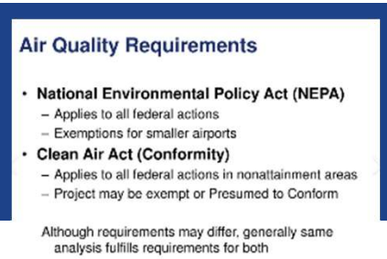
Poll Q4

For air permitting purposes, is your facility:

a. Major Source

b. Synthetic Minor Source

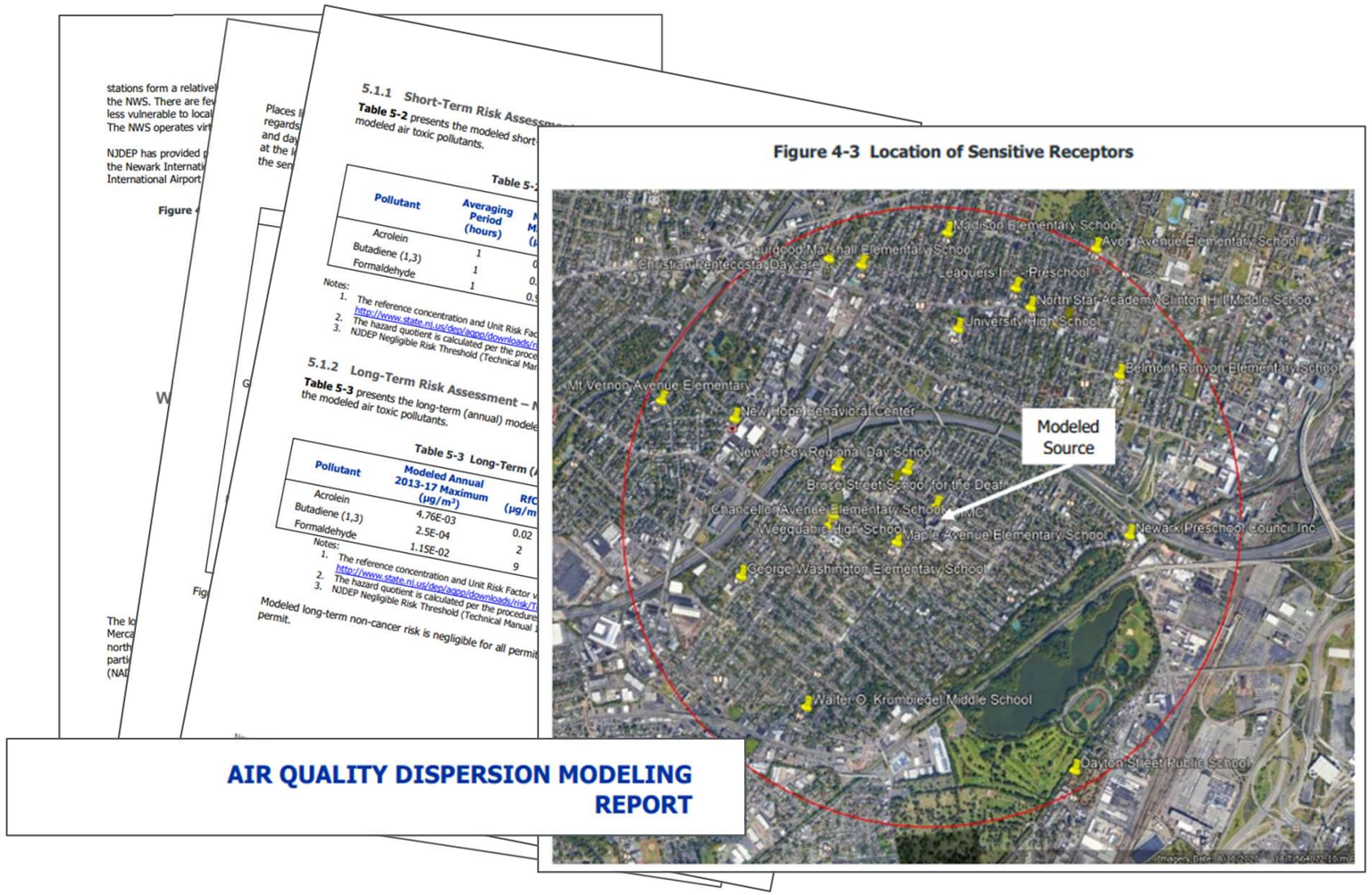
c. Minor Source



Local Air Quality Requirements

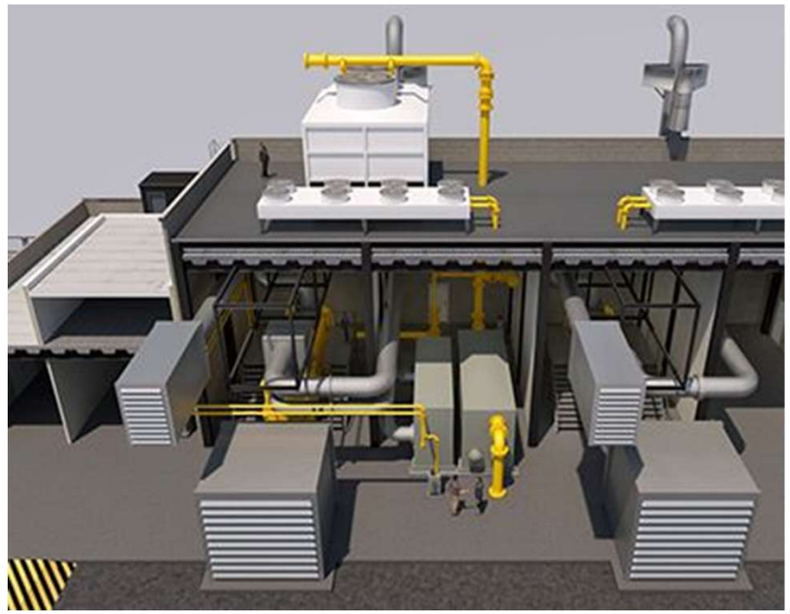
- Major characteristics that typically differentiate projects for air permitting purposes include:
  - Does the CHP system trigger permit requirements? If it is not exempt, what relevant emissions threshold is it below or above?
  - Is the site in an attainment area? Non-attainment areas feature more rigorous guidelines.
  - Is the site an existing or new facility? Is the site currently considered a major emissions source or a minor emissions source? Adding a new source of emissions to an existing major source can trigger additional permitting requirements; adding a new source to an existing minor source may move the facility into the major source category.
  - Do emissions of criteria pollutants and air toxics affect surrounding communities? If it appears that the source's emissions may affect public health, air quality modeling or an evaluation study may be necessary.

Project Snapshot



Depending on local area or state requirements and size of project (volume of emissions), one or more pollutants may be subject to further study including air dispersion modeling.

Project Implementation Questions



Packaged Systems & DOE's eCatalog

U.S. DEPARTMENT OF ENERGY

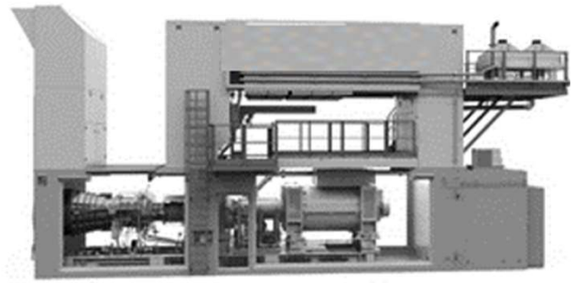
Packaged Systems

- The industry has rapidly moved toward packaged and modular systems within the past ten years particularly under 3.5 MW for packages and 20 MW for modular systems.
- The can be a means to reduce cost and improve operability, reliability and code compliance.
- When developing your final design, keep this in mind.

Benefits of Packaged Systems

- Self Contained Units or Modules
  - Prime Mover
  - Heat Recovery
  - Controls
  - Ancillary Equipment
- Standardized yet customizable
- Code Compliant
- Tested
- Factory assembled
- Moveable

2 MW package



7.5 MW (3 modules)

3.3 MW (3 modules)

1 MW Package (5 MTs)

Food Processing

Taylor Foods
One 2.0 MW CHP System

LOCATION: Gonzales, California
FACILITY SIZE: 250,000 sq. ft. Processing Plant
PEAK LOAD: 6 MW
EQUIPMENT: One 2 MW recip engine generator with heat recovery driving a 240-ton ammonia absorption chiller.
FUEL: Natural gas

Flooring Production

Mohawk
Five 1 MW CHP Systems

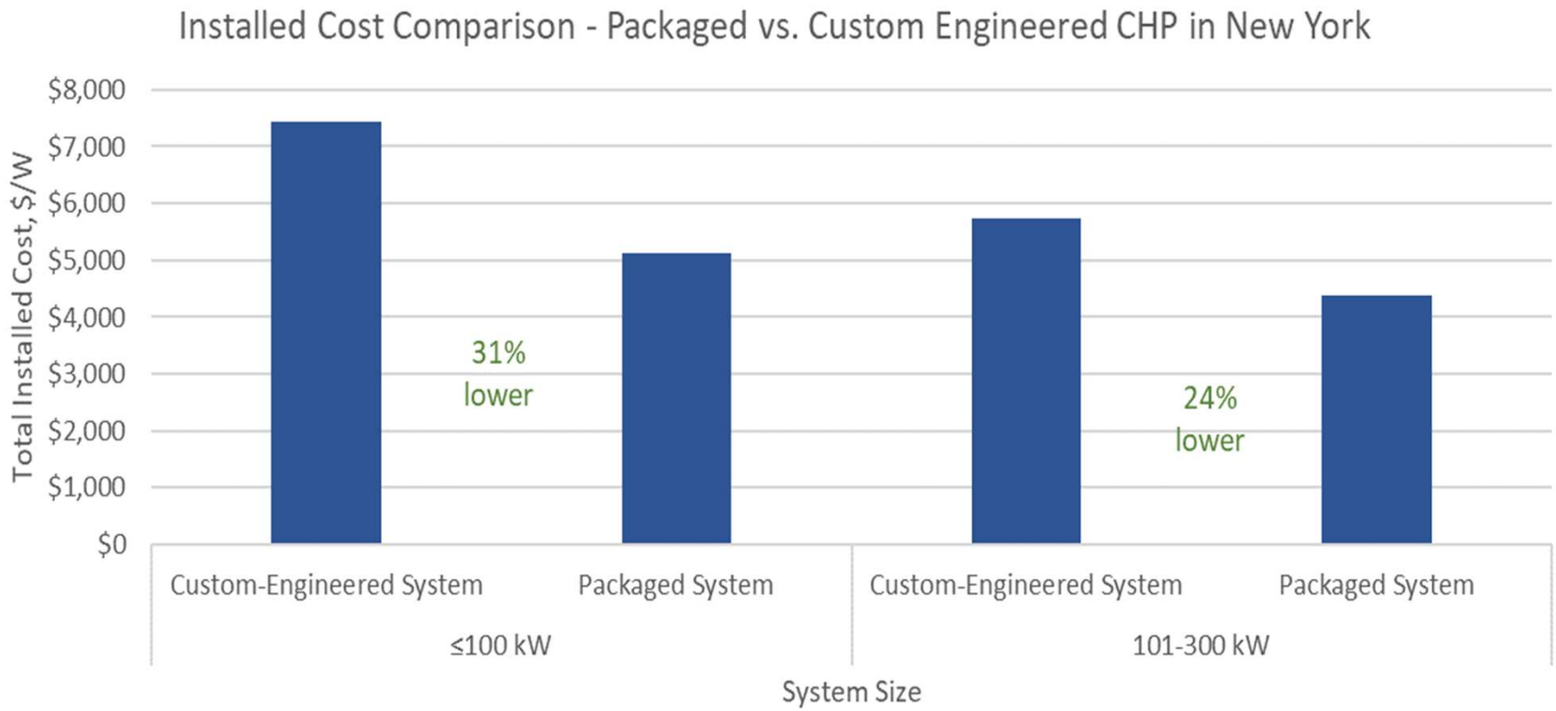
LOCATION: Dickson, Tennessee
EQUIPMENT: Five Capstone C1000s
USE OF THERMAL ENERGY: Supplement the burner in their spray dryer
FUEL: Natural Gas

Carpet Fiber Production

Shaw Industries
One 14.1 MW CHP System

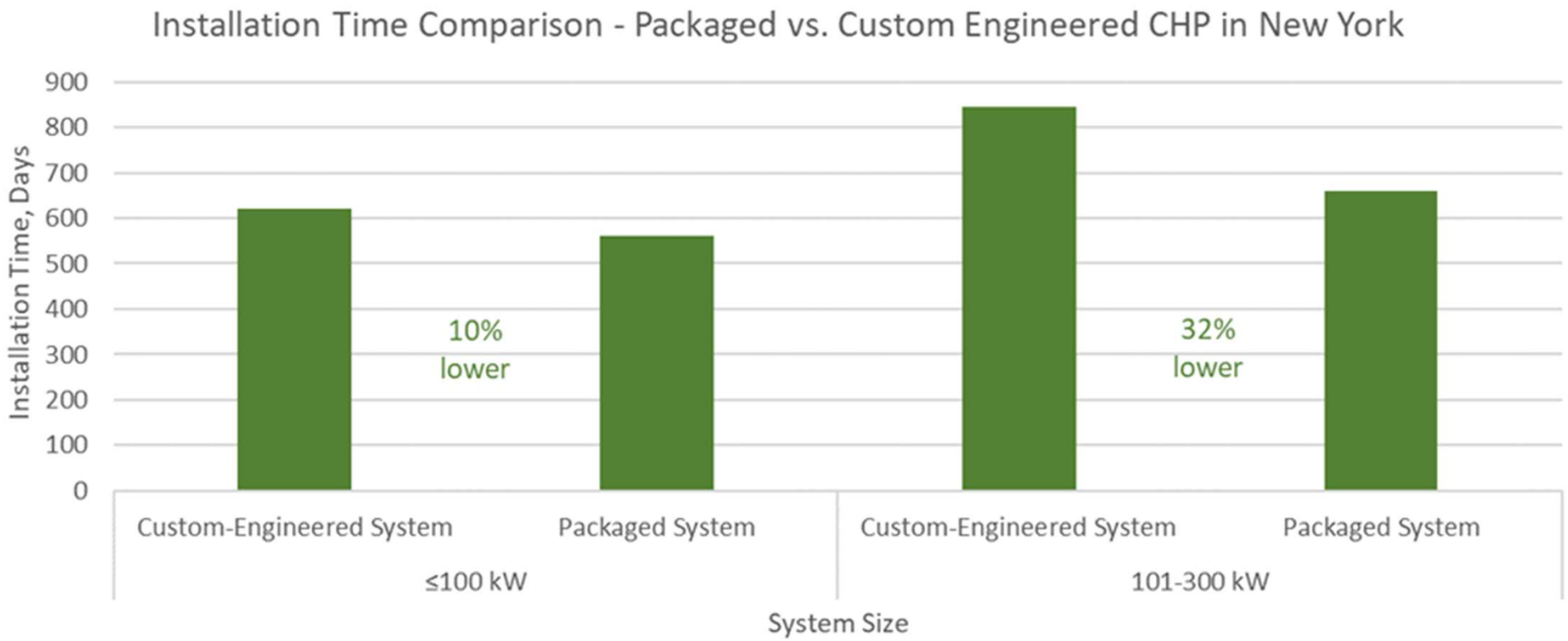
LOCATION: Columbia, South Carolina
EQUIPMENT: Solar Turbines Titan 130
USE OF THERMAL ENERGY: Process steam, hot water, cooling
FUEL: Natural Gas

Estimating Cost and Time Reductions from Packaged CHP



The DOE Packaged CHP Accelerator compared data on custom engineered systems installed in NYSERDA's CHP Program to data on packaged CHP systems from the CHP Catalog Program.

Estimating Cost and Time Reductions from Packaged CHP



Packaged CHP installations had reduced timelines between the start of the project and final commissioning in New York compared to custom engineered systems.

DOE Packaged CHP eCatalog

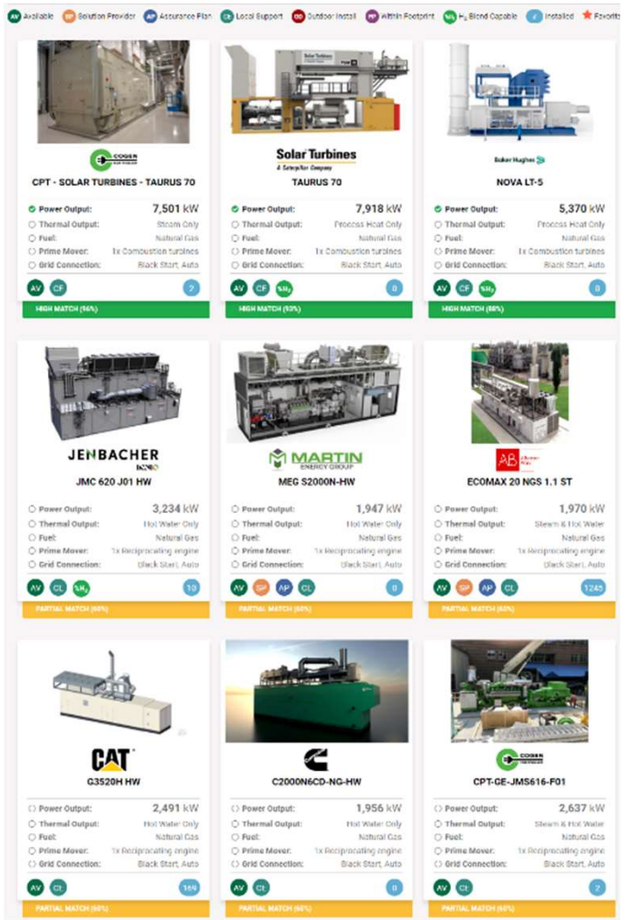
- A national web-based searchable catalog of DOE-recognized packaged CHP systems and suppliers with the goal to reduce risks for end-users and vendors through partnerships with:
  - CHP Packagers that assemble and support recognized Packaged CHP Systems
  - Solution Providers that install, commission and service packaged CHP systems
  - CHP Engagement partners that provide CHP market deployment programs at the state, local and utility level
- Pre-engineered and tested packaged CHP systems that meet DOE performance requirements
- eCatalog audience: end-users with engineering staff, consulting engineers, utilities, state energy offices, regulators, federal agencies, and project developers.
- Users search for applicable CHP system characteristics, and get connected to packagers, installers and CHP engagement programs
- Allows users to compare technology options on a common basis

Better Plants

U.S. DEPARTMENT OF ENERGY

Let’s Go Live

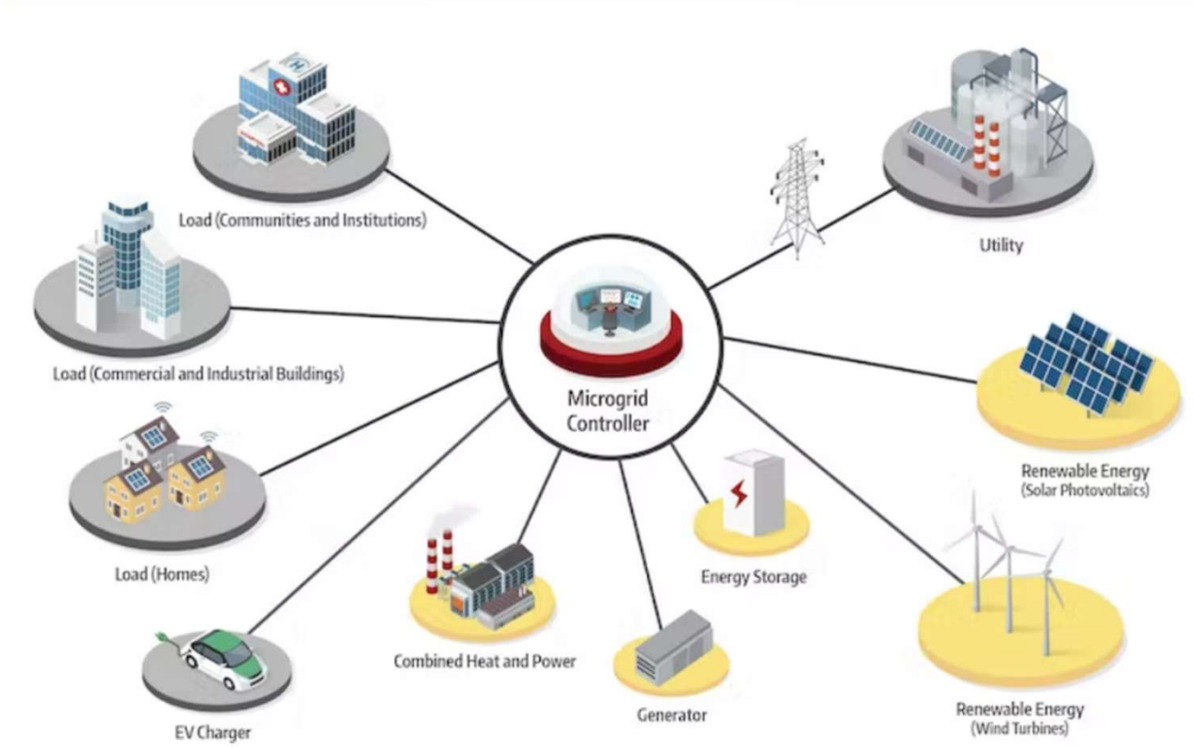
Packaged Systems or eCatalog Questions



Microgrid/Utility Integration

U.S. DEPARTMENT OF ENERGY

Microgrid/Utility Integration



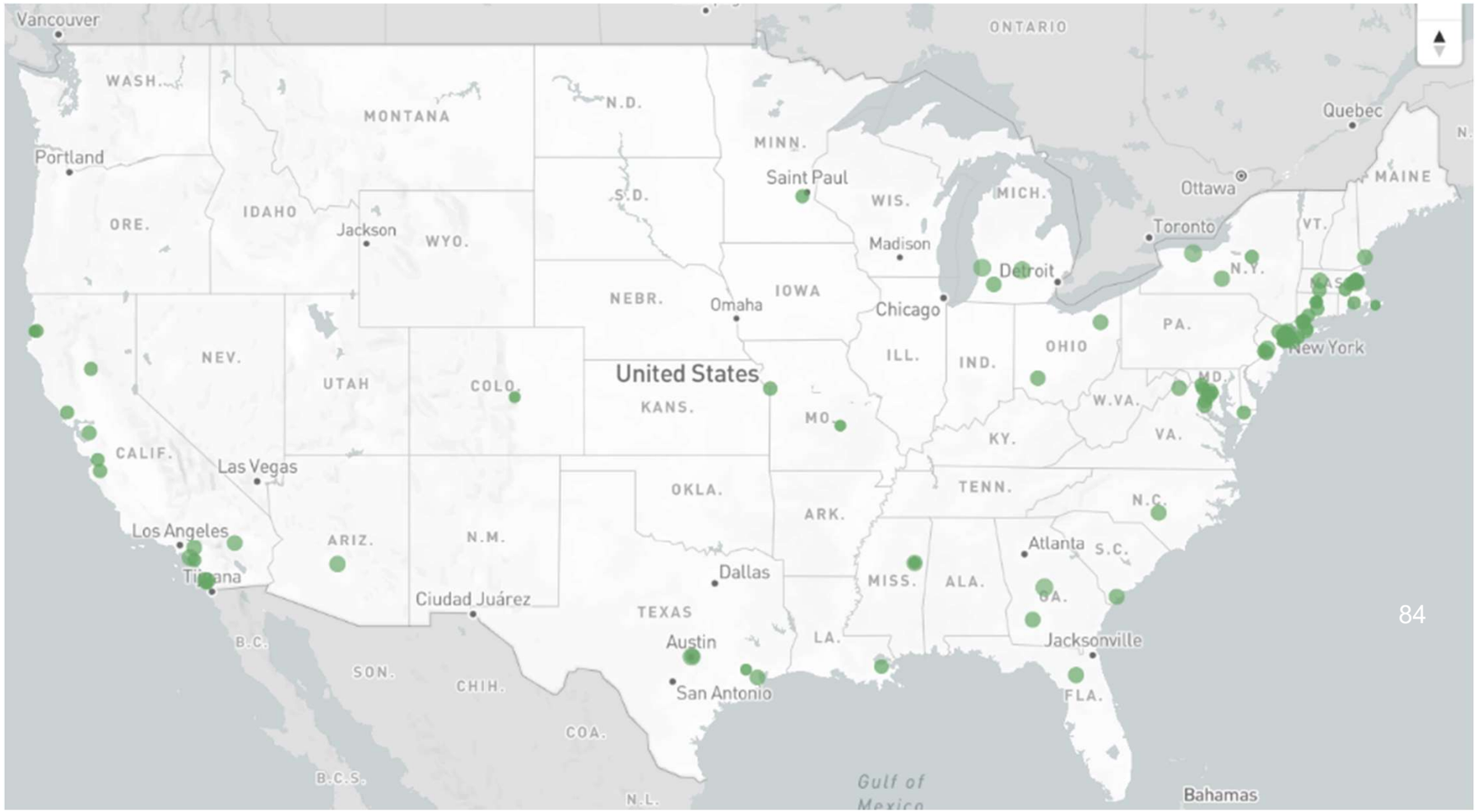
Courtesy of Microgrid Knowledge

Microgrid Definition

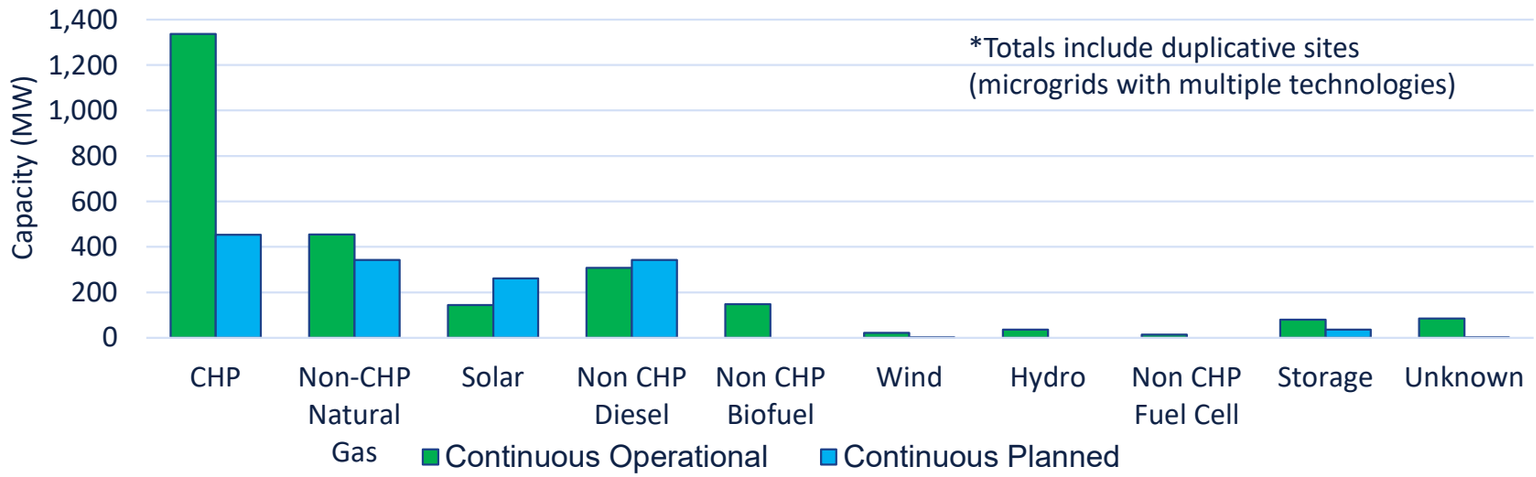
A microgrid is a network of distributed energy resources and loads that can disconnect and re-connect to the larger utility grid as a single entity, allowing the connected loads to be served during utility outages. Microgrids can also be found in remote locations where they may not be connected to a larger grid. Some standby/backup generators are configured to connect/disconnect and operate independently from the utility grid during an outage but these backup generators are not included in the database unless they are part of a microgrid that serves other functions, such as daily power requirements or participation in utility markets.

Source: Microgrid Database (U.S. installations as of February 18, 2021)

CHP Supported Microgrid Projects by State



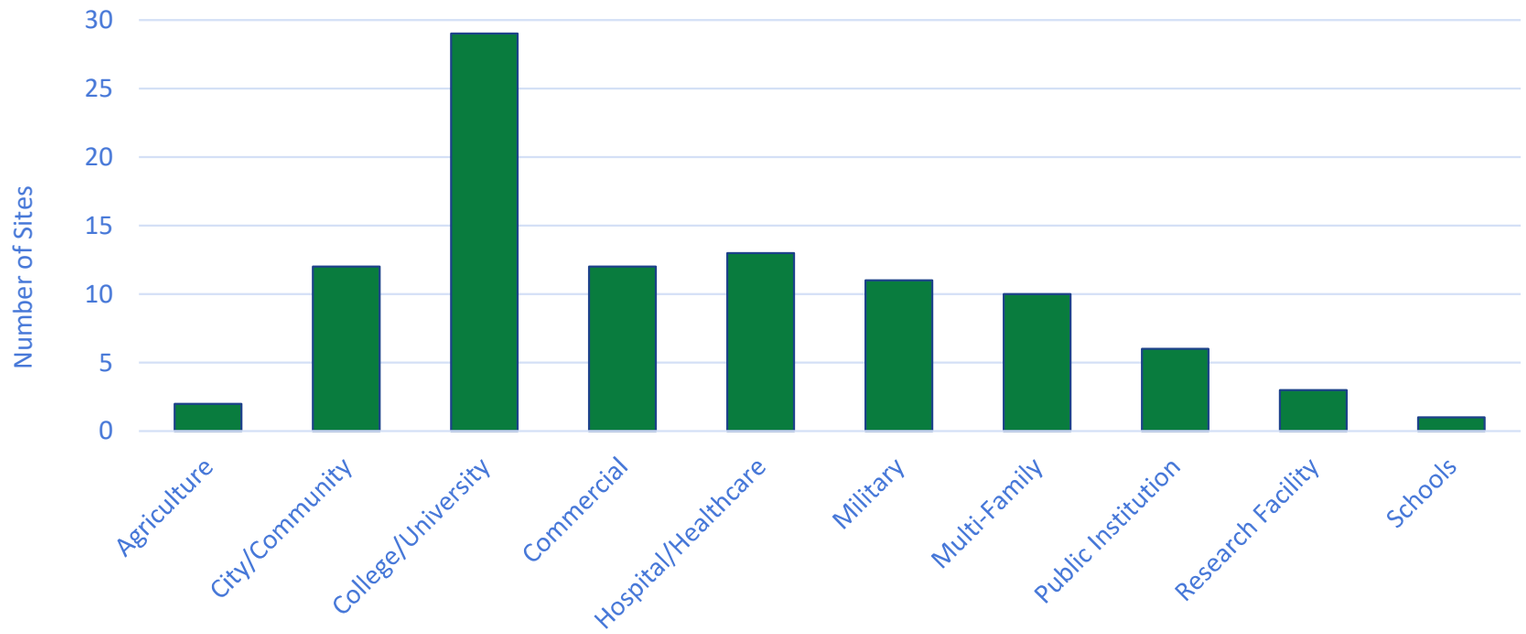
Planned and Operational Continuous Microgrid Capacity by Technology



101 microgrids (1,741 MW of installed capacity) out of 290 continuously operating microgrids in the U.S. (2,551 MW of installed capacity) are anchored with CHP systems?

Source: Microgrid Database (U.S. installations as of February 18, 2021)

Operational Continuous CHP Microgrid Sites by Primary Application



Source: Microgrid Database (U.S. installations as of February 18, 2021)

Poll Q5

How important is energy resilience and reliability to your operations:

a. Very

b. Somewhat

c. Little

Two pivotal events led Montgomery County leaders to pursue microgrids

- 2012 a devastating storm derecho, launched a surprise assault on the Mid-Atlantic. A complex line of tornadoes, lightning, wind, and rain leaving 250,000 Montgomery County residents and 71 county facilities were without power for multiple days.
- The electrical infrastructure within county buildings, low- and medium-voltage gear, was beginning to show its age. Government administrators needed to find a way to pay for expensive upgrades.
- In 2014, the county turned to the private sector for ideas, issuing a challenge in the form of a request for proposals that sought creative solutions from a proven energy partner.

Public Safety Headquarters Microgrid

~part of 2 MW PV: Roof Mounted Solar

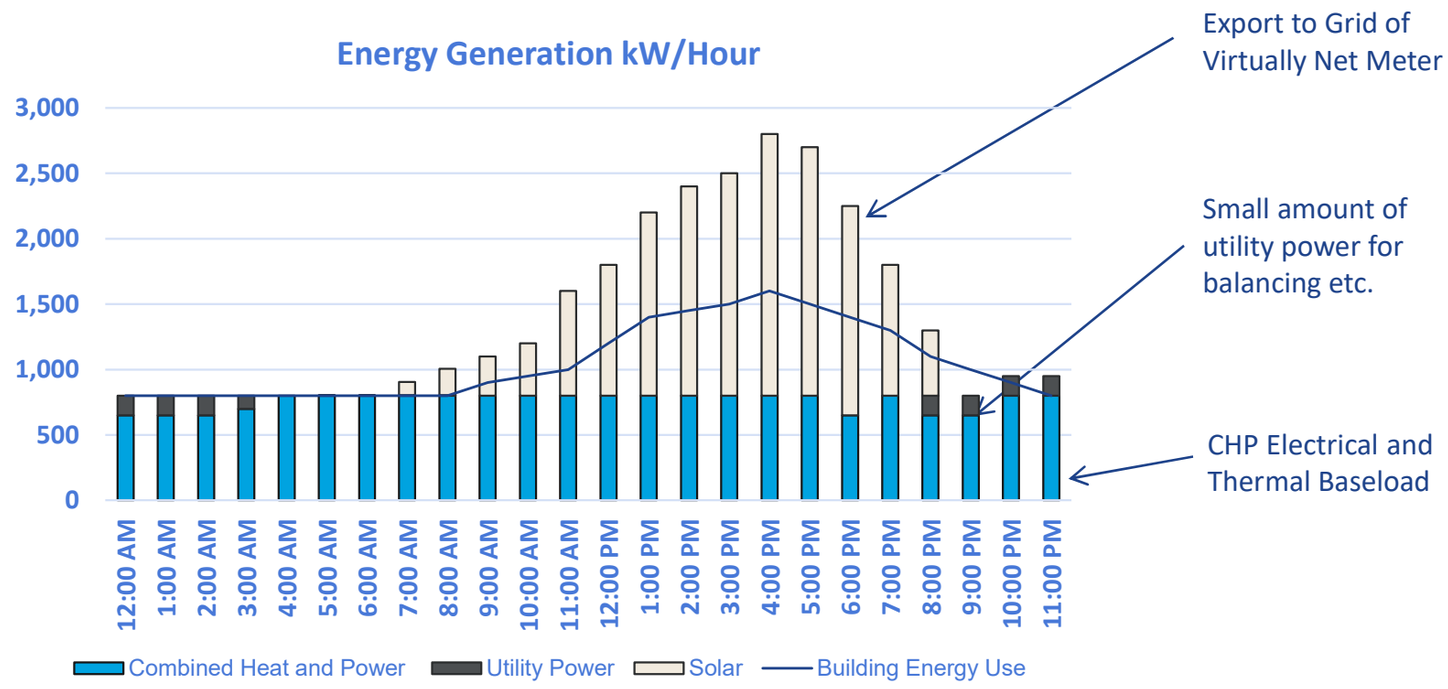
EV Charging

~part of 2 MW PV: Canopy Mounted Solar

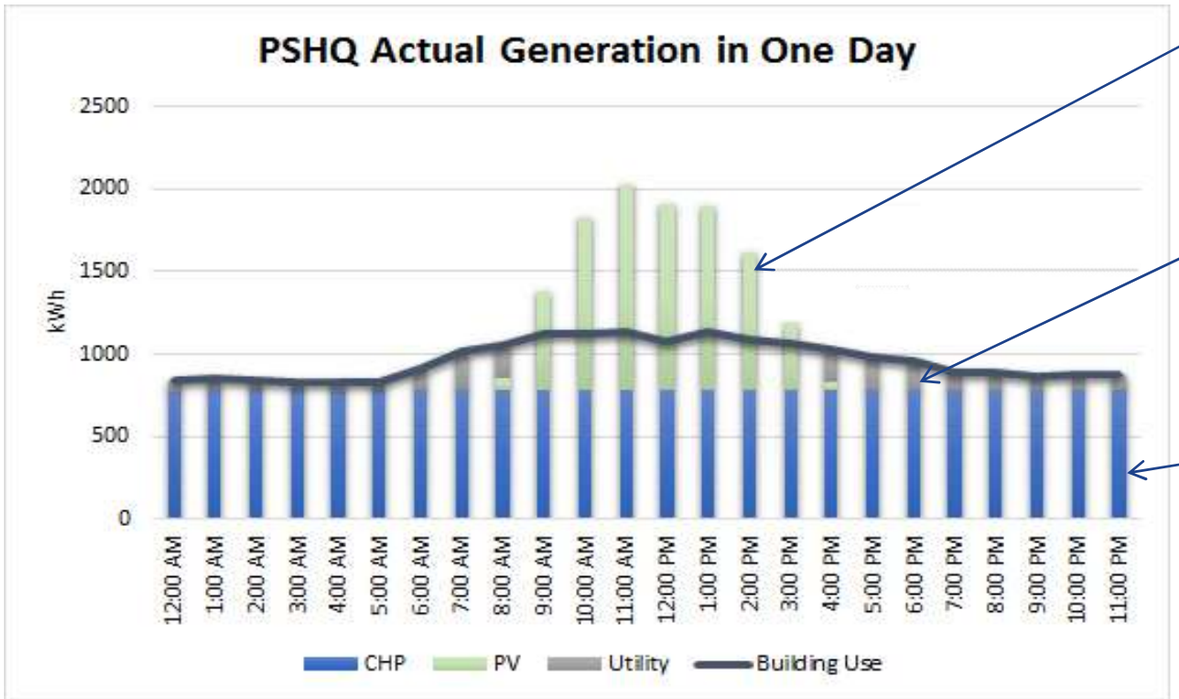
Packaged CHP System

Controls and Cybersecurity

PSHQ Operating Condition (Design Example)



PSHQ Actual Operating Condition

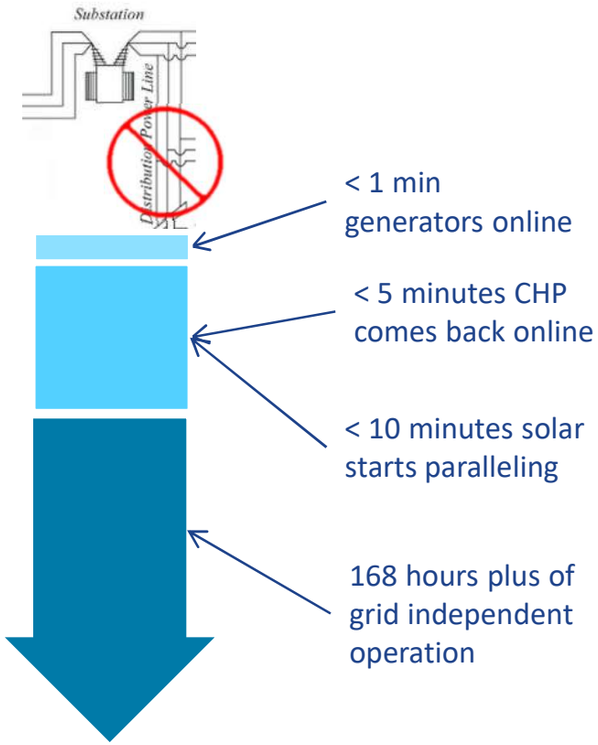


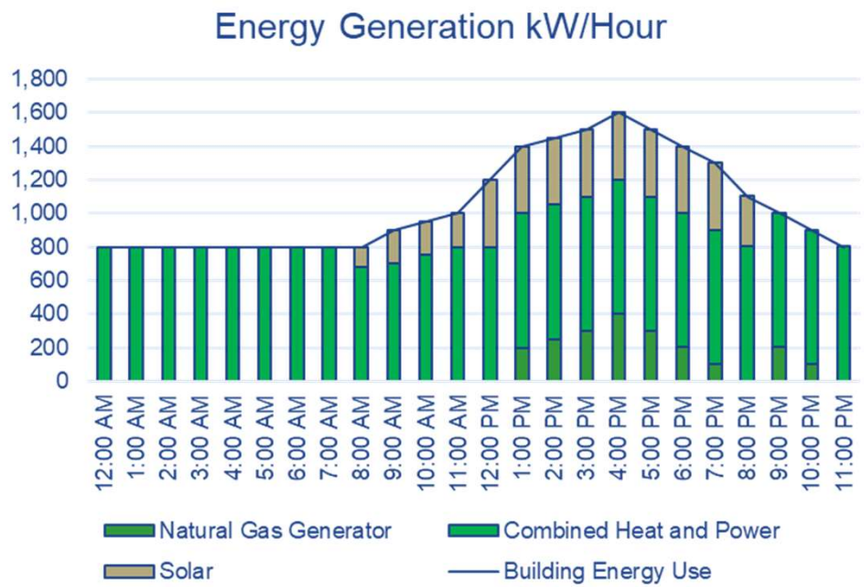
Export to Grid of Virtually Net Meter

Small amount of utility power for balancing etc.

CHP Electrical and Thermal Baseload

PSHQ Outage “Island” Event (Example)





PSHQ Sustainability

- Reducing greenhouse gas emissions by 5,900 metric tons annually, the equivalent of taking more than 1,200 cars off the road.
- 2 MW of solar photovoltaic canopies (25% of the Carbon Reduction)
- 800 kW NG Packaged Combined Heat and Power system (75% of the Carbon Reduction).
- The two times (November and December of 2019) the grid went down and the system responded as designed. No interruption to the facility operations. Tenants did not even know the grid was down.
- Note the CHP 800 kW Reciprocating Engine is capable of accepting hydrogen blends

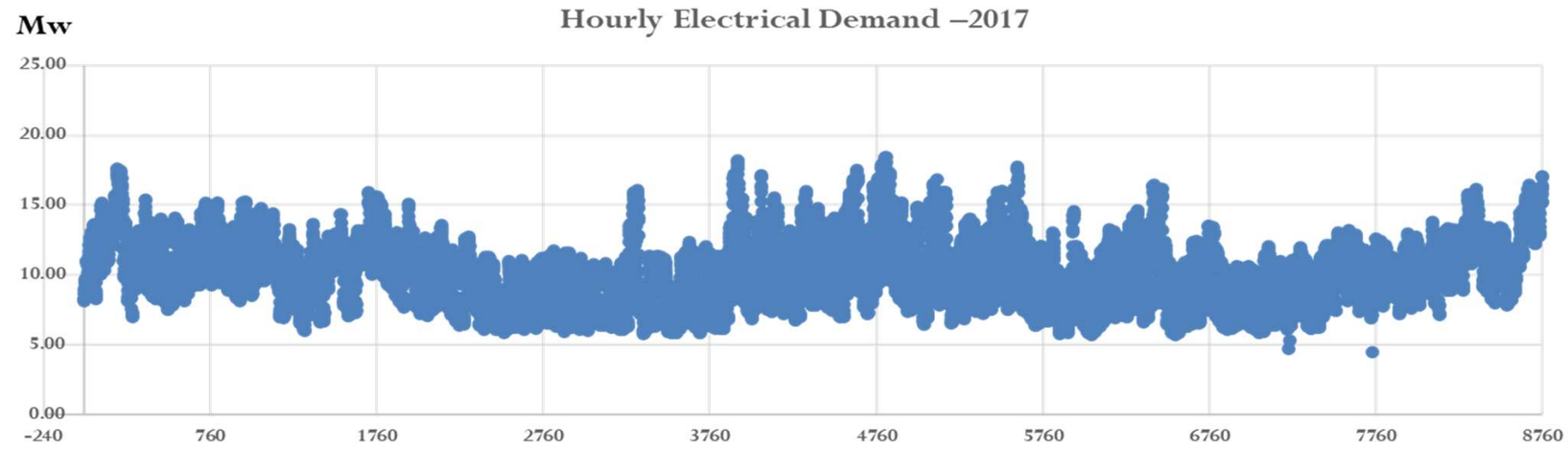
Quakertown Borough – Municipal Grid CHP+PV

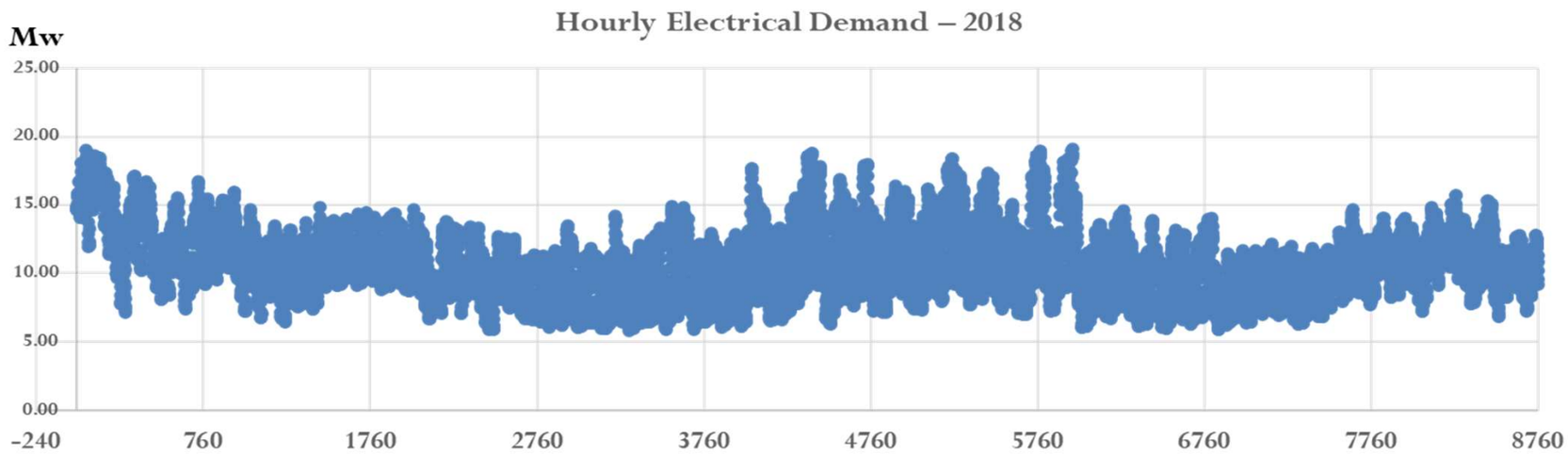
Quakertown Borough – Municipal Grid

Weather related resiliency issues

Large private industry wanting lower carbon footprint production

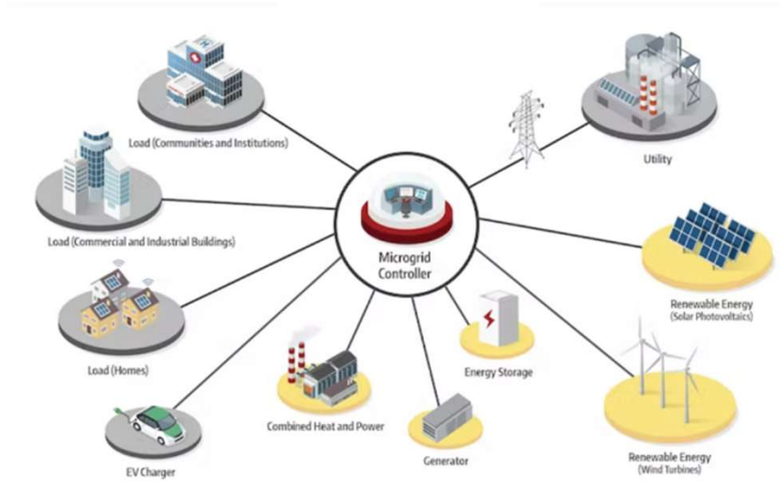
Town Council seeking path to low carbon MG operation – sustainability passed on





Private (Quaker Color)– Public (Municipal Grid) Partnership CHP+PV

Microgrid/Utility Integration Questions



Courtesy of Microgrid Knowledge

Thank You

Thank You

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Pennsylvania State University

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