Packaged CHP: Off the Shelf Solutions

May 11, 2016

Claudia Tighe
Moderator

U.S. DOE CHP Deployment Program

- **Market Analysis and Tracking** – Supporting analyses of CHP market opportunities in diverse markets including industrial, federal, institutional, and commercial sectors.

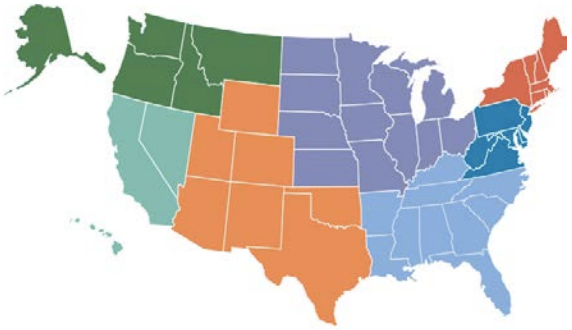
- **Technical Assistance through DOE's CHP Technical Assistance Partnerships (CHP TAPs)** – Promote and assist in transforming the market for CHP, waste heat to power, and district energy with CHP throughout the United States

- **Just Launched Combined Heat and Power (CHP) for Resiliency Accelerator -**

  Collaborating with Partners to support consideration of CHP and other distributed generation solutions for critical infrastructure resiliency planning at the state, local, and utility levels

- **Packaged CHP System Challenge (under development) -**

  Increase CHP deployment in underdeveloped markets with standardized, pre-approved and warrantied packaged CHP systems driven by strong end-user engagement via Market Mover Partners, such as cities, states, and utilities



www.energy.gov/chp

Dr. Dana Levy
NYSERDA

U.S. DEPARTMENT OF ENERGY

Incentive Program: Eligible List of Packaged Small-to-Medium CHP treated as a Pre-qualified Measure to Boost Uptake

Dr. Dana Levy of NYSERDA

NYSERDA CHP thought-leader since 1999

Recipient of the USCHPA CHP Champion Award in 2007

Recipient of the NECHPI CHP Champion Award in 2014

May 11, 2016

USDOE Better Buildings Summit, Washington DC

Axioms (we hold these truths to be self-evident)

Axiom #1

Public policy objectives encourage the deployment of clean & efficient CHP

Axiom #2

The perpetual use of publicly-funded subsidies is a less-desirable mechanism than transforming the market to where it can be self-sustaining

- Incentivizing CHP projects one-after-another helps build competency in the marketplace, and NYSERDA is committed to doing this, but this alone is too passive an approach for achieving “market transformation”
- The market needs genuine cost reductions in order to reach self-sufficiency
- A well-crafted CHP incentive program is important, but is not enough

NYSERDA's Approach

Objective: re-align the way deals are transacted in the marketplace so as to

(1) achieve genuine cost reductions, and

(2) increase customer confidence

Facilitating customer acquisition will

- reduce marketing costs

Facilitating replicable project designs will

- reduce design errors, associated performance losses, and re-work expenses
- reduce uncertainty among Authorities Having Jurisdiction, and thereby reduce time and costs for permitting

To enable these market alignments, NYSERDA's program is structured around a rigorously-vetted list of pre-approved mature products furnished by eligible installers

Sequence of NYSERDA's CHP Program Evolution

Explore Modularity

CHP Demonstration Program
Goal: Diversity -- Broad Portfolio for Learning via Trailblazing Examples

CHP Performance Program
Goal: Further acquisition of grid load relief

CHP Catalog Program
Goal: Market Transformation via Standardization & Maturity

2000 2006 2012

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Many Things Must Go Right for Success

A CHP project faces a sequence of challenges:

- Selection: choose size and type to meet needs of the site
- ~~Componentry: seek harmony among components constituting the CHP system~~
- Integration: design site-specific interface with the building's HVAC mechanical systems and electrical panel
- Construction: install equipment correctly
- Maintenance: perform regularly, throughout equipment lifespan
- Operation: dispatch the CHP system correctly per the site's varying needs each hour throughout the day, each day throughout the week, each season throughout the year

Addressing the "harmony among components" variable is fundamental

In the size range where prevalent, good-quality packaged CHP provides an advantage

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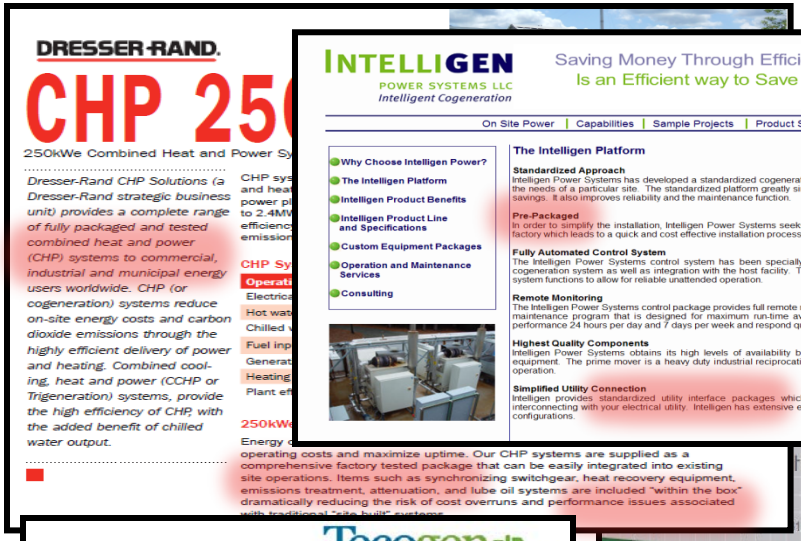
Packaged CHP Facilitates …

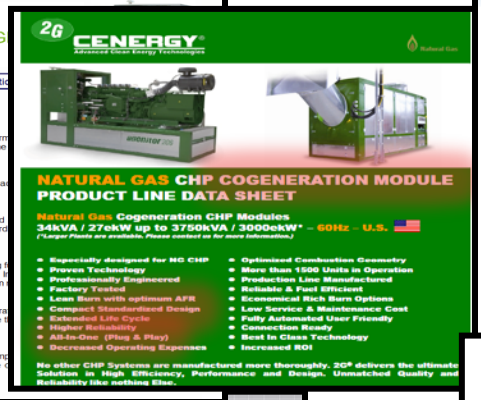
- Cost reductions for Customer Acquisition tasks
- Incorporation of value via expert design professionals
- Single point responsibility (no finger pointing)
- Expansion of alternative financing strategies, such as PPAs

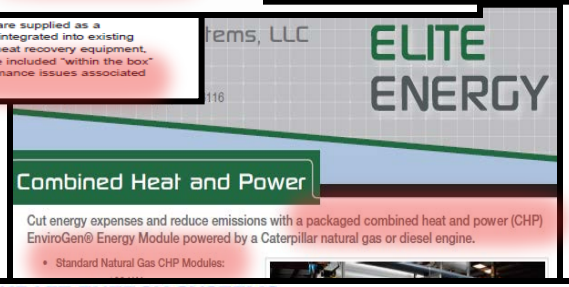
NYSERDA has launched an Incentive Program based on a list of good-quality packaged CHP that is supported by adequate local sales & service

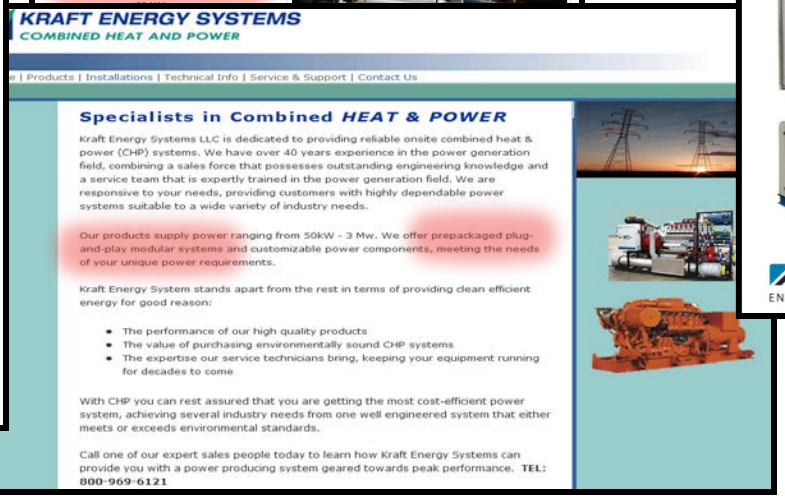
This format has enabled additional, important market interventions

CHP Offered as an Appliance









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http://energy.gov/sites/prod/files/2014/12/f19/0437-low-cost_packaged_CHP_factsheets.pdf

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Low-Cost Packaged Combined Heat and Power System

Increasing the Market Acceptance of Smaller CHP Systems

This project is developing a flexible, packaged combined heat and power (CHP) system that produces 330 kilowatts (kW) of electrical power output and 410 kW of thermal output while increasing efficiency and reducing total cost of ownership.

Introduction

Many CHP systems less than 1 megawatt (MW) use reciprocating internal combustion engines. Unfortunately, reductions in the size of these engines are associated with reduced efficiency and increased maintenance costs.

This project is leveraging core technologies developed under the U.S. Department of Energy's (DOE) Advanced Reciprocating Engine Systems (ARES) program to lower costs while increasing efficiency.

The project will result in one of the highest-efficiency systems for a CHP project less than 1 MW in size. The packaged system is expected to increase the adoption rate of smaller CHP systems through simplified installation and reduced total cost of ownership.

DOE/EE-0437 • Updated October 2014

The simple and low-cost design is intended to increase the adoption rate for high-efficiency CHP systems.
Photo credit Cummins Power Generation.

Applications in Our Nation's Industry

This project will target small applications (100–500 kW power range) in numerous industries, institutions, and other facilities,

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A Customer buys a Product

Not an assemblage of components

Car:

- A customer buys a car in the form of a product that has been produced from a factory assembly line, as opposed to hiring a mechanic to procure 40,000 components and assemble into a car

CHP:

- The old way resulted in a situation where each project looked like a science experiment
- The new way emphasizes the purchase of a product (packaged CHP)
- New way yields simplification via Personalization as opposed Customization

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Independent Endorsements

Based on in-depth analytical reviews

Car:

- Consumer Reports Magazine
- Road & Track Magazine
- Car & Driver Magazine

CHP:

- NYSERDA's CHP Catalog
  Version 3 has 16 Vendors with 138 products

  Eager for evolution to UDSOE eCatalog

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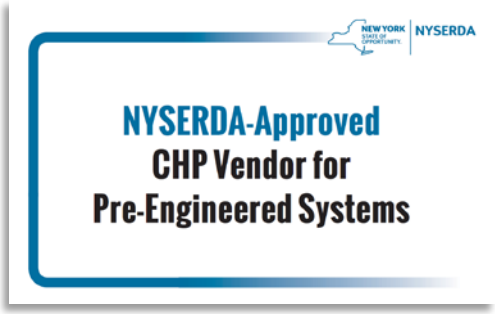
NYSERDA's CHP Catalog Program



Program Mechanism:

- Created a catalog of pre-qualified systems
  - reputable vendors, reputable components
  - harmony "within the box" (components properly size-matched)
  - bumper-to-bumper coverage (product, installation, service)
  - turn-key solutions with adequate local sales & support
- Assigned a specific incentive to each system
- Invited customers to comparison-shop from catalog

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Program Format facilitates Coaching, which enhances Consumer Protection

Learner

- What is CHP?
- Why is CHP good?
- Who among my peers have CHP?
- Could my building be a candidate for CHP?
- How can CHP complement and supplement energy efficiency and renewable energy?

Shopper

- How do I choose the right size CHP system?
- How do I choose the right CHP technology?
- How do I identify competent CHP solution providers?
- How do I conduct a site tour of my building for prospective CHP solution bidders?

Buyer

- How do I down-select among bids received?
- Should I buy, lease, PPA?
- What are O&M considerations?
- Are there incentives and/or special financing?
- How do I negotiate a fair and equitable contract?

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Comparison Shopping made Customer-friendly

Market mechanisms that simplify this

Car:

- Automotive superstores that have multiple brands at a single dealer showroom

CHP:

- NYSERDA's CHP Expos

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Example of a CHP Catalog Cut Sheet

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GEM | Energy

GEM Energy **IPS-130-CCHP** **130 kW**

Description

Type of prime mover	Number of prime mover units	Synchronous or Inverter	Type	Eligible for N+1 installation	Qualification Status
Microturbine	2	Inverter	CCHP	Yes	Conditionally qualified

NYSERDA Incentives

Downstate	Upstate
$262,050	$217,050

Performance at Full Load - Heating

Ambient DB °F	Fuel MBtu/hr (HHV)	PM Net kW	Hot Water to Building @ 120°F		Hot Water to Building @ 180°F		NOx lbs/MWhr
			MBtu/hr	Return °F	MBtu/hr	Return °F	
0°F	1,604	122	658	103.5	572	165.5	0.46
50°F	1,683	122	834	99	724	161.5	0.46
95°F	1,553	103	850	98.5	738	161	0.46

Performance at Full Load - Cooling

Ambient DB/WB	Fuel in MBtu/hr (HHV)	Net Prime Mover kW	Chiller Parasitics kW	PM Hot Water to Chiller			Chiller Capacity* tons	Cooling Water		
				MBtu/hr	Supply °F	Return °F		gpm	Supply °F	Return °F
95/78°F	1,553	103	0.67	716	191	173	40	405	83	89.2

*Using heat from the prime mover.

Footprint

	Width ft	Length ft	Height ft	Weight lbs
Core system based on minimum area*	12.9	25.5	8.3	12,000
Core system based on minimum width*	10.5	38.9	8.3	
PM Heat Rejection subsystem*	N/A	N/A	N/A	N/A
Chiller Cooling Tower*	8.0 diam.	8.0 diam.	12.7	1,510
Largest part for delivery	7.0 diam.	7.0 diam.	12.2	1,510
Heaviest part for delivery	5.86	6.43	6.84	4,740

*Includes maintenance clearances.

Vendor Statement

GEM Energy provides comprehensive energy technology integration services with a focus on advanced power generation, heating and cooling systems for commercial, industrial, institutional, and mission critical facilities. Our systems utilize Capstone MicroTurbines as the prime mover to offer high reliability, ultra-low emissions, and a low total cost of ownership. These systems can be packaged in a space conscious pre-engineered container or building integrated format.

Capstone Turbine Corporation

Vendor Information

GEM Energy
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Saratoga Springs, NY 12866
(866) 720-2700
LRay@gemenergy.com
www.gemenergy.com

NYSERDA CHP Acceleration Program PON 2568
Version 3 Revised September 2014
For the most recent version go to
http://www.nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/PON-2568-CHP-Acceleration-Program.aspx

91

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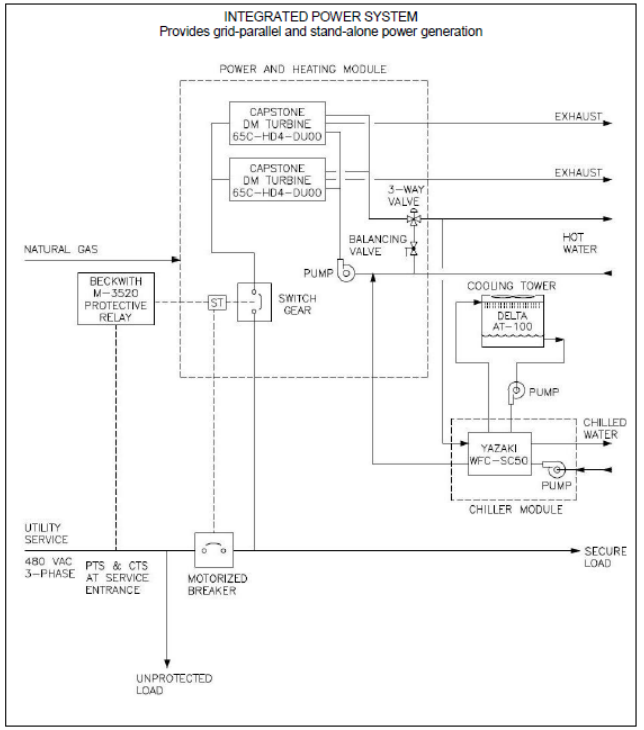
GEM | Energy

GEM Energy **IPS-130-CCHP** **130 kW**

INTEGRATED POWER SYSTEM
Provides grid-parallel and stand-alone power generation



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92

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Program Accomplishments

We've proven that this program format:

- Gets good projects
  - 76 projects in initial 3-years of applications, of which half have equipment delivered to the site or further progress, only 2 attrition
  - Robust market traction -- 10 of the 16 Vendors have projects
- Accelerates timelines
  - Application-to-Operation down from 25 to 17 months (30% time compression)
  - Harder to track Inquiry-to-Action timeline, anecdotally have observed acceleration
- Drives-down soft costs, such as customer acquisition
  - Overall project costs down 25%

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Program Accomplishments

Transformed the way deals occur in marketplace:

- Expanded the tendency toward healthy comparison shopping
- Market embraces a new objective of partnerships, instead of just sales
- CHP Vendor (packager/system integrator) at center-of-the-universe
- Consultants act as “personal shoppers” for building owner clients

We have achieved many of the aspirations enumerated at program launch as discussed at webinar on 10/31/2013 https://www.epa.gov/chp/webinars-and-presentations

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Aspiration for a well-functioning Marketplace

A future where many CHP vendors each sell a standard product so frequently that they are willing to build it on speculation and have it shrink-wrapped and sitting in their warehouse -- this approaches the market mechanisms where a shopper can pick a car at the auto showroom and drive it home that same day

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Thank You!

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NYSERDA, a public benefit corporation, offers objective information and analysis, innovative programs, technical expertise, and funding to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce their reliance on fossil fuels.

NYSERDA professionals work to protect our environment and create clean-energy jobs.

NYSERDA has been developing partnerships to advance innovative energy solutions in New York since 1975.

Next Steps:

- Entire marketplace will benefit upon evolution to USDOE administering an “eCatalog” (will enable Vendors to claim multi-locality approval)
- Will facilitate ability of Program Administrators in numerous localities to encourage customers to prefer vetted CHP products

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Lee Vardakas
Aegis Energy Services

U.S. DEPARTMENT OF
ENERGY

CHP Catalog Program:
A Vendor's Perspective

Lee Vardakas, President

May 11, 2016

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ENERGY SERVICES, INC.
COMBINED HEAT & POWER

Who we are at Aegis Energy Services, Inc.

- Large developer of small modular CHP in the Northeast and Mid-Atlantic
- In business for 30+ years
- Installer of 500+ CHP systems
- Privately held company headquartered in MA
- Total Vertical Integration
- Owners/operators of 3rd party CHP systems

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Aegen Thermopower 75 LE Modules

Three models available with Induction or Synchronous and Inverter based Generators

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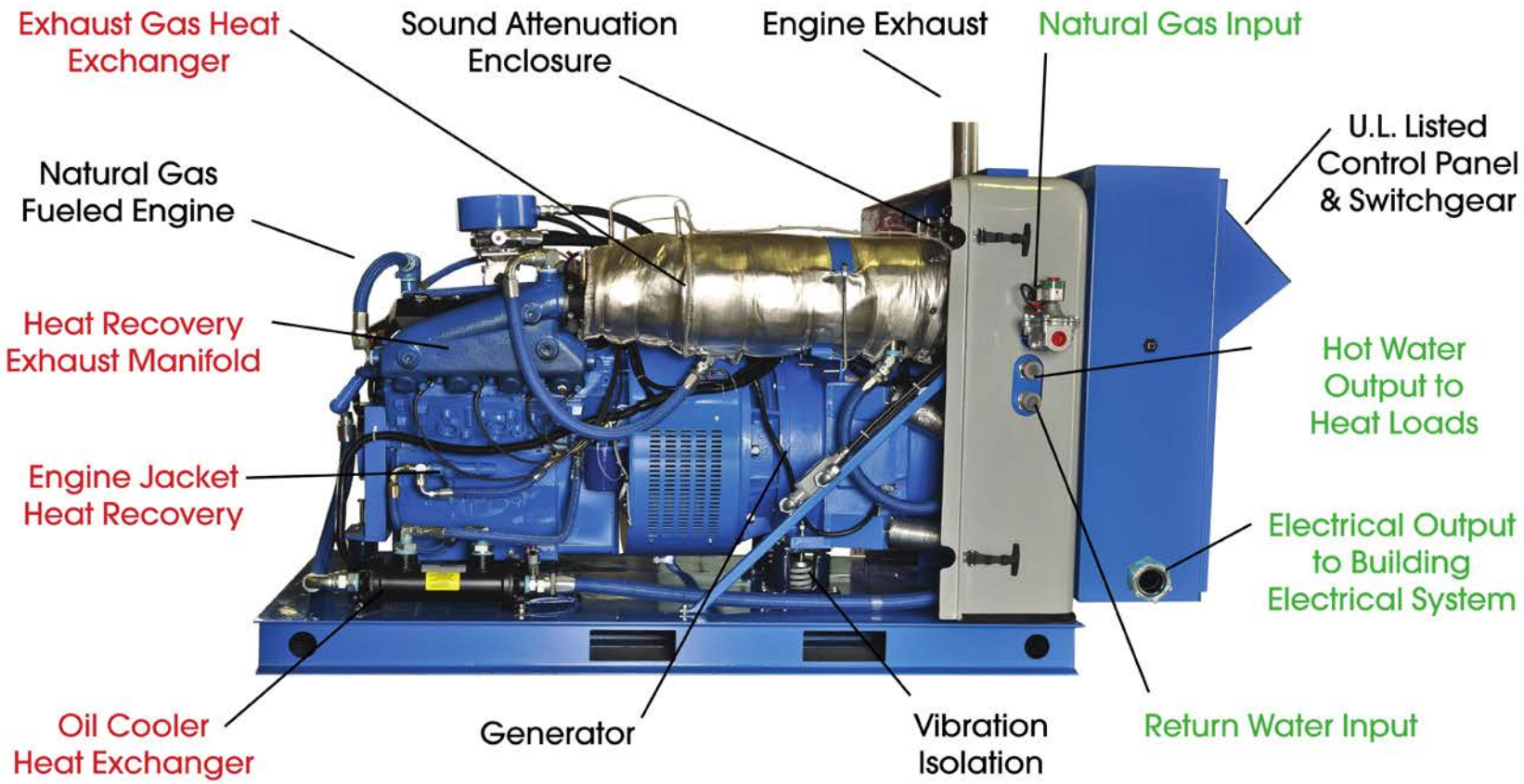
Product Architecture



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Modular and Scalable

Single

Multiple

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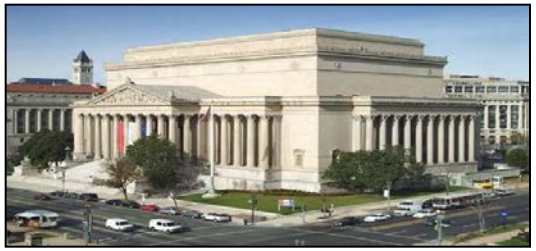
Markets Served

Hotels

Healthcare

Museums



Recreational

Multi-Family

Education

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Modular packaged CHP is a good fit for "Better Buildings"

- System size and multiples
- Easily adaptable to third party ownership models
- Normal gas pressure
- Pre-assemblies/balance of plant
- Simplified permitting
- Off site monitoring and maintenance packages
- Some net-metering allowed/REC credits/DR
- Resiliency /may be able to replace diesel genset
- Can contribute to overall LEED points

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Financing Options

- Revenues=Savings +REC credits + DR
- ROI 3-5 years
- Grants and Incentives
- Tax Credits/ Depreciation
- Third Party Ownership Models

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Aegis' Experience with NYSERDA Catalog Program

- Involved at start of program
- One of the first vendors in the catalog
- Secured 30+ grants via the program
- Attended all open-houses for end users
- Able to influence program design

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COMBINED HEAT & POWER

July 2013

Hurdles For CHP

For End Users

- Financing/Capital Requirements (esp black
- Uncertain outcomes start)
- Lack of education about CHP technology
- Reliable Vendor Selection
- Maintenance

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July 2013

Hurdles for CHP
For Developers

- Financing/Capital
- Lack of education of CHP technology
- Reaching/locating “good fit” end users
- Regulatory
  - Emissions/Air permits
  - Utility interconnection
  - Natural gas availability
  - Building permits

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NYSERDA Catalog Addressed Many Hurdles

- Funding via grants
- Program format empowers CHP vendor's expertise to drive project success
- Catalog has driven customers to us
- More knowledgeable customers
- NYSERDA approval further enhances our credentials
- Overall helpful on sales/marketing/reducing perceived risk to customer
- Less helpful on utility and install costs

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How DOE can further build on NYSERDA catalog program.

- Organize by state to capture local requirements
- Expand first to states with higher electric rates.
- Organize vendors by function, such as manufacturer, e.g.
- Broaden product offerings to include induction systems
- Reference various funding source websites such as EPA CHPP,e.g.
- Boost image of CHP as, established and proven “clean technology”
- Connect the catalog with other federal agencies,e.g. federal buildings, EPA, FEMP,etc
- Provide information on utility interconnections and obtain advance “buy-in” from them

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Thank you!

Contact me at (413)536-1156

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Visit us at aegisenergyservices.com

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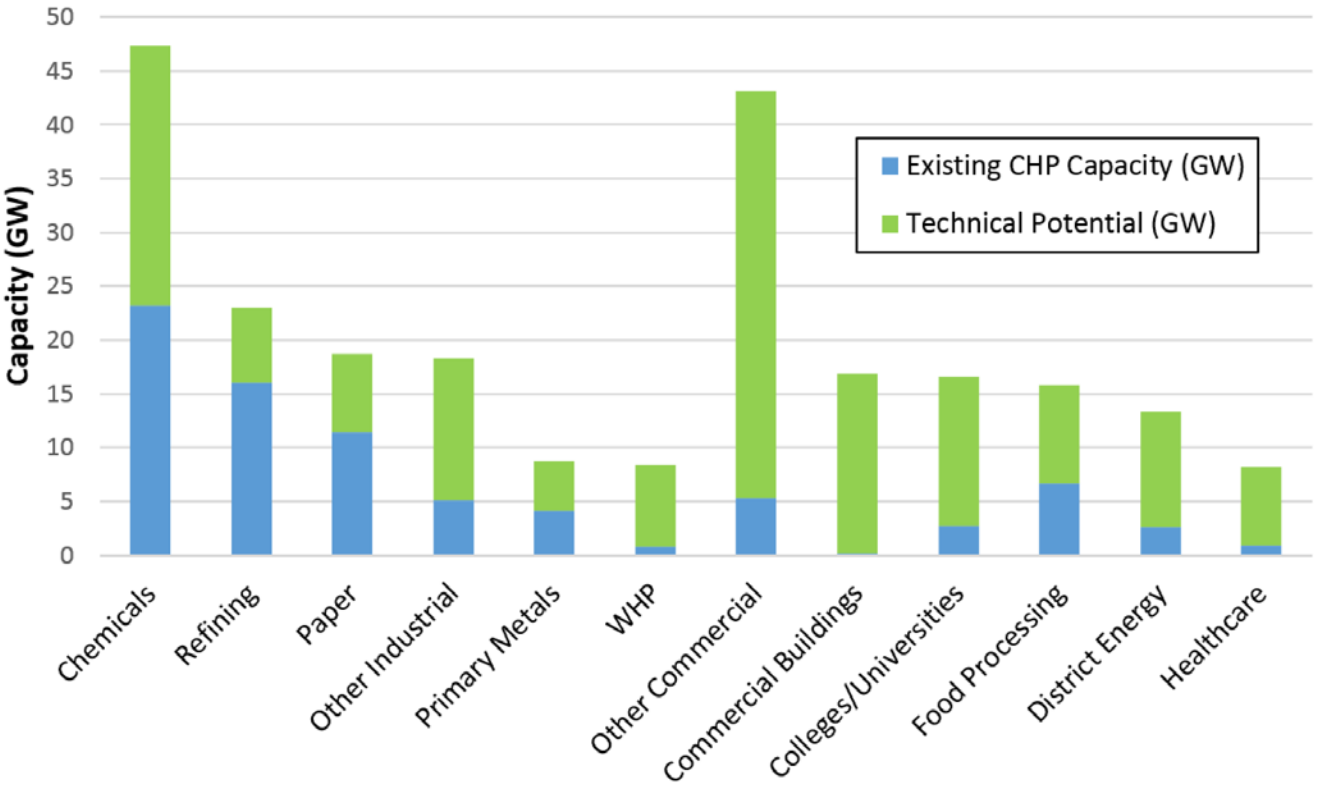
Richard Sweetser
Exergy Partners Corp.

U.S. DEPARTMENT OF ENERGY

Opportunities for CHP in the United States

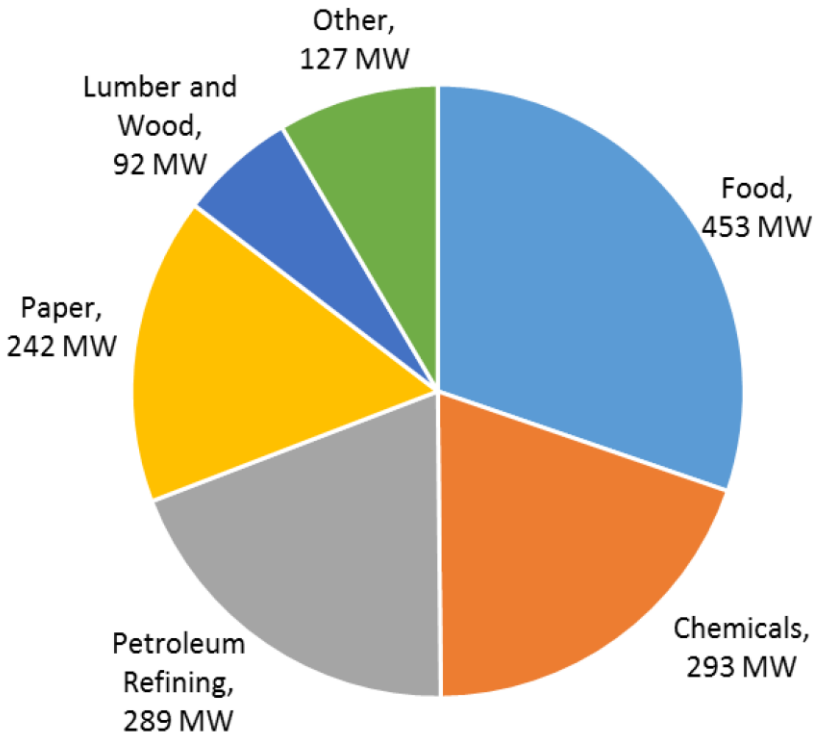
More than 240GW of CHP technical potential at over 291,000 sites in the U.S.



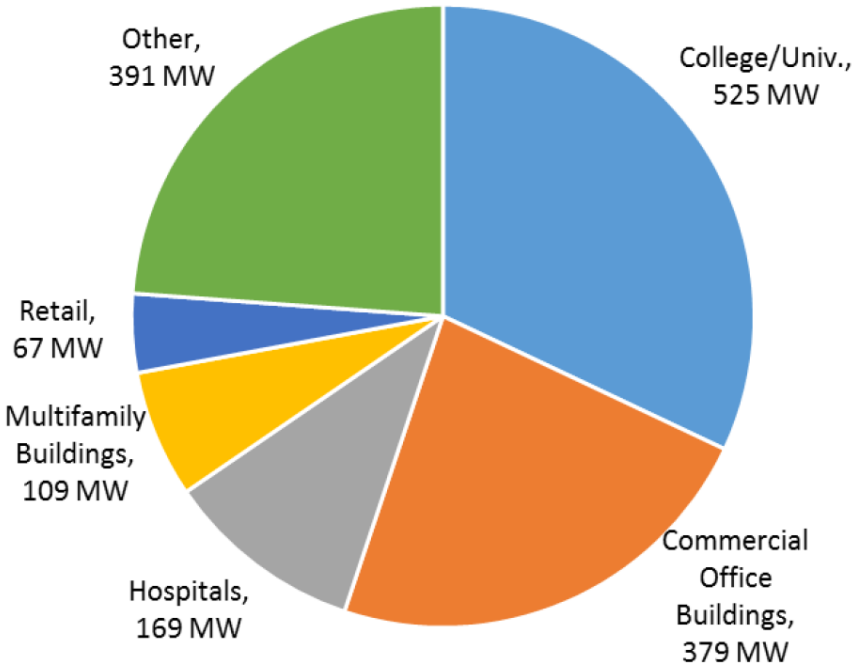
Source: USDOE, "Combined Heat and Power (CHP) Technical Potential in the United States," March 2016

CHP has a broad application base

Top Industrial CHP Sites

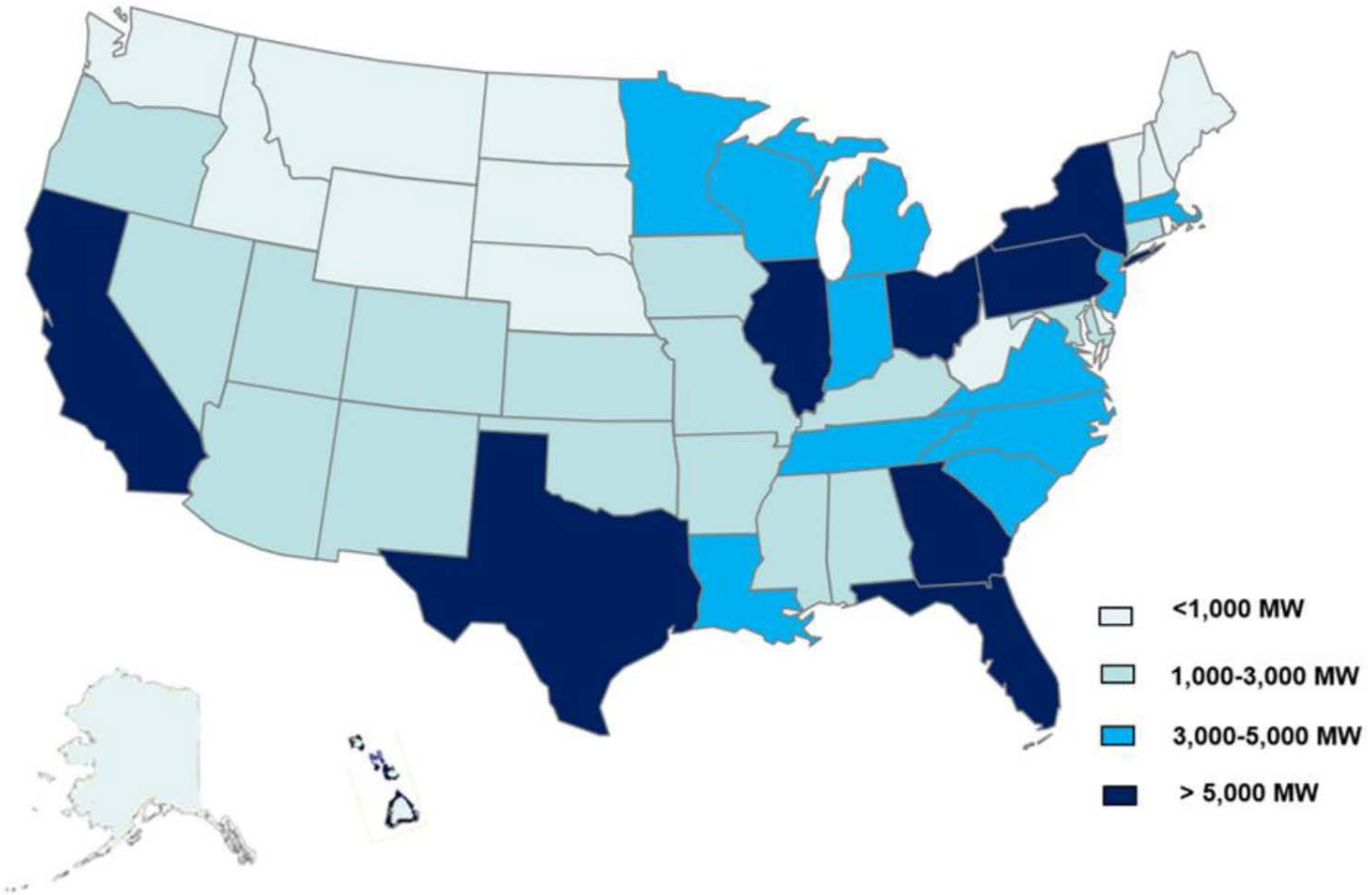


Top Commercial CHP Sites



Source: USDOE, "Combined Heat and Power (CHP) Technical Potential in the United States," March 2016

Technical potential spans the country



Source: USDOE, "Combined Heat and Power (CHP) Technical Potential in the United States," March 2016

Increasing focus on CHP

Resiliency

In the wake of Super Storm Sandy, the utility grid was down for extended periods. Twenty-seven (27) CHP plants continued to produce over 268 MW of electricity for hospitals, university campuses, government facilities, wastewater treatment plants, data centers, and local energy districts during Super Storm Sandy.

Better Buildings
U.S. DEPARTMENT OF ENERGY

Combined Heat and Power for Resiliency Accelerator

Source: US Department of Energy CHP Deployment Program, 2016

Industrial Competitiveness

- Industry consumes 30% of all energy
- Energy costs affects competitiveness.
- Expanded use of combined heat and power (CHP) will improve industrial competitiveness

Source: White House Executive Order 2012

Natural Gas Supply and Price

Source: Energy Information Administration - EIA

Increasing focus on CHP

Sustainability

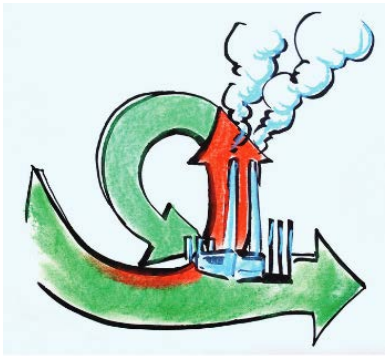
110 MWs of CHP allows P&G's largest plant in Mehoopany, PA to self-generate 100% of the site's electrical needs in addition to a significant amount of steam and hot air that is used to dry their Bounty and Charmin products.

This project helped P&G economically reduce CO_2 emissions by over 120,000 metric tons per year.

Jobs

Further, improving the efficiency of power generation could result in more than $200 billion in private investment over 10 years according to a study by the Industrial Energy Consumers of America, which represents many of the country's largest manufacturers.

With the help of CHP and WHP, manufacturers can generate at least a portion of their own power on site at reduced long-term cost and with greater efficiency and reliability.



Source: Proctor & Gamble 2014 Sustainability Report

Source: Pew Charitable Trusts Fact Sheet, June 2014

Packaged CHP Challenge

Reduce perceived risks to customers (end-users) and vendors, promoting active market engagement in regional/national markets

Current State

Market Delivers 5 – 9 year payback due to under-developed design, sales and installation infrastructure

Customer Demands 3 – 4 year payback due to perceived risks

Future State

Customer Accepts 4 – 5 year payback

Market Delivers 4 – 5 year payback

eCatalog and Market Engagement Program reduces risk to customer, and reduces sales, marketing, system and installation costs for vendor (system developer)

Objective is to align CHP value streams to support a self-sustaining and robust market

Packaged CHP Challenge – Focused on Reducing Risks for End-Users and Vendors

- Designed to increase deployment of CHP in key markets that are underdeveloped due to a variety of barriers that increase the perceived risks to both end-users and CHP system vendors.
- Combination of web-based eCatalog of pre-approved packaged systems and robust market engagement programs is targeted to reduce total project costs and installation times for CHP systems in these markets by 20%.
- CHP package qualifications and warranties included to reduce perceived risks of on-site generation particularly in commercial and manufacturing facilities.

Opportunities for Packaged CHP Systems

- Packaged systems and supporting market engagement can lead to reduced time to install and lower costs with pre-engineering, bulk purchasing, inspection and permitting streamlining
- Owners, in these markets, typically do not have energy engineers, staff to champion
- Many of the facilities within these markets/submarkets are very similar in size, operations, configurations, and energy usage
- Standardization allows for comparison shopping across products leading to more competition

Technical Potential Served by CHP Challenge – 70% of Total

Application	50- <500 kW (MW)	500 kW- <1 MW (MW)	1- <5 MW (MW)	5-<10 MW (MW)	10 - <20 MW (MW)	≥20 MW (MW)	Total MW
Industrial	6,281	4,341	15,567	9,064	7,971	22,157	65,381
Commercial	20,068	18,100	20,284	5,504	3,948	8,026	75,930
Total	**26,349**	**22,441**	**35,851**	**14,568**	**11,919**	**30,183**	**141,311**

Source: US DOE *CHP Technical Potential* in the US, March 2016

99,200 MW of technical potential <10 MW

CHP Challenge Approach

- Build upon the successful CHP program developed by NYSERDA
- Create a regional/national eCatalog of "pre-qualified" packaged CHP systems and vendors
  - Approved vendors, robust and reliable components, demonstrated performance
  - Harmony "within the box" (components properly size-matched)
  - Bumper-to-bumper warranty coverage (product, installation, service)
  - "Turn-key solutions" with adequate local sales & service support
- Couple with robust market engagement programs by Market Mover Partners (states, cuties, utilities*)
  - Education and outreach support is critical to success (demystify CHP)
  - Match customers and vendors (comparison shop)
  - Provide guidance through evaluation and buying process (through DOE CHP TAPs)
  - Provide technical assistance (DOE CHP TAP)

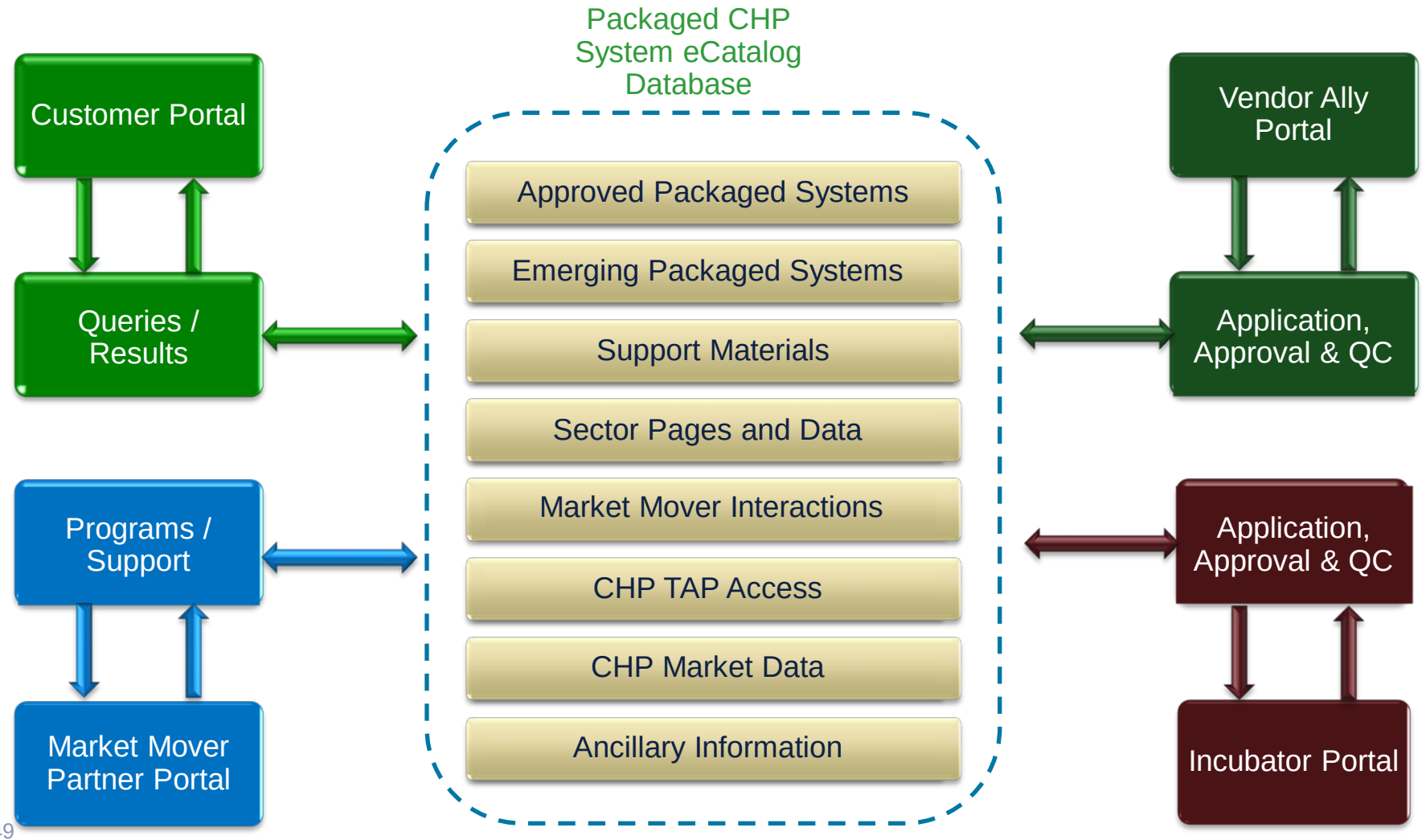
* State and local governments could be joined by utilities in supporting the Packaged CHP Challenge

Designed to Facilitate Market Realignment

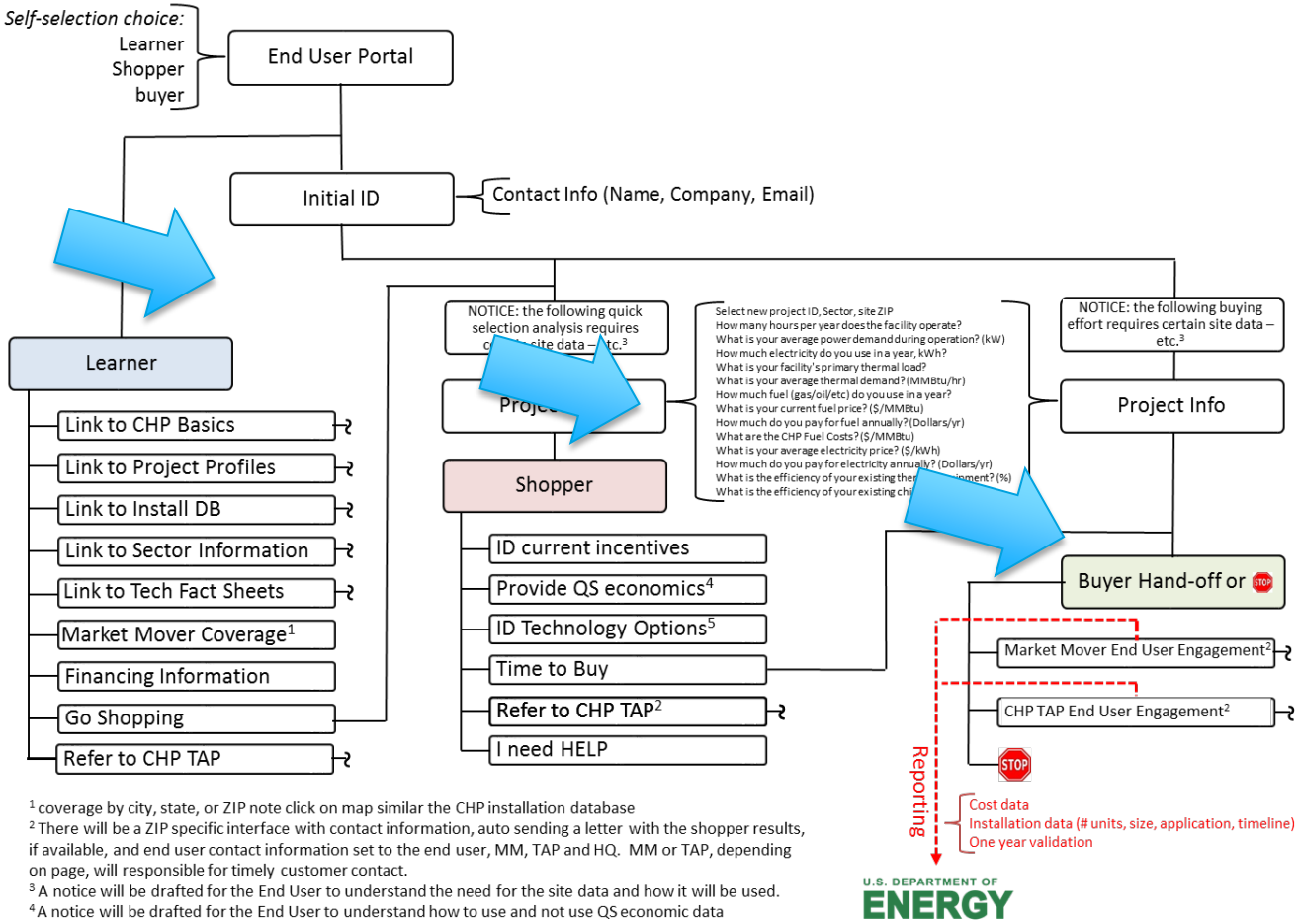
A program structured around a “list of pre-approved products furnished by pre-qualified vendors” enables a new market alignment:

- **Replicable product designs** will reduce design errors and the associated performance losses and/or re-work expenses and will reduce uncertainty among jurisdictional authorities and reduce time and costs for permitting.
- **Risk reduction** through standardization and prequalification which in turn reduces perceived risk by users leading to shorter decision times.
- **Competition** will increase product offerings, improve quality, and control costs
- **Customer identification and acquisition** will reduce marketing costs for CHP vendors.

Proposed DOE CHP eCatalog Structure



eCataog Logic



[1] coverage by city, state, or ZIP note click on map similar the CHP installation database
[2] There will be a ZIP specific interface with contact information, auto sending a letter with the shopper results, if available, and end user contact information set to the end user, MM, TAP and HQ. MM or TAP, depending on page, will responsible for timely customer contact.
[3] A notice will be drafted for the End User to understand the need for the site data and how it will be used.
[4] A notice will be drafted for the End User to understand how to use and not use QS economic data
[5] Allow access to all CHP systems in the DB by search criteria with results listing each CHP System identifier which is hyperlinked to the system PDF data sheet.

→ means link to outside page

Market Engagement Program

- The eCatalog alone is not enough – success requires a market engagement program designed around the eCatalog. This will require commitment by participating states/entities* to:
  - Strategically design links to incorporate the eCatalog program
  - Actively engage with vendors, end-users and other stakeholders to promote the program
  - Create a “friendly” environment for CHP with streamlines processes
  - Improve end-user confidence with performance verification

* State and local governments could be joined by utilities in supporting the Packaged CHP Challenge

DOE Role

- Lead the development of a regional/national CHP Challenge:
  - eCatalog (develop and support “back office” services)
    - Develop eCatalog structure and operation plan
    - Develop (with NYSERDA) criteria for CHP system, vendor, and service requirements for listing in the eCatalog
    - Establish application review and listing QC procedures
    - Provide resources for web portal design, hosting, and operation
      - Establish web portal and required database(s)
      - Secure a host site for website
      - Provide resources for ongoing operation and maintenance
  - Market Engagement (tools and assistance for Market Mover Partners)
    - Develop guidelines for state/entity support programs
    - Develop tools and support resources for states/entities and CHP TAPs
    - Provide assistance for CHP market analysis and program decision strategies to promote CHP installations
    - DOE, in partnership with states/entities, to provide resources for review and approval of eCatalog applications, and ongoing QC of listings

Vendor Ally Role

- Develop Packaged CHP systems based on robust, reliable and tested components that are harmonized “within the box” (components properly sized and matched)
- Pre-install appropriate performance measurement sensors to facilitate performance verification
- Provide a single point of responsibility for product, installation and service
- Secure robust installation and service capabilities where Packaged CHP systems are offered
- Cover each CHP Package with a 5-year bumper-to-bumper warranty
- Integrate marketing and sales efforts with MMP market engagement programs

Market Mover Partner Role

- Provide education/outreach support
- Provide technical assistance to help end-users utilize the eCatalog
- Actively match potential users and qualified vendors
- Link any CHP incentive programs in this size range to the eCatalog (it is not a requirement to have an incentive program per se)
- Partner with the DOE CHP TAPs
- Partner with DOE to provide resources for review and approval of eCatalog applications, and ongoing QC of listings
- Provide feedback loop on vendor design, installation and service performance

Pilot Program Plan

Start incrementally – ideally a group of interested states/entities in a region close to NYSERDA

- Multiple states/entities increases available resources and incentivizes vendors with larger target market
- Proximity to New York will ensure participation by regional developers with experience with NYSERDA program and developed sales/service infrastructure
- Proximity of states/entities to each other will put less strain on CHP vendor (manufacturers and developers) resources, particularly with respect to service and maintenance

Packaged CHP Challenge - Timing

- Program Rollout Announcement – May 2016 – Better Buildings Summit
- Year One – design and development of the eCatalog, initiate pilot program - recruitment of vendors to populate the eCatalog with DOE-approved packaged CHP solutions, recruitment of Market Mover Partners to develop CHP programs to engage end-users
- Year Two – Beta test eCatalog system with Market Mover Partner programs and the Resiliency Accelerator partners, recruit additional MMPs and vendors to continue expansion of packaged CHP system usage across the country

Additional Information

Visit:
energy.gov/chp
or
send us an email at:
CHP@ee.doe.gov

Discussion