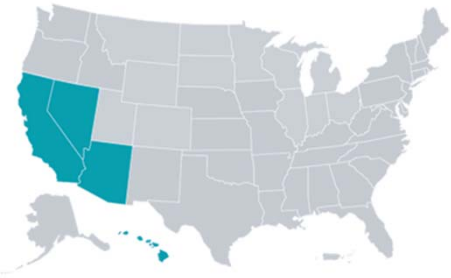
WESTERN

CHP
TECHNICAL ASSISTANCE
PARTNERSHIPS



Woody Biomass for Combined Heat & Power

Statewide Wood Energy Team (SWET)
CA Forest Biomass Working Group
January 15, 2020

Keith Davidson
DOE Western CHP TAP

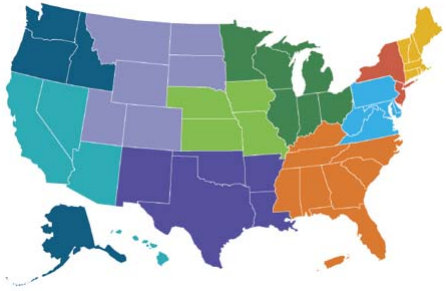
CHP Technical Assistance Partnerships

Presentation Overview

- DOE CHP TAP Deployment Program
- Overview of Combined Heat & Power (CHP)
- Woody Biomass Market
- Working with the Western CHP TAP
- Next Steps and Questions

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.



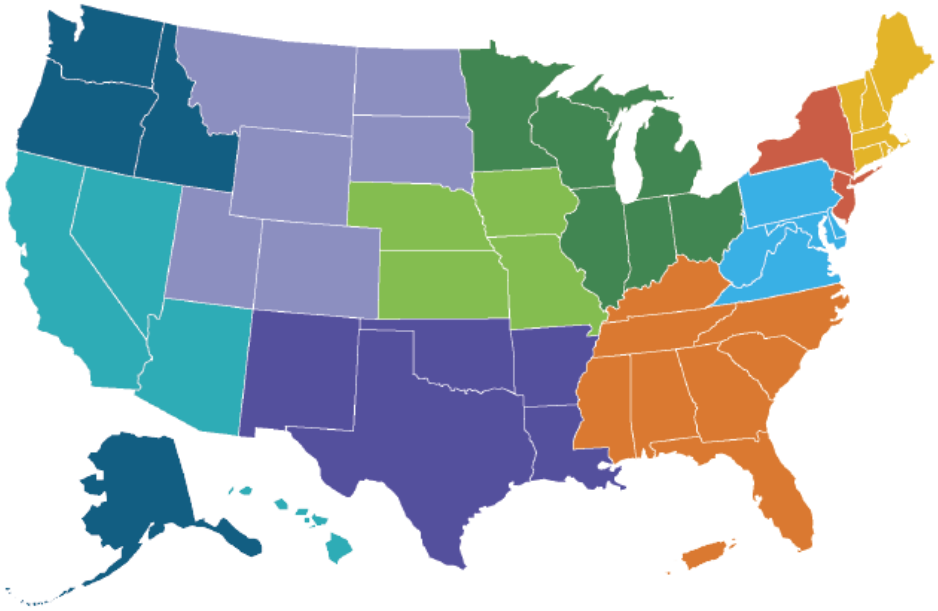
- Technical Assistance through DOE's CHP Technical Assistance Partnerships (CHP TAPs) – Promote and assist in transforming the market for CHP, waste heat to power, and district energy with CHP throughout the United States

www.energy.gov/chp

- 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

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

CHP Technical Assistance Partnerships (CHP TAPs)



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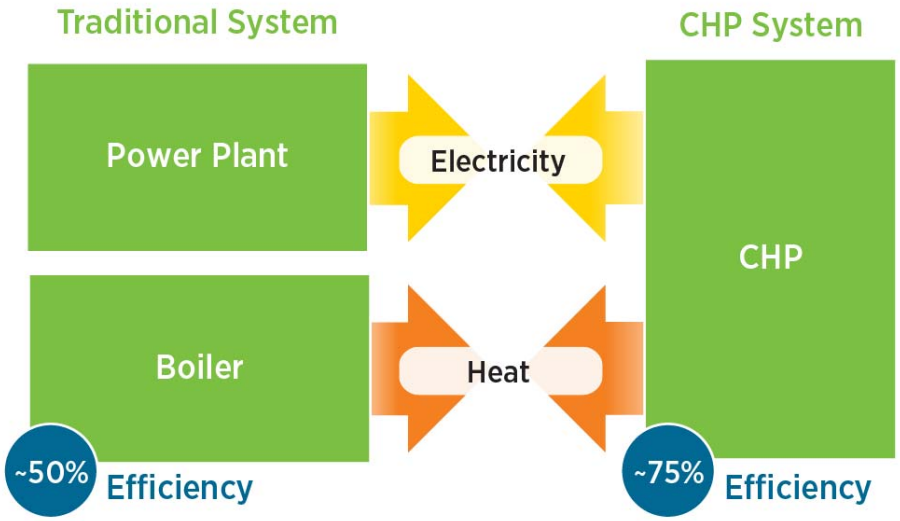
CHP: A Key Part of Our Energy Future

- Form of Distributed Generation (DG)
- An integrated system
- Located at or near a building / facility
- Provides at least a portion of the electrical load and
- Uses thermal energy for:
  - Space Heating / Cooling
  - Process Heating / Cooling
  - Dehumidification



CHP provides efficient, clean, reliable, affordable energy – today and for the future.

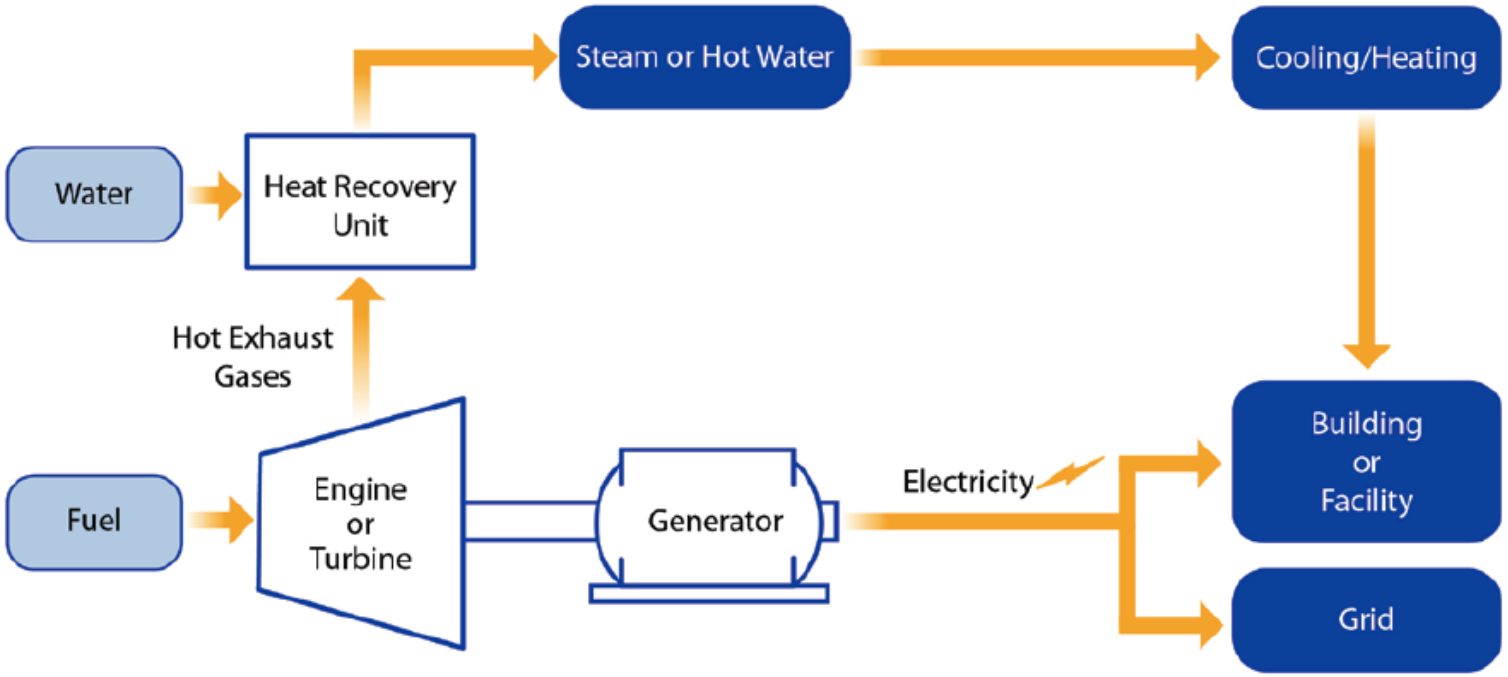
Source: www.energy.gov/chp

Defining Combined Heat & Power (CHP)

Conventional CHP

(also referred to as Topping Cycle CHP or Direct Fired CHP)

The on-site simultaneous generation of two forms of energy (heat and electricity) from a single fuel/energy source



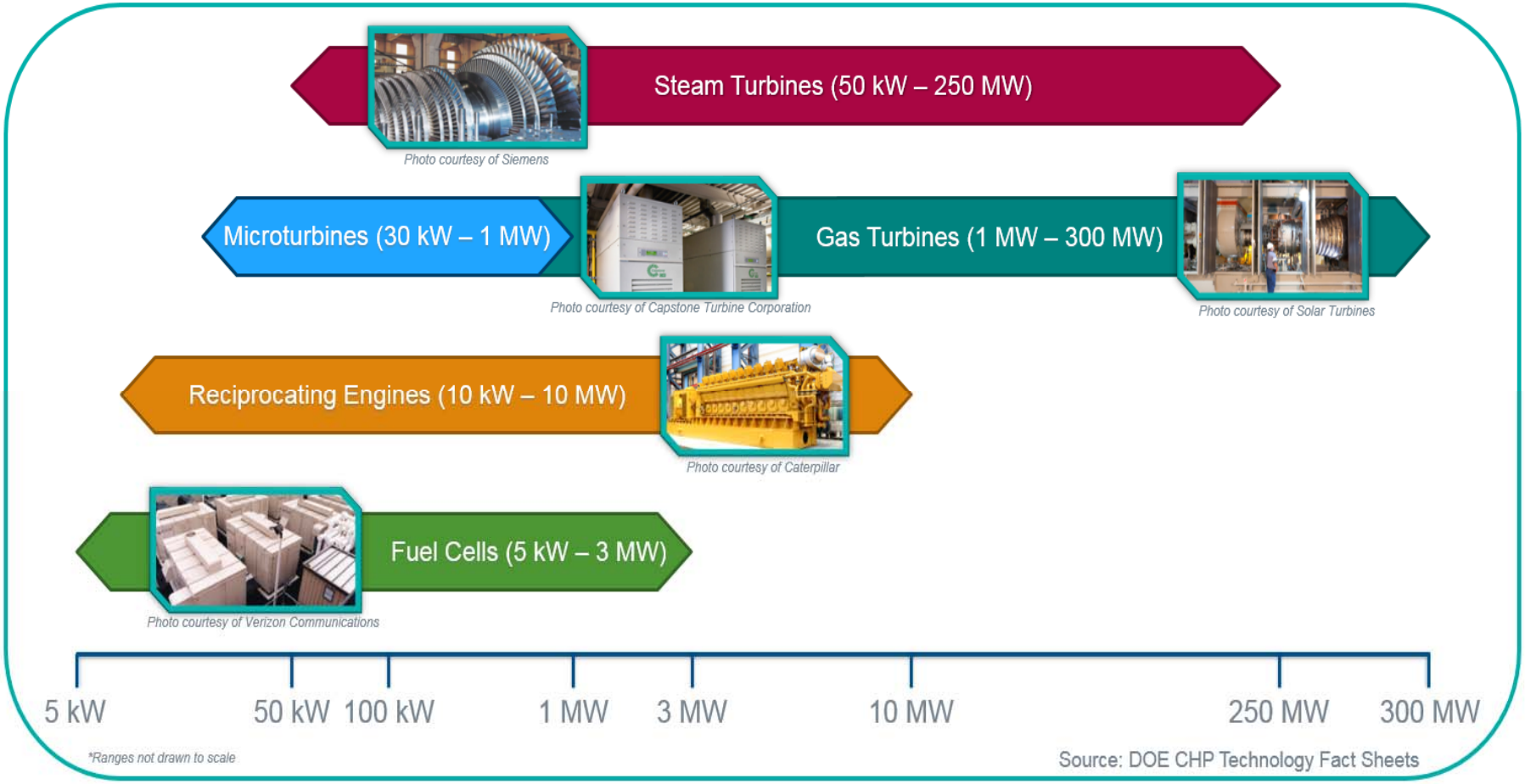
Separate Energy Delivery:

- Electric generation – 33%
- Thermal generation - 80%
- Combined efficiency – 45% to 55%

CHP Energy Efficiency (combined heat and power)
70% to 85%

CHP Technical Assistance Partnerships

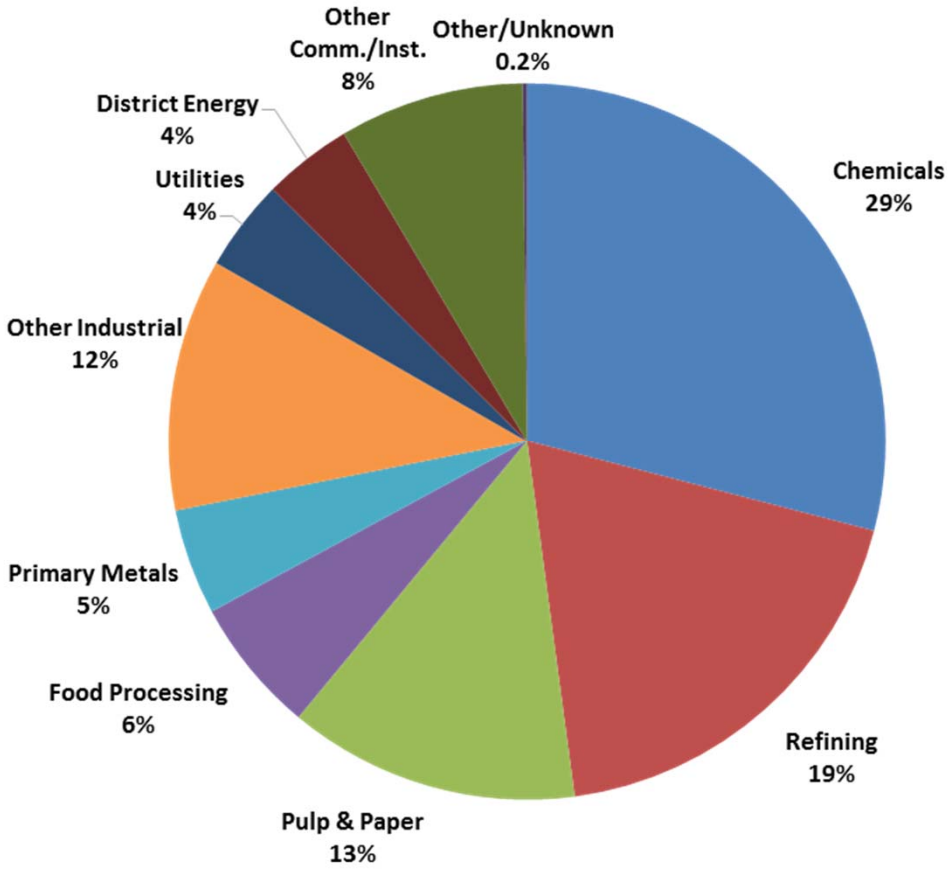
Which CHP Technology Fits My Energy Loads?



What Are the Benefits of CHP?

- CHP is **more efficient** than separate generation of electricity and heating/cooling
- Higher efficiency translates to **lower operating costs** (but requires capital investment)
- Higher efficiency **reduces emissions** of all pollutants
- CHP can also increase **energy reliability, resiliency** and enhance power quality

CHP Today in the United States



- 81.1 GW of installed CHP at more than 4,500 industrial and commercial facilities
- 8% of U.S. Electric Generating Capacity; 14% of Manufacturing
- Avoids more than 1.8 quadrillion Btus of fuel consumption annually
- Avoids 241 million metric tons of CO_2 compared to separate production

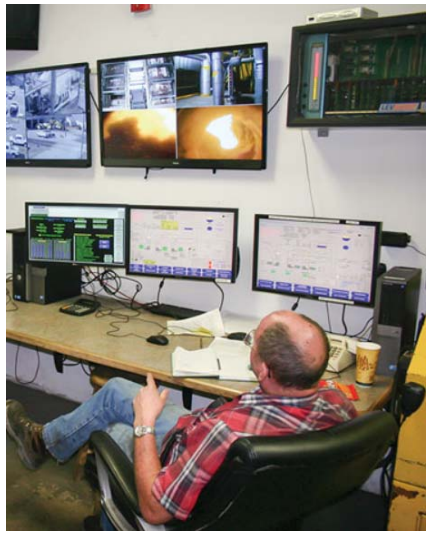
Source: DOE CHP Installation Database (U.S. installations as of December 31, 2018)

Opportunities for Woody Biomass CHP

- Pulp and Paper Mills
- Lumber Mills
- Furniture Factories
- Lumber Treatment
- Woody Biomass Drying

Woody Biomass CHP Example- Roseburg Biomass CHP

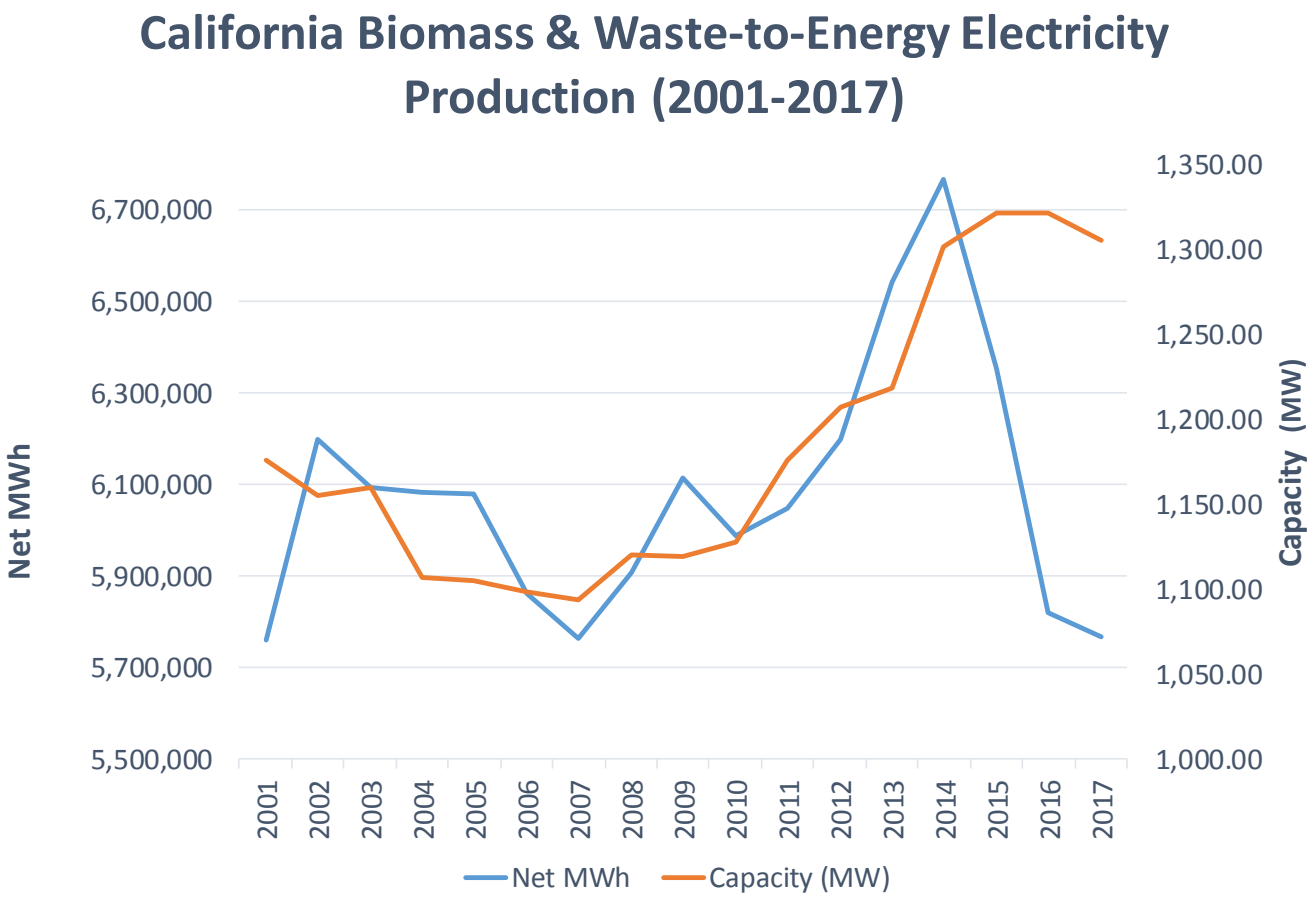
- Roseburg Forest Products include engineered wood, lumber, softwood plywood, composite and hardwood panels, decorative laminate and wood pellet fuel
- Boiler/steam turbine CHP plant at Weed, CA facility was upgraded in 2014 with a superheater and emission controls producing 12 MW
- Excess power is sold back to the grid
- Steam is used in processing the plant's veneer



Western CHP Woody Biomass Technical Assistance Recipients

Recipient	Site	Type of Service
Sierra Forest Products	Terra Bella Lumber Yard	Qualification Screening
Camptonville Community Partnership	Celestial Valley Site	Qualification Screening; Feasibility Study
HomeFriends Properties, Inc.	Mad River Sawmill	Qualification Screening; Adv Technical Assistance
Atlas Carpet Mills	Los Angeles furniture factory	Qualification Screening; Adv Technical Assistance
Yosemite Clean Energy	Sierra Nevada mountains bioenergy center	Feasibility Study

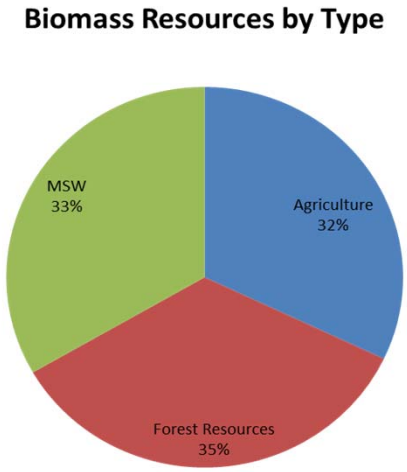
Biomass Trends in California

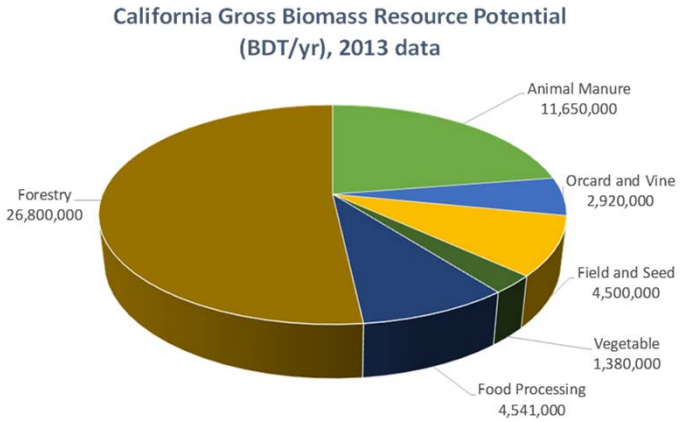


Source: https://www.energy.ca.gov/almanac/renewables_data/biomass/

California's Biomass Resources

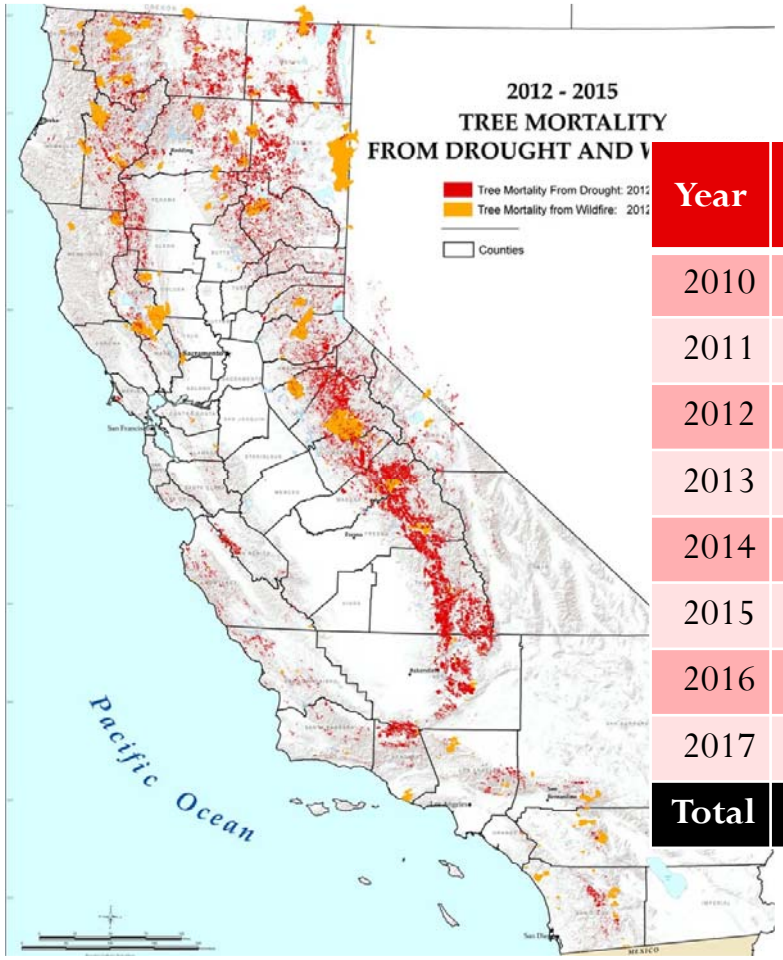
- Gross resource – 78 million bone dry tons per year (BDT/y)
- Biomass considered to be available on a technically sustainable basis – 35 million BDT/y
- Gross electrical generation potential = *9,900 MWe*
  - Agriculture – 2,300 MWe
  - Forestry – 3,500 MWe
  - MSW – 3,900 MWe
- Biogas potential from animal manures, landfill gas, anaerobic digestion of food, leaves and grass from MSW disposal stream, and wastewater treatment plants = *93 billion cubic ft/year*
- Report from CEC-funded Resource Assessment with California Biomass Collaborative, UC Davis. Published March 2015





Source: https://biomass.ucdavis.edu/wp-content/uploads/CA_Biomass_Resource_2013Data_CBC_Task3_DRAFT.pdf

California's Biomass Resources: Tree Mortality



Year	Tree Mortality
2010	3.1 million
2011	1.6 million
2012	1.8 million
2013	1.3 million
2014	3.2 million
2015	29 million
2016	62 million
2017	27 million
Total	**129 million**

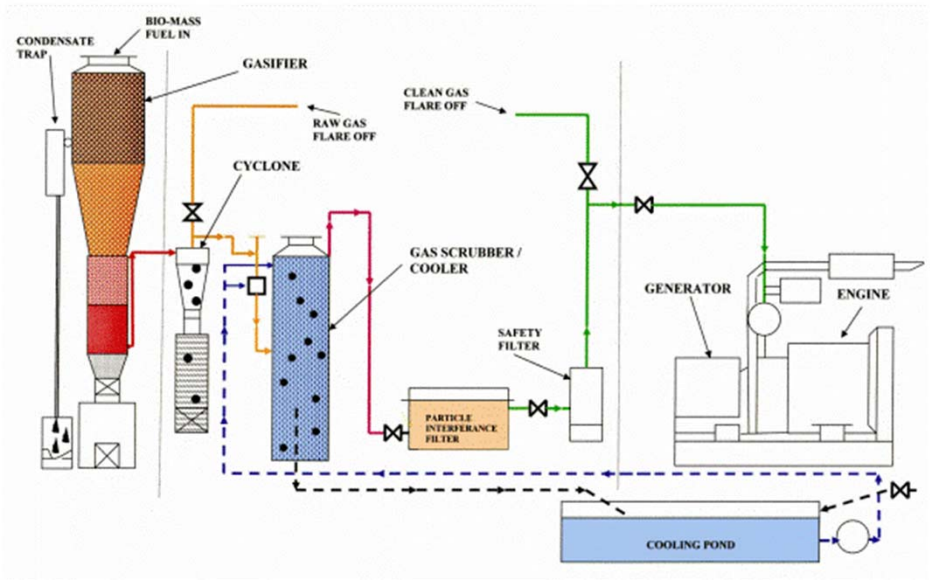
Emergency Proclamation due to Tree Mortality

On October 30th 2015, Governor Jerry Brown issued an Emergency Declaration, and called for action to safely remove dying trees, particularly in the high risk zones of communities near forested areas.

Source: California's Tree Mortality Task Force (https://www.fire.ca.gov/treetaskforce//)

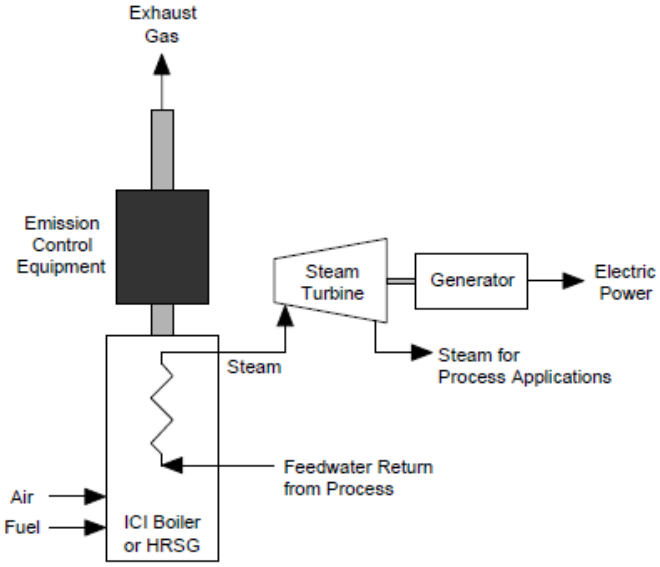
Woody Biomass Technologies

Gasifier and Engine or Turbine



Schematic diagram of the Johansson Biomass Gasifier

Boiler and Steam Turbine



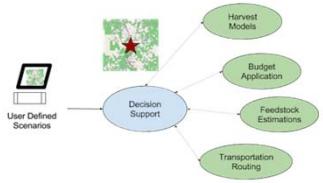
Typical Boiler / Steam Turbine Configuration

California Bioenergy Demonstration and Deployment

- Applied R&D for thermochemical conversion and innovative approaches

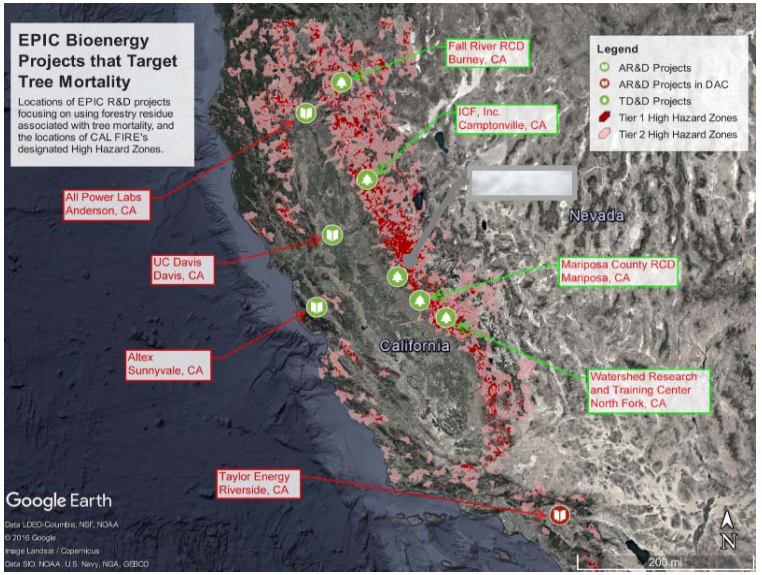
Decision Support for Siting Bioenergy

- Robust web-based facility siting application
- Quick economic feasibility and environmental performance of potential bioenergy facility



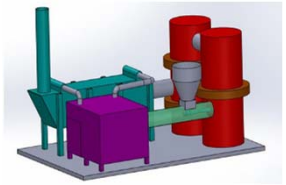
Powertainer + Gasification Platform

- Multi-modal power and products to process forestry waste
- Scale-up of Powertainer to 210-250 kW with combined heat and power module



FORPOWER Technology

- Modular power system to convert forest slash to power at a viable cost
- Based on indirectly-fired gas turbine system using a novel heat exchanger and a gasifier



Taylor Energy's Gasification

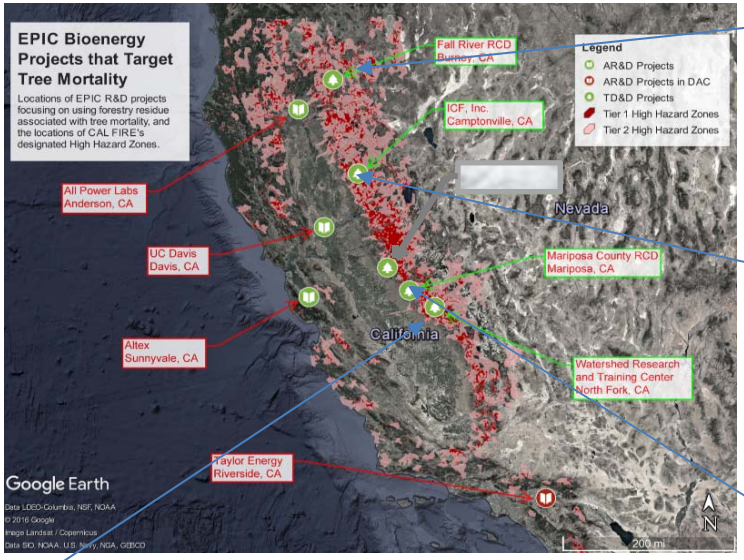
- Woody biomass gasification that uses input of pulse-combustion and pulse detonation to drive the process
- Intended for communities in the 3 MW to 12 MW range

Source: "Bioenergy RD&D in Support of California's Clean Energy Goal" Presentation by Rizaldo Aldas, PhD, Energy Research and Development Division, California Energy Commission, DOE Bioeconomy Summit, November 2018

California Bioenergy Demonstration and Deployment

(cont.)

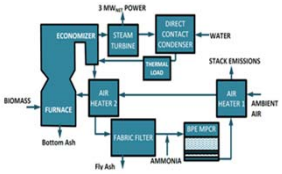
- Thermochemical conversion solutions to address tree mortality



Burney-Hat Creek Bioenergy

- Rotary gasification system based on rotary drum dryer design
- 2.88 MW system consuming 22,000 BDT per year of forest biomass
- Heat and biochar byproducts

Camptonville Biomass-to-Energy Project



- Integrates advanced emissions controls and a state-of-the-art low water condenser with boiler- steam turbine
- 3 MW system from ~ 30,000 BDT per year of forest biomass

North Fork Community Bioenergy Project

- Adapts GE's integrated biomass gasification system and engine
- 1 MW (will expand to 2 MW) system using sustainably harvested forest biomass

Mariposa Biomass Project

- Implements bioenergy facility using Cortus Energy's WoodRoll gasification technology
- Capacity of 2.2 using wastes from forest management

Source: "Bioenergy RD&D in Support of California's Clean Energy Goal" Presentation by Rizaldo Aldas, PhD, Energy Research and Development Division, California Energy Commission, DOE Bioeconomy Summit, November 2018

Woody Biomass CHP in California

Organization Name	City	Application	Op year	Capacity (kW)	Primary Fuel
Mendota Biomass Power	Mendota	Agriculture	1993	25,000	Agricultural Residue
Thermal Energy Development LP	Tracy	Food Processing	1990	23,000	Agricultural Residue
Stockton Biomass	Stockton	Wood Products	2014	45,000	Wood & Ag Residue
Roseburg Products (Weed Cogen)	Weed	Wood Products	2011	10,000	Wood Waste
Big Valley Lumber (Forest Power)	Burney	Wood Products	1989	31,500	Logging & Mill Residue
Auberry Energy, Inc. /Yanke	Auberry	Wood Products	1985	7,500	Wood Waste
California Cedar Products	Stockton	Wood Products	1984	840	Wood Waste
Sierra Pacific Industries, Inc.	Anderson	Wood Products	2015	30,200	Logging & Mill Residue
Sierra Pacific Industries, Inc.	Lincoln	Wood Products	2004	17,000	Mill Residue
Sierra Pacific Industries, Inc.	Quincy	Wood Products	1999	27,500	Mill Residue
Sierra Pacific Industries, Inc.	Burney	Wood Products	1986	20,000	Mill Residue
Sierra Pacific Industries, Inc.	Sonora	Wood Products	1981	7,500	Logging & Mill Residue
Collins Pine Company	Chester	Wood Products	1994	12,000	Wood Waste
Eel River Power (Scotia Cogen)	Scotia	Wood Products	1988	28,000	Wood Waste

Source: DOE CHP Installation Database (Accessed 01/02/2020)

Notes:

1. All operating CHP plants incorporate a boiler and steam turbine
2. Total CHP Capacity: 285 MW

Pulp & Paper Facilities Powered by Natural Gas-fueled CHP

Facility Name	City	Op Year	Capacity (kW)
Sierra Pine	Martell	2005	4,500
Kimberly Clark	Fullerton	2002	13,400
Procter & Gamble Plant	Oxnard	1989	68,700
Simpson Paper Company	Ripon	1988	49,500
New-Indy Containerboard	Oxnard	1986	25,000
San Gabriel Pulp & Paper Mill	Pomona	1986	36,000
New-Indy Containerboard	Ontario	1985	36,000

Source: DOE CHP Installation Database (Accessed 01/02/2020)

Notes:

1. All operating CHP plants incorporate gas turbines
2. Total CHP Capacity: 233 MW

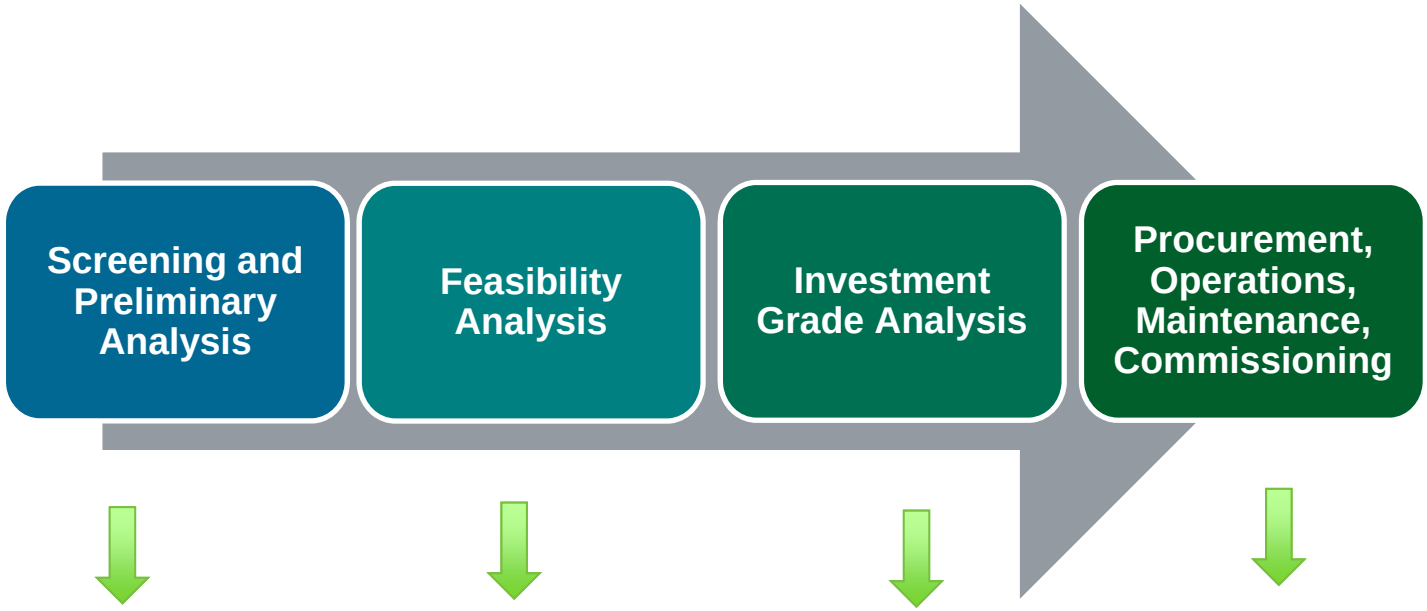
Woody Biomass Electric Generation Incentives

- Bioenergy Market Adjusting Tariff (BioMAT)
  - 50 MW Capacity reserved for Woody Biomass; Most (47 MW) are for PG&E territory
  - December 2019 Price: $199.72/MWh
- 10% Federal Tax Credit (up to 15 MW) plus Accelerated Depreciation
- Self-Generation Incentive Program
- Government Grants
  - California Energy Commission
    - No immediate plans for new biomass generation solicitation
    - But its in the 2018 – 2020 EPIC Investment Plan
  - US Department of Energy
    - The Bioenergy Technologies Office (BETO) has published a Funding Opportunity Announcement (FOA) titled "FY20 Bioenergy Technologies Multi-Topic FOA" to support high-impact technology research and development

Best Candidates for CHP

- Consistent source of organic matter to produce biogas
- High and constant thermal load
- Favorable spark spread
- Need for high reliability
- Concern over future electricity prices
- Interest in reducing environmental impact
- Planned facility expansion or new construction; or equipment replacement within the next 3-5 years

CHP TAP Technical Assistance



US DOE CHP TAP Services:

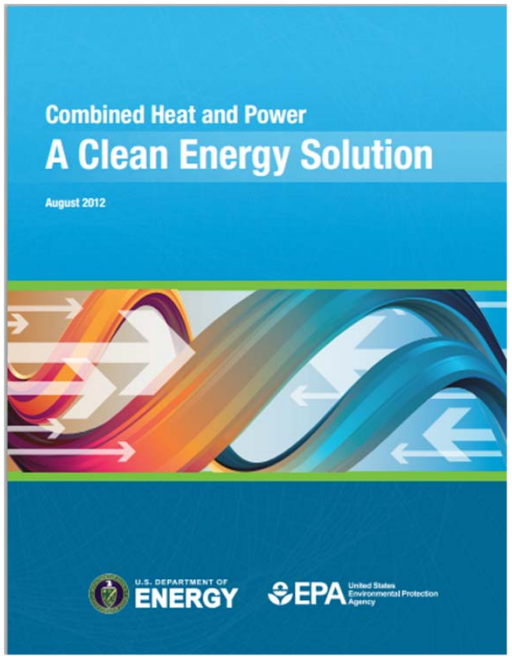
Quick screening questions with spreadsheet payback calculator.	Estimate - annual energy savings, installation costs, simple paybacks, equipment sizing and prime mover type.	3rd Party review of Engineering Analysis. Review equipment sizing and choices.	Review RFP bids and Specifications Limited operational analysis

CHP Project Resources

DOE CHP Technologies Fact Sheet Series

www.energy.gov/chp-technologies

Good Primer Report



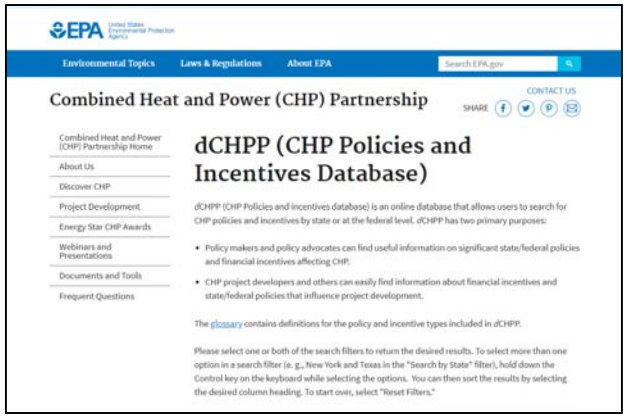
www.eere.energy.gov/chp

CHP Project Resources

DOE Project Profile Database

energy.gov/chp-projects

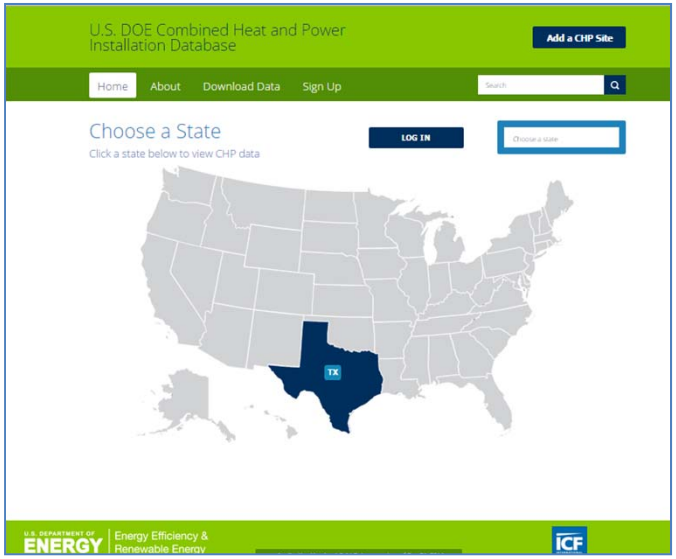
EPA dCHPP (CHP Policies and Incentives Database)



www.epa.gov/chpdchpp-chp-policies-and-incentives-database

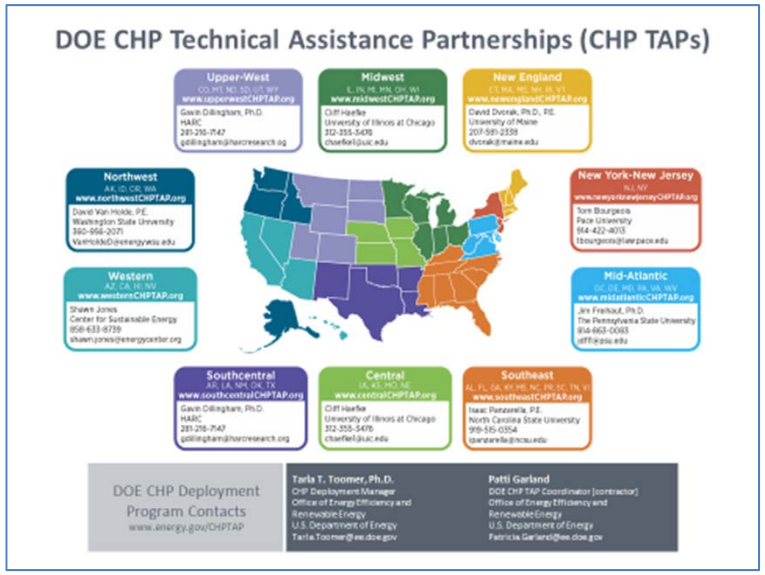
CHP Project Resources

DOE CHP Installation Database (List of all known CHP systems in U.S.)



energy.gov/chp-installs

Low-Cost CHP Screening and Other Technical Assistance from the CHP TAP



energy.gov/CHPTAP

Next Steps and Questions?

Contact Western 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 are interested in expanding it
- Need an unbiased 3rd Party Review of a CHP proposal
- Want to assess CHP potential at a site to provide resiliency to your operations
- Want to learn more about CHP or our program

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http://www.wCHPTAP.org/

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