Combined Heat and Power Applications for Tribal Facilities

USDOE Office of Indian Energy Policy and Programs

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CHP Technical Assistance Partnerships
NORTHWEST

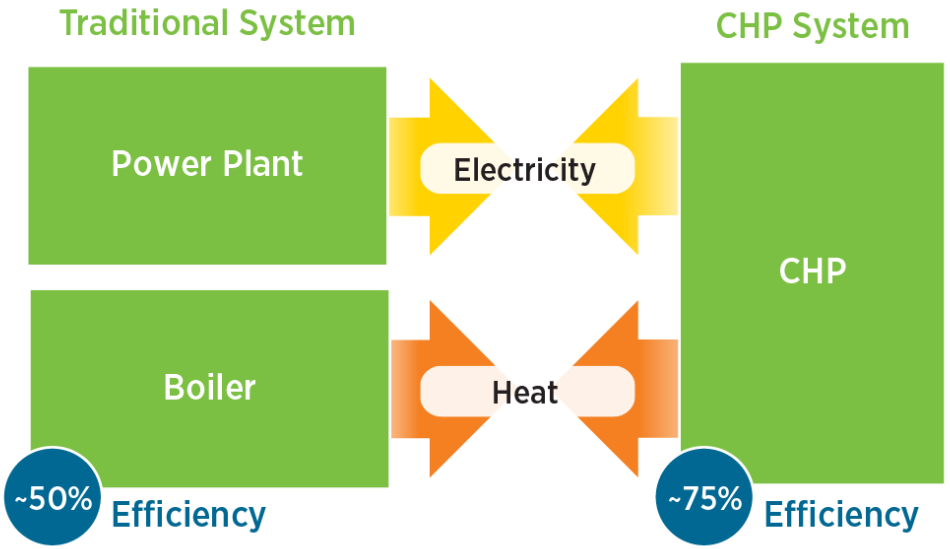
Outline of Presentation

- CHP Overview
- CHP Technologies
- Emerging Trends
- US DOE's CHP Technical Assistance Partnerships: Who we are and what we do

CHP Overview

CHP: A Key Part of Our Energy Future

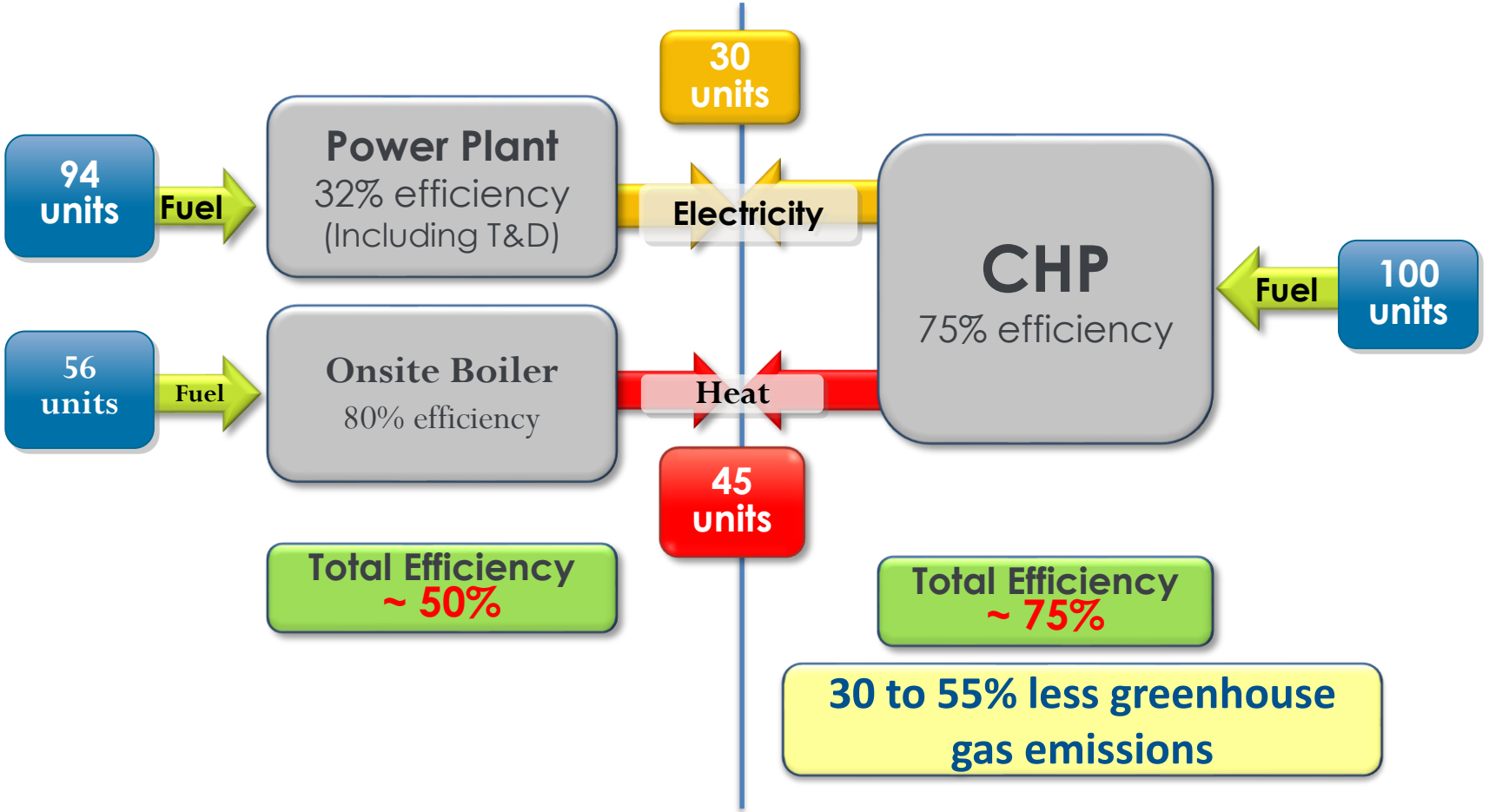
- Form of Distributed Generation (DG)
- An integrated system
- Located at or near a building / facility
- Provides at least a portion of the electrical load and
- Uses thermal energy for:
  - Space Heating / Cooling
  - Process Heating / Cooling
  - Dehumidification



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

Source: www.energy.gov/chp

CHP Recaptures Heat of Generation, Increasing Energy Efficiency, and Reducing GHGs



Common Uses for Thermal Energy Recovered

- Space heating at a single facility, or campus

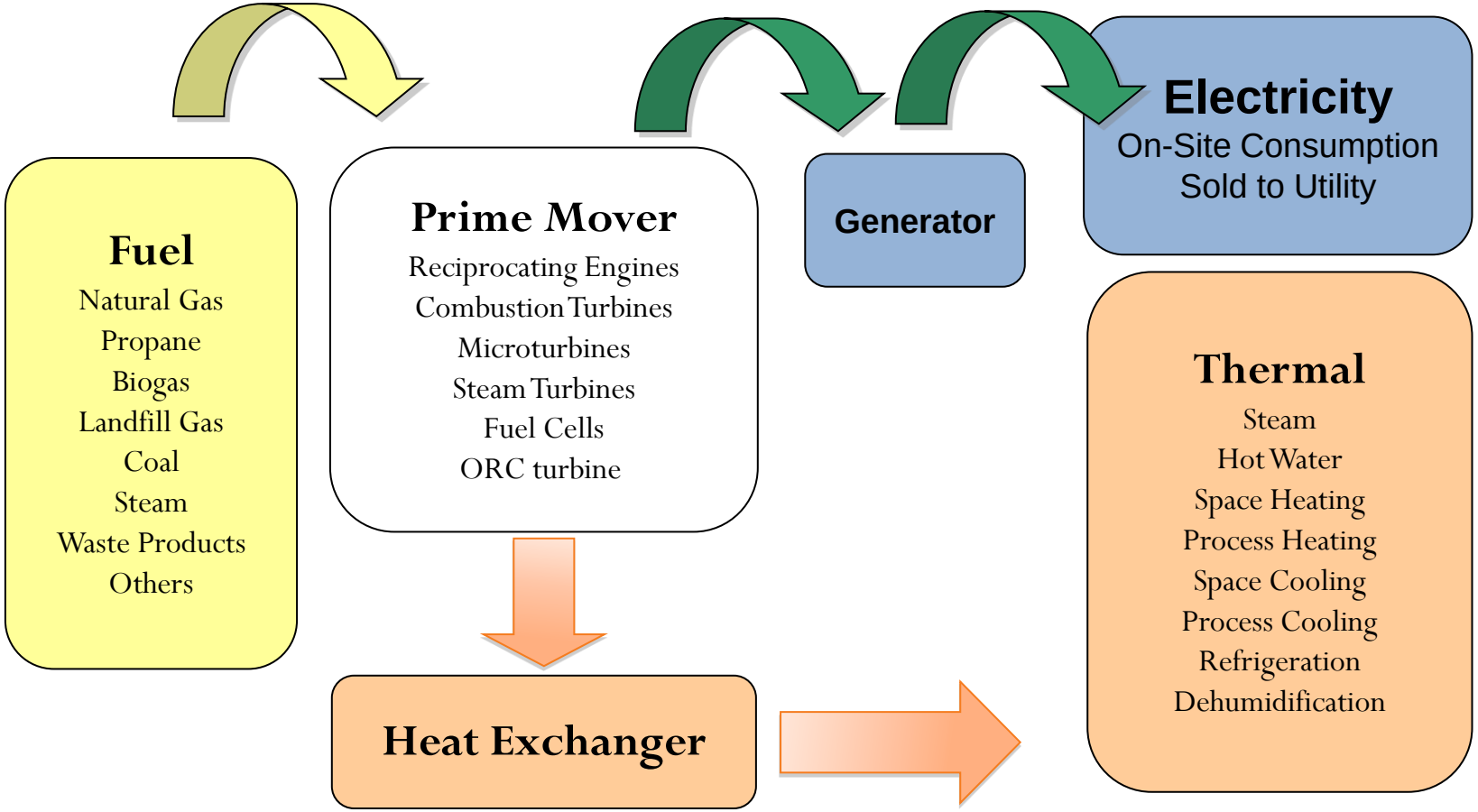
  "District heating" project
- Domestic water heating, laundromat/washerteria
- Process hot water or steam at an industrial facility
- Hospitals: Steam for space and water heating, humidification and sterilization
- Pool or spa heating at hotels, schools, recreation centers, casinos
- Freeze protection for water supply and wastewater
- Absorption chilling for space cooling & refrigeration

What Are the Benefits of CHP?

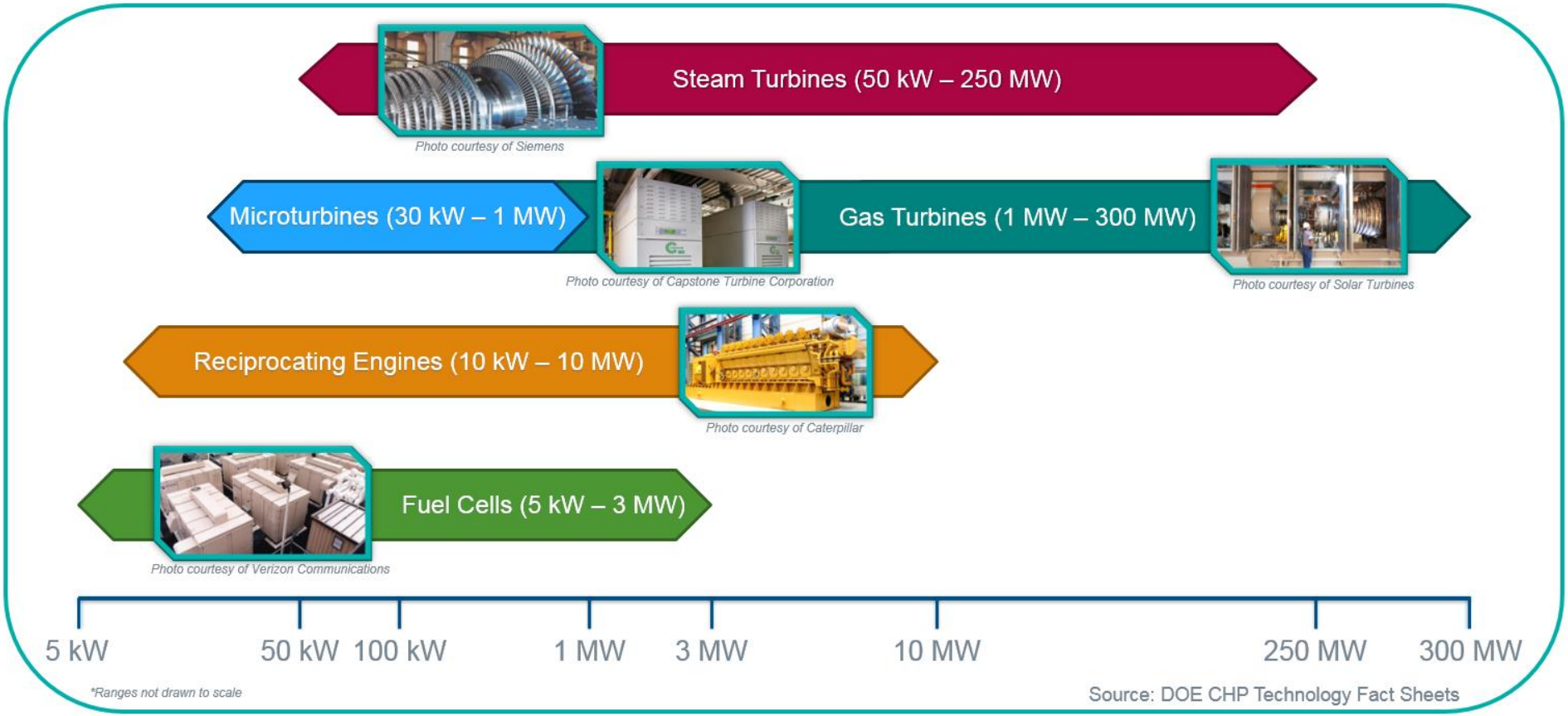
- CHP is **more efficient** than separate generation of electricity and heating/cooling
- Higher efficiency translates to **lower operating costs** (but requires capital investment)
- Higher efficiency **reduces emissions** of pollutants
- CHP can also increase **energy reliability; provide resiliency benefits at critical facilities** and enhance power quality
- On-site electric generation can **reduce grid congestion** and avoid distribution costs.

CHP Technologies

CHP System Schematic



Common CHP Technologies and Capacity Ranges



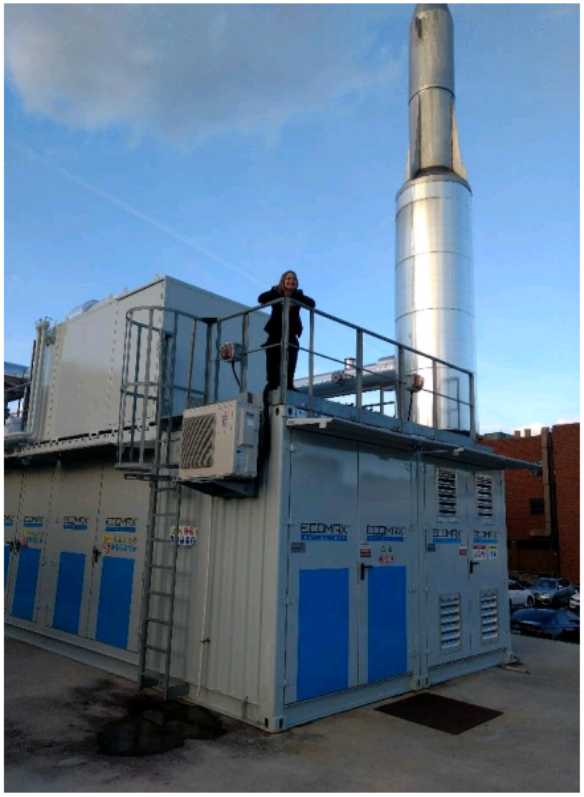
Economy of Scale when Designing CHP Systems

- Total Installed Cost, $/kW
- Heat Rate, Btu/kWh
- Efficiency for electrical generation, %
- Maintenance costs, $/kWh
- Transport Gas Availability and Cost
- Possibly in Permitting and Project Financing

Emerging Trends

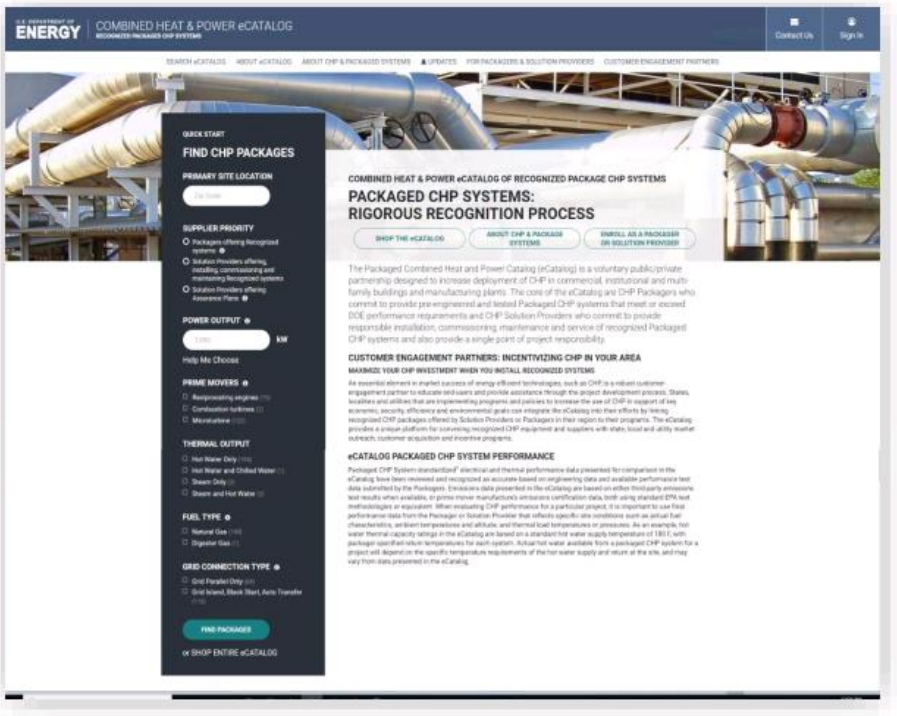
New Markets for Packaged CHP

- CHP technology advancements allow for standardized packaged CHP systems
  - Most systems range from 10 kW to 2 MW
- Packaged systems expected to expand the CHP market to new customers
  - Avoid costs and delays associated with customized engineering and design
  - 26 GW of CHP technical potential in the 50-499 kW size range
- Packaged systems are increasingly including solar PV in addition to CHP equipment
- DOE Packaged CHP eCatalog seeks to increase package options up to 10 MW



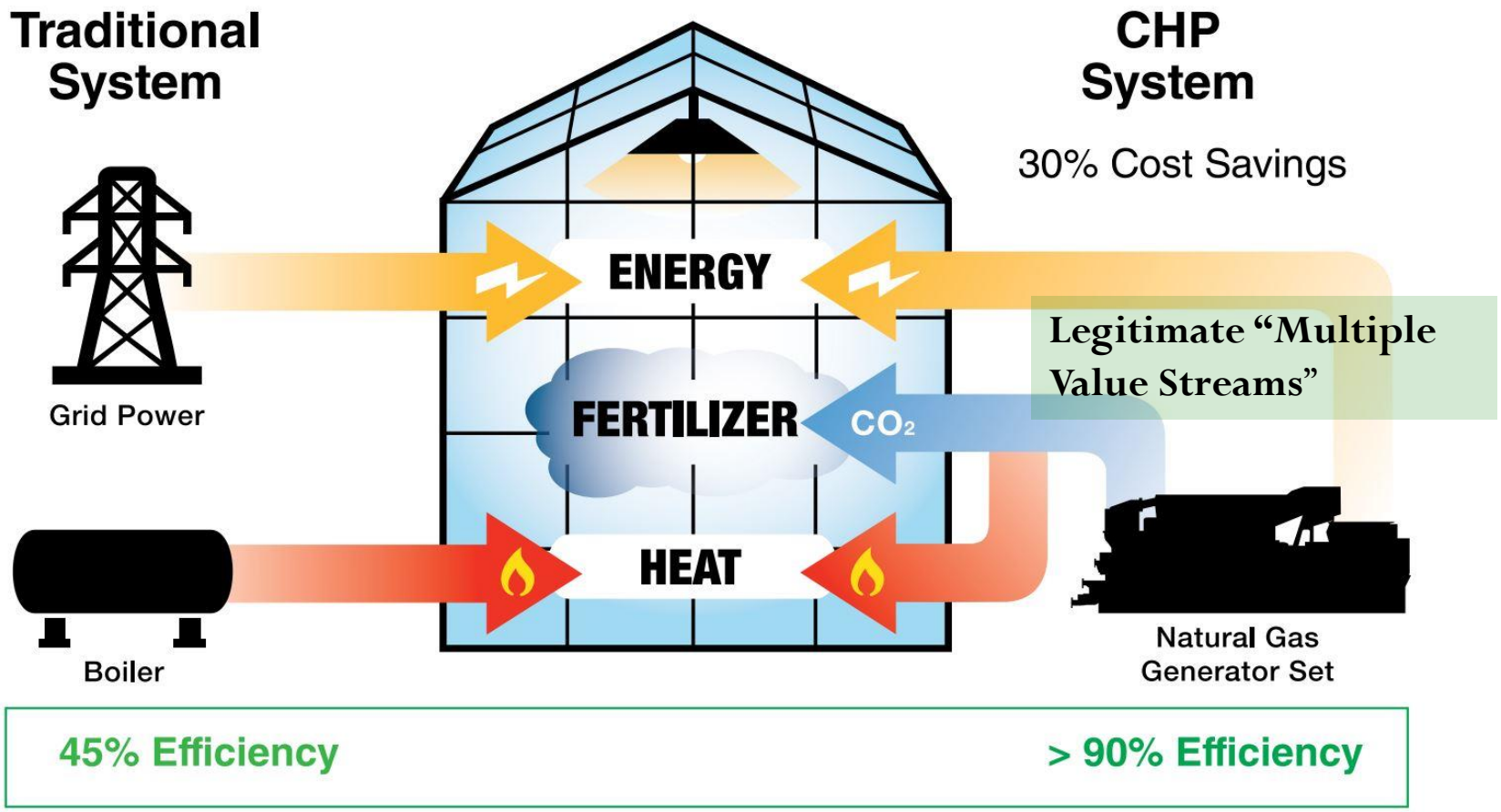
DOE Packaged CHP eCatalog

- A national web-based searchable catalog (*eCatalog*) of DOE-recognized packaged CHP systems and suppliers with the goal to reduce risks for end-users and vendors through partnerships with:
  - *CHP Packagers and Solution Providers* that assemble, 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
- End-users and design engineers 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



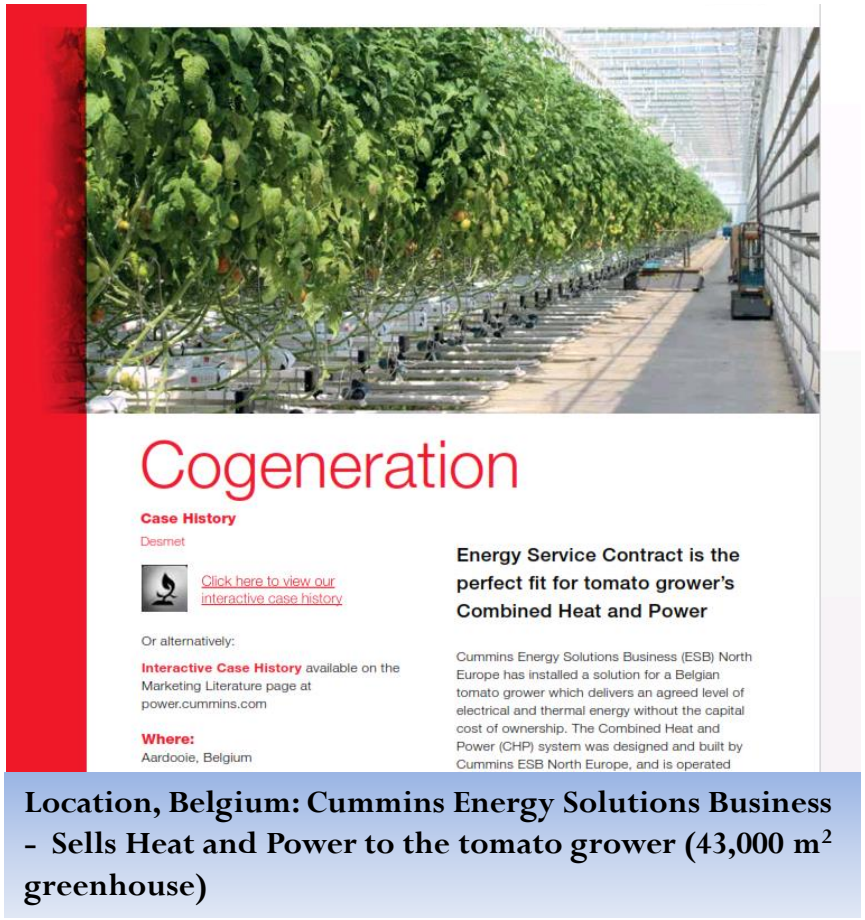
https://chp.ecatalog.lbl.gov/

CHP in The Greenhouse – Synergistic



Source: Cummins *Power Topic* #GLPT-5929-EN
Credit: Cummins Power Generation and Stan De Wit

…rapidly expanding applications worldwide, with clean combustion

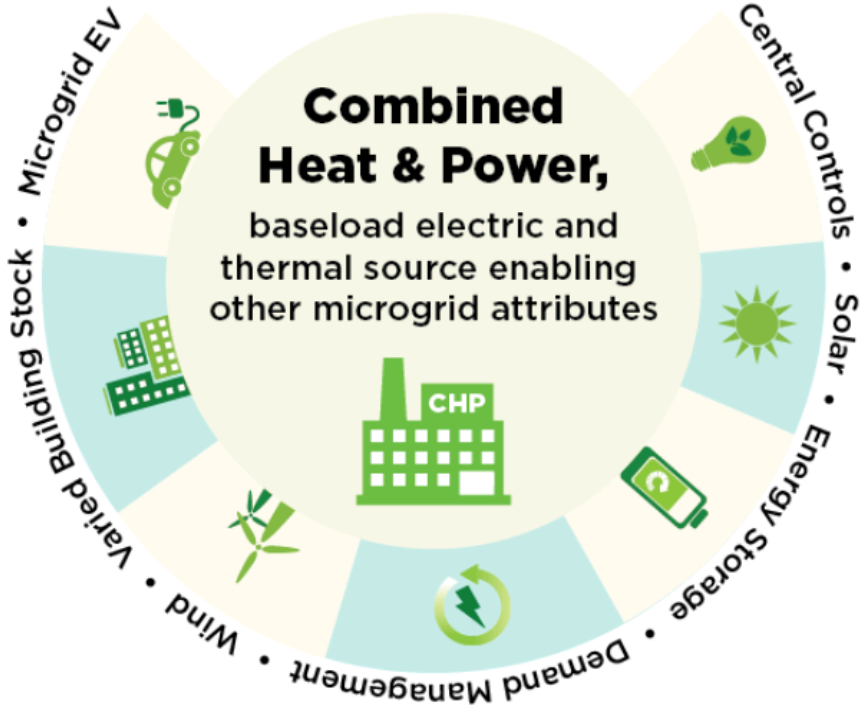


Location, Belgium: Cummins Energy Solutions Business - Sells Heat and Power to the tomato grower (43,000 m^2 greenhouse)

Source: Cummins Bulletin 5410766 (5/17)
Credit: Cummins Power Generation

Photo Courtesy of Houwelings Group

CHP Can Enable Other Microgrid Technologies



- With a CHP system providing baseload electric and thermal energy, microgrids can add:
  - Solar and wind resources
  - Energy storage
  - Demand management
  - Central controls
  - Electric vehicle charging
- Flexible CHP systems can ramp up and down as needed to balance renewable loads and provide grid services

CHP Integration with Renewables & Storage

- **CHP + Solar PV** - solar seldom meets the entire electricity load, making room for CHP to supply thermal loads and electricity when PV electricity is insufficient or unavailable
- **CHP + Battery Storage** – 1) dampen daily demand swings; 2) Shift power usage from off peak to on-peak periods; 3) enhanced resiliency and availability; and 4) enhance grid value-stacking capabilities (voltage support, T&D deferral, reserve capacity, reliability, over-generation management)
- **CHP in a Microgrid** – 1) efficient measure to serve thermal load; 2) backup power during extended outages; 3) supplements generation from PV & storage
- **CHP is a Flexible Generation Resource –** most CHP technologies can be powered down or off when renewable supply exceeds demand
- **CHP Powered by Renewable Gas (biogas, hydrogen) -** would enable CHP to partially or completely utilize renewable fuel either by piping non-pipeline quality biogas to the CHP site; using directed renewable gas; or purchasing pipeline gas that that has been blended with renewable gas

Microgrid Implementation Drivers (continued)

- **Reliability & Resilience**
  - Improve electricity and thermal energy reliability and resilience during grid outages and other major disruptive events
  - Especially important for critical infrastructure facilities
- **Remote Grid**
  - Provide power to remote locations that cannot rely on the power grid, such as an island community
- **Renewables Integration**
  - Incorporate renewable technologies into power generation mix while using other technologies to offset the intermittency of renewables

Project Snapshot:

Food Waste to Energy

FOREST COUNTY POTAWATOMI
Keeper of the Fire

Forest Country Potawatomi Community Renewable Generation

Milwaukee, WI

Application/Industry: Casino

Capacity: 2 MW

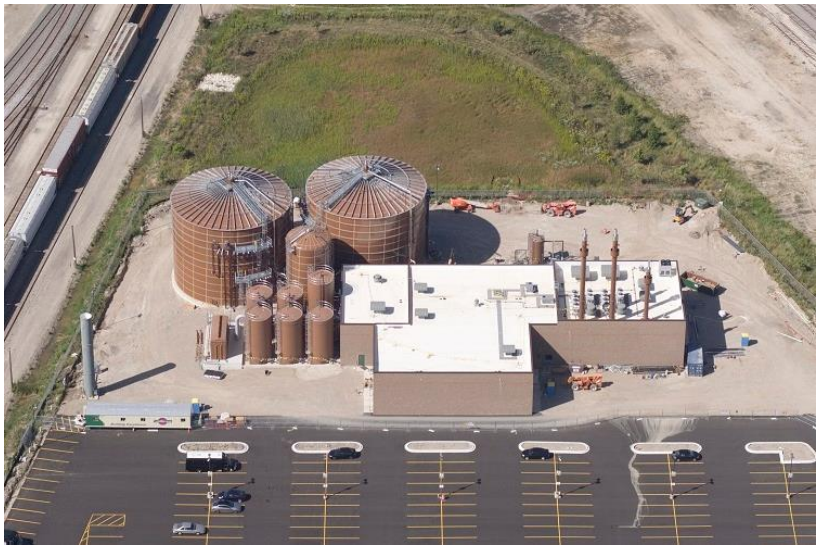
Prime Mover: Reciprocating engine

Fuel Type: Biomass

Thermal Use: Heating, hot water

Installation Year: 2013

Energy Savings: Unknown



Highlights: Waste from a variety of local food producers fuels the 2 MW CHP plant on Potawatomi tribal land. Power is sold to We Energies. The system also provides heat and hot water to the nearby Potawatomi Bingo Casino.

Implementing a CHP Project with the Help of the CHP TAP

What We Do: Maniilaq Health Center CHP Opportunity – A Typical Engagement:

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

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Maniilaq Health Center
Kotzebue, AK

December 20th, 2017

Matt Bergan, PE
Kotzebue Electric Association
Project Engineer

Subject: Advanced Technical Assistance for Maniilaq Health Center CHP Project Alternatives

Introduction---Maniilaq Health Center Annual Energy Use and Costs: The Northwest CHP TAP recently completed a Combined Heat and Power (CHP) Qualification Screening study (QS) that found that a 250 kW reciprocating engine would be cost-effective when serving electrical energy and thermal loads at the Manillaq Health Center in Kotzebue, AK. Based on follow-up discussions between Maniilaq Health Center, Kotzebue Electric Association (KEA), the Alaska Energy Authority and the Northwest CHP TAP, the Health Center and KEA requested a more detailed analysis be performed where a number of different CHP technology and ownership options were more deeply analyzed. This letter describes the outcome of those studies by the NW CHP TAP.

Kotzebue is a remote town with a population of about 3,245 located above the Arctic Circle. The Health Clinic is operated by the Indian Health Agency. Cost-effectiveness of the 250 kW CHP project is excellent, with a simple payback to the Health Center of about 2.7 years, due to both the high electrical rates ($0.37/kWh) and the high heating fuel prices (about $4.18/ for No. 1 fuel or kerosene) at the Health Center site.

The Health Center consumed about 2.44 million kWh of electrical energy in 2016 at a cost of $896,000 plus about 143,296 gallons of No. 1 fuel oil. Current cost for fuel oil is about $4.18/gallon indicating an annual expense of about $598,977. The fuel oil is combusted in hydronic boilers (3 at 4,250 MBH each) and steam boilers (3 at 1,100 MBH each). A 2007 Energy Audit concluded that 58% of the fuel oil is combusted in the hydronic boilers for hot water used for space heating with 42% used to provide steam for supply air humidification, autoclaves, and laundry needs. Steam use was later increased due to adding domestic hot water heating loads and then subsequently reduced as humidification loads decreased when relative humidity setpoints were reset to lower values. An inspection of daily average steam load estimates provided by the Health Center (15,618 lbs of 100-psig steam is used per day) and No. 1 fuel oil annual use indicates that approximately 39% of annual fuel consumption is currently used to raise steam. This calculation is dependent upon assumptions related to steam boiler efficiency, condensate return, and condensate return temperature.

Kotzebue's electrical energy needs are met through a microgrid operated by the Kotzebue Electric Association (KEA), a cooperative power producer. They meet winter loads of about 3.2-3.3 MW during

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u have questions or require

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cc: Dan Smith, Alaska Industrial Development and Export Authority (AIDEA)

- Initial contact through Alaska Energy Authority
- Gather site information and energy data
- Initial "Screening" – does it look viable? –Yes. Initial Letter report
- Conversations with those involved, to review findings
- Request for advanced assessment – Done; still looks good
- More calls and conversations, etc.

Maniilaq Health Center

Need for Reliability & Price Stability in a Critical Facility

Problem

- $1.6M energy costs in 100,000 sf facility; 17 patient / 18 nursing home beds
- $0.367/kWh for electricity, $4.18/gallon for No. 1 fuel oil in 2018.
- Fuel oil prices change dramatically. In 2016, price was $5.48 per gallon

Proposed Solutions: Consider 250-kW Reciprocating Engine or 200 kW Microturbine

- CHP shifts heat from No. 1 fuel oil (kerosene) to No. 2 (diesel) – Much lower price!
- Thermal recovery for potable hot water and steam for health center applications

Outcome of Screening and Technical Assessment

- Estimated payback 1.85 – 6.3 years, depending on options chosen
- Improved reliability of a critical facility,
- Hedge against rising energy costs

Strategy

Utility integration to address load loss and integration with existing generation

Involve the Electric Utility

- Contact your local electric utility to gain an early understanding of retail rates, net metering possibilities, avoided costs, and interconnection requirements.
- Identifying win/win solutions
  - Utilities co-locating their generating facilities at load centers
  - Constructing district heating thermal distribution loops
  - Add waste heat recovery to existing reciprocating engines

Next Steps

Resources are available at no cost to assist in developing CHP Projects at your site

Contact your CHP TAP to:

- Perform CHP Screening Technical Assistance study for a particular facility
- Identify existing CHP sites at similar facilities
- Advanced Technical Assistance (emissions determination, life cycle cost analysis, sensitivity analysis)

DOE CHP Technical Assistance Partnerships (CHP TAPs)

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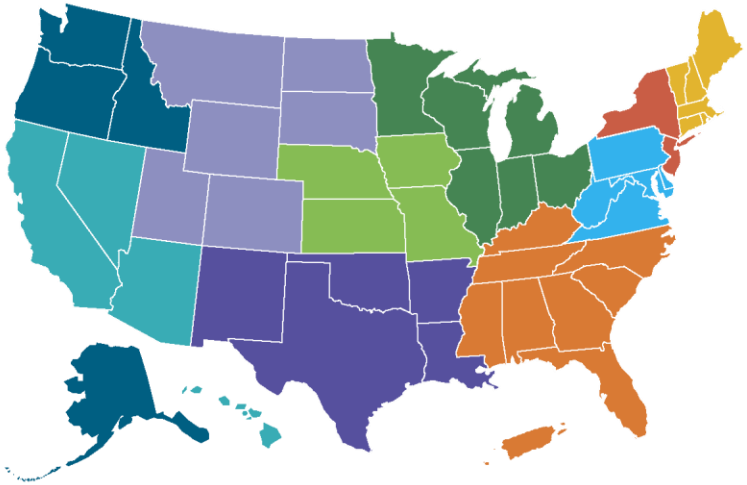

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Thank You!

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