Distributed CHP Challenges and Opportunities in Remote Communities

David Van Holde, P.E. CEM
Director
Northwest CHP Technical Assistance Partnership

Emerging Priorities in Energy Research
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Outline of Presentation

- Introduction: US DOE's Combined Heat and Power (CHP) Technical Assistance Partnerships (TAPs)
- Introduction to Combined Heat and Power
- The Why and How of CHP in Alaska - The Value of CHP to Remote Communities and Their Utilities
- Finding the Best Candidates for CHP in Alaska
- Examples of a project and proposal
- Developing CHP projects with CHP TAP resources

DOE CHP Technical Assistance Partnerships (CHP TAPs)

- **End User Engagement**
  Partner with strategic End Users to advance technical solutions using CHP as a cost effective and resilient way to ensure American competitiveness, utilize local fuels and enhance energy security. CHP TAPs offer fact-based, non-biased engineering support to manufacturing, commercial, institutional and federal facilities and campuses.
- **Stakeholder Engagement**
  Engage with strategic Stakeholders, including regulators, utilities, and policy makers, to identify and reduce the barriers to using CHP to advance regional efficiency, promote energy independence and enhance the nation's resilient grid. CHP TAPs provide fact-based, non-biased education to advance sound CHP programs and policies.
- **Technical Services**
  As leading experts in CHP (as well as microgrids, heat to power, and district energy) the CHP TAPs work with sites to screen for CHP opportunities as well as provide advanced services to maximize the economic impact and reduce the risk of CHP from initial CHP screening to installation.

www.energy.gov/chp

DOE CHP Technical Assistance Partnerships (CHP TAPs)

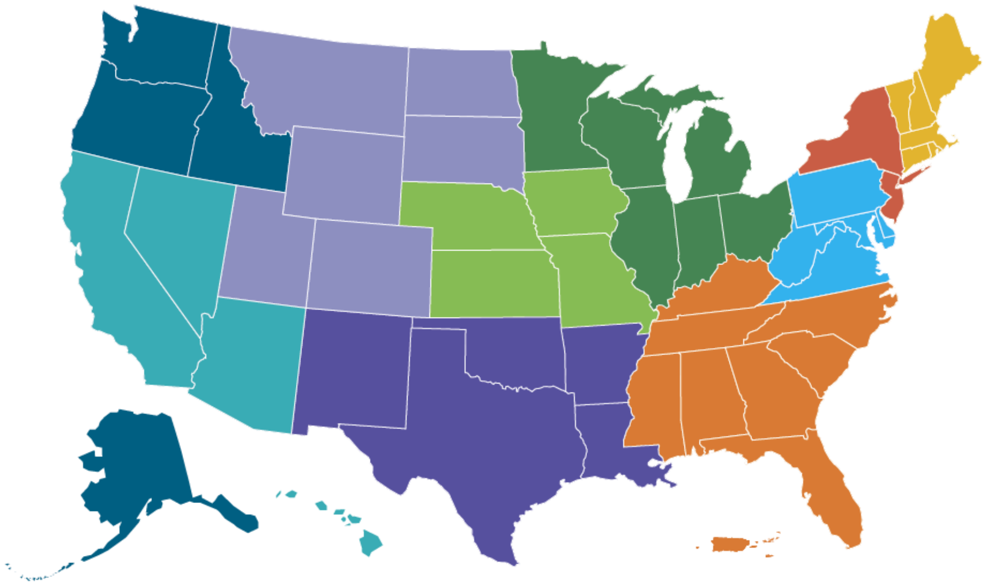
Northwest WA, OR, ID, AK
www.northwestCHPTAP.org
David Van Holde, P.E.
Washington State University
360-956-2071
VanHoldeD@energy.wsu.edu

Upper-West UT, CO, WY, MT, ND, SD
www.upperwestCHPTAP.org
Gavin Dillingham, Ph.D.
HARC
281-216-7147
gdillingham@harcresearch.org

Midwest MN, WI, MI, IL, IN, OH
www.midwestCHPTAP.org
Cliff Haefke
University of Illinois at Chicago
312-355-3476
chaefk1@uic.edu

New England VT, NH, ME, MA, RI, CT
www.newenglandCHPTAP.org
David Dvorak, Ph.D., P.E.
University of Maine
dvorak@maine.edu
207-581-2338

New York-New Jersey NY, NJ
www.newyorknewjerseyCHPTAP.org
Tom Bourgeois
Pace University
914-422-4013
tbourgeois@law.pace.edu



Mid-Atlantic PA, WV, VA, DE, MD, DC
www.midatlanticCHPTAP.org
Jim Freihaut, Ph.D.
The Pennsylvania State University
814-863-0083
jdf11@psu.edu

Southeast KY, TN, NC, SC, GA, FL, AL, MS
www.southeastCHPTAP.org
Isaac Panzarella, P.E.
North Carolina State University
919-515-0354
ipanzarella@ncsu.edu

Western CA, NV, AZ, HI
www.westernCHPTAP.org
Gene Kogan
Center for Sustainable Energy
858-633-8561
gene.kogan@energycenter.org

Southcentral TX, NM, OK, AR, LA
www.southcentralCHPTAP.org
Gavin Dillingham, Ph.D.
HARC
281-216-7147
gdillingham@harcresearch.org

Central NE, IA, KS, MO
www.centralCHPTAP.org
Cliff Haefke
University of Illinois at Chicago
312-355-3476
chaefk1@uic.edu

DOE CHP Deployment Program Contacts
www.energy.gov/CHPTAP

Tarla T. Toomer, Ph.D.
CHP Deployment Manager
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
Tarla.Toomer@ee.doe.gov

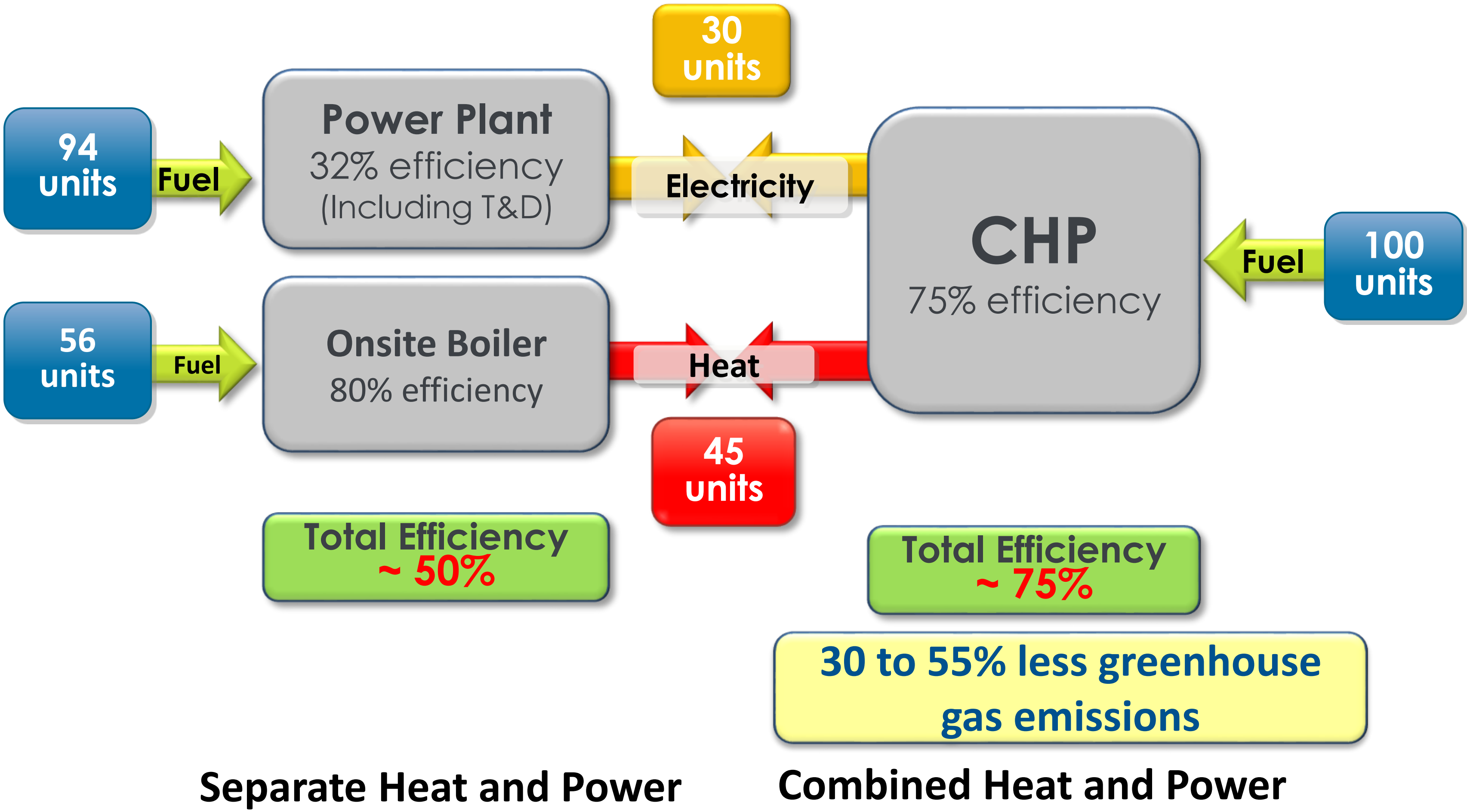
Patti Garland
DOE CHP TAP Coordinator [contractor]
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
Patricia.Garland@ee.doe.gov

Ted Bronson
DOE CHP TAP Coordinator [contractor]
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
tbronson@peaonline.com

What is Combined Heat and Power (CHP)?

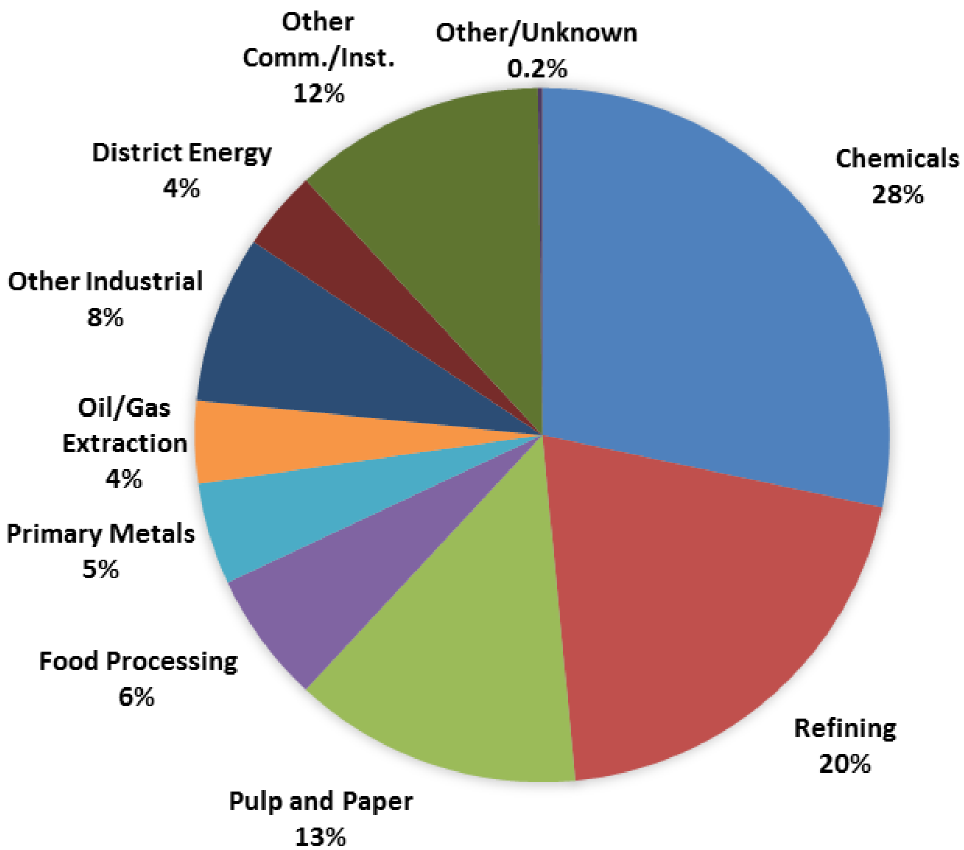
- **<u>Nothing new or complex here:</u>** CHP is an established *efficient technology application strategy* that:
  - Greatly increases the net energy efficiency of electric power generation supply compared to standalone I-C generators
  - Also supplies heat - A primary customer need not usually met by electric utilities.
- **<u>Your Takeaway:</u> CHP (for new generation equipment) or power plant Heat Recovery (HR - for existing power plants) is likely the largest net energy savings opportunity an isolated power system operator can implement.**
- CHP is capable of delivering large energy and cost operating savings to both the utility and its customers
- CHP expands the scope of utility service to supply the largest energy need in most remote Alaskan settlements: Building Heat.

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



CHP Today in the United States

Existing CHP Capacity



- **81.3 GW** of installed CHP at more than 4,400 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, 2017)

What CHP Looks Like: Integral in Communities, Built With Proven Technologies and Practices

WHY CHP - What Are the Benefits?

- 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 or “resilience”** and enhance power quality

Hot Stuff: Beneficial Uses for Thermal Energy Recovered

- Space heating at a single facility, district or campus
  - "District heating" – An appropriate technology solution in remote communities
- Domestic water heating
- Process hot water or steam at an industrial facility
  - Prime Alaska example: Seafood processing
- Hospitals: Steam for space & water heating, humidification and sterilization
- Pool or spa heating at schools, rec centers or hotels

WHY CHP HERE? - Remote Community Imperatives

…You know these facts:

1. With no regional power grid to remote communities, local *prime power* must be sized to the maximum load (with black start/step-load capability and safety factors)
2. This prime power need is either classed as a "Mission Critical" load, or something close to that:
   a. Power supply must be 8760 hr./yr. @ 99.9% + reliability
   b. Supply requires superlative resources and support - 24/7 skilled staffing and significant fuel reserves.
   c. This mode of operation precludes any intermittent sources *except as net energy resource addition measures*
   d. Short-term energy storage is useful as *a peak-load/black start/step-load management measure*

WHY CHP HERE? – Cont'd – *More you know:*

3. The only *prime power* sources known and available to remote communities that meet all these needs use fuel.

4. The prime power source therefore must have a continuous supply of fuel, almost always stored locally in sufficient quantity and shipped great distances, resulting in high cost of energy.

5. All such prime power sources also produce heat – typically as a waste product of electric power generation – at temperatures too low to cost-effectively capture more electric power from the heat.

6. The high cost of energy translates directly to a high value of both *supply and demand* side energy efficiency… And that lost heat…

<u>Takeaway #2:</u> All this adds up to a truly compelling case for CHP in your remote communities.

HOW - In Alaska, Utilities Should Develop CHP

Local electric utilities are integral to remote communities

- **What is different in Alaska**
  - In the continental US, CHP installations are typically very small sources of power, relative to a utility's distribution system – and impacts are local or nonexistent
  - In much of Alaska, the utility grids are microgrids – and any generator (or load) has large effects
- **Utility engagement as cooperating partners is essential**
  - Any loss of a major baseload (such as public buildings) has great impacts on small isolated utilities. So independent CHP development is likely a threat to them
  - A major load loss also negatively impacts all end users in a microgrid by increasing costs to remaining end users.
- **Identifying win/win solutions**
  - Utilities co-locating their generating facilities at thermal load centers to sell waste heat and power to customers
  - Construct district heating thermal distribution loops
  - Add waste heat recovery (HR) to existing reciprocating engines
    - Thermal uses can be as simple as de-icing or as complex as refrigeration

Finding the Best Candidates for CHP

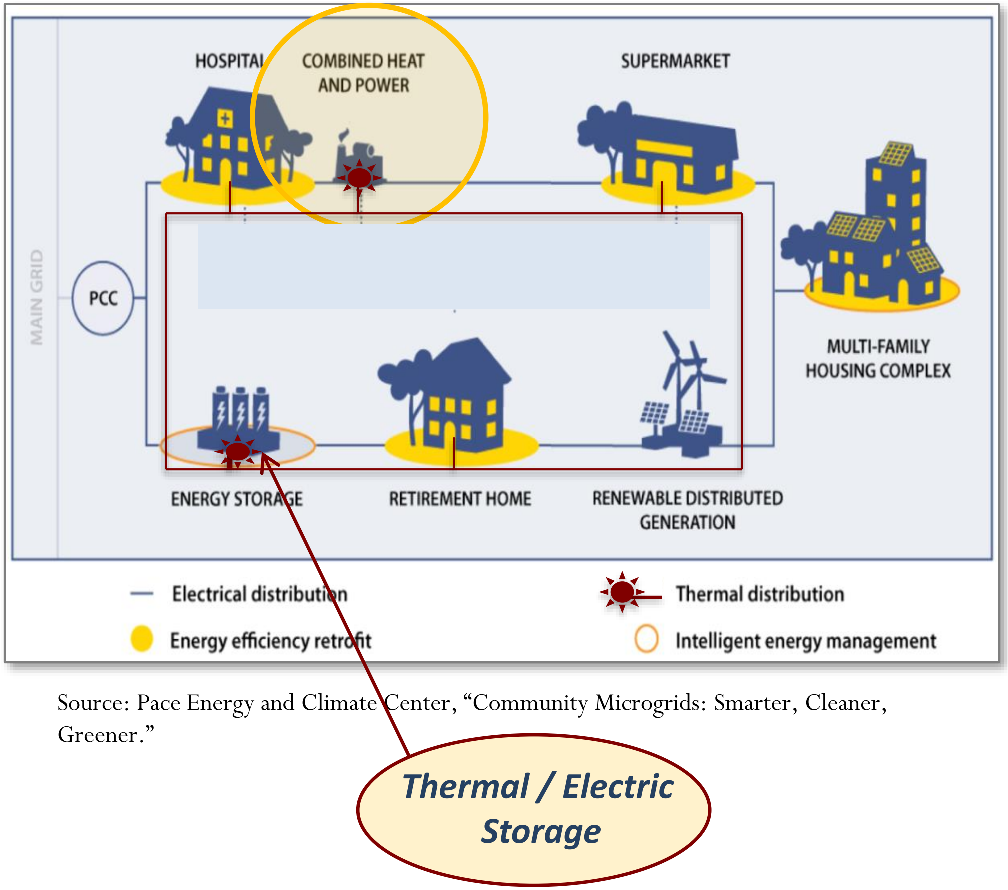
Look for Some or All of These Characteristics:

- High and constant thermal load – *Common in Alaska*
- Favorable "spark spread" – *Prevalent in Alaska*
  - High electricity rates *relative* to fuel prices
  - Both expressed in $ per MMBtu
- Need for high reliability – *Imperative at most remote sites*
- Concern over future electricity and/or heating prices - *Yes!*
- Interest in reducing environmental impact
- Existing central power or heating plant
- Planned facility expansion or new construction; or equipment replacement within the next 3-5 years
- Other local or regional societal benefits – *e.g. heating housing*

CHP Has a Role in Alaska's Many Microgrids

CHP can provide a stable "anchor" for community electric *and thermal* microgrids

- Provide uninterruptable baseload power
- Supply thermal energy for cooling and heating
- Prime power support for integration/optimization of intermittent resources, such as wind
- Addition of building-sited generators can provide town grid services (stabilizing) to existing power plant



Source: Pace Energy and Climate Center, "Community Microgrids: Smarter, Cleaner, Greener."

One Rural Alaska Example:

Generation of Power and Heat in an Integrated System

Woody Biomass Powers and Heats School in Central Alaska

Tok School
Gateway Schools, Tok Junction, Alaska

Application/Industry: School / Forest Management

Capacity: 125kW

Prime Mover: Elliot Steam Backpressure Turbine

Fuel Type: Timberland thinning and forest slash for wildfire prevention

Thermal Use: School and Greenhouses

Installation Year: 2013

Highlights: The system heats the 80,000-square-foot local school and a greenhouse growing 20,000 lb. of fresh vegetables for the school district's food service program, while saving an estimated $125,000 per year on fuel. With savings from the biomass CHP project's, Tok School has been able to rehire three staff members for the school: a music teacher, counselor, and a boiler operator.

"All of those BTUs, all of that energy, just went up in smoke. By the school using this material, it's saving me a minimum of $1,000 an acre." Jeff Hermanns (Tok area forester)

http://www.northwestchptap.org/NwChpDocs/Tok%20AK%20Gateway%20School%20District%2007_2017.pdf

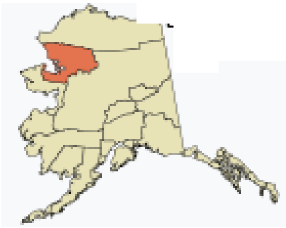
Tok School's biomass-fueled boiler generates 5.5 MMBtu/h, enough to provide steam heat and power for the campus
PHOTO CREDIT: ALASKA GATEWAY SCHOOL DISTRICT

CHP Opportunity Summary: Kotzebue Hospital

Constant Loads, 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

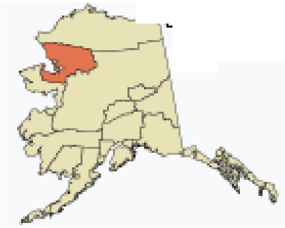
- Estimated payback 1.85 – 6.3 years, depending on options chosen
- Improved reliability of a critical facility,
- Hedge against rising energy costs

Strategy

Utility integration to address load loss and integration with existing generation

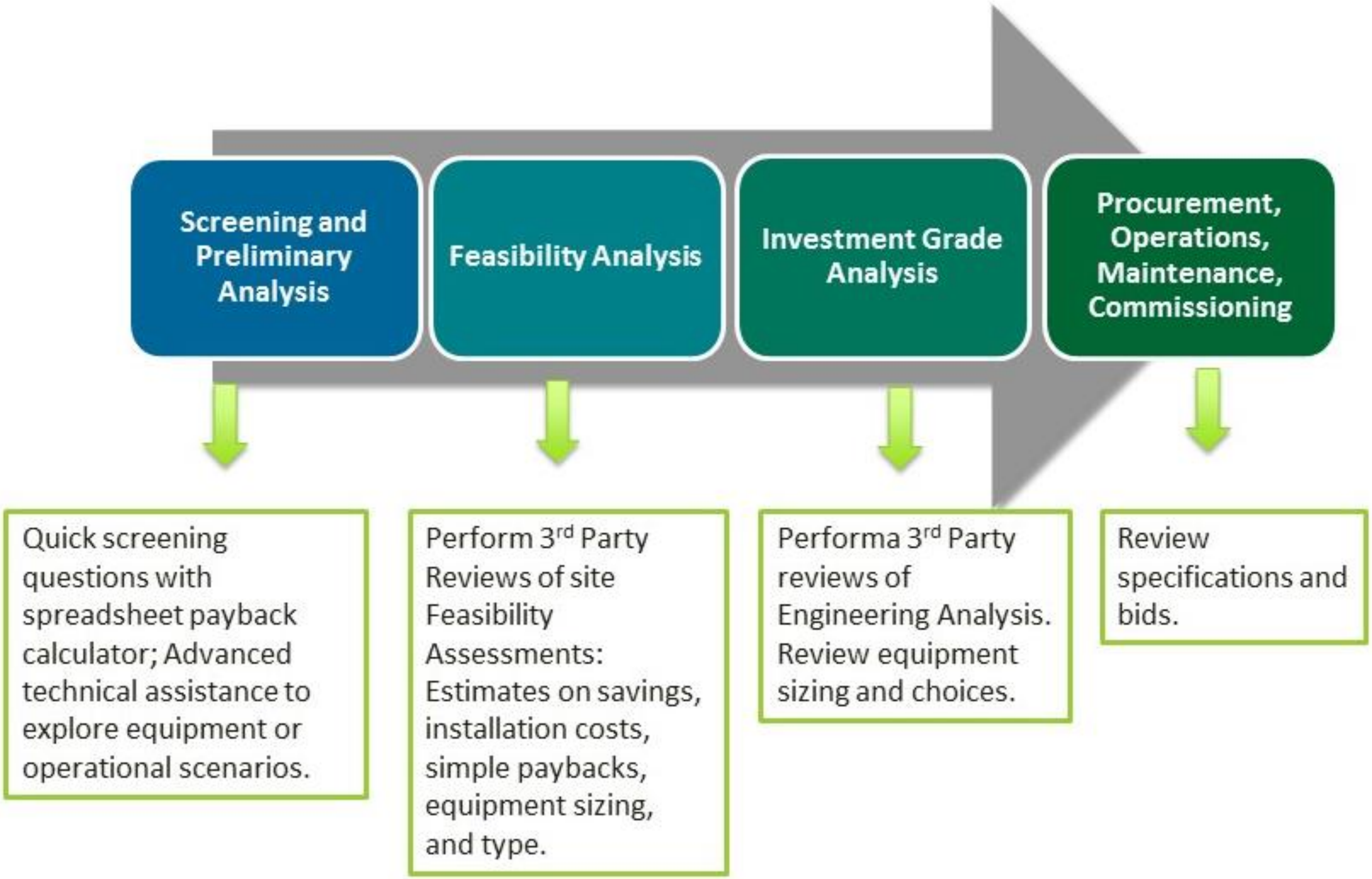
CHP Opportunity Summary: Kotzebue Hospital

Concept for a Kotzebue District Energy System



How to Implement a CHP Project with the Help of the CHP TAP

CHP TAP Role: Technical Assistance



DOE CHP TAP
Advanced Technical Assistance:

Where opportunity and end-user interest are high, the DOE NW CHP TAP can provide additional analyses customized to the site, end-user and their specific needs:

- 3rd Party Review of proposals you receive
- Emissions Analysis
- Electrical load profiling
- Thermal load profiling
- Thermal use determination (what to do with the heat)
- Installation cost estimations
- Financial calculations (simple payback, ROI, etc.)
- Cost/savings information compared to what your facility would pay if the CHP system were not installed
- Etc….

Next Steps

Resources are available to assist in developing CHP Projects at your site. By the NW CHP TAP and our partners – Alaska Energy Authority… And YOU.

Contact the AEA or Northwest CHP TAP to:

- Perform CHP Qualification Screening for a particular facility
- Identify existing CHP sites for Project Profiles
- Additional Technical Assistance

Thank You!

Questions & Contact Information:

Northwest CHP Technical Assistance Partnership
Washington State University Energy Program

Dave Van Holde, PE, Director

VanHoldeD@energy.wsu.edu

(360) 956-2071