CLEAN ENERGY

Combined Heat & Power

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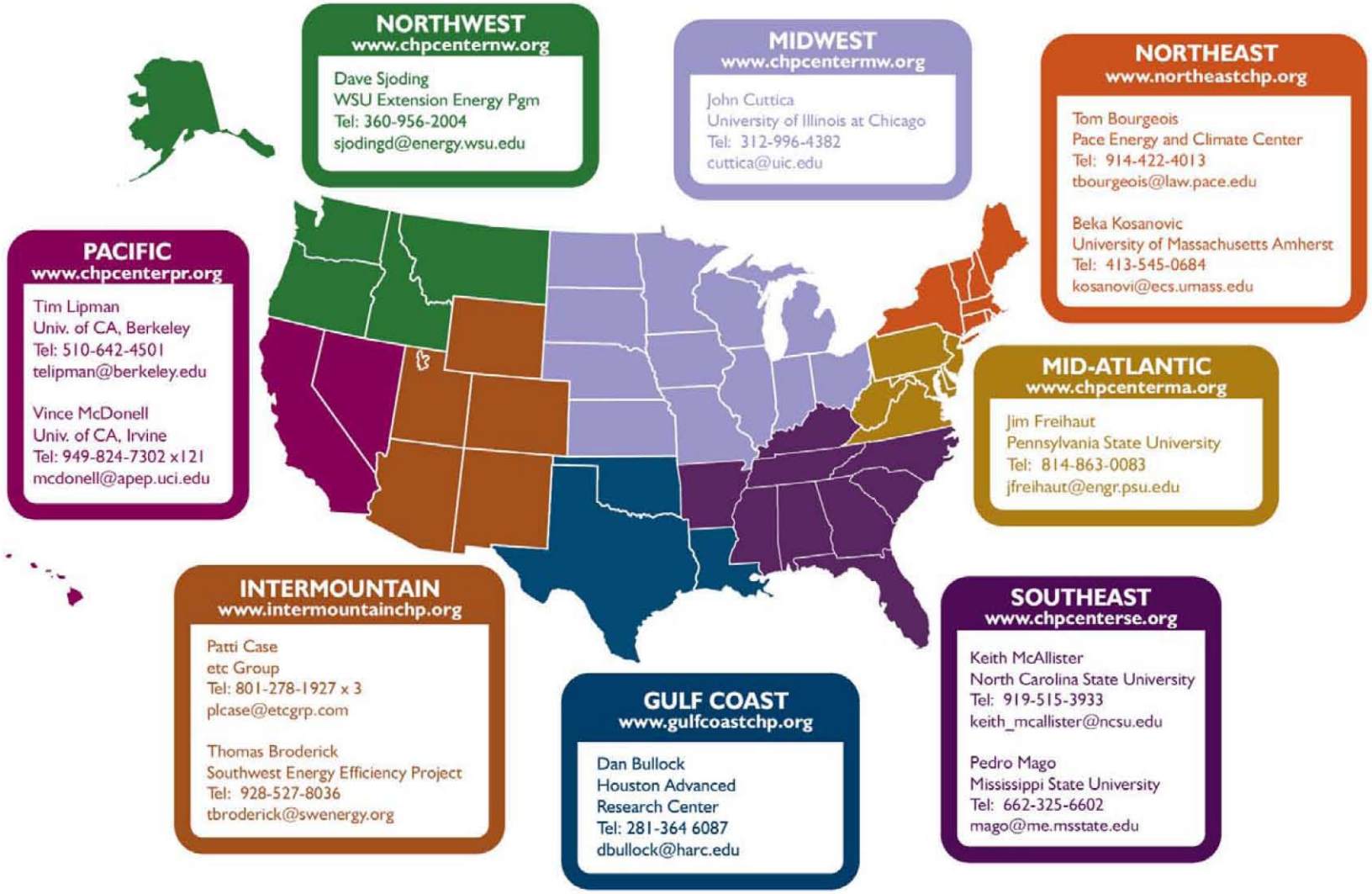
U.S. DEPARTMENT OF ENERGY
Clean Energy Application Center
MID-ATLANTIC

Promoting CHP, District Energy, and Waste Energy Recovery

Evolution of "Clean Energy Application Centers"

- Originally Established as "Regional **CHP** Application Centers"
- Pilot Center Started in 2001 in the Midwest
- Eight Regional CHP Application Centers Established in 2003/2004 through DOE Competitive Process
- Energy Independence & Security Act (EISA) - 2007
  - *Re-designated the 8 Regional "**CHP** Application Centers" as "**Clean Energy** Application Centers"*
  - *Directs DOE to Continue the Operation and Effectiveness of the 8 Centers*

DOE Clean Energy Application Center Locations, Contacts, and Web Sites



For more information visit http://www1.eere.energy.gov/industry/distributedenergy/racs.html

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Clean Energy Application Centers (RACs)

- **Mission:** Develop technology application knowledge and the educational infrastructure necessary to lead "clean energy" technologies as viable energy options and reduce any perceived risks associated with their implementation

- **Focus:** Provide an outreach and technology deployment program to end users, policy, utility, & industry stakeholders aimed at:
  - **Targeted Education**
  - **Unbiased Information**
  - **Technical Assistance**

RAC Services & Capabilities

Unbiased Information

Develop & distribute informational materials

Perform market research to identify high profile candidate applications

Targeted Education

Develop & conduct target market workshops, seminars, internet programs to educate end users, regulators, and other stakeholders

Assist in overcoming policy and other market barriers

Technical Assistance

Provide technical assistance to potential user sites

Provide or coordinate on-site assessments for entities considering deployment of clean energy technologies

"Clean Energy" Technologies

CHP

The sequential production of electric and thermal power from a single dedicated fuel source

Waste Heat Recovery

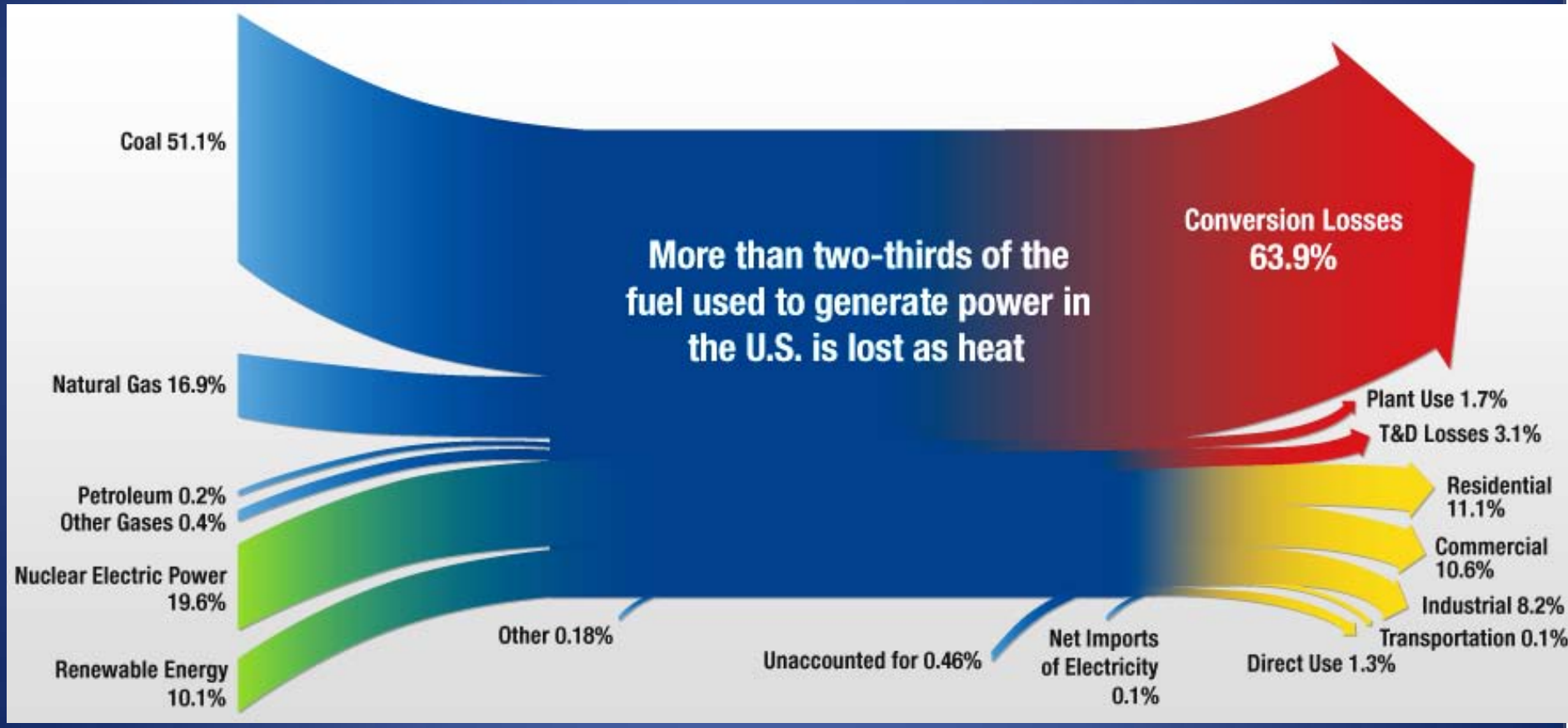
Captures heat otherwise wasted in an industrial process and utilizes it to produce electric power. These systems may or may not produce additional thermal energy

District Energy

Central heating & cooling plants that incorporate electricity generation along with thermal distribution piping networks for multiple buildings (campus / downtown area)

Traditional Power is VERY Inefficient

CHP more efficient + less emission



Source: DOE Energy Information Administration Annual Energy Review 2007
Combined Heat and Power, Oak Ridge National Laboratory

What is CHP?

CHP or cogeneration is the sequential production of power (electricity) and thermal energy (heating and/or cooling) from a single energy source.

- CHP can reduce the amount of fuel energy required for a fixed load by up to 50%.
- CHP can reduce emissions, including greenhouse gases, by up to 50% or more.
- CHP can be an economical investment over the life cycle of the system.

RACs Support DOE Industrial Technology Program (ITP)

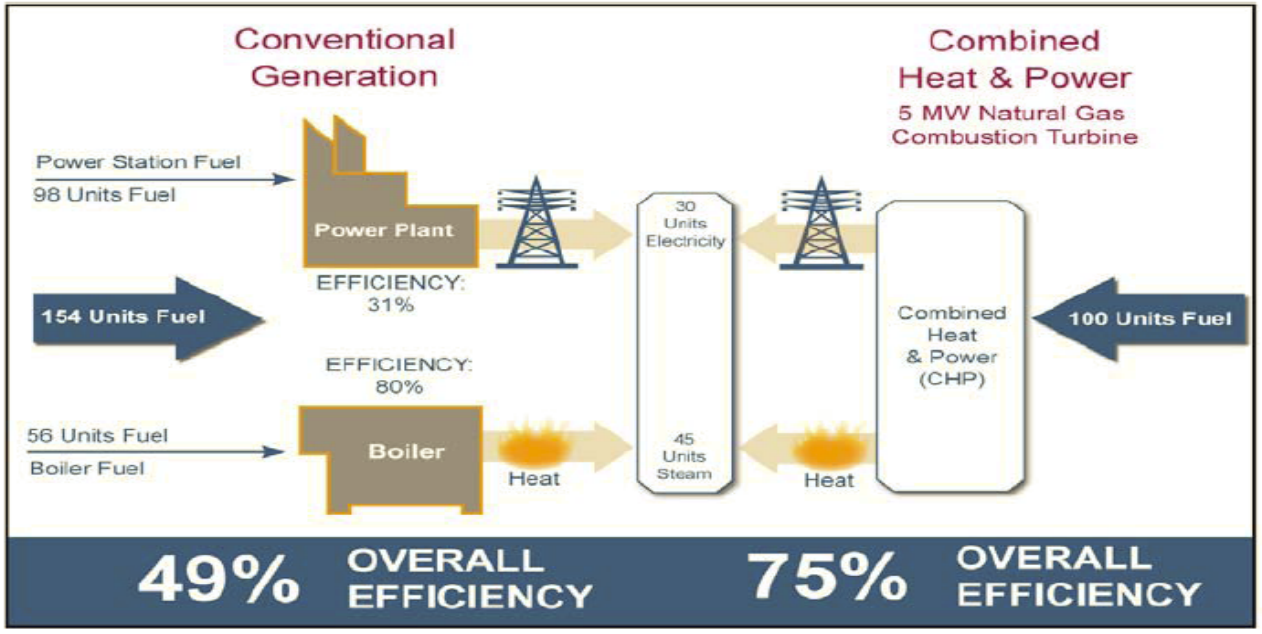
- ITP overall goal of reducing energy intensity in the industrial sector by 25% over the next ten years
- Increase CHP Capacity from 9% of US Generating Capacity in 2010 to 20% by 2030

Historical CHP Capacity and Growth Needed to Achieve 20% of Generation

- $234 billion private sector investment
- Nearly 1 million new jobs
- Reduces fuel use and CO_2 emissions

Source: Combined Heat & Power – Effective Energy Solutions for a Sustainable Future Dec. 2008

Combined Heat & Power (CHP)
vs
Separate Heat and Power (SHP)



Note: Assumes national averages for grid electricity and incorporates electricity transmission losses.

Summary of Potential DG Benefits

- Can be a cost effective source of peaking and/or baseload power.
  - DG can provide cost control and stability.
  - Use of fuel contracts can provide long term predictability
- Flexibility
- Ease in siting
- Can be operational within relatively short period.\
- Capacity can be grown to match load growth
- Energy efficient
- Environmentally benign and easier to permit
- Easier to finance as compared to other energy investments.

CHP Why Now?

Start With a Need for Generation!

Significant need for additional generation capacity.

- 35% of existing generation is 35 years or older.

Load growth may be unprecedented.

- Internet and e-commerce growth projected at 25% to 35% of existing demand.
- UPS growth is 24% annually.

Add Customer Requirements

Price: Rate and volatility are issues.

Reliability: Poor power reliability estimated to cost $50,000,000,000 annually.

Availability: Transmission system congestion and reliability coupled with inability to construct new lines constrains customer growth and limits availability of new supplies.

Quality: Requirements for high reliability and power quality; voltage, frequency and harmonic content more pervasive.

CHP – Where?

Characteristics of Good Applications

Good applications have 1 or more of the following characteristics:

- High electric rates / low fuel costs – good “spark spread”
- Larger facility size – yields lower first cost per kW
- Long operating hours
- Central heating and/or cooling plant – need thermal load
- Good coincidence between electric and thermal loads
- Nearby waste fuel or heat source available
- Need or want more reliable power supply

Heat Recovery Approaches

Thermal energy can be cost effectively recovered in various media:

- Direct drying is low cost, high efficiency approach
- Water heating
- Steam
- Chilled Water

Applications

- Industrial
- District Heating and Cooling Energy Centers
- Emergency Power
- Medical
- Educational
- Data Centers

District Heating and Cooling "Energy Centers"

Heating and cooling loop are seasonal thermal loads.

- Use of heat driven chillers can increase load factor.
- Hot and chilled water systems inherently include thermal storage.
- Distribution system thermal losses create a steady baseload.
- Hot and chilled water systems provide opportunity for storage to match electric and thermal loads.

Local CHP Installations

University of Maryland, College Park

- 2 combustion turbines @ 10 mw + 1 steam turbine @ 7 MW; total capacity of 27 MW.
- Integrating campus emergency generators into system for peak shaving and demand reduction.

NIH, Bethesda

- 4 combustion turbines @ 4.5 MW + 1 reciprocating engine @ 5.6 MW; total capacity of 24 MW.

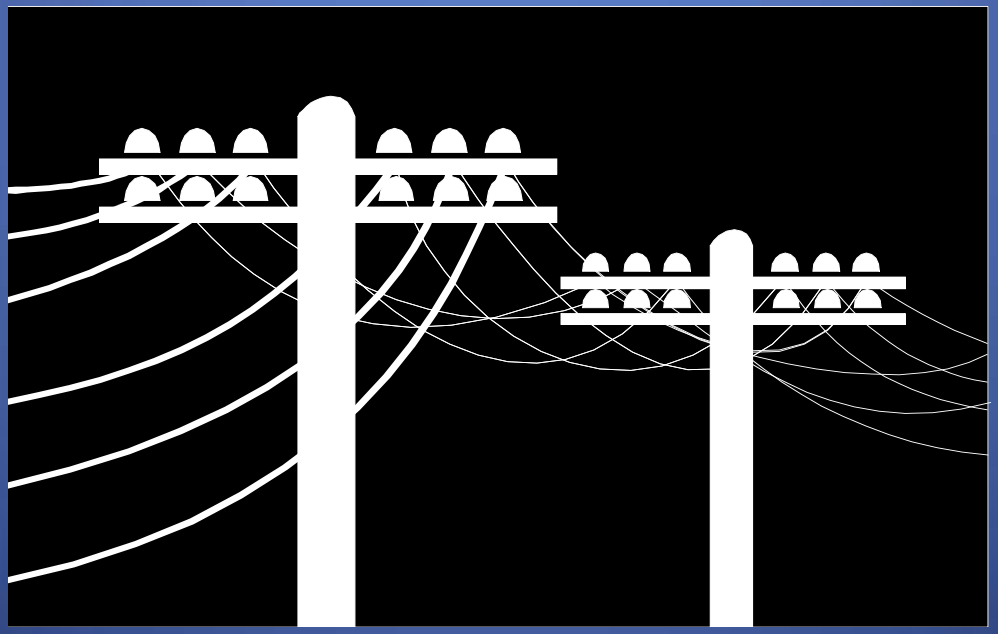
FDA White Oak, Bethesda

- 4 combustion turbines @ 4.5 MW + 1 reciprocating engine @ 9 MW; total capacity of 27 MW.

CHP Capacity Base (MW)

	Maryland	Virginia	District of Columbia
Total	836.0	2,189.0	10.0
Combustion turbine	54.3	11.3	10.0
Reciprocating Engine	15.3	29.7	0.0
Waste Fueled	217.7	180.0	0.0

Power Availability/Reliability MicroGrids



Power Quality and Availability

New technology availability requirements:

- Automated processes require six 9's - 99.9999%
- Integrated grid might provide four 9's - 99.99%

Power quality problems cost the US over $125 Billion annually. Problems include:

- outages
- voltage stability; sags and swells
- frequency deviation
- waveform distortion; harmonics, noise, transients

T&D Issues

T&D system is the cause of as many as 90%$^{+}$ power disruptions.

T&D vulnerabilities:

- Weather
- Congestion - Load grew 22%, capacity grew 4% over last ten years.
- Age
- Sabotage

Upgrading T&D is a lengthy and costly task.

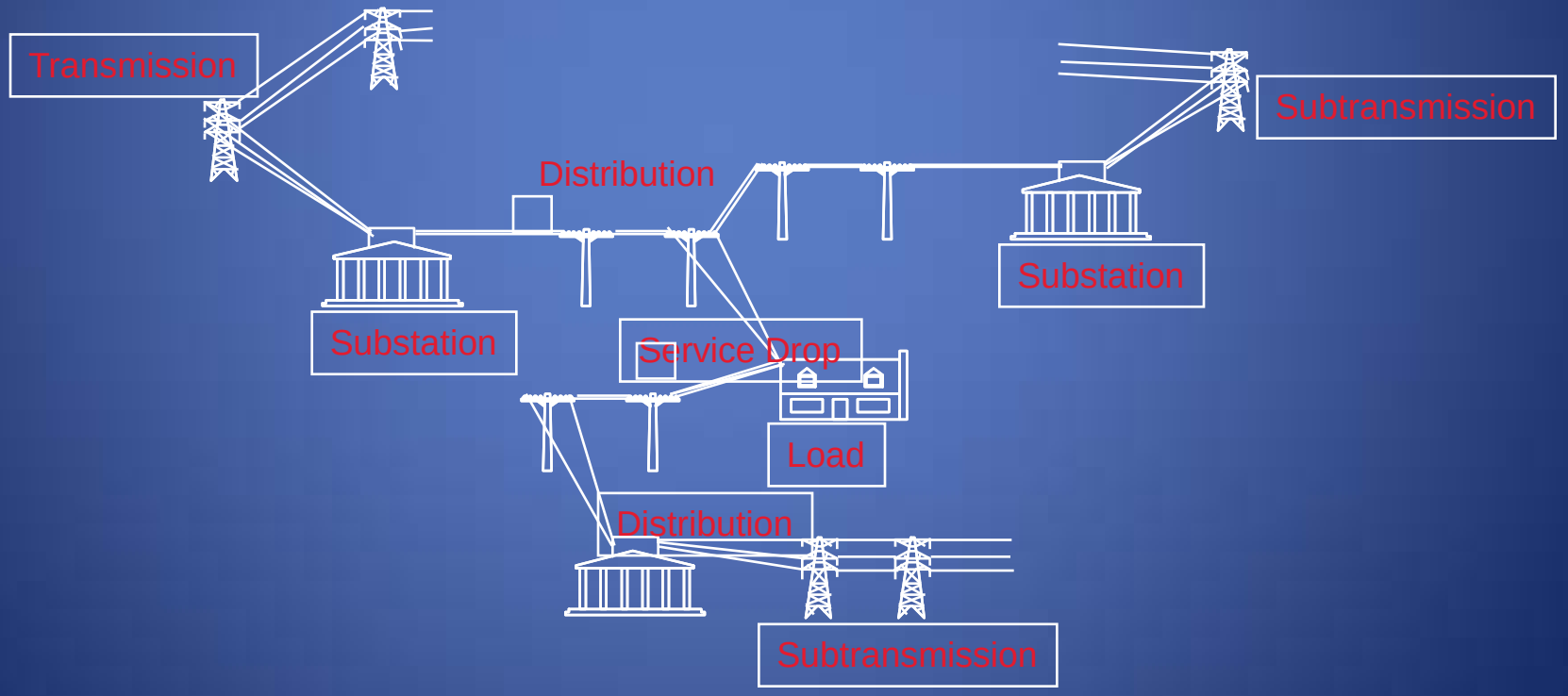
DG and MicroGrids

Localized grouping of electricity sources and loads that normally operates connected to and synchronous with the traditional centralized grid but can disconnect and function autonomously as conditions dictate.

- DG is key component
- Mitigate transmission and distribution system outages.
- Avoid peak cost grid electricity.

Network Distribution

Multiple paths between the end user and the the transmission grid or generation sources. Used in urban areas and for critical loads e.g. hospitals, universities, internet servers, etc.



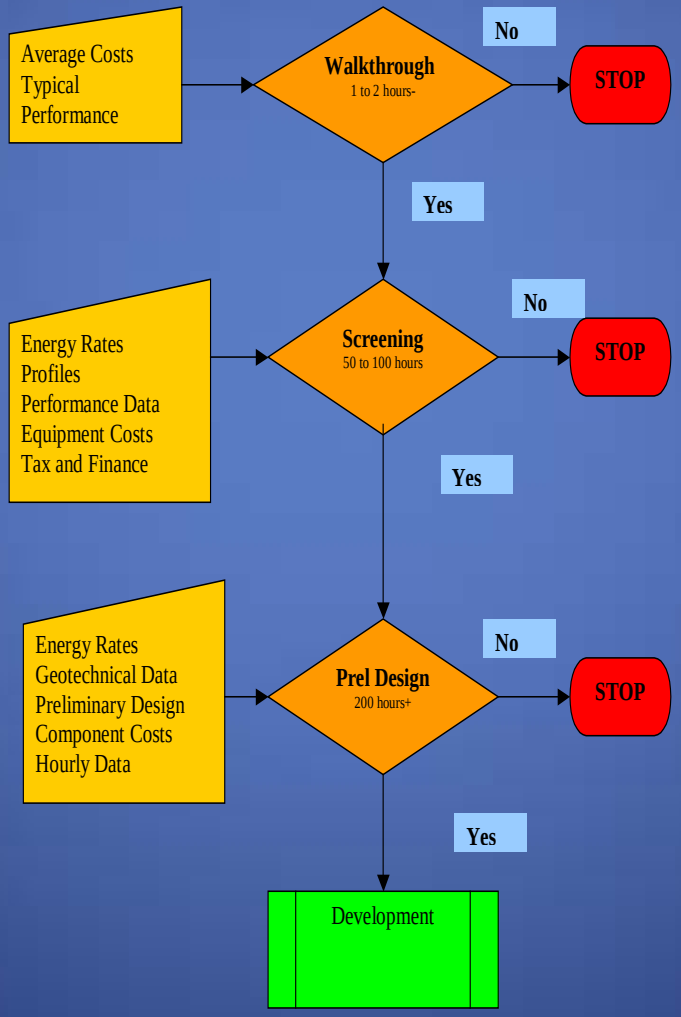
Four Steps to CHP

What to do next?

- Obtain more detailed information and answer to questions. Telephone session often good first step
- Walkthrough evaluation
- Screening study
- Preliminary design of system/financing study

How to Get Started

Decision Making Process



Walkthrough

The objective of the "walkthrough" is to screen a site to determine if it is a possible candidate for CHP, and requires at most a few hours.

- Economics; cost savings and payback time (estimates)
- Technical issues
- Existing conditions including infrastructure, zoning and environmental controls
- Space

Some Immediate Local Initiative

Include CHP in any renewable program

Require CHP evaluations as part of design of new/renovated local facilities.

Require emergency generators be equipped for parallel operation with grid as a demand reduction measure.

Questions

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