US DOE CLEAN ENERGY APPLICATION CENTERS

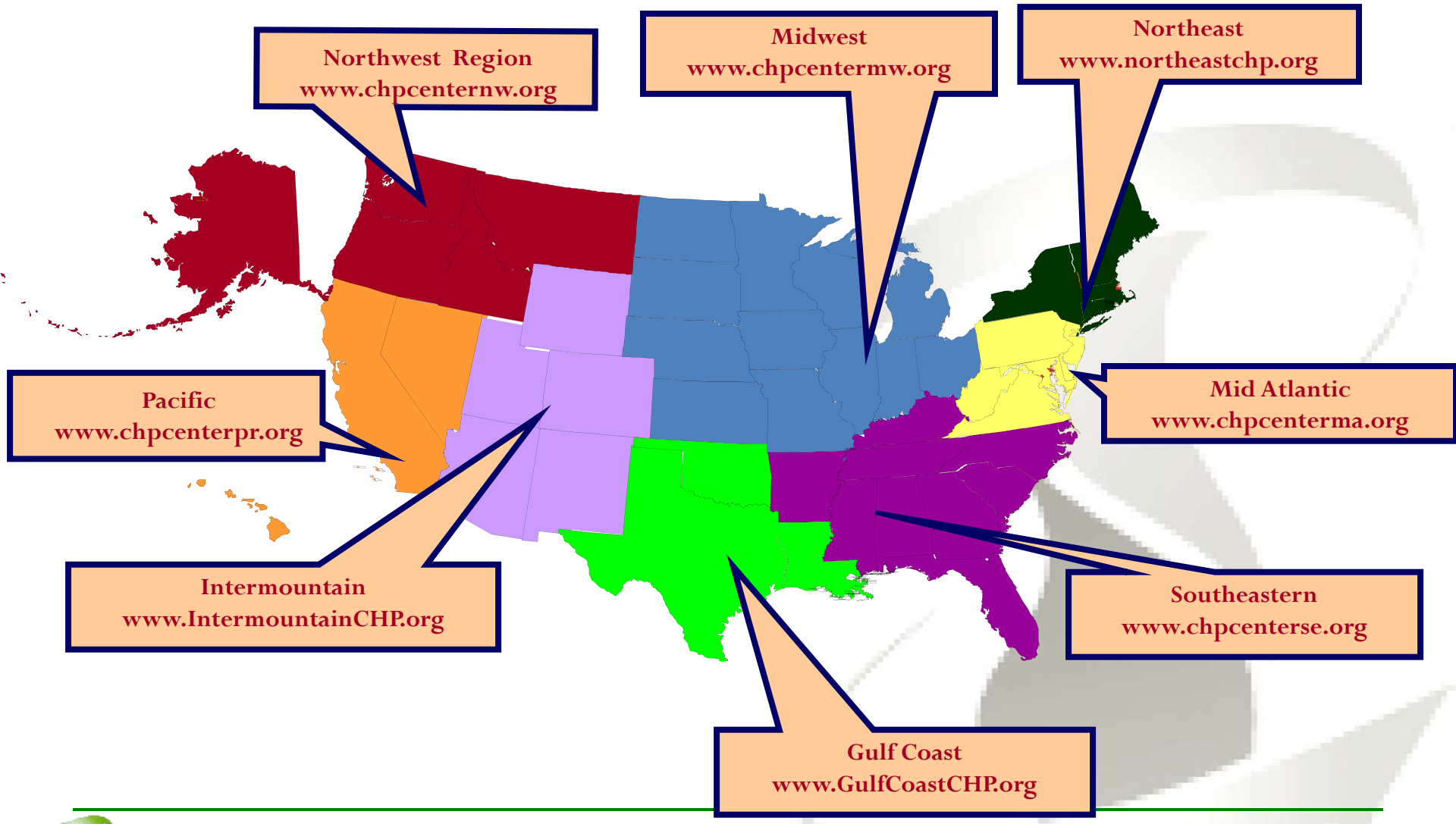
Intermountain Ski Area Association

June 9,2010

Alta, Utah

Regional Centers to Lead Deployment and Market Transformation

- Combined Heat and Power, Waste Heat, District Energy
- Educating stake holders to reduce perceived risk. *Regionally focused. Both technical and policy*
- Workshops, Webcasts, Website, Newsletters, Case Studies, Project Profiles, Resource Guides, Toolkits, Policy Briefs, ...
- Project specific support


Northwest Region
www.chpcenternw.org
Midwest
www.chpcentermw.org
Northeast
www.northeastchp.org
Pacific
www.chpcenterpr.org
Mid Atlantic
www.chpcenterma.org
Intermountain
www.IntermountainCHP.org
Southeastern
www.chpcenterse.org
Gulf Coast
www.GulfCoastCHP.org

U.S. DOE INTERMOUNTAIN Clean Energy Application Center

- States of Arizona, Colorado, New Mexico, Utah, and Wyoming
- Integration – Systems Approach to Energy
- Technology Focus
  - Combined Heat and Power
  - Waste Heat Use/Recovery
  - District Energy
- ETC Group, Salt Lake City, Utah
- Southwest Energy Efficiency Project (SWEEP) Boulder, Colorado

Activities

- Market assessment
- Education and outreach
- Coalition building
- Project support and facilitation
- Policy review and reform
- www.intermountain chp.org

U.S. DOE NORTHWEST Clean Energy Application Center

- States of Alaska, Idaho, Montana, Oregon, Washington
  - Industrial CHP operated in cooperation with the Department of Energy's Industries of the Future Program
  - District energy systems including HeatMap CHP software that is the international standard for district energy system design and re-design
  - Waste heat to power systems such as Kalina and Organic Rankine Cycle
  - Legal, institutional and regulatory aspects of CHP
- Washington State University Extension Energy Program

The Other Clean Energy

Combined Heat and Power, Waste Heat, District Energy

We Aren't Really Interested in Energy

Fossil Biomass Wind Solar
Geothermal Nuclear ….

We're Interested in What it Does

Snow Lifts Light HVAC ….

We "Manage" Energy in Silos

Fossil		Solar		Biomass	
Thermal	**Electrical**	**Thermal**	**Electrical**	**Thermal**	**Electrical**
Policy	**Policy**	**Policy**	**Policy**	**Policy**	**Policy**
Regulatory	**Regulatory**	**Regulatory**	**Regulatory**	**Regulatory**	**Regulatory**
Economics	**Economics**	**Economics**	**Economics**	**Economics**	**Economics**
Engineering	**Engineering**	**Engineering**	**Engineering**	**Engineering**	**Engineering**

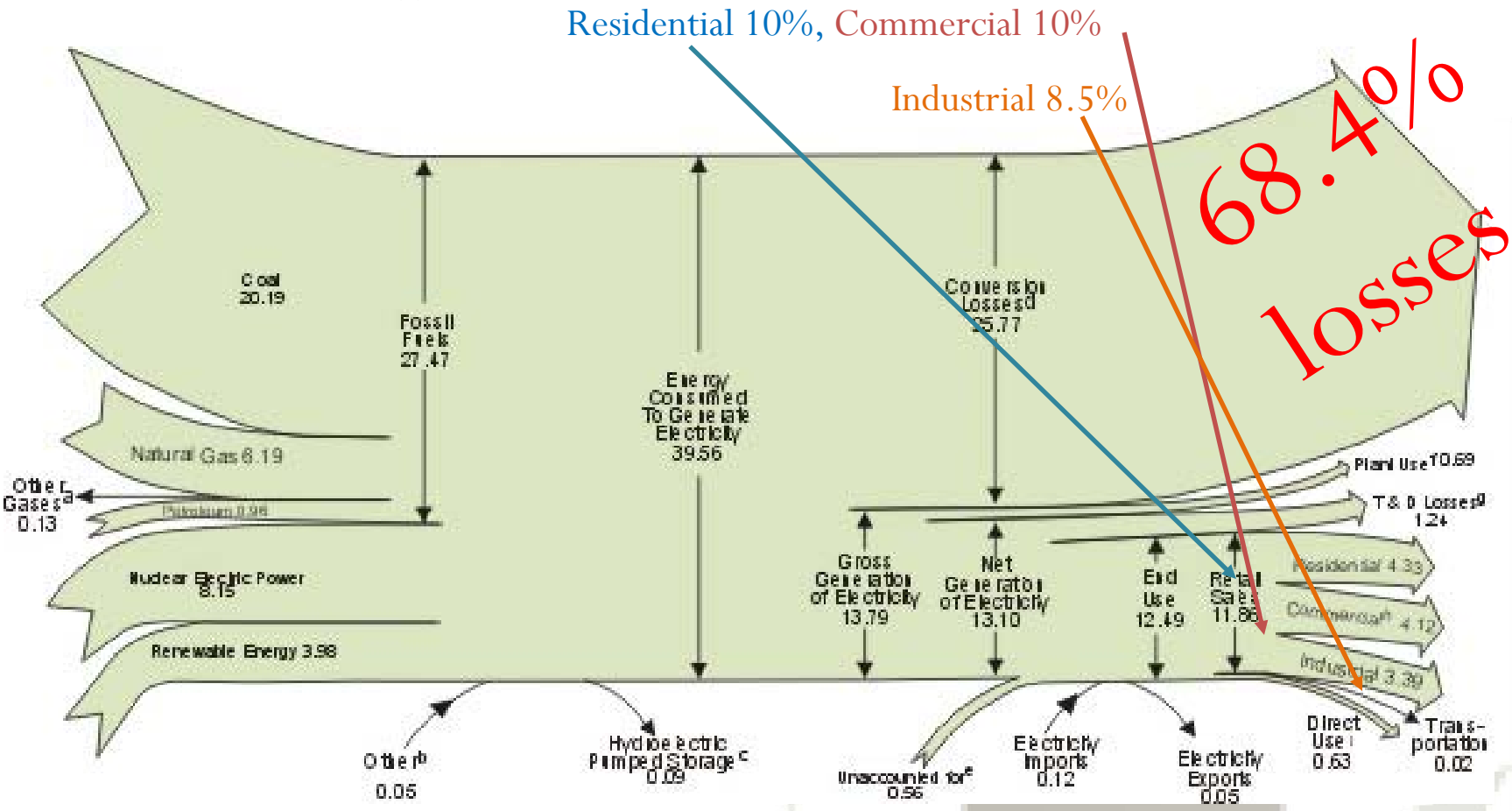
Efficiency is defined differently for EACH!!

Lack of integration creates waste

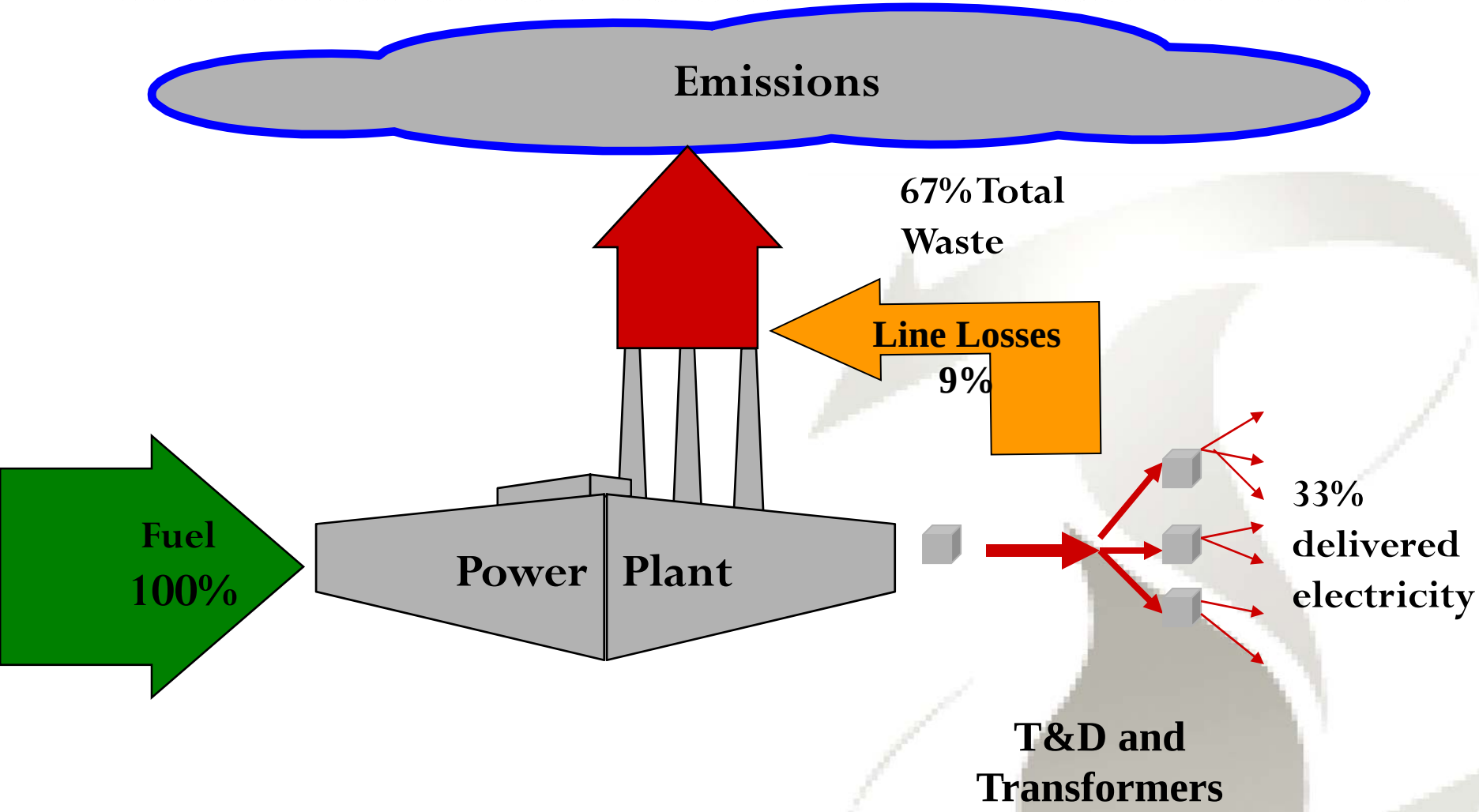
Inefficiency Increases Both Costs and Environmental Impacts of Energy Use

- This is true for the Supply side as well as the Demand side.
- A systems approach will
  - Integrate Supply Side and Demand Side
  - Integrate Electrical and Thermal Systems
  - Reduce Waste
  - Save Money
- The Other Clean Energy

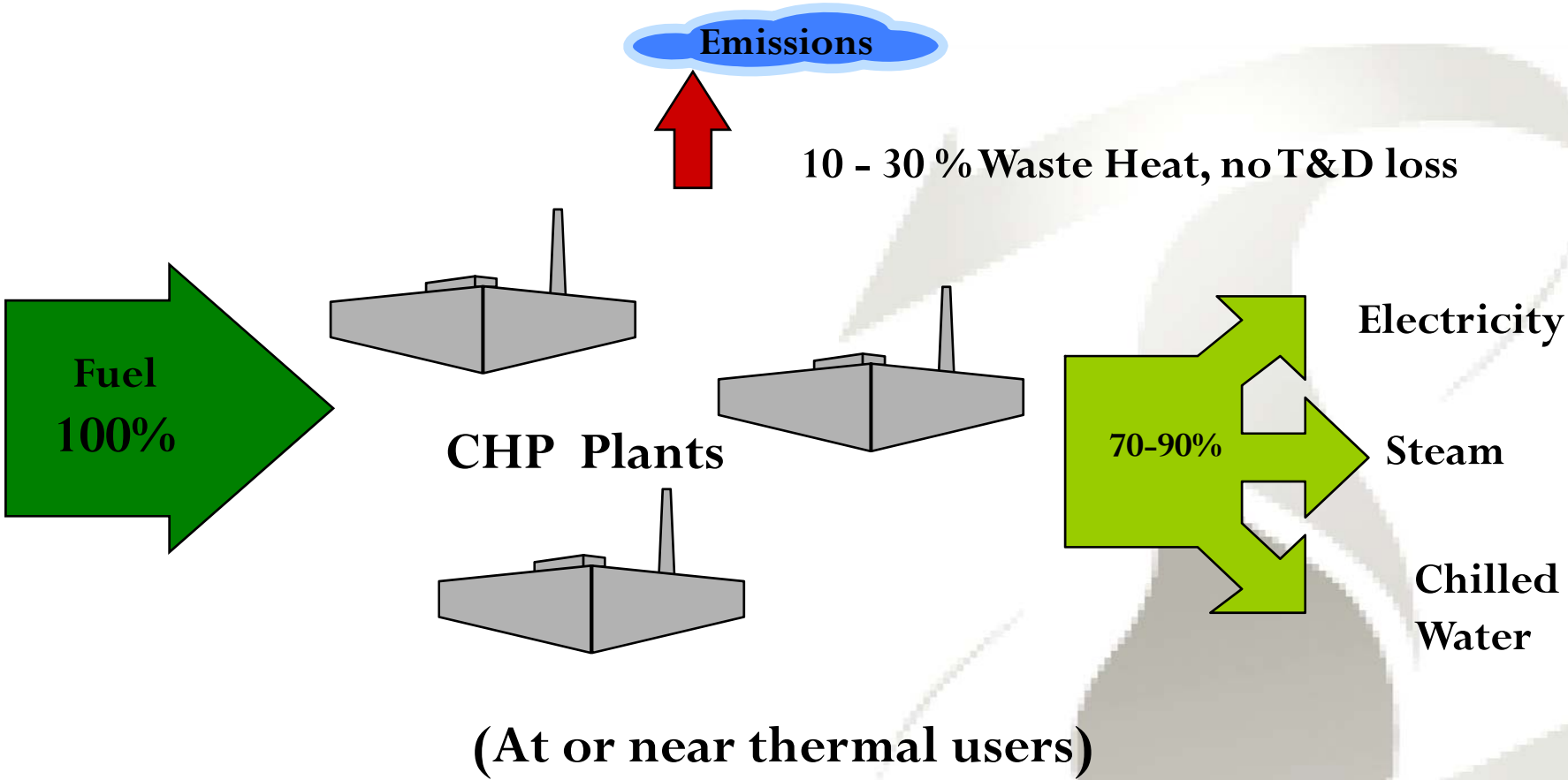
Electricity Generation and Use



Thermal and Electrical Loads in Silos



Integrating Thermal and Electrical Loads



Combined Heat and Power

- "Traditional" CHP
- Recycled Energy or Waste Heat CHP

CHP BASICS

Simultaneous production of electricity/mechanical power and heat (cooling) from one fuel input

- Why CHP - Benefits
- Cycles and Technologies
- Characteristics of favorable sites
- Evaluation steps

CHP Benefits- End User

- Energy savings
- Emissions reduction (source based)
- Reliability/Security of electric supply
- Power quality

CHP Benefits

- Emissions reduction
  - Over 50% reduction of CO2 to provide same electricity and thermal outputs
  - Other emissions, NO_x, SO_2, particulate, mercury….also reduced
  - EPA CHP Partnership developed an Emissions Calculator-rigorous, but easy to use, emissions benefit calculator
    - www.epa.gov/chp

Reliability benefits of DG, CHP

- August 2004 Blackout
- 50 million people, 61,800 MW (Ohio, Michigan, Pennsylvania, New York, New Jersey, and Connecticut)
- United States $4-$10 billion, Canada GDP down 0.7% in August
- Facilities with CHP systems
  - "The lights stayed on"
  - Hospitals, Food Processing, Multi family Commercial/Residential, Chemical/Pharmaceutical

CHP Fuels

- Traditionally, natural gas
- Waste heat (recycled energy)
- "Opportunity fuels": non-traditional fuels usually a by-product or waste product
  - Example: wood waste from forests or sawmills, industrial compounds with energy content, but little other value, digester or land-fill gas, agricultural wastes

CHP Cycles

- Power then heat
  - Need a gas or liquid fuel
- Heat then power
  - Can use solid fuel (coal, wood….)

CHP Equipment Types

- Engines (generation or direct drive)
- Gas Turbines (generation or direct drive)
- Steam Turbines (generation or direct drive)
- Organic Rankine-Cycle Turbines
- Microturbines
- Fuel Cells

CHP Equipment Types

- Engines 200 kW to 2000 kW
  - Electrical efficiency: 24-38%
  - Heat produced: 4-5000 BtuH/kW
  - Load-follows well
  - Good match for under 200F heating loads

CHP Equipment Types

- Gas Turbines 1,000 kW- 50,000 kW
  - Electrical efficiency: 24-36%
  - Heat produced: 5-6000 BtuH/kW
  - A little more heat, a little less electricity
  - Better match for steady base loads
  - Good match for steam heating loads
  - Lower capital and operating cost than engines

CHP Equipment Types

- Microturbines 30 kW to 200 kW
  - Electrical efficiency 25-30%
  - Heat produced 6-7000 BtuH/kW
  - A little more heat, a little less electricity than turbines or engines
  - Good match for hot water heating loads
  - New integrated systems for power & cooling
  - Higher capital cost per kW, similar operating cost to engines

CHP Equipment Types

- Steam Turbines 200 kW to 10,000 kW
  - Electrical efficiency: 15-40%
    - Condensing higher, backpressure lower
  - Heat produced: Varies widely
  - Load-follows well
  - Good match for existing steam system or when fuels are combusted in boiler (Need high pressure steam.)

CHP Equipment Types

- Fuel Cells 5 kW to over 1000 kW
  - Electrical efficiency 33-60%
  - Heat produced varies
  - No combustion, very low emissions
  - Very expensive, 3 times capital cost of engines/turbines

Waste Heat - Recycled Energy

- Recycled energy is useful energy derived from
  - Exhaust heat from any industrial process;
  - Industrial tail gas that would otherwise be flared, incinerated or vented; and
  - Pressure drop in any gas

CHP Evaluations

- Initial Screening
- Detailed Screening
- Engineering

Initial Screening

- Favorable Characteristics
  - High electric costs compared to CHP fuel cost i.e. large “spark spread”
  - Coincident thermal and electrical loads and/or
  - Significant and quantifiable reliability drivers
  - Significant capital upgrades to boiler systems0“in the works”
  - A place to put it!

CHP Evaluations

- Initial Screening
  - Drivers – what is most important
  - Thermal and electrical load evaluation
  - Fuel source(s) evaluation
  - Existing equipment evaluation
  - Equipment and load “matching” (size, high or low temp thermal load, top or bottoming cycle…
  - Dispatch - peak shaving” or “base load” operation is more favorable

CHP Evaluations

- Initial Screening (con't)
  - Select largest CHP system sized for high utilization for electric and thermal loads
  - Estimate operating costs and savings, capital costs
  - Screen in or out for further analysis

CHP Evaluations

- Detailed Screening
  - Can be done in multiple steps, with progressively more detailed and site-specific inputs
  - More accurately specify:
    - Load profiles, operating schedule, operating costs and savings, capital costs, non-economic benefits
  - Sensitivity and risk analysis on assumptions

CHP Evaluations

- Detailed Engineering
  - If detailed screening indicates favorable project, then expense of detailed engineering makes sense
  - Confirms or alters detailed screening
  - Produces drawings and specifications for bids

DOE Clean Energy Application Center Contacts

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