Distributed Energy Resources and Cooling, Heating and Power: Partnering for Success

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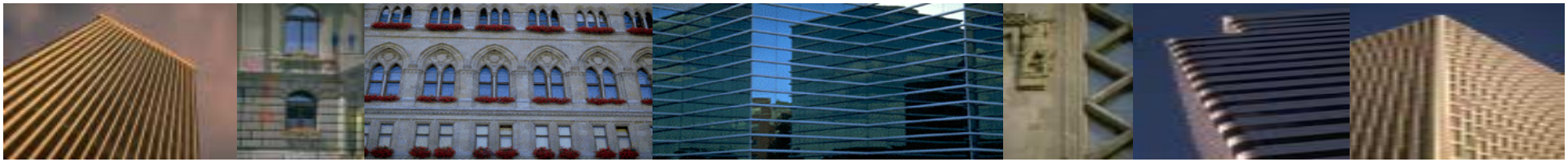


DER: The Issues

- Reliability of Power
- Efficiency of Resource Utilization

Distributed Energy Resources

a new century, a changing economy, new opportunities

Storage Systems

Reciprocating Engines

Microturbines

Photovoltaics

Fuel Cells

Wind

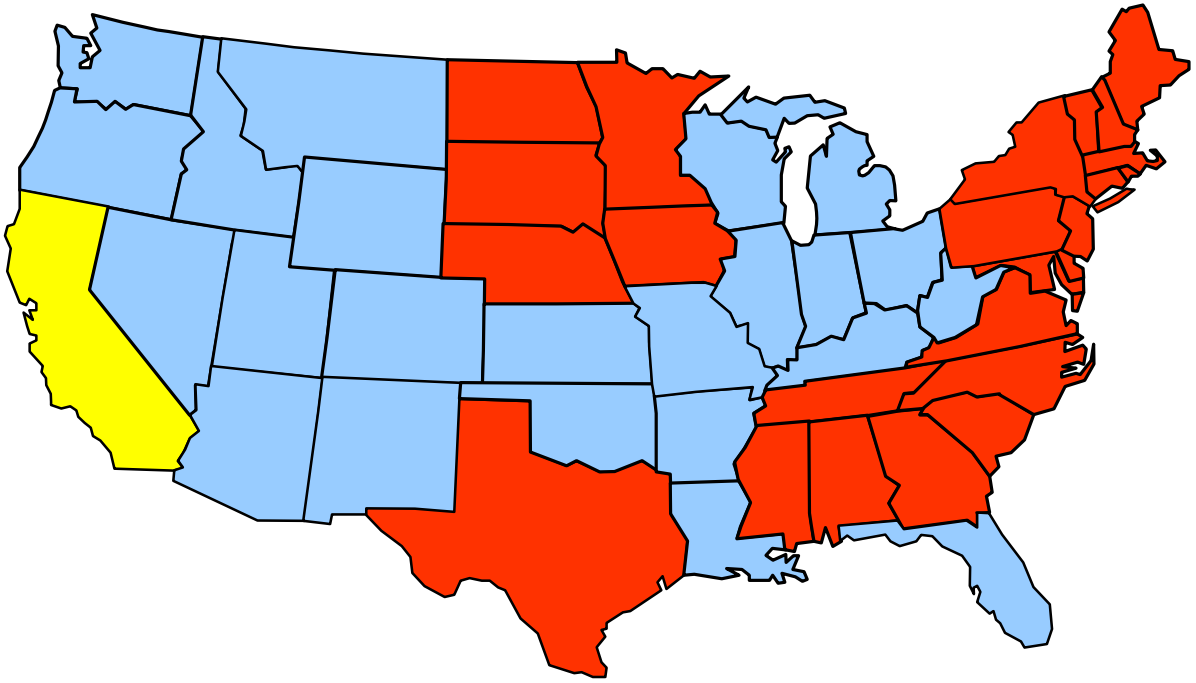
Thermally Activated Technologies

Grid Integration

Reliability Concerns

"**Local power outages doubled between 1996 and 1998 due to strong U.S. demand for electricity and deregulation**" -- *Wall Street Journal, March 16, 2000*

Areas with Capacity Margins < 10 percent



Distributed Energy Resources – A National Strategy

- Holistic approach (efficiency and reliable delivery)
- Federal leadership
- Technology development partnerships
- System infrastructure, interconnection support, policy coordination
- State/public education/outreach

Power Quality, Reliability Benefits of the DER Approach

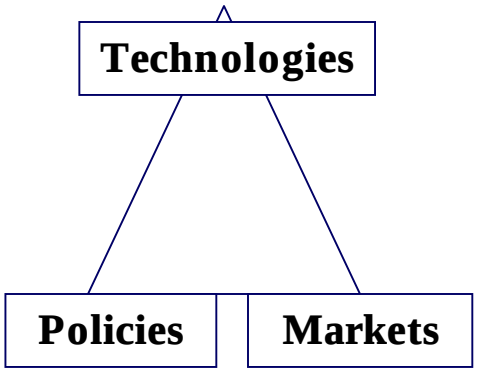
- It is estimated that power quality and power outages cost our economy about $26 billion in lost time and revenue –DER is the solution

- High power quality required for e-commerce – DER is the solution

- 99.99999 to 99.999999 percent reliability required to prevent large economic losses, but this is not required for entire grid – DER is the solution

The Federal Role

An Integrated Approach



Support RD&D in advanced energy technologies

Address regulatory and institutional barriers

Establish cost-shared partnerships with industry and others

The Ultimate Goal

A competitive marketplace for the expanded use of clean, efficient, reliable, and affordable energy resources

Resource Efficiency

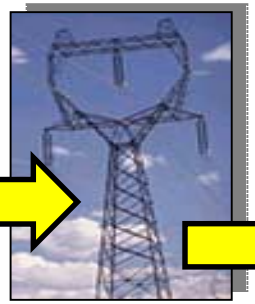
Efficiency of CENTRAL POWER GENERATION

100% 98% 32% 31% 29%

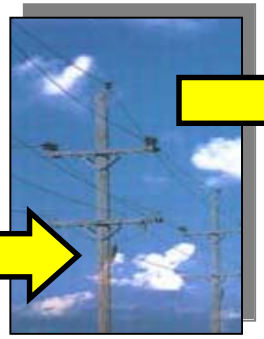
Natural Resource

Coal Power Plant

Transmission



Distribution



Delivered Efficiency of CHP

100% 91% 50% 80%

Natural Resource

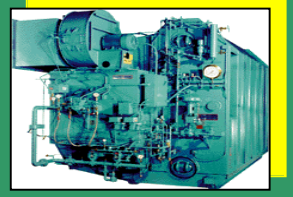
30% to 50% Electrical

or

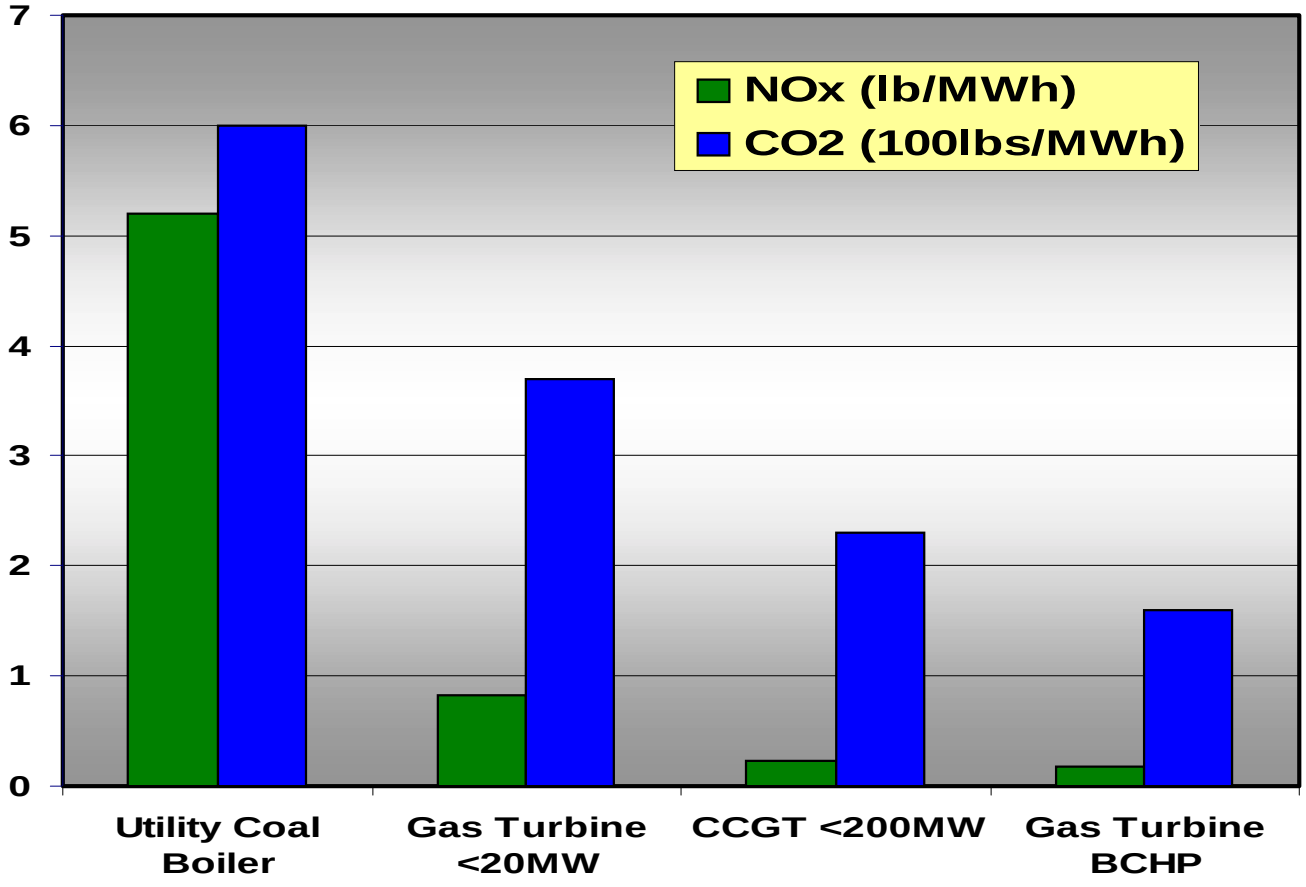
50% to 30% Thermal

BCHP POWER PLANT

End Uses



Emissions
Benefits of the DER Approach



The CHP Goal and Roadmap

CHP and BCHP Roadmapping Events

Date	Event	Location
December 1, 1998	CHP Summit	Alexandria, VA
March 1, 1999	CHP Data Workshop	Washington, DC
March 11-12, 1999	CHP Initiative Founders Meeting	Chicago, IL
June 1-3, 1999	CCHP Roadmap Workshop	Chantilly, VA
June 8-9, 1999	CHP Vision Workshop	Washington, DC
June 28, 1999	CHP Analysis Workshop	Washington, DC
October 6, 1999	Combined Heat and Power – A New York Perspective	Albany, NY
November 8-9, 1999	BCHP Technology Program Planning Workshop	Chicago, IL
November 10-11, 1999	Lake Michigan Regional CHP Roadmap Workshop	Chicago, IL
January 12-13, 2000	BCHP Process Workshop	Washington, DC
January 19-20, 2000	Northeast Regional CHP Roadmap Workshop	Piscataway, NJ
February 1-2, 2000	International Symposium on Combined Heat and Power	Washington, DC
March 20-21, 2000	Pacific Northwest Regional CHP Challenge Workshop and Exposition	Seattle, WA
March 20-21, 2000	BCHP Policy Workshop	College Park, MD
April 6, 2000	Upper Northeast CHP Workshop	Orono, ME
May 16, 2000	New Mexico Summit on Combined Heat and Power	Albuquerque, NM
August 14-15, 2000	Texas CHP Workshop	Houston, TX
October 12-13, 2000	National CHP Roadmap Workshop	Baltimore, MD

Thermally-Activated HVAC Technology are key to improving Overall Efficiency of DG

ORNL 2000-00054ldg

Distributed Generation Technologies

Thermally-Activated HVAC Technologies

800ºF

600ºF

360ºF

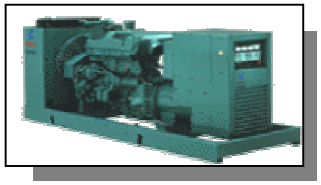
180ºF

Gas-turbine

Solid Oxide Fuel Cell

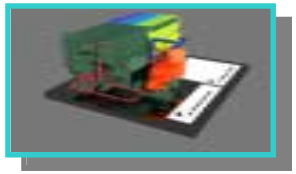
Micro-turbine

Commercial Phosphoric Acid Fuel Cell



I.C. Engine

Residential PEM Fuel Cell



Triple-Effect Absorption Chiller

Double-Effect Absorption Water-Cooled Chiller

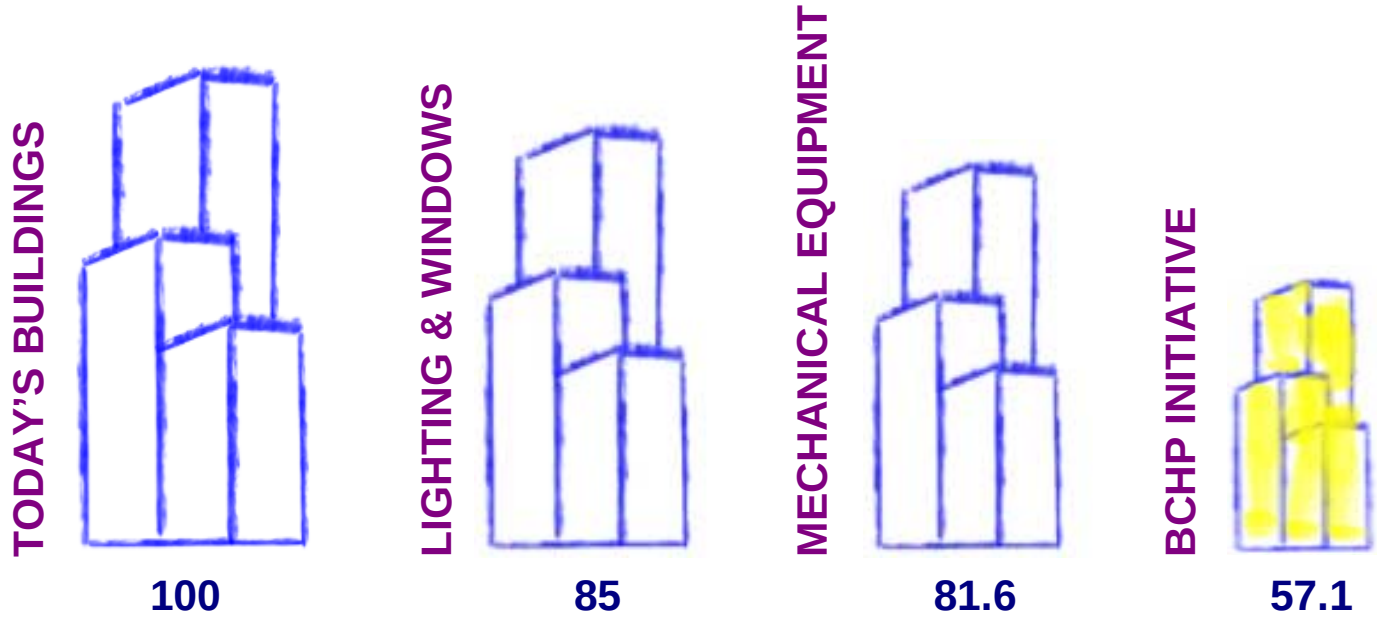
Single-Effect Absorption Chiller

Desiccant Technology

Recoverable Energy Quality (Temperature) and HVAC Technology Match

Efficiency
Benefits of the DER Approach

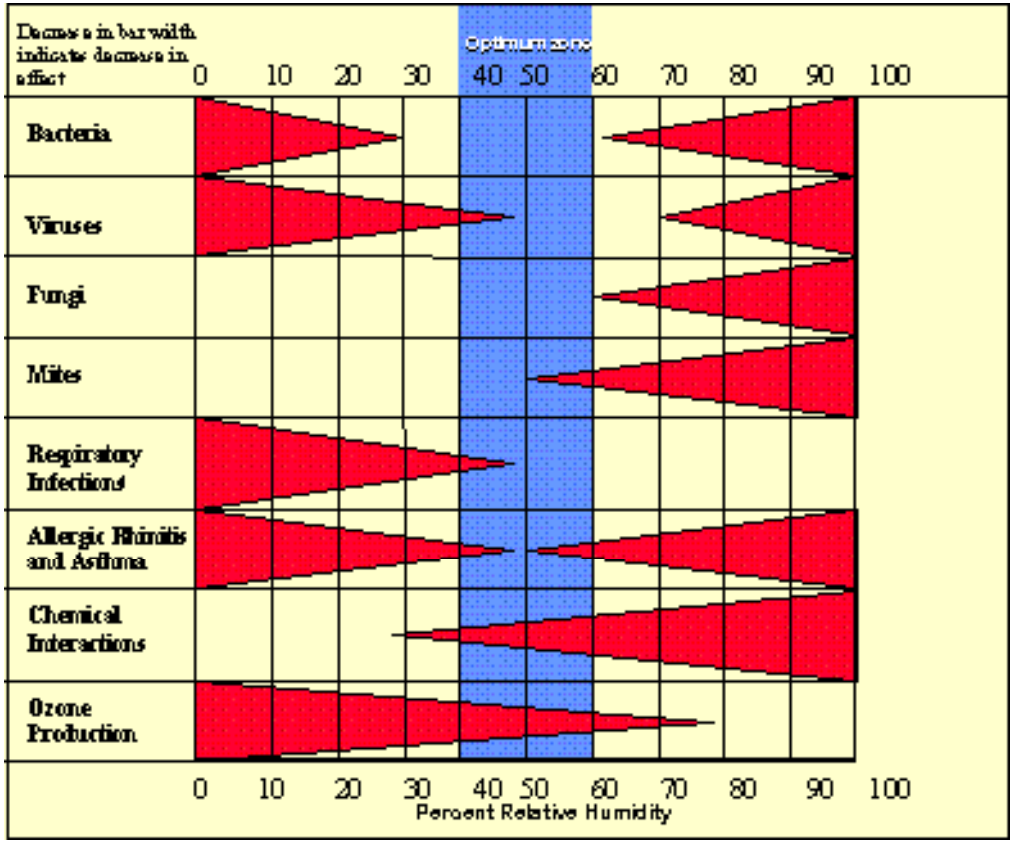
30 % Natural Resource Savings



% ENERGY USE vs STATUS QUO

Indoor Air Quality (IAQ) Benefits of the DER Approach

Buildings CHP Significantly Improves Humidity Control Through Recovered Energy Powered Desiccant Dehumidification and Steam Humidification



Early Markets Can Be Served with Available Equipment and "Engineered" Integration

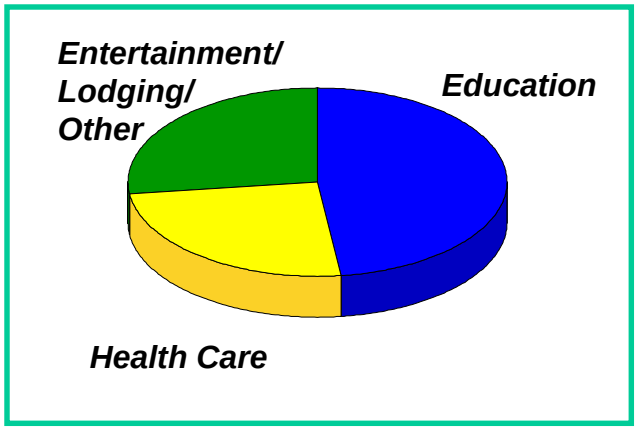
- 5 MW gas turbine system with heat recovery, chiller
- 1,000 RT double-effect absorption chiller
- Inlet air cooler uses 300 RT of CW output
- Operating since 1996
- O&M costs reduced from $3 million /yr "pre-BCHP" to $2 million/yr

OPRYLAND Hotel and Convention Center

Case Study provided by:
IC Thomasson Associates, Inc.
Consulting Engineers
Nashville, Tn

Assessing BCHP Application Opportunities involves Several Energy, Economic Factors

- Match of thermal and power load profiles
  - Use of byproduct thermal energy
- High occupancy with services needed round-the-clock or multiple shifts
- Common-ownership buildings complex/ campus for scale + load diversity
- Owner-occupied vs tenant leased
- Close proximity of DG energy conversion and thermal services "user"



Reflected in current (3500 MW) Building Sector CHP Use

- *College campuses*
- *Hospitals*
- *Hotel complexes*

Turbine-based CHP Developing "Track Record" in Universities

- Vanderbilt University
- Middle Tennessee State University
- Clemson University

University CHP Installations Include

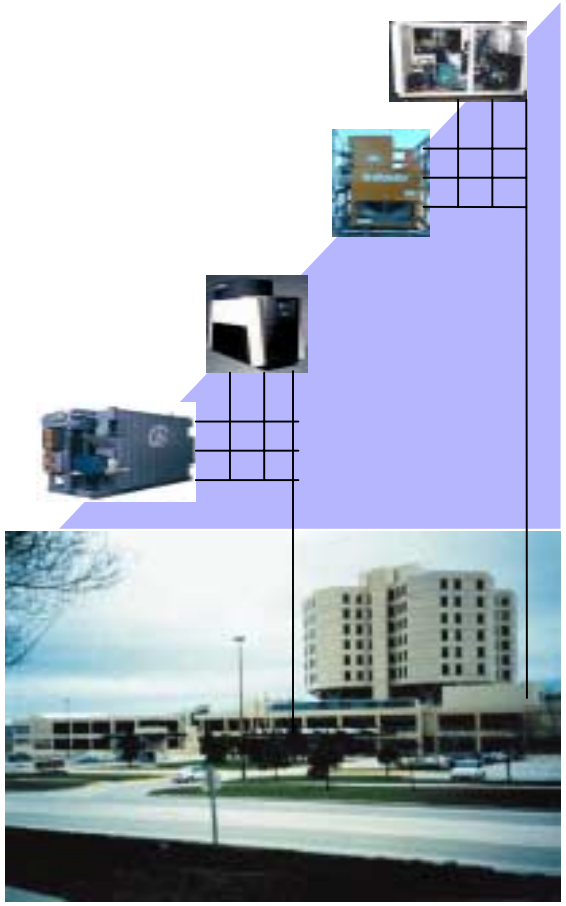
•5 MW-class turbines, heat recovery SGs, 1000-ton absorption chillers, upgraded distribution (P,S,CW) systems

- some replace old coal-based powerhouses, reduce emissions 20-80%

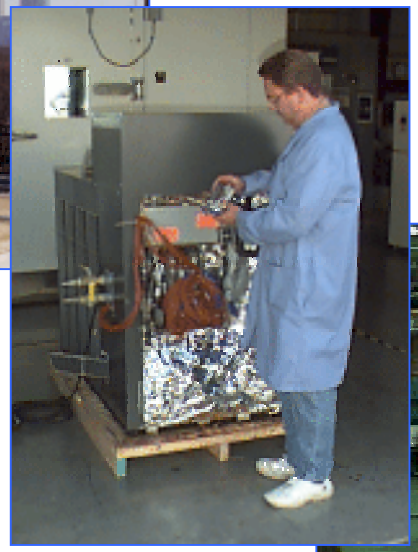
Mechanical/Electrical Systems Vision

2000: Discrete systems

2010: Efficient building integrated systems

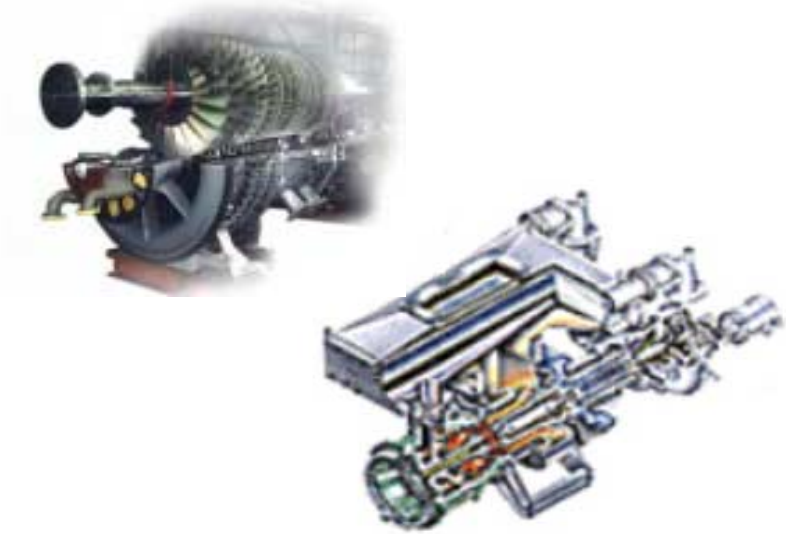


Technology Under Development: To Serve 2002 - 2010 Market Needs



Next Generation Gas Turbine Vision

2000: First generation advanced gas turbine @ 4,500 kW



2010: Broad product lines of cost reduced advanced gas turbines

Microturbine Vision

2000: First generation microturbines ~ 22-25 % efficient & $1,000 / kW

2010: Advanced microturbines ~ 35% efficient equipment (LHV) & $500 / kW equipment price

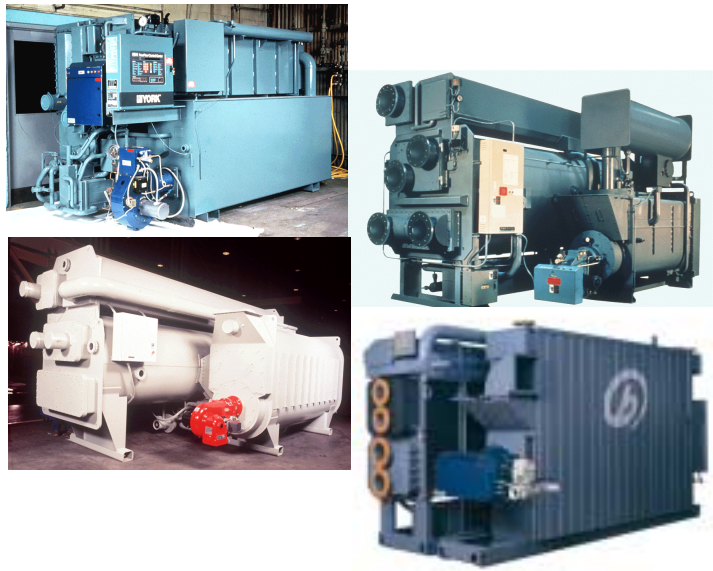
Fuel Cell Vision

2000: First generation fuel cells $3,500 / kW & low temperature recoverable energy

2010: Advanced fuel cells ~ $1,000 / kW equipment price & high temperature recoverable energy

LiBr Absorption Chiller Vision

2000: Good technologies, but limited penetration



2010: Broad market penetration through 25% cost reduction 30% more efficiency and integration with BCHP systems

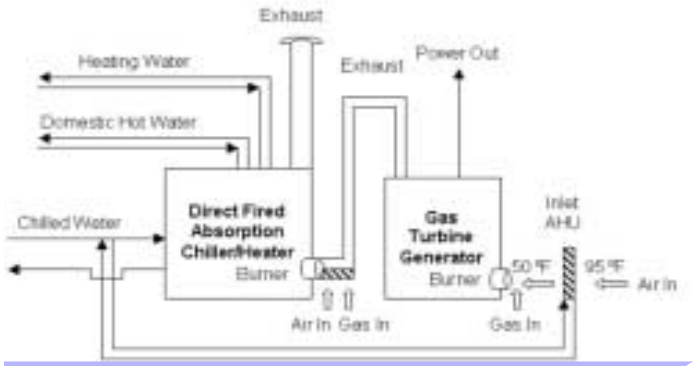
Desiccant Dehumidifier Vision

2000: Niche market equipment for high value humidity control applications

2010: Mainstream humidity control using new solid desiccant materials & new liquid technologies resulting in 50% cost reductions

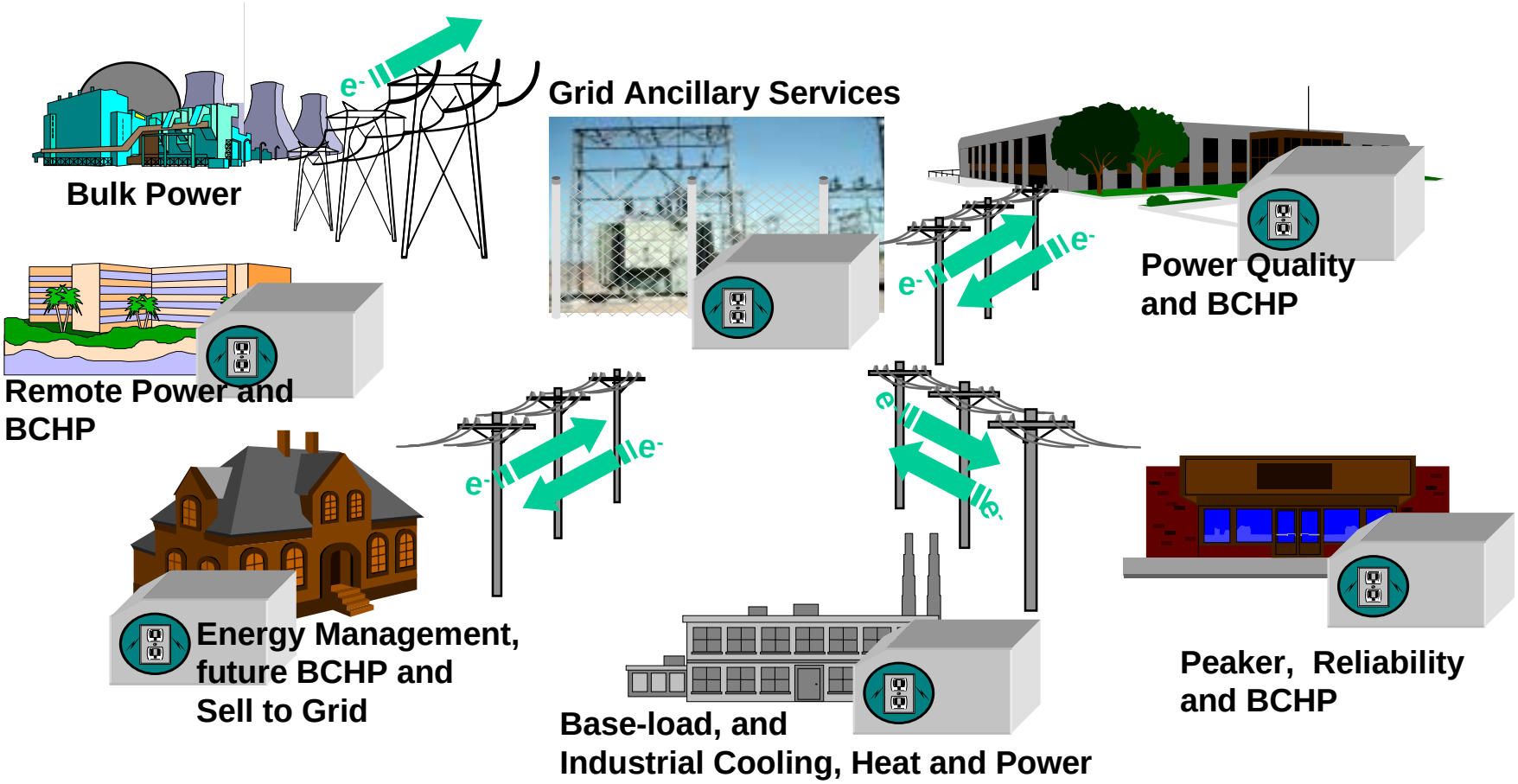
BCHP Vision
Packaged System Integration

2000: Individually optimized products



2010: BCHP optimized systems

A Distributed Energy Future



DER Strategy
Federal Coordination

Partnership

- Industry leadership is essential.
- DG and BCHP technologies are ready today to be applied.
- Take advantage of IDEA-DOE partnership potential
  - case studies - document benefits
  - add field monitoring of installations
  - technical assistance in CHP evaluation
  - joint R&D initiatives
  - institutional and regulatory barriers