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# A River of Energy Solutions

## Combined Heat & Power Systems - Distributed Energy for Mitigating Energy Security Risks

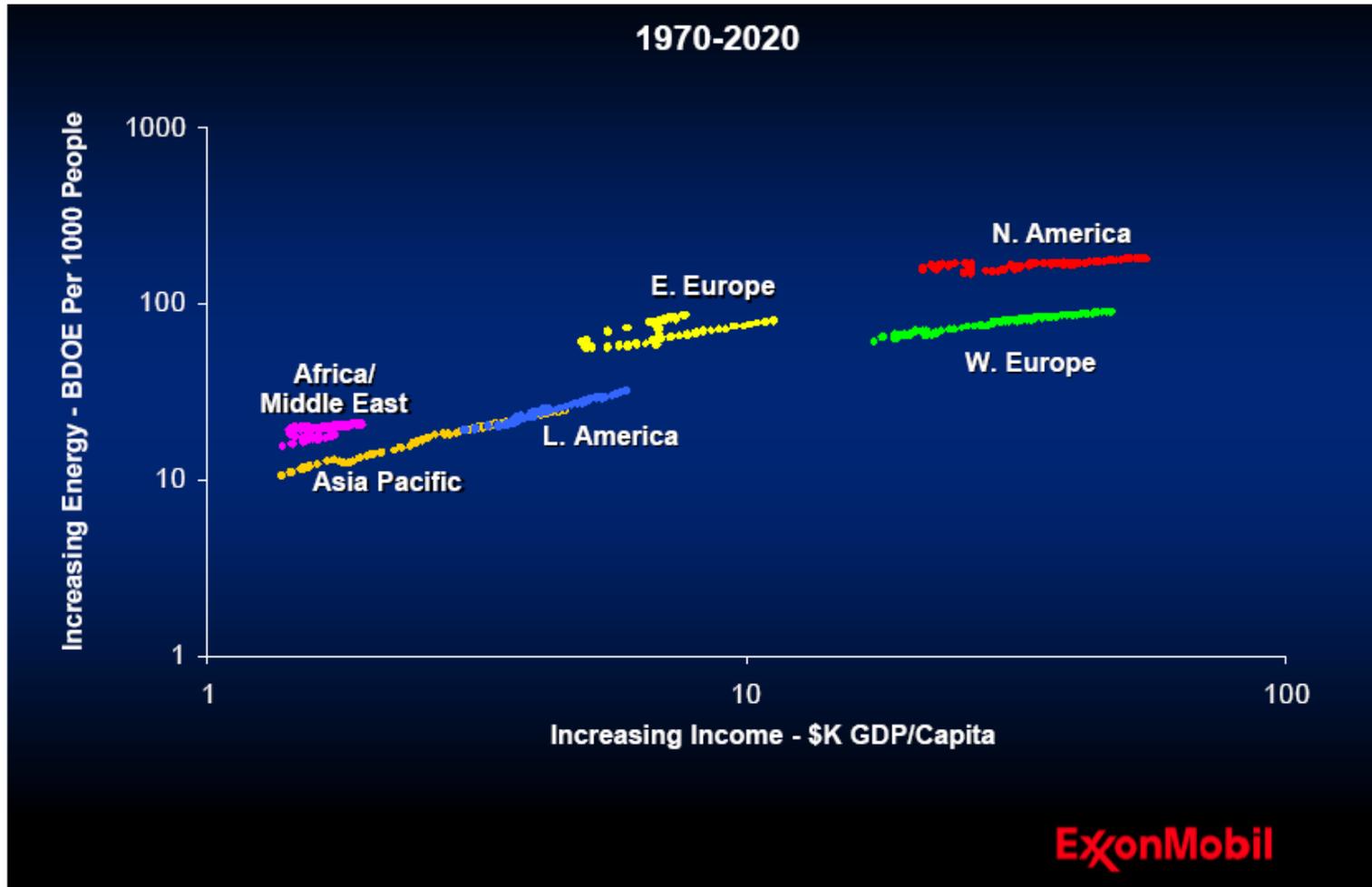
Bob DeVault

# Energy is the defining challenge of our time

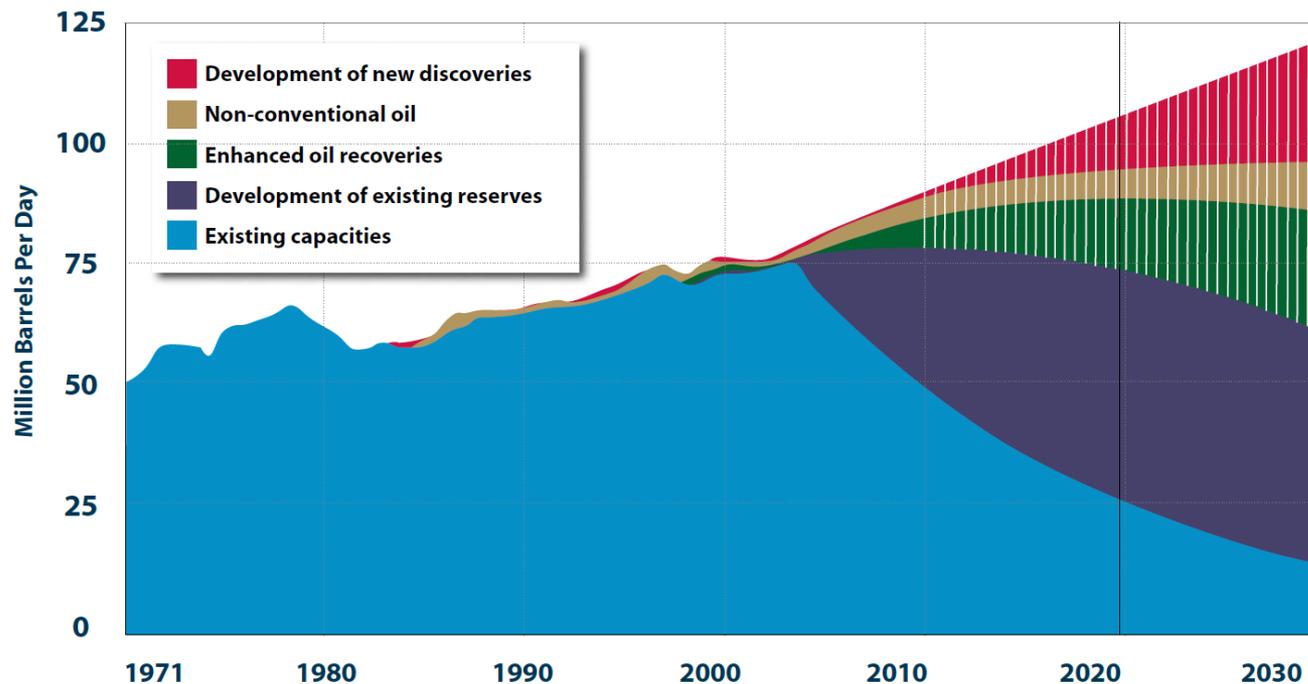
Global energy consumption will increase 50% by 2030

- The major driver for
  - Climate change
  - National security
  - Economic competitiveness
  - Quality of life
- Incremental changes to existing technologies cannot meet this challenge
  - Transformational advances in energy technologies are needed
  - Critically dependent on the best science and technology

# Energy and GDP Growth Closely Linked



# World Oil Peak – is it near?



**FUTURE WORLD OIL PRODUCTION**

SOURCE: International Energy Agency - World Energy Outlook, p. 103

PART III: TRENDS INFLUENCING SECURITY

“By 2012, surplus oil production capacity could entirely disappear, and as early as 2015, the shortfall in output could reach nearly 10 MBD.”

# Energy Information Administration (USDOE)

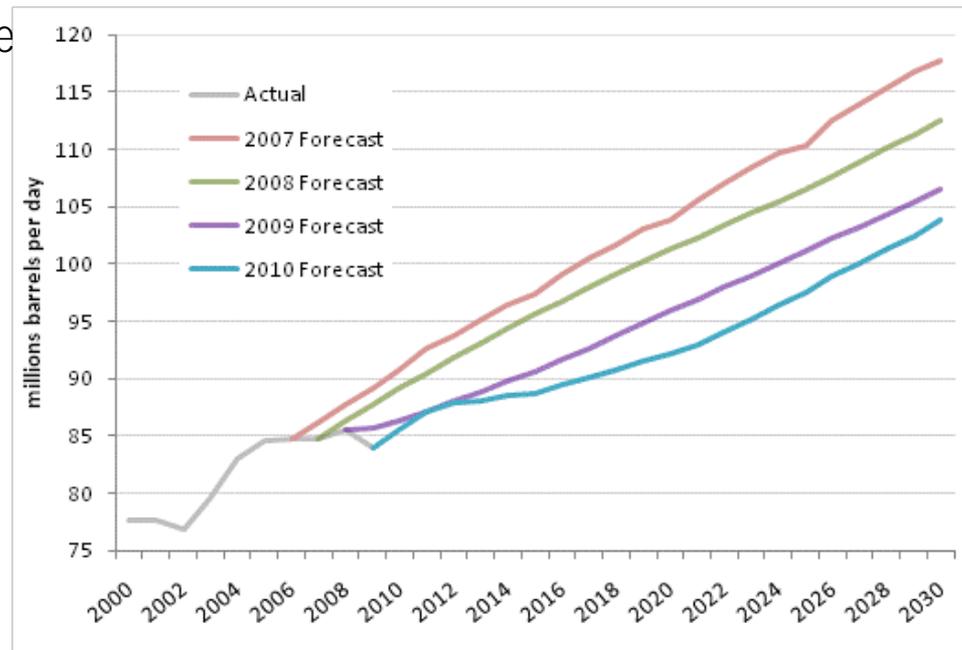
## – “Rosy Future” Reconsidered

- The EIA, the statistics arm of the US Department of Energy, recently released its [International Energy Outlook \(IEO\) for 2010](#).

- The IEO is a touchstone for the energy industry and is treated as the authoritative government forecast in the press and in capital raising documents like prospectuses.
- It influences policy-makers, the media, public opinion and investors.
- What it says matters.

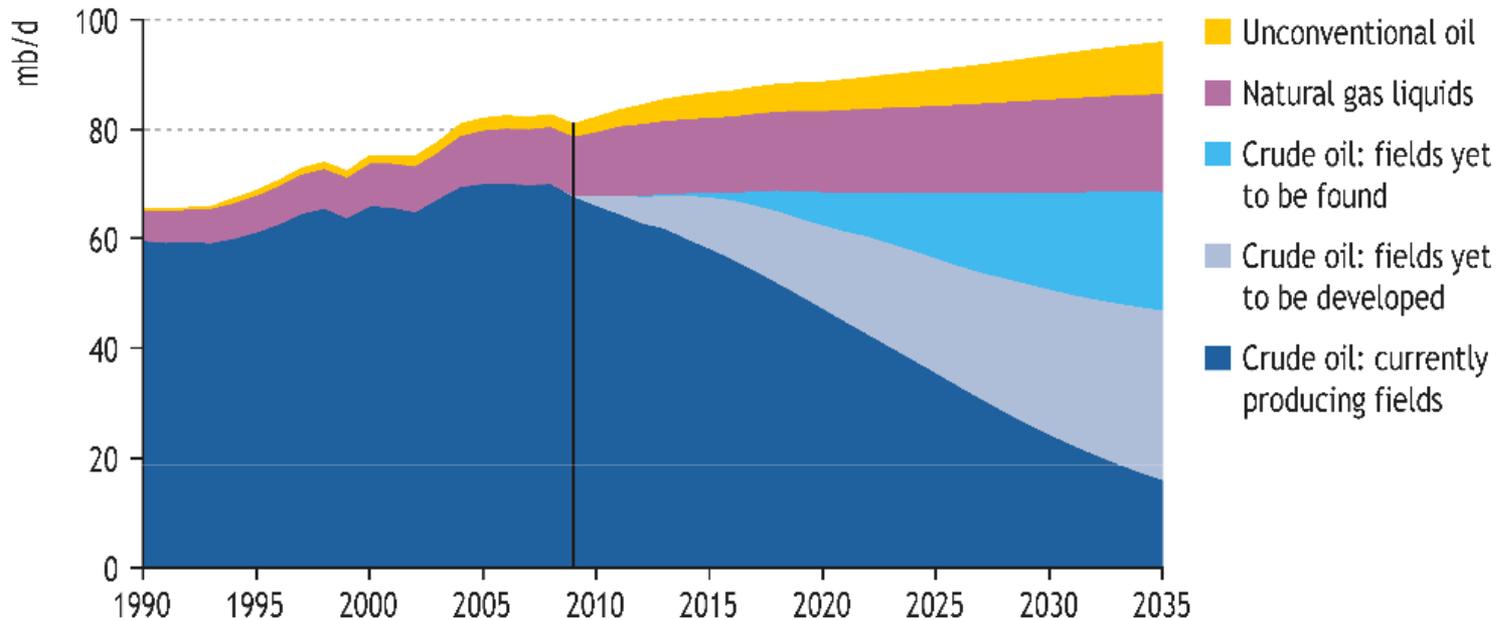
And what does it now say?

- That peak oil is all but on us.



# IEA: Conventional Oil Production May Already Have Peaked (~ 2006)

## World oil production by type in the New Policies Scenario



“The IEA is forecasting for the first time that the global crude oil production peak has in fact already been reached more than four years ago, in 2006.”<sup>2</sup>

Sources: (1) <http://www.energybulletin.net/stories/2010-11-11/iea-acknowledges-peak-oil>  
 (2) [http://www.liveoilprices.co.uk/oil/peak\\_oil/11/2010/iea-forecasts-that-peak-oil-production-started-in-2006.html](http://www.liveoilprices.co.uk/oil/peak_oil/11/2010/iea-forecasts-that-peak-oil-production-started-in-2006.html)  
 (3) International Energy Agency: “World Energy Outlook 2010”; [www.iea.org](http://www.iea.org)

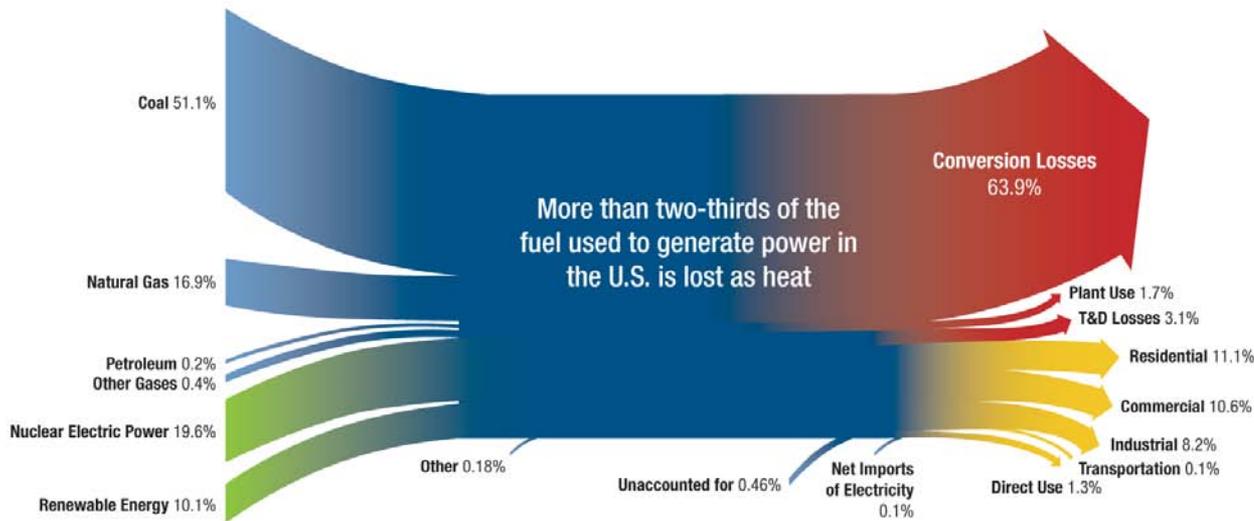
# Combined Heat and Power and Distributed Energy



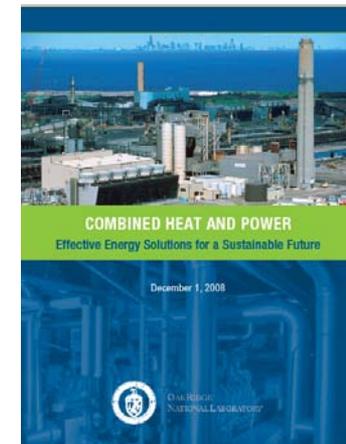
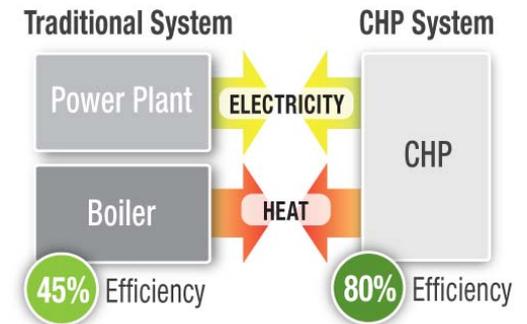
**Pathway to Large Energy Efficiency Improvements, CO<sub>2</sub> Reductions, and Energy Security**

# The Case for CHP

– Capturing Wasted Energy, Improving Energy Efficiency and Reducing CO<sub>2</sub>



CHP Process Flow Diagram

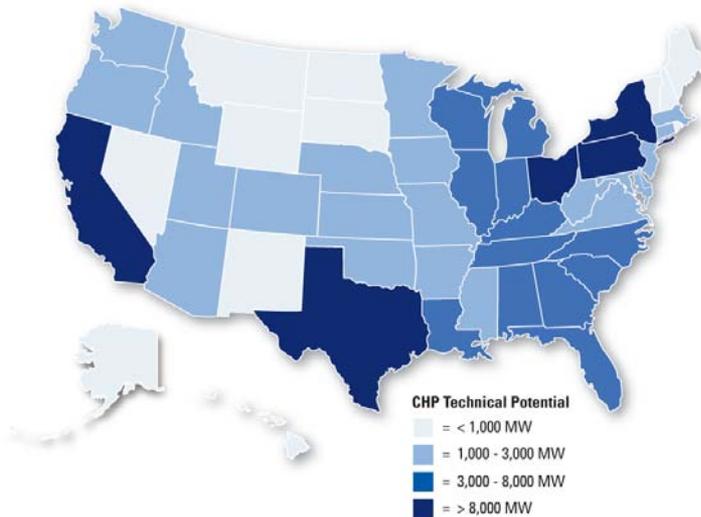


# CHP Is Broadly Applicable Across the US

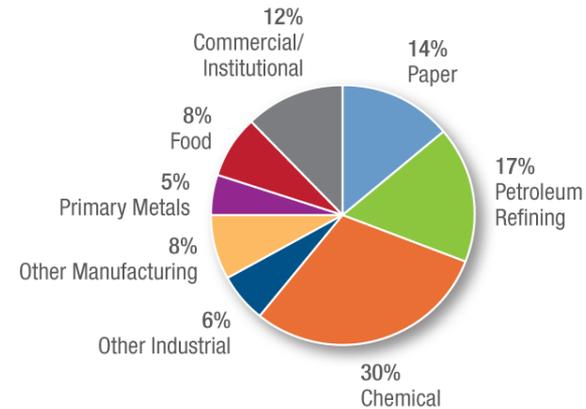
2006 CHP Electricity Generating Capacity	85 GW*
Annual Energy Savings	1.9 Quads
Annual CO <sub>2</sub> Reduction	248 MMT
Number of Car Equivalents Taken Off Road	45 million

\*9% of 2006 US Electricity Generating Capacity

Remaining Technical CHP Potential



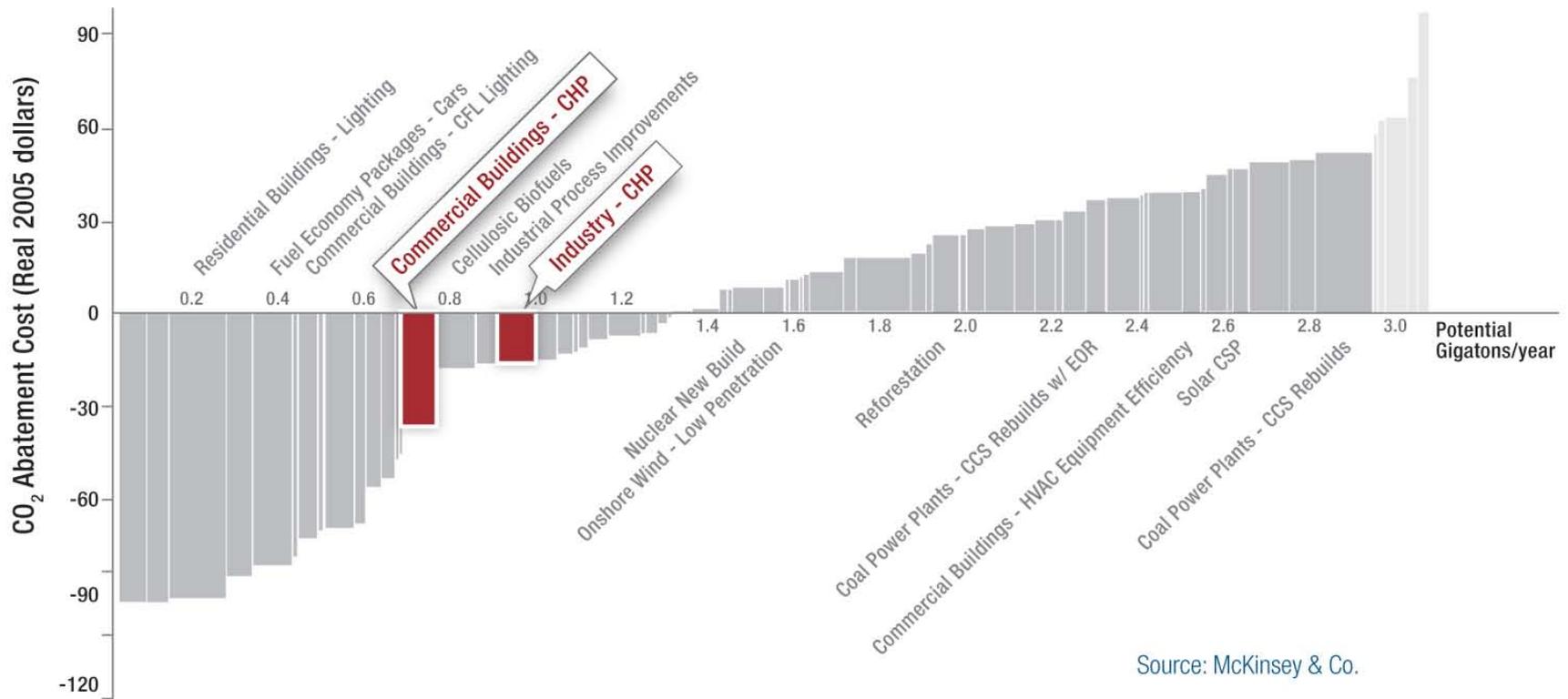
Existing CHP Capacity by Application



Source: EEA, Inc. CHP Installation Database.

# CHP as a Current GHG Mitigation Approach

Cost of CO<sub>2</sub> Reduction Technologies

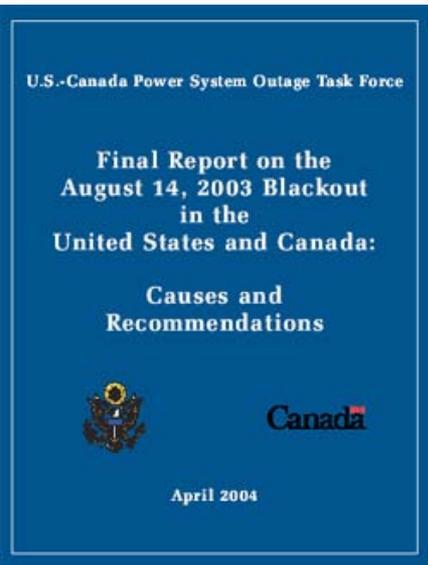
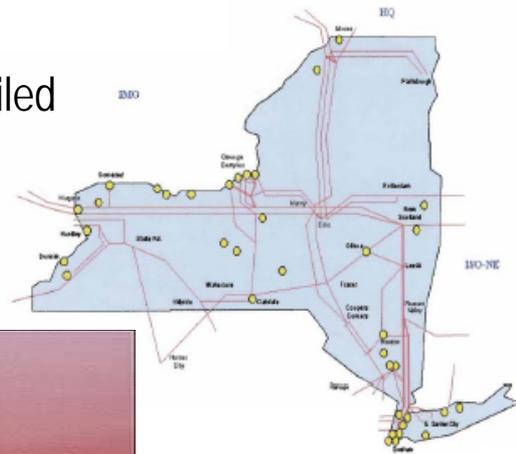


Source: McKinsey & Co.

# Lessons Learned from August 2003 Blackout

- Grid and population are vulnerable to large-scale disruption
  - 50 million North Americans affected
  - Cell phones inoperable
- Cost as much as \$6 billion NYC, NYSERDA and DOE post-blackout reviews:
  - Many emergency backup generators failed (e.g. for hospitals and communications)
  - CHP systems performed as designed

Initial Report  
*by the*  
New York State  
Department of Public Service  
*on the*  
August 14, 2003  
Blackout



February 2004



# Hurricane Katrina – One Hospital Fully Operational

## The Calm in the Storm

Baptist Memorial Hospital in Jackson, MS, has a 4.3-MW, natural gas-fired CHP system that enabled the hospital to remain open during Hurricane Katrina, which hit the area August 29, 2005. It was the only hospital in the metro Jackson area to be fully operational during the crisis. It treated a high volume of patients and provided food and housing for displaced patients. In normal circumstances, the CHP system meets almost 100 percent of the electricity needs and 60 percent of the chilled water needs at Baptist Memorial. It also provides an average utility cost avoidance of \$738,000 annually.



**Baptist**  
HEALTH SYSTEMS  
*The Spirit of Healthcare*



**BAPTIST.**  
MEMORIAL HEALTH CARE

# Dell Children's Medical Center First LEED Platinum Hospital

- The CHP system at Dell Children's Medical Center made it one of the first grid-independent hospitals in the nation.
- In 2009 the Dell Children's Medical Center became the world's first hospital to be awarded Leadership in Energy and Environmental Design (LEED®) Platinum Certification by the U.S. Green Building Council.
- The CHP plant contributed 8 out of a possible 10 Energy & Atmosphere Credit points toward that certification.



**With more than 150 beds, the Dell Children's Medical Center in Austin, Texas, uses an on-site 4.6 MW Mercury 50 recuperated turbine generator set from Solar Turbines to meet hospital process loads, including chilled water for thermal energy storage (TES) and steam for heating and other process needs. The Burns & McDonnell-designed CHP system allows the hospital to operate at 70 percent fuel efficiency and to dispatch excess electricity onto the grid after its own needs are met.**

**Photo courtesy of Solar Turbines**

Reference and picture courtesy of US  
DOE: "COMBINED HEAT AND  
POWER: Effective Energy Solutions  
for a Sustainable Future "

# Hospital Support

- 56 sites with medical centers/hospitals assisted
  - DOD and VA
- Multiple Technologies Evaluated/Reviewed
  - Gas Turbines
  - Internal Combustion Engine (Reciprocating Engines)
  - Microturbines
  - Fuel Cells
  - Steam Turbine (Combined Cycle) Applications
  - Biomass Opportunities (Alternate Fuels)
    - Landfill Gas
    - Biogas
    - Wood Residue
    - Biodiesel
    - Municipal Solid Waste
  - Waste Heat Boilers (not CHP)

# Hospital Support - continued

- Operating Strategies Identified
  - Electric vs. Thermal Demand
  - Base Load vs. Peaking
- Utilization of Waste Heat – Critical Component
  - Space Heating (Steam, Hot Water)
  - Service Hot Water
  - Domestic Hot Water
  - Desiccant Applications
  - Absorption Chillers

# Factors for Successful CHP Application

- Technologies and Fuels
  - Hospitals have intense electrical loads
- Utilization of Waste Heat
- Right-sizing Equipment
- Reliable, High Quality Power
  - “Island” for Grid Independency



# DOE Combined Heat and Power Assistance

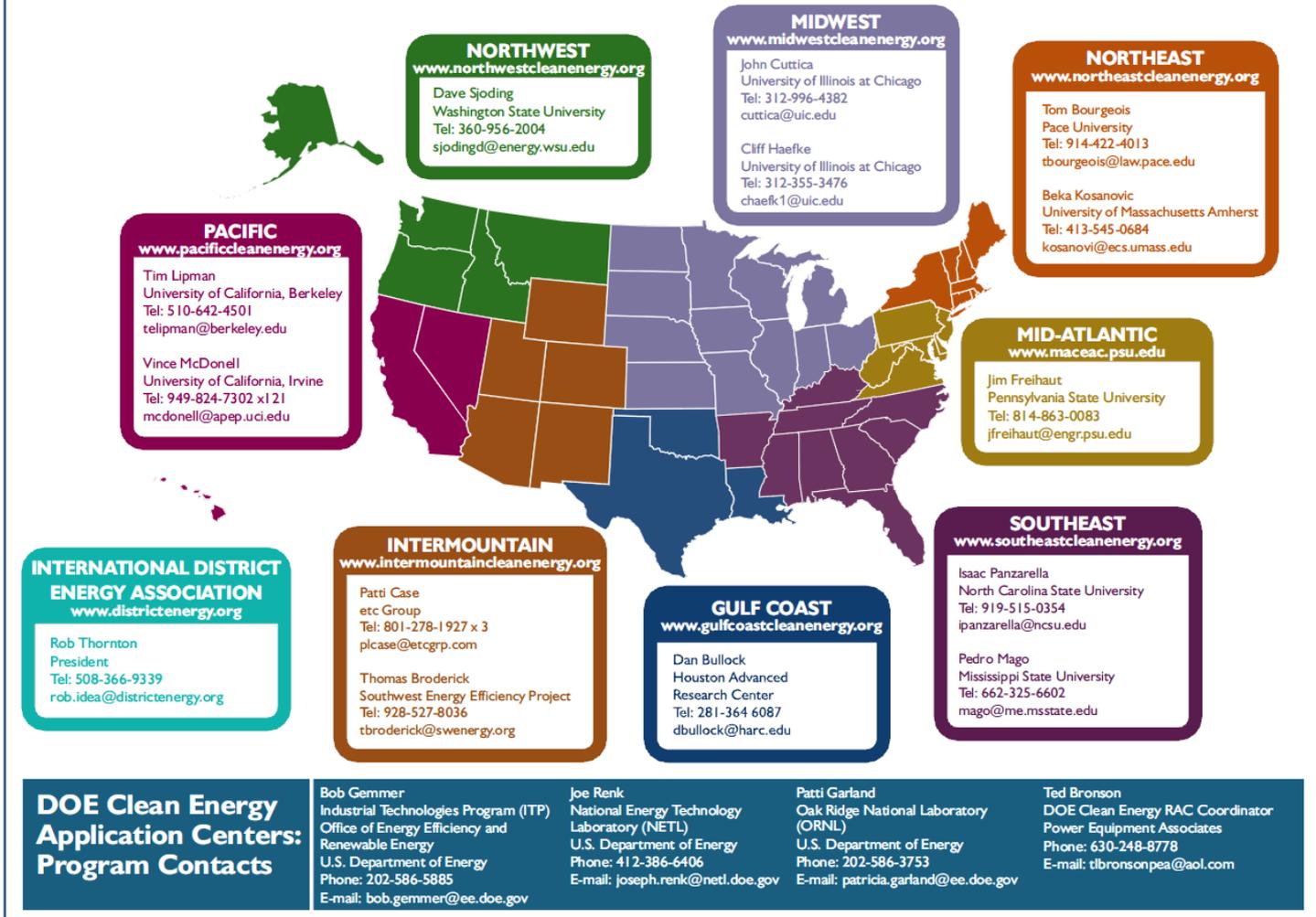
- CHP Feasibility Screenings
  - Multiple Technologies Evaluated
  - Operating Strategies Identified
  - Calibrated Model for Analysis
- Feasibility Analysis Review
- Proposal Review
- 3<sup>rd</sup> Party Review of Project Documents
- Level 2 Analysis
- Design/Technical Assistance
- Price Proposal Review
- Evaluation of Financing Options

# DOE Clean Energy Application Centers

- DOE's **Clean Energy Application Centers**, formerly called the Combined Heat and Power (CHP) Regional Application Centers (RACs), promote CHP, waste heat recovery, and other clean energy technologies and practices and offer regional assistance for specific projects throughout the United States.
- Key services of the DOE Clean Energy RACs include:
  - **Market Assessments** – Supporting analyses of CHP market potential in diverse sectors, such as supermarkets, restaurants, health care facilities, industrial sites, hotels and motels, and new commercial and institutional buildings and facilities.
  - **Targeted Education and Outreach** – Publicizing the benefits and applications of CHP through educational resources and case studies distributed via workshops, webinars, seminars, and training.
  - **Technical Assistance** – Performing site assessments, producing project feasibility studies, and providing technical and financial analyses.
- To learn more about the involvement of DOE Clean Energy RACs in project development, visit the CHP Projects page and the RAC page.

# DOE Clean Energy Application Centers

## DOE Clean Energy Application Centers: Locations, Contacts, and Web Sites



# For Further Information

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DOE CHP Projects page

[http://www1.eere.energy.gov/industry/distributedenergy/chp\\_projects.html](http://www1.eere.energy.gov/industry/distributedenergy/chp_projects.html)

DOE Clean Energy RACs

<http://www1.eere.energy.gov/industry/distributedenergy/racs.html#>