



# The Second U.S.-China Energy Efficiency Forum



Lawrence Berkeley National Laboratory

## U.S. Department of Energy (DOE) Industrial Technology Program (ITP) Industrial Distributed Energy: Combined Heat & Power (CHP)

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U.S. DEPARTMENT OF ENERGY  
**Mid-Atlantic Clean Energy Application Center**

*Promoting CHP, District Energy, and Waste Heat Recovery*



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## DOE ITP FY'11 Budget: \$100M

**33%** Industries of the Future

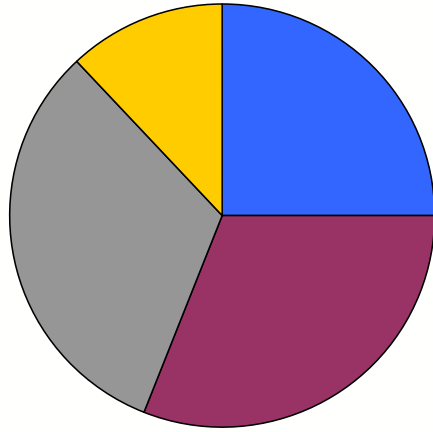


R&D addressing top priorities in America's most energy-intensive industries and cross-cutting activities applicable to multiple industrial subsectors

**25%** Industrial Distributed Energy



Activities to spur widespread commercial use of CHP and other distributed generation solutions



**32%** Industrial Technical Assistance



Helping plants save energy today using efficient energy management practices and efficient new technologies

**10%** Manufacturing Energy Systems



Knowledge development and dissemination centers for rapid innovation of new products and processes



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## Why CHP: CO<sub>2</sub> Emissions Reduction Plus

| Category                       |                  | 1 MW CHP | 1 MW Solar PV | CHP vs. PV |
|--------------------------------|------------------|----------|---------------|------------|
| Annual Electricity Production  | MWh              | 7,880    | 1,927         | 409%       |
| Annual Heat Production         | MW <sub>th</sub> | 7,802    | 0             | ∞          |
| Footprint Required             | ft <sup>2</sup>  | 1,500    | 100,000       | 1.5%       |
| Cost                           | Million          | \$2.40   | \$4.60        | 52.2%      |
| Annual Energy Savings          | MMBtu            | 37,694   | 20,584        | 183%       |
| Annual CO <sub>2</sub> Savings | Metric tons      | 4,625    | 1,722         | 269%       |

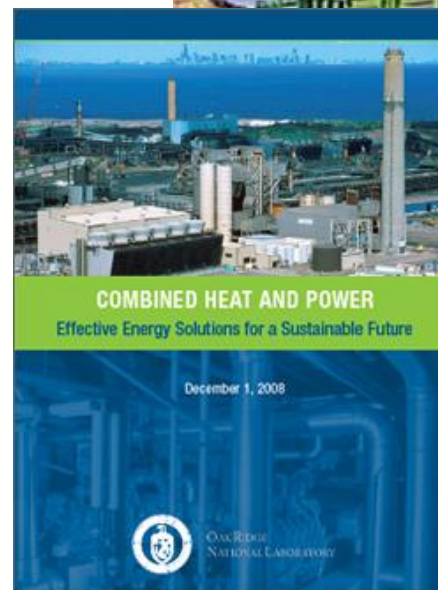
Based on:  
 1 MW Recip Engine CHP  
 34 % electric efficiency  
 68 % total efficiency  
 U.S. average fossil generation



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## ITP's Combined Heat and Power (CHP) Program

- CHP is recognized as the best means to *simultaneously*
  - Reduce GHG emissions
  - Promote use of secure domestic and renewable energy sources
  - Reduce exposure to energy price hikes and volatility
- ITP activities include
  - Facilitating deployment and addressing barriers
  - Serving as an independent, credible voice on applications and benefits
  - Conducting R&D to improve efficiency, lower costs, and extend applications



**CHP offers a sizable near-term option for large energy efficiency improvements and CO<sub>2</sub> reduction**

Source: EPA



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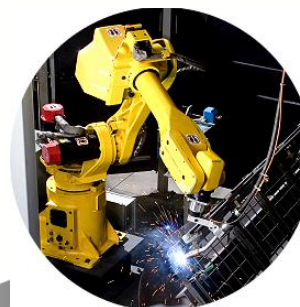
## ITP Role in CHP

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- Leads Federal efforts to implement innovative CHP technology solutions
- Program includes a robust research and development, and demonstration portfolio
- Leader and primary catalyst for partnerships to eliminate institutional and market barriers to CHP
- Supporter of applied technology development to improve efficiency, reduce waste heat, utilize alternative fuels, create green jobs, reduce GHG emissions, and maximize competitiveness of U.S. industry



Stakeholder  
Collaboration



Investing in research & development for high-efficiency manufacturing



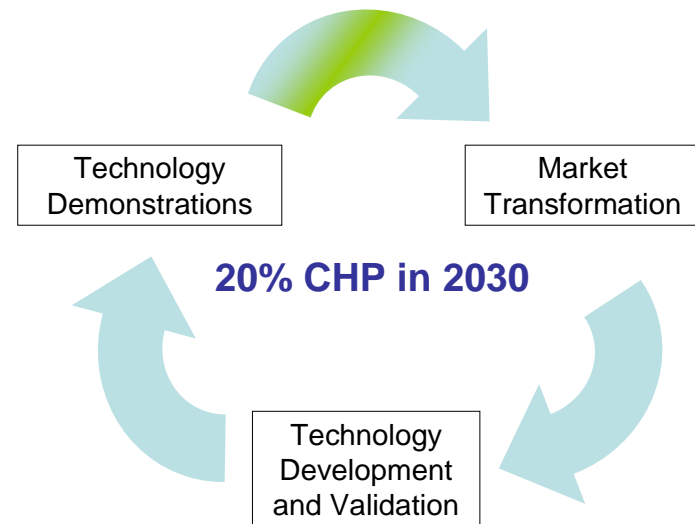
Putting energy-efficient practices and technologies into use



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## Three Major Program Elements

1. **Technology Research and Development**
2. **Technology Demonstrations – Convince potential customers that CHP will help them meet their strategic objectives**
3. **Market Transformation – Remove the barriers to CHP**





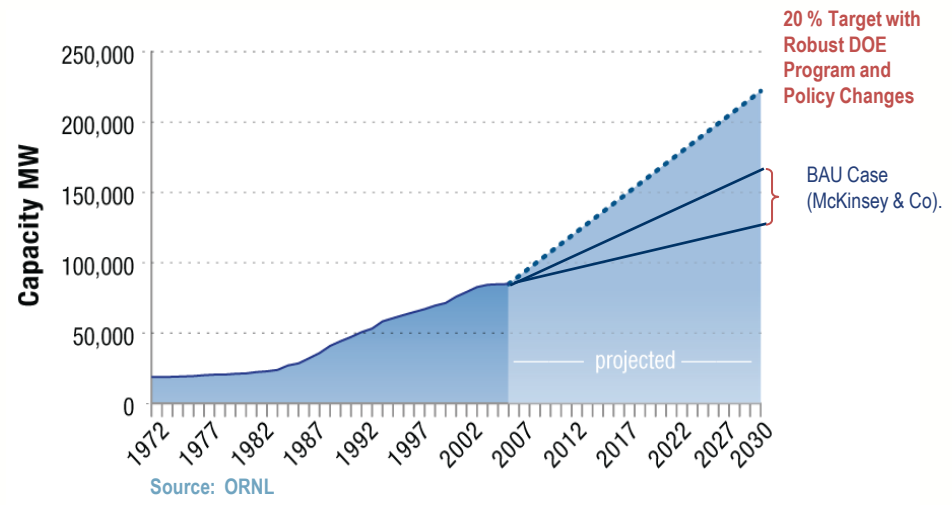
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## CHP - 20% of US Generating Capacity in 2030

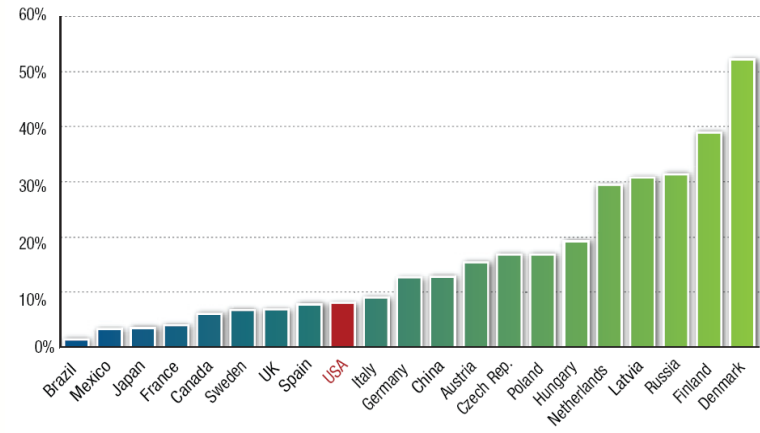
U.S. DEPARTMENT OF ENERGY National Development and Reform Commission (NDRC)

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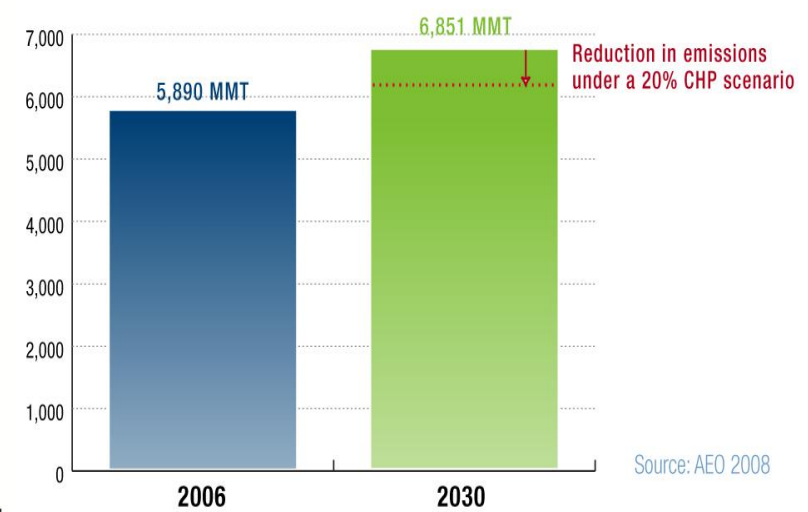
| CHP                                      | 2006                           | 2030 Target                          |
|--|--------------------------------|--------------------------------------|
| Total Electricity Generating Capacity    | 85 GW (9% of current capacity) | 240.9 GW (20% of projected capacity) |
| Annual Energy Savings                    | 1.9 Quads                      | 5.3 Quads                            |
| Annual CO <sub>2</sub> Reduction         | 248 MMT                        | 848 MMT                              |
| Number of Car Equivalents Taken Off Road | 45 million                     | 154 million                          |



### CHP in a Global Context – 20% Capacity Goal is Reachable



### Carbon Dioxide Emissions 2006 and 2030 (MMT)





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## Current CHP/Distributed Energy R&D Portfolio



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## ARRA District Energy Award, Houston

- Texas Medical Center received \$10 million for a district energy system
- Largest medical center in the world, 140+ buildings
- The new CHP plant will generate 45 MW of power and provide steam to the district heating plant; the project will save an estimated 0.75 trillion Btu annually over separate electrical and steam generation



*Texas Medical Center, along with Rice University, looking towards downtown Houston*



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## ARRA District Energy Award, Seattle



Sustainably Reliable

- **Seattle Steam Company, a private utility that provides heat to Seattle's Central Business District and First Hill neighborhoods, received an \$18,750,000 award**
- **Utility powers approximately 200 buildings**
- **The new CHP plant will generate 50 MW of electrical power and steam to offset existing, inefficient steam production equipment; the CHP plant will save an estimated 1.84 trillion Btu annually over the current, inefficient infrastructure**



*Seattle Steam's historic plant, where the advanced turbine will be installed*



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## Frito-Lay CHP Demonstration

### Combined Heat and Power in Action

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- DOE cost-shared project with Frito-Lay
- System took plant off the grid
- GHG emissions cut by > 5%
- CHP System
  - 4.6 MW Solar Taurus 50 Gas Turbine with SCR for NO<sub>x</sub> Control
  - Provides 100% electricity needs and 80% of site steam needs
- Site in Killingly, Connecticut
  - 400 employees
  - Processes 250,000 lb/day of corn and potatoes (each) for chips
- Fully functional since March 2009





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## 2009 CHP RD&D Solicitation

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- The objective of the FOA is to solicit applications for cost-shared proposals for RD&D in CHP systems in three size ranges:
  - Large (>20 MWe)
  - Medium ( $\leq 20 \text{ MWe} \geq 1 \text{ MWe}$ )
  - Small (<1 MWe)
- A total of 107 applications were received, with 100 deemed suitable for comprehensive review
- Six applications selected for funding



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## 2009 FOA Project Descriptions

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- **Dresser Waukesha** – “Ultra Clean 1.1 MW High Efficiency Natural Gas Engine Powered System”
- **CMCE**- “CARB 2007-Compliant, Energy Efficient CHP Assembly for Industrial and Commercial Boilers”
- **Cummins Power Generation** - “330 kWe CHP System with Reduced Emissions”
- **Gas Technology Institute** - “Flexible Combined Heat and Power System with Low NO<sub>x</sub>, Co, and VOC Emissions”
- **FuelCell Energy** – “Ultra Efficient CHP Using a High Temperature Fuel Cell to Provide On-Site Process Reducing Gas, Clean Power, and Heat”
- **Capstone** “High Efficiency 370kW Microturbine with Integral Heat Recovery”



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## Transforming the Market



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## Clean Energy Application Centers

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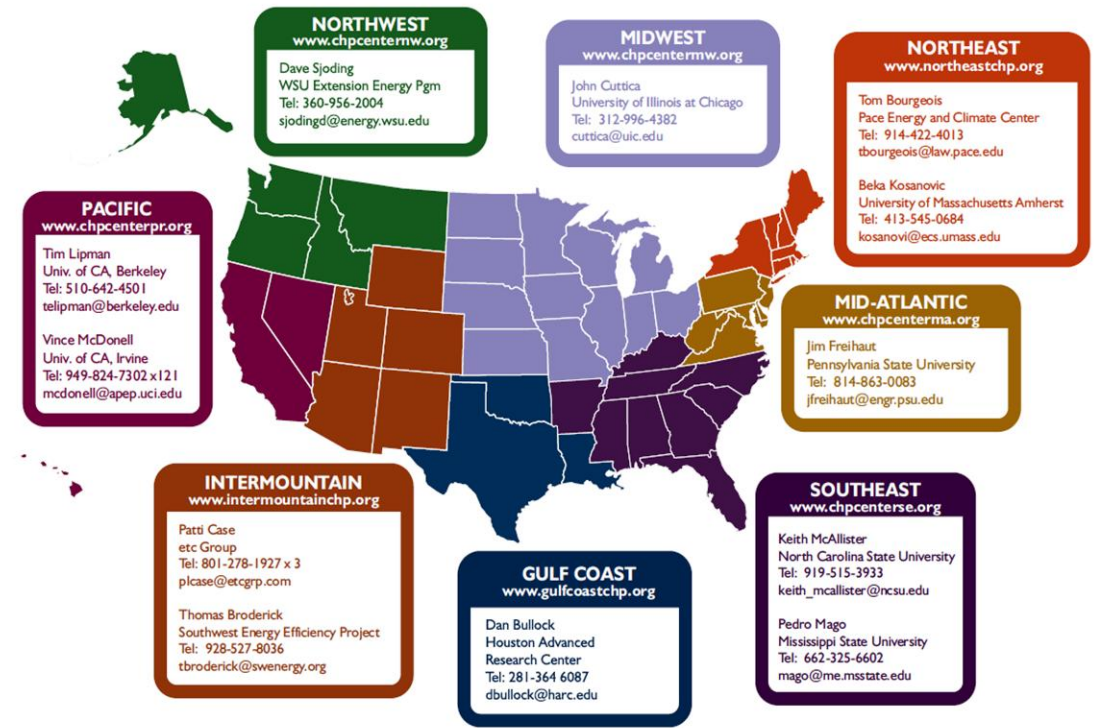
### Mission:

- Support project development
- Promote technology as an effective clean energy solution
- Educate prospective users & policy makers on the benefits and available resources

### Services:

- Unbiased Information
- Targeted Education
- Technical Assistance

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



| DOE Clean Energy Application Center Program Contacts   |  |  |
|--|--|--|
| Ted Bronson<br>DOE Clean Energy Application Center Coordinator<br>Power Equipment Associates<br>Phone: 630-248-8778<br>E-mail: tbronsonpea@aol.com | Bob Gemmer<br>Industrial Technologies Program (ITP)<br>Office of Energy Efficiency and Renewable Energy<br>U.S. Department of Energy<br>Phone: 202-586-5885<br>E-mail: Bob.Gemmer@ee.doe.gov | Patti Garland<br>Distributed Energy/<br>CHP Program Manager<br>Oak Ridge National Laboratory<br>Phone: 202-586-3753<br>E-mail: Patricia.Garland@ee.doe.gov |



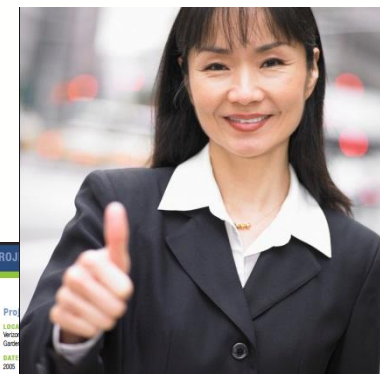
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## DOE RAC Track Record of Success

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### • Notable RAC Accomplishments

- Educated over 25,000 on CHP
  - Coordinated over 120 target workshops and 60 conferences
- Policy Maker Education
  - CHP in RPS, state interconnection standards, and CHP incentive programs
- Project Support
  - Over 225 assessments and 700 technical support activities to projects representing over 1.5 GW of CHP installed or in development



**DISTRIBUTED ENERGY PROGRAM PROJ**

**Keeping the High-Tech Industry Plugged-In with Onsite Energy**  
CHP System Provides Reliable Energy for a Verizon Telecommunications Switching Center

In high-tech industries, large amounts of reliable, high-quality power are critical to continuous processing operations—industry giant Verizon Telecommunications was no exception. To ensure the reliability of their operations, Verizon needed a power source that could handle their distributed energy systems that provide clean, reliable, and efficient power and cooling—and Verizon is getting those benefits in its high-tech “smart” office of the future in Garden City in New York’s Long Island.

The smart office is a 302,000-sq-ft building that houses 300 employees and provides telecommunications services to more than 25,000 customers in Long Island. The facility is served by distributed energy technology that makes use of “brown base” base waste gas from a combined heat and power (CHP) system.

CHP system can recover and utilize heat from fuel cell to provide useful services such as cooling to reduce its peak power from conventional power grid electricity.


The Verizon facility now uses fuel cells, packaged boilers, engines, two absorption chillers, and a heat recovery system to provide cooling and heating to the facility. It is the largest providing energy services to a Verizon facility.

**FACTS**  
200,000 sq. ft.  
ELECTRIC & THERMAL  
• Seven UTC 200-kW natural gas-fired fuel cells  
• Two 70-ton Thermal LIB absorption chillers  
• One exhaust heat recovery steam generator  
• One Caterpillar natural gas (20%) and diesel (80%) dual-fuel engine  
• Two standby Caterpillar diesel engines

**ANNUAL ENERGY SAVINGS**  
\$0.5 million for the first five years

**PAYBACK**  
10-year payback on system

**ENVIRONMENTAL BENEFITS**  
11.1 million pounds of CO<sub>2</sub> offset per year

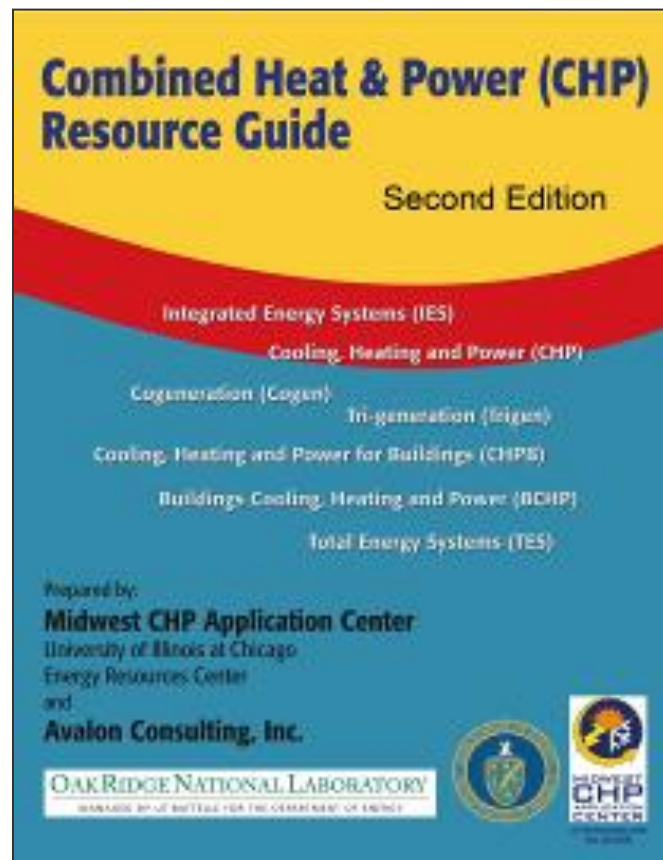





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## RAC Accomplishments: Unbiased Information

- Over 100 Project Profiles Available
- CHP Guidebooks (more than 150,000 copies downloaded since 2004)
- Market Studies
- CHP Installation Data Base by State
- Numerous Technical Reports





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## Areas for Collaboration

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- Existing CHP in China is:
  - Mostly coal-based
  - Integrated with municipal or industrial district heating systems or
  - Tied to power plants selling a small amount of steam to adjacent industrial sites or district heating loops
- Existing CHP in the United States is:
  - Mostly natural gas based
  - Customer or EMC owned and operated
- There are new low carbon approaches for China and the US using CHP in new and different ways



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## Areas for Collaboration

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- Position consumer-based CHP as a least cost option for energy efficiency, GHG reduction and climate change compliance.
- Highlight CHP as the most efficient use of valuable natural gas and biomass resources.
- Work with NEA and the provincial DRCs to evaluate the benefits of customer-based CHP and urge them to:
  - Issue and enforce national interconnection standards and procedures
  - Provide credible information on natural gas supply and timing
  - Consider CHP incentives including demonstration programs



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## Thank you



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