Combined Heat and Power Program
Current and Future Activities

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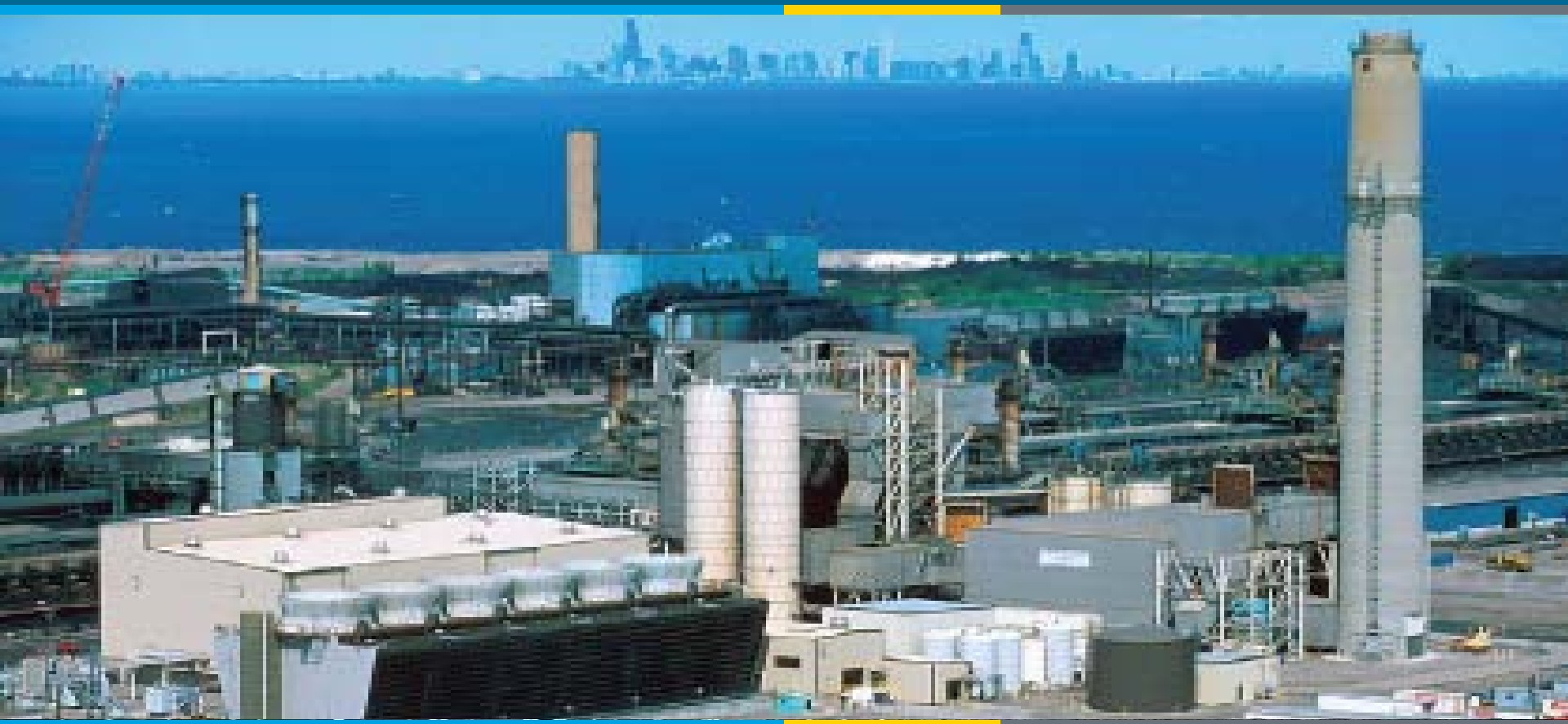

Industrial Technologies Program
Bob Gemmer, Technology Manager

Industrial Assessment Centers
Student Meeting
February 4, 2010

CHP Role in US and Global Energy Issues

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- Deployable today for substantial energy savings if enabled by market conditions and policies
  - Energy efficiency and waste energy recovery reduces energy demand and emissions from our traditional inefficient energy supply
- New technology advances will greatly expand range of viable applications and improve case for increased investment
  - Higher penetration mitigates very large portion of projected carbon increases
- Contributor to meeting ambitious 2050 GHG cap (83% reduction in HR 2424)
  - Transformational R&D to simultaneously approach theoretical limits of efficiency and criteria pollutants
  - Maintain viable economic growth in a carbon-free supply scenario

CHP R&D Plan

CHP Installations: What Drives the Market?

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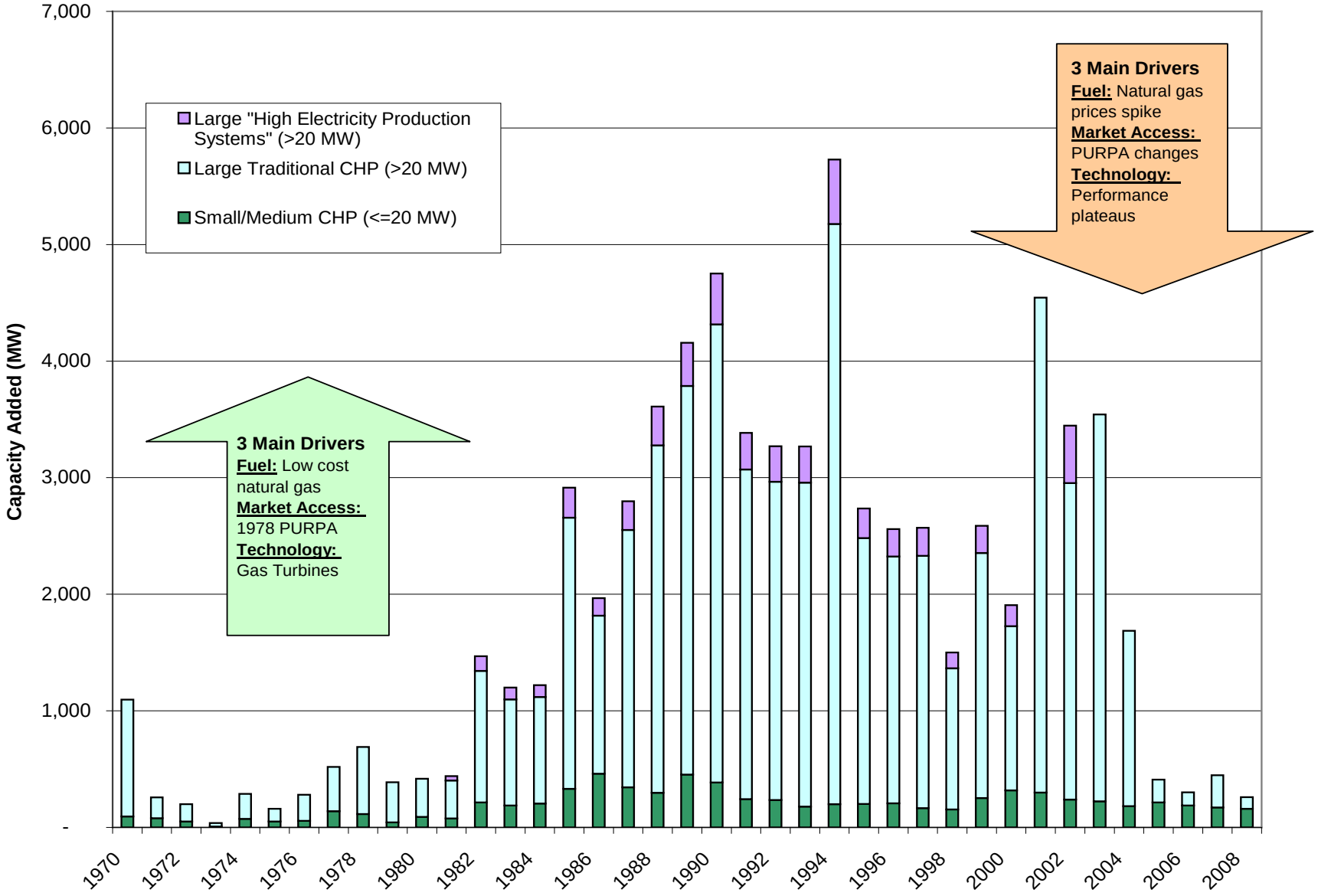

Major Issues and Market Drivers

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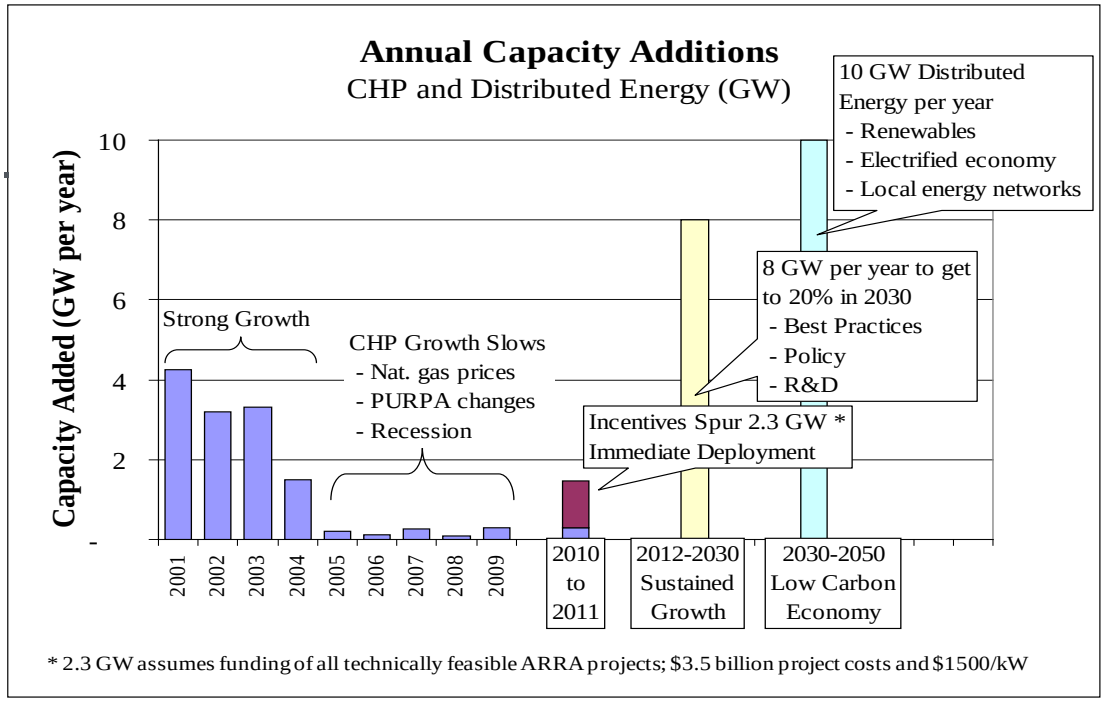
The previous expansion of CHP (1980 to 2004) was driven by three factors:

1. Fuel (natural gas),
2. Market access (PURPA),
3. Technology (gas turbine technology).



Restarting the CHP market requires overcoming the barriers that negatively affect the adoption of CHP technologies.

These Barriers include:

- Grid Interconnection and Regulatory Issues
- Capital and Life-cycle Cost
- Fuel Availability and Price Volatility
- Inconsistent Environmental Permitting
- Uncertainty in the future of CO2 emissions treatment

3 Major Program Areas:

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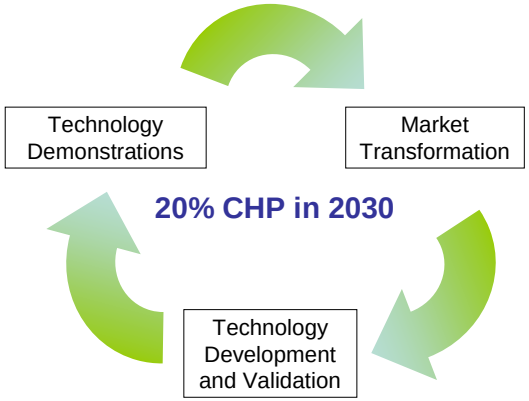


1. Technology Research and Development

- *Utilize alternative fuels and low-value waste heat*
- *Develop small and mid-size systems for new markets*
- *Improve technical performance of CHP (efficiencies, emissions, reliability, capital and operating costs)*

2. Technology Demonstrations – Convince potential customers that CHP will help them meet their strategic objectives

- *Publicize performance for markets where CHP not been demonstrated and adopted - (data centers, hospitality, residential)*
- *Reduce technical risk for industries seeking to use alternative fuels or waste energy to meet climate change objectives*
- *Showcase small systems with turn-key operation for fleet implementation*

3. Market Transformation – Remove the barriers to CHP

- *Coordinate with utilities on technical and regulatory issues – find the "win-win"*
- *Assist workforce training and development of codes and standards*
- *Accelerate the CHP investment decision process*

1. Technology Research and Development

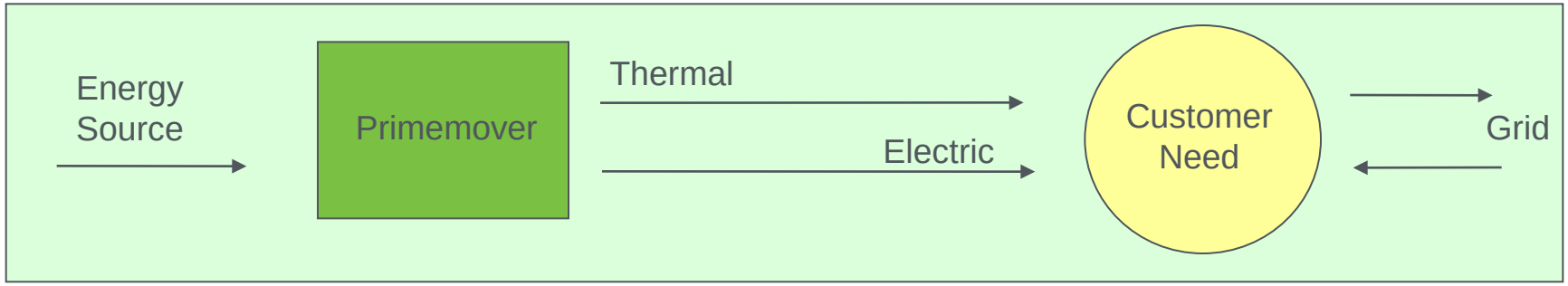
- Improve technical performance (efficiencies, emissions, reliability)
- Develop systems and controls for new applications

New markets demand systems that deliver business benefits

- *Moving beyond spark-spread*
- *The most efficient primemover may not be the best for CHP*

Work with partners to share knowledge, reduce costs and spread risks

New Technologies must be fully commercialized 2015-2020



- Alternative fuels
- Waste heat recovery

- Primemover
- Combustion
- Materials

- Thermal utilization
- Novel heat recovery

- Integrated systems
- Controls
- Facility and energy network integration

Structure of CHP Program (continued)

2. Technology Demonstrations

CHP is proven in many industrial applications; what is achieved by more demonstrations?

Reduce technical risk through validation of system performance and business models in new applications.

examples:

- Large CHP: novel heat recovery or use of new alternative fuels in manufacturing
- Performance at data centers within industry standards for reliability and power quality
- Residential/small commercial systems with turn-key operation, attractive energy performance and capital costs attractive to developers

In the current economic environment, financial support of projects with newly commercial products and innovations will improve the economic viability of projects.

3. Market Transformation

Strategic activities designed to reduce barriers that are due to:

- Existing regulatory frameworks
  - Electric utility coordination on technical and regulatory issues
  - Outreach on the role of CHP in a carbon-constrained world
- Inefficient business models
  - Identify underexploited high value opportunities
  - Better integration of fractured CHP supply chain
  - Accelerate the investment decision process
- Lack of awareness on the part of key constituents and stake holders
  - Raise the profile of CHP value proposition
  - Facilitate strategic networking and partnerships
  - Enable a wider range of CHP customers

Also:

Continued *DOE support of the RACs* for local, specific project implementation assistance

Targeted Market Segments for CHP Program

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Large CHP

>20 MW

Traditional Industrial Markets

- Energy-Intensive Industries
- High Thermal Loads
- Waste Energy Sources

Mid CHP

1 MW to 20 MW

- **Light Industrial**
- **Large Commercial**
- **Institutional**
- **District Energy/ Municipal**

- Modest Thermal Loads
- Variable Loads

Small CHP

<1 MW

- **Small Commercial**
- **Residential**
- **Multi-family**
- **Micro-CHP**

- Low Heat Requirements
- Turn-key operation

More ← **Facility Size Complexity Established Market** → Less

The segments overlap and are intended to reflect the range of challenges for CHP

CHP Program Timeframes

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Current Market:
Application Support, Deployment and Policy Barriers

→ **Increase Market Uptake and Accelerate Investment**

Near-Term:
Applied R&D, Demonstration, and Market Transformation

→ **Broaden Range of Viable CHP Users and Minimize Waste Streams**

Longer-Term:
Transformational Technology Development

→ **Enable Carbon-free Distributed Energy Paradigm**

Current CHP Programmatic Activities

Advanced Reciprocating Engine Systems (ARES) – Reorienting the Framework for Industrial Research

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DOE Collaboration with Industry to set a mid-long term R&D goals to improve performance of gas engines.

- The ARES program (part of a bigger DE/CHP program strategy) seeks to improve energy efficiency from 36% to 50% for small industrial/commercial DE applications over a 15 year period.
- The ARES program was designed to have multiple intermediate commercial-ready products (42% in 2006, 47% in 2010, 50% in 2013).
    - It includes both hard core R&D in the national labs, applied manufacturing R&D in the engine companies, and field evaluation.

Advanced Reciprocating Engine Systems (ARES)

Promotes separate, but parallel engine development between the major stationary, gaseous fueled engine manufacturers in the U.S

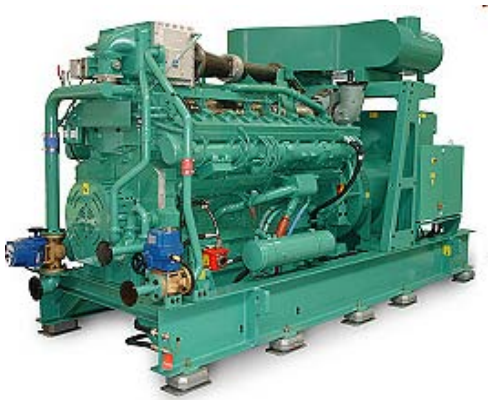
Three competitively selected projects with engine manufacturers Caterpillar, Cummins, and Dresser-Waukesha, plus laboratory support from Argonne National Laboratory and Oak Ridge National Laboratory

- 2010 Funding: $8.1 million
- Work is being performed in three phases:

	Efficiency (% BTE)	Efficiency (% BTE)	Cost of Ownership	Reliability
Phase 1	44	0.5		
Phase 2	47	0.1		
Phase 3	50	0.1	10% Lower	Maintain

ARES Funding and Status

- Caterpillar
  - R&D on Lean combustion and SCR for NO_x reduction
  - Start/end: 2001/2013
  - Completed Phase 1 – Product in market
  - Currently working on Phases 2 and 3 at same time
- Cummins
  - R&D on stoichiometric combustion and 3-way catalyst
  - Start/end: 2001/2009 (continuation under negotiation)
  - Completed Phase 1 – Product in market
  - Currently working on Phase 2
- Waukesha/Dresser
  - R&D to reduce combustion and engine losses
  - Start/End: 2001/2012
  - Completed Phase 1 – Product in market
  - Currently working on Phase 2
- Argonne National Laboratory
  - Provide technical and program support for ARES
- Oak Ridge National Laboratory
  - Provide technical support for ARES



Cummins' QSK60G advanced reciprocating engine combines ultra-low NOx emissions with 44% brake thermal efficiency

ARES Program Goals:

- 50% brake thermal efficiency (BTE); 80+% with combined heat and power (CHP)
- A maximum of 0.1 gm /bhp-hr NO_x emissions
- Maintenance costs below $0.01/EkW-hr
- Maintaining cost competitiveness

2008 FOA issued seeking proposals for RD&D in CHP systems and related technologies.

- Four projects selected:
  - General Electric:
    - Flexible Distributed Energy and Water from Waste for the Food and Beverage Industry
  - United Technologies Research Center:
    - Technology for Definition, Development and Verification of a 1 Megawatt electrical (MWe) Microturbine/Chiller CHP Packaged System
  - Exergy Partners Corp.:
    - R&D of an Advanced Low Temperature Absorption Chiller Module with a CHP System for a Distributed Data Center
  - Houston Advanced Research Center (HARC)
    - Battleground Energy Recovery Project

2009 FOA

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 (≤20 MWe≥1 MWe)
- Small (<1 MWe)

- A total of 107 applications were received, with 100 deemed suitable for comprehensive review
- Applications are currently being evaluated for selection

Clean Energy Regional Application Centers (RACs)

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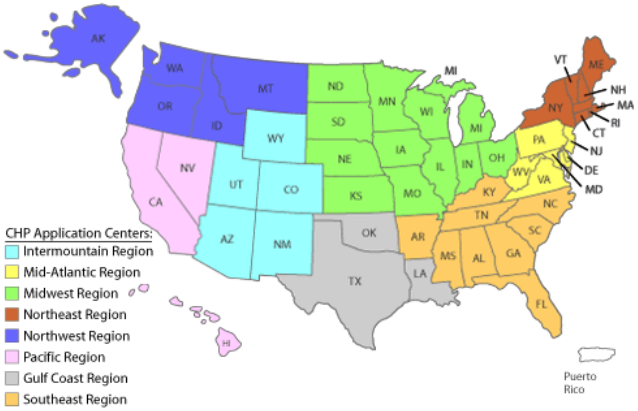
The RACs were established to help transform the market:

- CHP
- District Heating
- Waste Heat recovery
- Other clean energy technologies



- Authorized by the 2008 Energy Independence and Security Act
- The RACs provide important services:
  - Support CHP project development by producing project feasibility studies, analyzing permitting issues, and assessing applicable tariffs/rates through technical and financial analyses
  - Promote CHP as an effective clean energy policy solution to state policymakers and regulators and to educate this audience on barriers that prevent widespread adoption of CHP
  - Inform prospective CHP users, including targeted market sector representatives, on resources and incentives available to help facilitate CHP project viability through websites, workshops, and training.
- Currently eight RACs have been established across the country. The International District Energy Association is also supported under this activity

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Technical and Analytical Support

- Activities and Accomplishments include:

Reports and Program Technical Support
- STEP Analysis Support
- White Papers on CHP Barriers etc.
- Strategic Planning
- Impacts Report Analysis
- Annual Reports on Installed CHP Systems
- CHP Potential Analysis
- Opportunity Fuels Analysis
- IEA Analytical Support
- District Energy/CHP Annex IX Support
- Support to ITP Communications Staff on CHP Accomplishments [ex. Frito Lay Press Release]

Technical Support and Outreach
- Web Site Updates
- Interagency Team Meetings
- Conference Presentations and Co-Sponsorship
- Clean Energy RAC data collection and metrics reporting
- RAC Coordination and Program Management
- Training on District Energy
- CHP Dialogues
- District Energy/CHP Annex IX Support
- Support to ITP Communications Staff on CHP Accomplishments [ex. Frito Lay Press Release]

Questions??