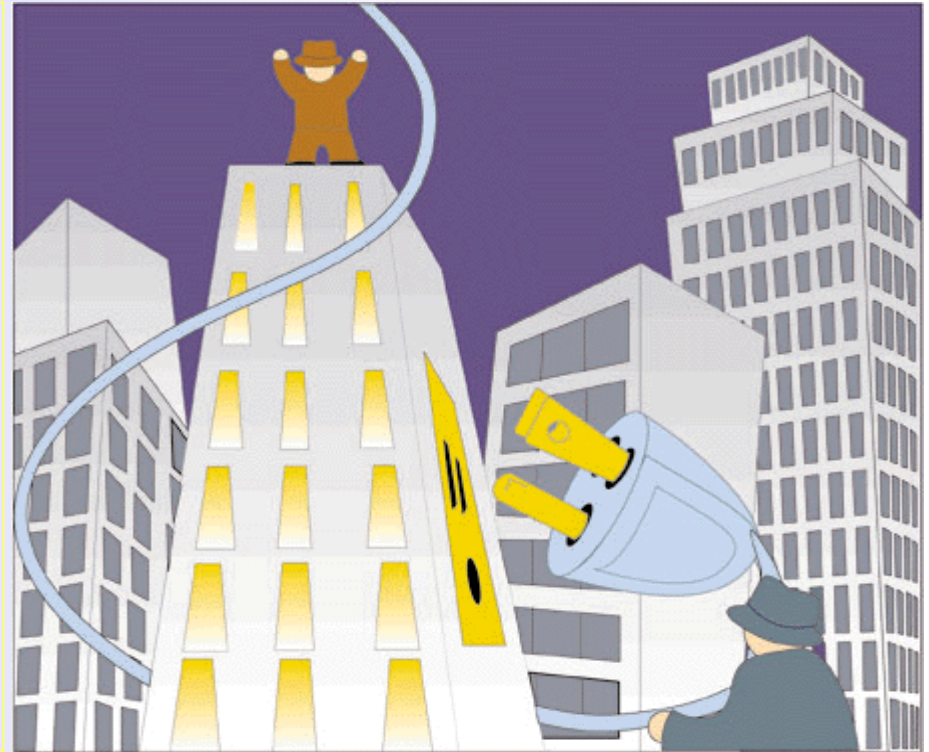


High Natural Gas Prices and the Updated Market For CHP

World Energy Engineering Congress

**Paul Lemar, President
E.J. Honton, Director
Resource Dynamics Corporation**

8605 Westwood Center Drive
Vienna, Virginia 22182
703-356-1300 | pll@rdcnet.com



*World Energy Engineering Congress
September 23, 2004*



Presentation Outline



- Background
- Installed Base of CHP/DG
- Market Potential for Additional CHP/DG Installations
- Implications for the Future

*World Energy Engineering Congress
September 23, 2004*



What's the CHP/DG Market Opportunity?



- Facilities use DG to generate power on-site in lieu of grid purchases
- Cutting energy costs is a primary motivation, but using the thermal output, boosting reliability and the quality of power are also drivers
- Currently, U.S. manufacturers ship over \$3 billion annually in DG worldwide, mostly diesel engine gensets for backup power
- Rising natural gas prices change both CHP/DG fuel costs and competing grid prices

*World Energy Engineering Congress
September 23, 2004*



What's the CHP Buzz About?

- Re-structuring promises opportunities for CHP
 - T&D capacity shortages in CA, TX, and other areas
 - Merchant plants have added a lot of capacity 2000-2002
- Environmental concerns add complexity
 - High price regions overlap with non-attainment areas
 - NOx control cost burdens smaller units
 - CHP seen as environmentally sound, but not “green”
 - Output-based standards are promoting CHP
- Plethora of CHP options
 - New technologies being commercialized
 - Ambitious improvements slated for old standbys

Natural Gas Market

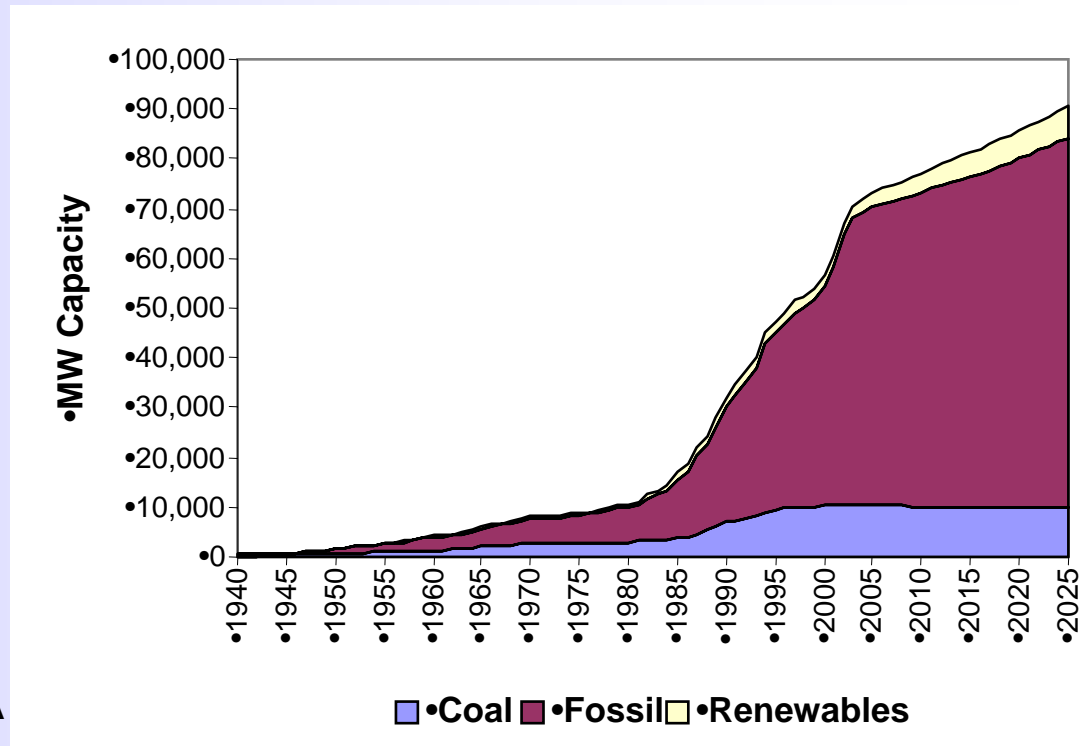


- Recent rise in natural gas price
 - increases CHP/DG fuel price
 - increases the competing electric price
 - may increase the spark spread

*World Energy Engineering Congress
September 23, 2004*

History and Future of CHP in the U.S.

- Turn of the century: CHP most common electric generators
- Pre-1970: CHP loses favor to central station
- Late 1970s: energy crises renewed interest in CHP
- 1978: Public Utilities Regulatory Policies Act (PURPA) removed many barriers, including sale of CHP excess power
- 1992: Energy Policy Act signaled the onset of restructuring
- 1998: Restructuring emerges in CA and other states and DOE issues CHP Challenge (46 to 92 GW)
- Future: Most of the forecasted CHP additions are gas-fired



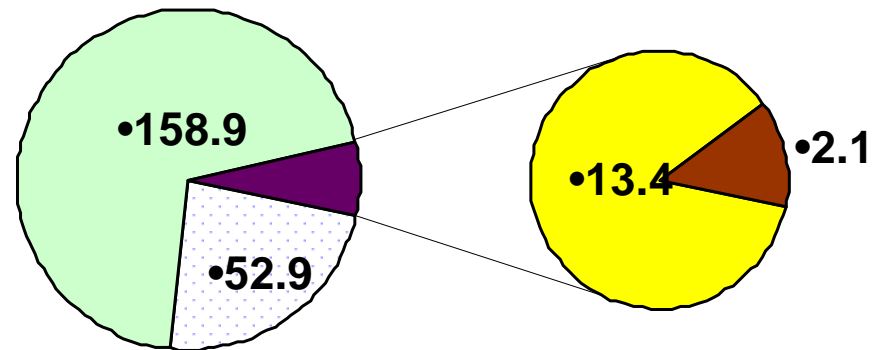
Source: Energy Information Administration. Numbers for 1909-2003 are historical installations as contained in the Form 860 database for 2003, covering units greater than 1 MW in size. Forecasts for 2004-2025 indicate the amount of additional CHP capacity to be added by year, from the *Annual Energy Outlook 2004*.

World Energy Engineering Congress
September 23, 2004

Recent U.S.

- Includes both utility and non-utility, interconnected and non-interconnected, capacity additions of all sizes
- 15.5 GW change in CHP reflects incentives to build after California crisis and other market changes
- 87 percent of new CHP is non-DG

•Capacity Added 2001-2003 •(GW)



□ •Non-interconnected

■ •Interconnected Non-CHP

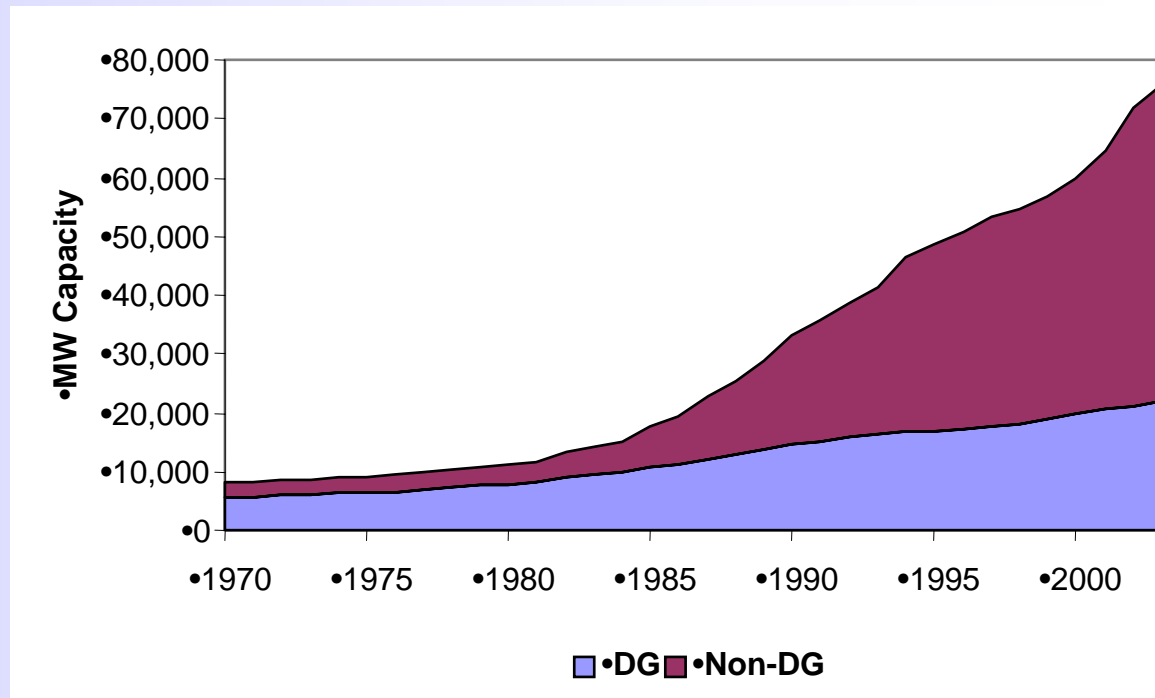
■ •CHP Non-DG

■ •CHP DG

Source: The Installed Base of U.S. Distributed Generation, 2001 Edition, Resource Dynamics Corporation, Washington D.C.

DG and Non-DG CHP

- Chart shows CHP capacity of all sizes by year first installed
- Non-DG is either > 60 MW in size, or the generation is primarily used by an electric utility
- 35.2 GW of non-DG capacity was added 1990-2003, including many merchant plants
- 7.2 GW of DG capacity was added 1990-2003, creating a total CHP DG capacity of 22 GW



Source: *The Installed Base of U.S. Distributed Generation, 2004 Edition*, Resource Dynamics Corporation, Washington D.C.

Current Installed Base

- By end of 2003, by adding significant gas fired capacity, reached 75 GW of the 92 GW year 2010 CHP Challenge goal
- 70 GW of CHP are >1 MW in size, much of it interconnected
- 3 main differences exist between CHP and DG:
 - CHP units can be > 60 MW
 - CHP units sometimes primarily sell their power to electric utilities for non-local consumption; these are not considered DG
 - DG includes not only CHP, but also baseload, peaking, interconnected standby, and emergency applications

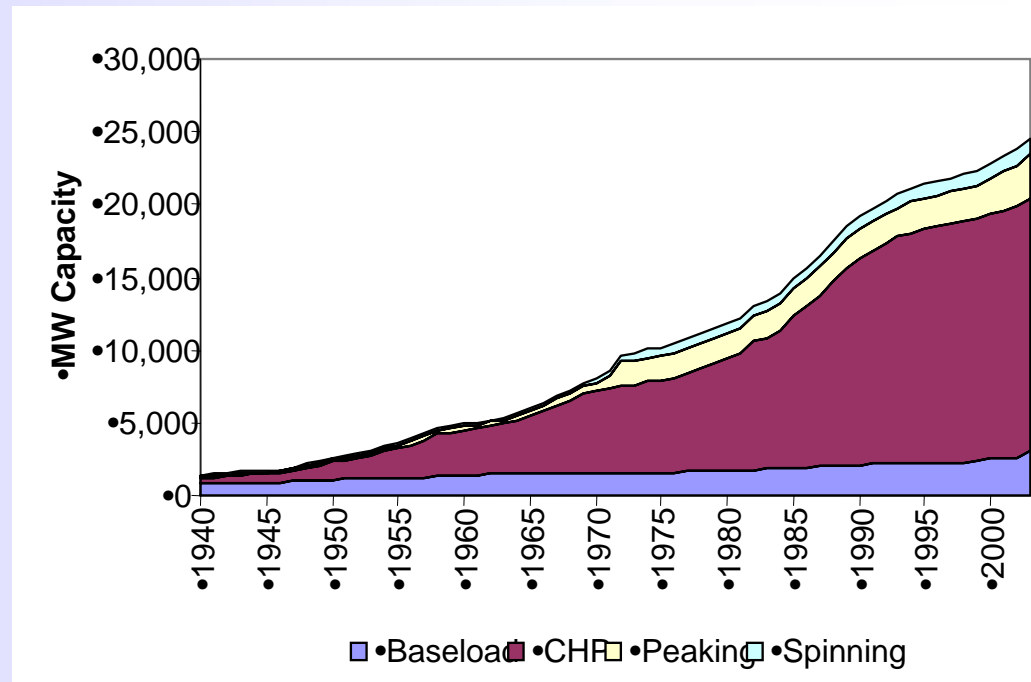
**•TABLE 1. U.S. INSTALLED CHP AND DG
•CAPACITY 2003**

•Category	•GW
•Total CHP	•75
• Greater than 60 MW units	•45
• Under 60 MW power sold to electric utility	•8
• DG, under 60 MW, power used locally	•22
•Total DG	•234
• CHP	•22
• Baseload	•4
• Peaking	•6
• Interconnected standby	•1
• Emergency non-interconnected	•188
• Other non-interconnected	•13

Source: *The Installed Base of U.S. Distributed Generation, 2004 Edition*, Resource Dynamics Corporation, Washington D.C.

History of Interconnected DG

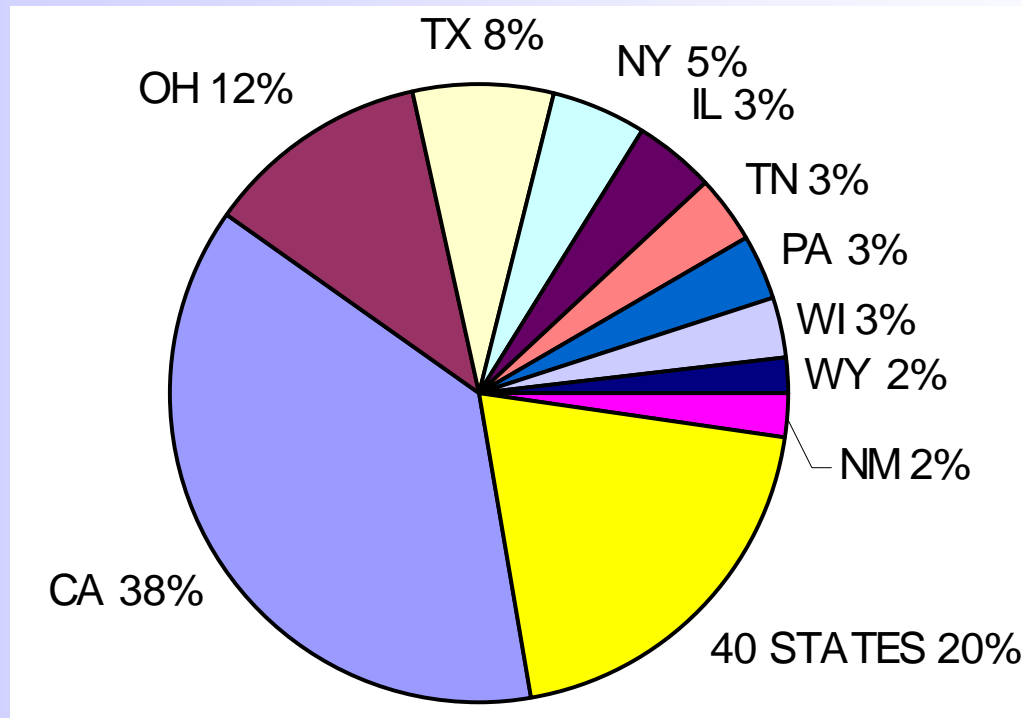
- Charts historically interconnected 1-60 MW sized DG units installed as of end of 2003 (does not include emergency or other non-interconnected DG)
- CHP is the single largest application of interconnected DG by far
- Despite significant CHP having been installed decades ago, considerable new CHP capacity has been added since 1990 and it continues to grow



Source: Energy Information Administration, Form 860 databases for 2002-2003.

Over Three-Fifths of DG Installed 2000-2003 Was in Just 4 States

Percent of Capacity Interconnected 2000-2003 by State, Units > 1 MW

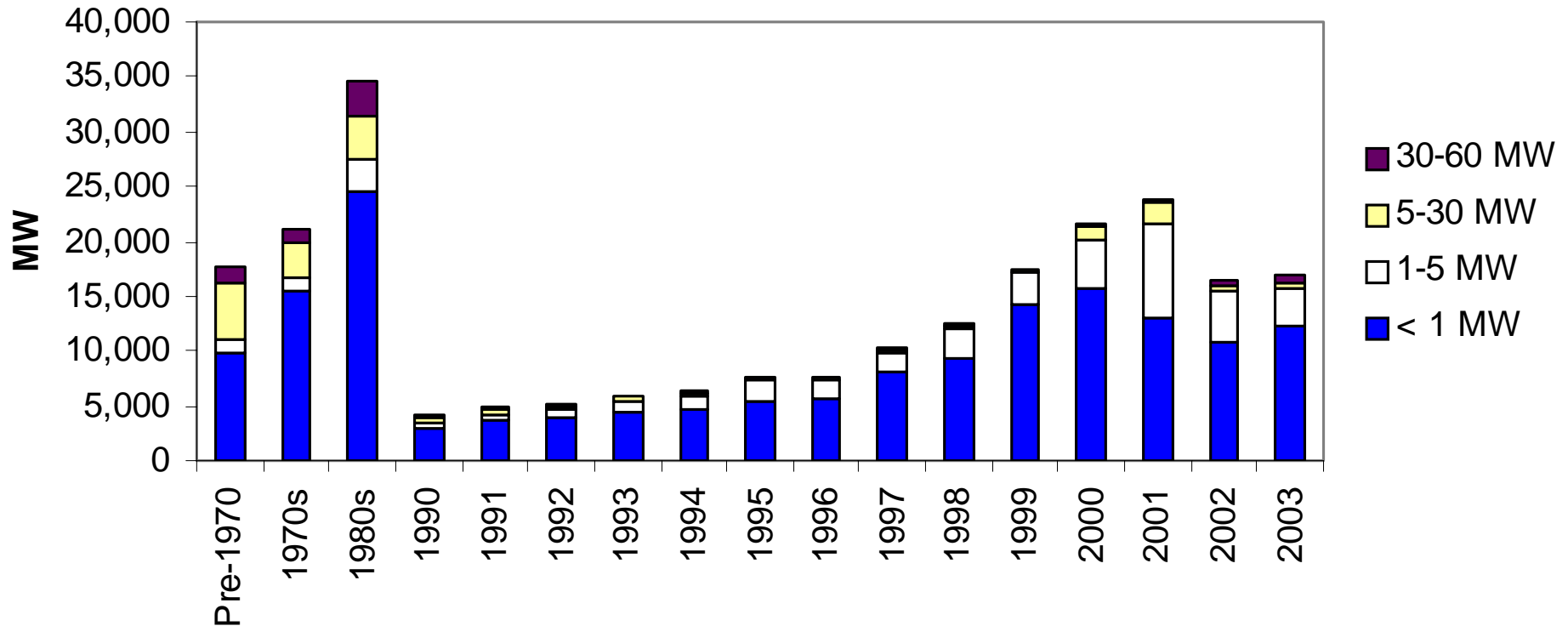


Source: *The Installed Base of U.S. Distributed Generation, 2004 Edition*, Resource Dynamics Corporation, Washington D.C.

World Energy Engineering Congress
September 23, 2004

DG Installations Since 2001 Have Been Slowing

Capacity of DG Installed by Year by Size



Source: *The Installed Base of U.S. Distributed Generation, 2004 Edition*, Resource Dynamics Corporation, Washington D.C.

Includes emergency, other non-interconnected DG, as well units under 1 MW in size

World Energy Engineering Congress
September 23, 2004



Additional CHP/DG Market Potential

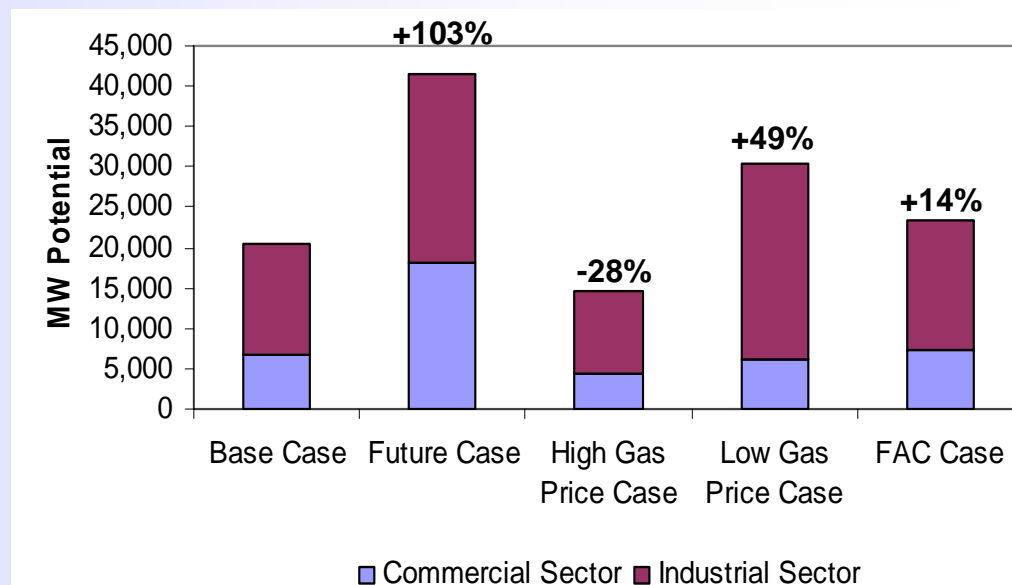
- To measure how much additional CHP/DG market potential exists, we used DISPERSE (DIStributed Power Economic Rationale SElection)
- Estimates the economically rational potential of a defined CHP market by competing various CHP technology proposals against one another and with the traditional purchase of electricity from a retail supplier
- For each commercial and industrial facility in the U.S., the model determines which technology, unit size, and operating mode is the most economic
- DISPERSE forecasts the number of units, capacity, generation and thermal output

*World Energy Engineering Congress
September 23, 2004*



Market Potential For Additional CHP/DG Capacity

- **Base Case (20 GW) includes:**
 - Most likely DG technology development over the next 10 years
 - \$8.10/MCF commercial and \$5.67/MCF industrial average starting gas prices which reflect recent market prices
 - Annual gas price increases of 2.4% to 11.2%
- **Natural gas prices are a critical input variable. Four other Cases:**
 - *Future Case*: considers DG technology price and performance advances forecast by DOE as achievable by 2014
 - *High Gas Prices Case*: gas price escalation rates range doubles to 4.9% to 22.4% per annum
 - *Low Gas Prices Case*: gas prices are reduced to their historic 1990s level
 - *Fuel Adjustment Clause Case*: pass through changes in gas prices into electric rates, state-by-state



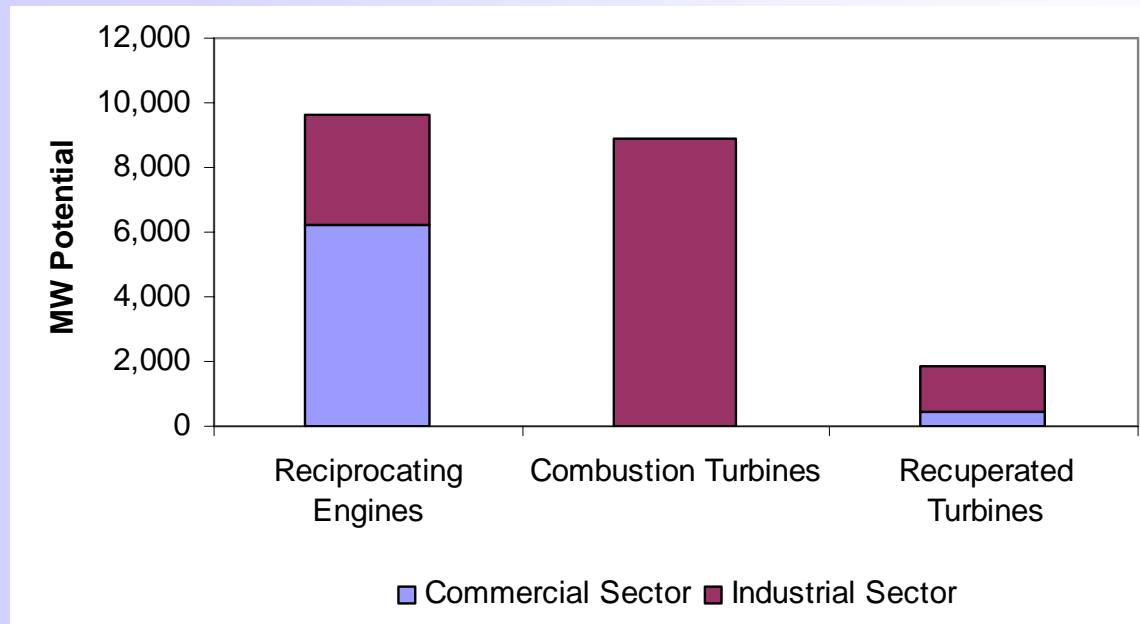
Source: *The Potential U.S. Market For Distributed Generation, 2004*, Resource Dynamics Corporation.

World Energy Engineering Congress
September 23, 2004



Market Potential For CHP/DG Capacity by Technology

- Reciprocating engines and combustion turbines have nearly equal market potential
- Engines are much more likely to be deployed in the commercial sector



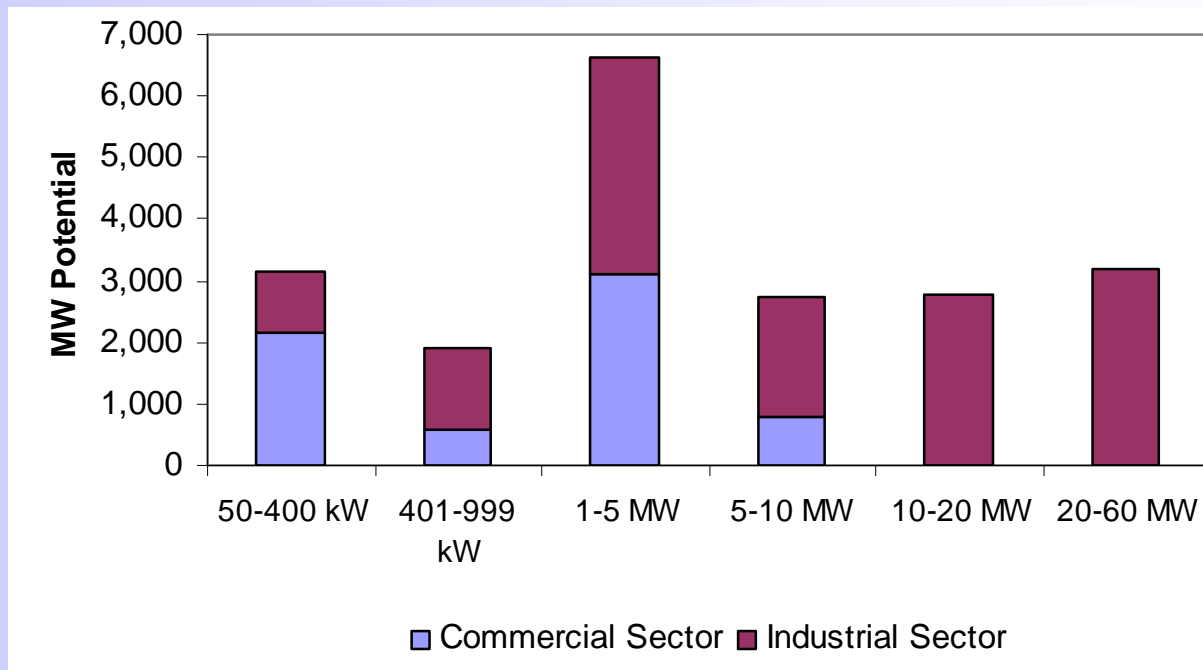
Source: *The Potential U.S. Market For Distributed Generation, 2004*, Resource Dynamics Corporation.

World Energy Engineering Congress
September 23, 2004



Market Potential For CHP/DG Capacity by Size

- Commercial applications are more economical in smaller size ranges
- A broad range of sizes might economically be deployed in the industrial sector



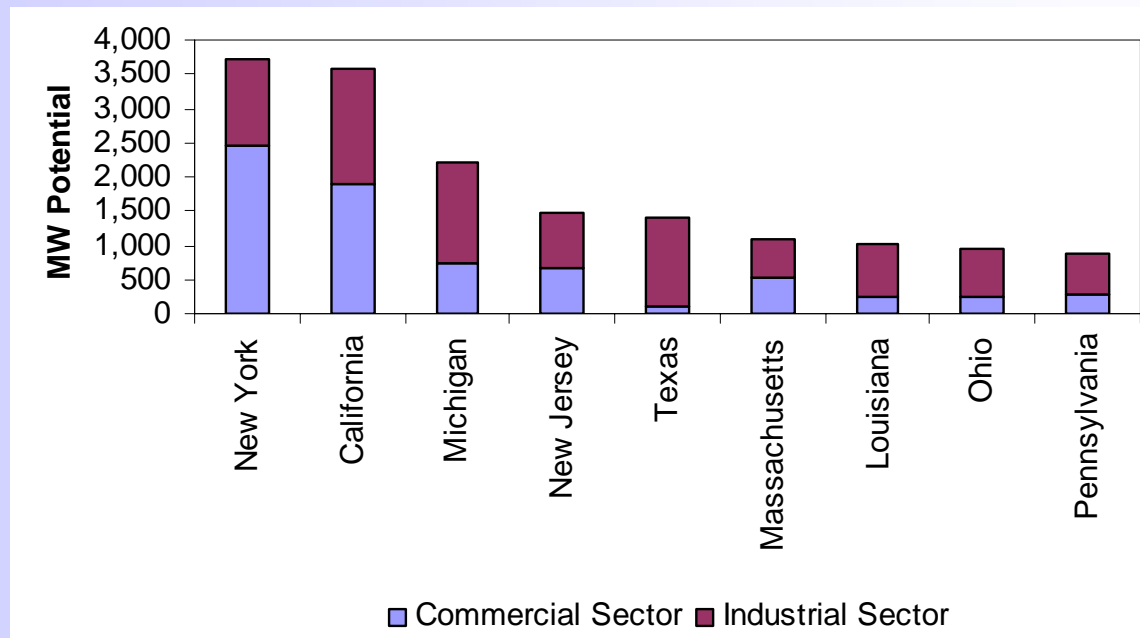
Source: *The Potential U.S. Market For Distributed Generation, 2004*, Resource Dynamics Corporation.

World Energy Engineering Congress
September 23, 2004



Market Potential For CHP/DG Capacity by State

This list of states is not surprising as they have a) the largest populations, b) the most industrial and commercial enterprises, c) the largest existing installed base of CHP, and d) in several cases, done the most to improve the regulatory environment to allow CHP to compete on a level playing field



Source: *The Potential U.S. Market For Distributed Generation, 2004*, Resource Dynamics Corporation.

World Energy Engineering Congress
September 23, 2004



Filling the Installation Gap

Installed 22 GW of CHP/DG could be 63 GW if Future Case price and performance were achieved. Why the gap?

- 21 of the 41 GW of new market potential only becomes economically viable once performance improves over the coming decade. The introduction of CHP with cooling systems is part of this trend.
- A knowledge barrier limits CHP adoption even when it can be the economically preferable solution. This includes low levels of knowledge about CHP, its siting, its operation, and the state and federal regulations that affect its use.
- Siting costs are relatively high compared with a small CHP unit's capital cost. This is a particular problem for commercial sector CHP.
- There are CHP use restrictions in some locations, especially for smaller reciprocating engines. Under the Clean Air Act stationary generators must meet strict air emission requirements in some nonattainment areas.

CHP Outlook



- The existing 22 GW of CHP/DG could double to 42 GW even under high gas price conditions. As technology improves, the market's size could triple
- CHP applications dominate overall DG industrial and commercial market potential, comprising over two-thirds of all DG Base Case market potential and over half of the Future Case market potential
- CHP is likely to be the best growth application for nearly all industrial sectors, with economics superior to those associated with either baseload or peaking applications
- CHP is underutilized in the commercial buildings sector, with great promise

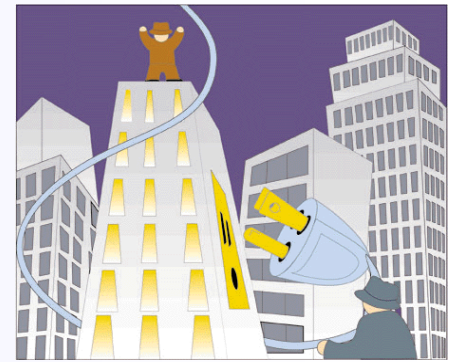
*World Energy Engineering Congress
September 23, 2004*



For More Information

Paul Lemar, President
Resource Dynamics Corporation
8605 Westwood Center Drive, Suite 410
Vienna, VA 22182
703-356-1300 ext. 204
pll@rdcnet.com

www.rdcnet.com
www.distributed-generation.com
www.dgmonitor.com



*World Energy Engineering Congress
September 23, 2004*

