MARKET ASSESSMENT OF DISTRIBUTED ENERGY IN NEW COMMERCIAL AND INSTITUTIONAL BUILDINGS AND CRITICAL INFRASTRUCTURE FACILITIES

Submitted to
UT-Battelle, LLC
Under BOA 4200000106
Task 4000038143

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September 2006

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EXECUTIVE SUMMARY

Electricity and natural gas demand and the need for power reliability to fuel increasing energy demands are on the rise. In our increasingly high-tech world, with burgeoning telecommunications, commercial data processing and internet services, and electronic data and signal processing requirements, energy is taking on greater and greater importance. Increasing energy demand, coupled with high transaction costs and an aging infrastructure that is near capacity, is leaving customers looking to new power generation, transmission, and distribution options.

Distributed energy resources include on-site, grid-connected, or stand alone small scale and modular energy systems. Potential benefits of distributed energy, or distributed generation, include reduced grid congestion, increased overall efficiency of providing electrical and thermal energy through combined heat and power (CHP); reduced losses from long-distance transmission of electricity (line losses); and deferred siting and construction of new central station plants.

There are commercial – or market – benefits of DE as well. In many high-cost utility markets, the cost of self-generation can be lower than the retail cost of electricity, mainly due to low natural gas costs. But today, many states and localities across the country are facing unusually high natural gas costs. Thus, the most economical configuration is to identify nearby heat loads that can utilize waste heat generated by either electricity production or process heating. Numerous other market studies have identified both customer and grid-side benefits of distributed energy in selected vertical markets, noting its potential to ease many problems plaguing the U.S. electric grid. Yet, the role of distributed generation is still small, accounting for only three percent of U.S. installed capacity.

This report characterizes the market for distributed energy technologies and systems in **new** commercial and institutional environments and critical infrastructure facilities, and provides examples of distributed energy installations in selected sub-sectors.

In conducting this study, the first step was to undertake an extensive literature search to uncover both qualitative and quantitative information on these markets. A list of data sources is provided as Appendix A.

Secondly, a *DE Market Assessment Questionnaire*, attached to this document as Appendix B, was designed to query individuals in both the new commercial and institutional markets as well as the critical infrastructure market. As a starting point, we identified trade associations to which these individuals belong, and which provide technical and support services to key decision-makers in these two markets.

Specifically, we tried to ascertain energy concerns; ability to address those concerns at a facility level; interest in distributed energy and combined heat and power as a way to meet shortfall and reliability concerns; and willingness to take steps in that direction through policy and administrative actions.

In the commercial and institutional market, we identified interviewees through the following associations:

- American Institute of Architects (AIA)
- American Society of Mechanical Engineers (ASME)

- Association of Energy Engineers (AEE)
- Energy Storage Council
- Institute of Electrical, and Electronics Engineers (IEEE)
- Building Owners and Managers Association (BOMA)
- Association of Shopping Center Owners and Managers
- American Society of Heating, Refrigeration, and Air Conditioning Engineer (ASHRAE)
- U.S. Combined Heat and Power Association (USCHPA)
- International District Energy Association (IDEA)
- American Hospital Association (AHA)
- Health Care Council

We were able to contact and interview one-half of these organizations, in addition to a number of individuals involved in financing, constructing, and managing commercial and institutional buildings. We also contacted manufacturers of distributed energy equipment and systems, reaching 32 of them for interviews.

In the critical infrastructure market, we identified interviewees through the following associations:

- International Facility Management Association
- Association of First Responders (Potomac, Md.)
- The Network for Call Center Facility Managers
- Association of Public Safety Communications Officials
- National League of Cities
- National Association of Counties
- National Association of City and County Health Officials
- International Association of Chiefs of Police
- International Association of Fire Chiefs
- State Emergency Management Associations
- State Police Associations
- State Sheriffs' and Deputies' Associations
- State Emergency Medical Services Associations
- State Departments of Public Safety

We attempted to conduct telephone interviews with individuals within these organizations. However, at the time we attempted to survey them, Hurricanes Katrina and Rita hit the Gulf Coast, hampering our efforts to interview first responders and others serving the critical infrastructure market. We were only able to reach a handful of them.

Our third major effort involved sending an e-mail to all 50 state energy offices to determine the nature and extent of information and data they had collected on the market penetration of DE technologies in new construction and critical infrastructure facilities. We received responses from 29 states, identifying specific incentives for installation of DE and specific projects.

The result of our surveys, interviews, research, and analysis is thus based on a somewhat limited sample of organizations and institutions involved in manufacturing, designing, financing, and installing DE in new commercial and institutional buildings and critical infrastructure facilities. Our results are primarily qualitative – not quantitative – with the exception of data that is currently available on the EIA website, and data provided by states which responded to our e-mail.

CONCLUSIONS:

Despite the challenges and barriers complicating the installation of distributed energy technologies in new commercial and institutional facilities and critical infrastructure facilities, proactive measures will promote the benefits of these technologies and ease their market acceptance.

As interconnection, permitting, and siting become standardized procedures throughout the country, the cost of installation and monitoring and evaluation will become less, improving the cost-benefit for each project. As builders, architects, and others involved in the construction marketplace become more familiar with DE and CHP, investment in projects will grow. And as more systems are packaged, or integrated, and can be more easily and seamlessly installed, first costs will decrease, leading to bottom-line improvements. And as net metering becomes more common throughout the country, reliability on peaking or baseload power will improve, rather than reliance solely on emergency back-up.

What is the value proposition to end users who want to install DE or CHP in their new building plans? How can spark spread be used to best advantage to make projects pencil? If the price of natural gas remains so high that projects are not cost-effective in today's marketplace, can the use of biofuels or alternative fuels make projects cost-effective?

Many individuals and organizations are tackling these issues, and it is hoped that they can be worked out in the coming years. In the meantime, it is unlikely that new construction projects that incorporate DHP and CHP will come on line, at least not without significant government or corporate financial support.

1. INTRODUCTION

"Keeping America competitive requires affordable energy. And here we have a serious problem: America is addicted to oil, which is often imported from unstable parts of the world. The best way to break this addiction is through technology. Since 2001, we have spent nearly $10 billion to develop cleaner, cheaper and more reliable alternative energy sources. And we are on the threshold of incredible advances….To change how we power our homes and offices, we will invest more in zero-emission coal-fired plants; revolutionary solar and wind technologies; and clean, safe nuclear energy. Breakthroughs on this and other new technologies will help us reach another great goal: to replace more than 75 percent of our oil imports from the Middle East by 2025."

– President George Bush, State of the Union Address, January 31, 2006

Electricity and natural gas demand and the need for power reliability to fuel increasing energy demands are on the rise. In our increasingly high-tech world, with burgeoning telecommunications, commercial data processing and internet services, and electronic data and signal processing requirements, energy is taking on greater and greater importance. Increasing energy demand, coupled with high transaction costs and an aging infrastructure that is near capacity, is leaving customers looking to new power generation, transmission, and distribution options.

Distributed energy resources include on-site, grid-connected, or stand alone small scale and modular energy systems. Potential benefits of distributed energy, or distributed generation, include reduced grid congestion, increased overall efficiency of providing electrical and thermal energy through combined heat and power (CHP); reduced losses from long-distance transmission of electricity (line losses); and deferred siting and construction of new central station plants.[1]

There are commercial – or market – benefits of DE as well. In many high-cost utility markets, the cost of self-generation can be lower than the retail cost of electricity, mainly due to low natural gas costs. But today, many states and localities across the country are facing unusually high natural gas costs. Thus, the most economical configuration is to identify nearby heat loads that can utilize waste heat generated by either electricity production or process heating. Numerous other market studies have identified both customer and grid-side benefits of distributed energy in selected vertical markets, noting its potential to ease many problems plaguing the U.S. electric grid. Yet, the role of distributed generation is still small, accounting for only three percent of U.S. installed capacity.

The purpose of this market assessment is to characterize the market for distributed energy technologies and systems in **new** commercial and institutional environments and critical infrastructure facilities, and to provide examples of distributed energy installations in selected sub-sectors.

[1] *Quantifying the Air Pollution Exposure Consequences of Distributed Energy Generation, University of California Energy Institute, May 2005,* www.ucei.org.

2. Market Sector Discussion

2.1 New Commercial and Institutional Construction

The focus on new commercial and institutional construction reflects the market growth in this marketplace. Overall, the commercial and institutional building sector has seen a 4.4% growth between 1999 and 2003 with the addition of 203,000 new buildings. Education, food sales, office space, places of worship, and service buildings have increased by 405,000 new buildings. Figure 1 compares the number and type of commercial and institutional buildings installed in the U.S. in 2003 as compared to 1999 and the percentage change as a result of this growth.

Figure 1: Number of Buildings by Type in the United States

Building Type	Number of Buildings (thousands)		Δ	Percent Change
	1999	2003		
Education	**327**	**386**	**59**	**18.0%**
Food Sales	**174**	**226**	**52**	**29.9%**
Food Service	349	297	-52	-14.9%
Health Care	**127**	**129**	**2**	**1.6%**
Lodging	153	142	-11	-7.2%
Mercantile	667	657	-10	-1.5%
Office	**739**	**824**	**85**	**11.5%**
Public Assembly	305	277	-28	-9.2%
Public Order and Safety	72	71	-1	-1.4%
Religious Worship	**307**	**370**	**63**	**20.5%**
Service	**478**	**622**	**144**	**30.1%**
Warehouse and Storage	603	597	-6	-1.0%
Other	102	79	-23	-22.5%
Vacant	253	182	-71	-28.1%
Total	**4656**	**4859**	**203**	**4.4%**

Source: EIA, Commercial Buildings Energy Consumption Survey, 2003

Market growth in educational and health care buildings, food sales, office space, service buildings, and religious institutions has shown the largest change in the 1999-2003 time period. Often the most cost-effective time to impact energy, water, and other resource consumption is during the planning process for these new buildings. There are many decisions made at the time of design that greatly impact the future energy use of the facility.

Three primary decision-makers are key in the new commercial and institutional construction marketplace: the investor, designer/architect, and the builder. In most instances these three parties are not in any way connected with the organization that will occupy the space. This often means that construction and development costs are of primary concern, and energy investments are secondary, as the buildings' tenants will occupy the property and have to bear the utility costs. In commercial and institutional buildings, utility expenses are normally included in the lease; as those costs increase, rental fees go up at the time the lease is re-negotiated.

In addition, the cost of energy for the facility is often much less than that of personnel and other operating costs. As a result, even as a tenant, energy costs are not always a concern. There is little inducement to create an energy efficient building beyond that of the current energy code.

Unfortunately, even enforcing the energy code can be challenging. City and county code enforcement agencies properly assign health and safety as a higher priority than energy efficiency. Often it is necessary to simply rely on the building's engineering design team to ensure compliance. In the last twenty-five years, energy efficiency and renewable energy advocates have looked to these design teams for the vision and foresight to design and build energy efficient buildings. And now, with reliability and vulnerability concerns at a high level, these teams are being asked to address on-site cogeneration, CHP, distributed energy systems, and renewable energy – energy technologies that may or may not be familiar to them. The growth in new construction as shown in Figure 1 clearly provides a sense of the market opportunity for distributed energy, if we are able to overcome economic, technical, and institutional barriers.

2.2 Critical Infrastructure Facilities

In the critical infrastructure environment, the Department of Homeland Security (DHS) has the lead role in developing the strategy for enhancing protection of the nation's key buildings, facilities, and resources from direct terrorist attacks and natural, man-made, or technological hazards. DHS has identified the Emergency Services Sector as one of the seventeen critical infrastructure and key resources sectors for which specific activities and initiatives must be developed. This sector consists of five disciplines: (1) emergency management; (2) emergency medical services; (3) fire and hazardous materials; (4) law enforcement; and (5) search and rescue.[2] The sector is the "first line of defense and prevention" in any terrorist attack or other disaster.

For this reason, energy supply disruption is – or should be – a critical issue, one which could be addressed with distributed energy resources. The Sector-Specific Plan for the energy sector, provided as input to the National Infrastructure Protection Plan by the U.S. Department of Energy, notes that "(Co)generation units (coal-, oil-, or gas-fired) can provide both electricity and process heat, and excess power may be sold to the grid. Distributed generation, energy efficiency and renewable energy sources offer the promise, in the longer term, of reducing the burden on the electric grid and **providing power to key areas during outages**."[3] (Emphasis added)

Figure 2 provides data on the number and type of critical infrastructure facilities in the United States, illustrating the market opportunities for distributed energy. When compared to the five disciplines noted above, there are approximately 200,000 individual facilities to which distributed energy equipment and systems could be applied.

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[2] *National Infrastructure Protection Plan, Base Plan, Revised Draft NIPP V2.0,* U.S. Department of Homeland Security, January 2006

[3] *Sector Specific Plan, Energy Sector for Critical Infrastructure Protection, As Input to the National Infrastructure Protection Plan,* Department of Energy, Redacted Draft, September 3, 200, www.dhs.gov/nipp_plan.pdf**.**

Figure 2. U.S. Critical Infrastructure Facilities: Type of Asset and Quantity

Category	Critical Assets	Quantity
Water	Reservoirs	1,800
	Waste water	1,600
Public Health	Hospitals	5,800
Emergency Services	U.S. localities	87,000
	Fire departments	28,724
	Fire stations	51,650
	EMS agencies	18,000
	Emergency management agencies	4,500
	Law enforcement agencies	14,000
Aviation	Commercial airports	450
Mass Transit	Major public transit operators	500
	Heavy rail systems (11,000 cars)	14
	Light rail systems (1,800 cars)	28
	Commuter rail agencies (5700 cars)	21
	Bus agencies	2,264

Source: The National Strategy for the Physical Protection of Critical Infrastructures and Key Assets, February 2003.

Public concern about homeland security heightens the market potential, or the value proposition, for distributed energy in the emergency services sector. When asked to rate their level of concern about nine potential security events, one-third of facilities managers recently identified the threat of an interruption in power distribution at a Level 5 concern. Figure 3 below illustrates the results of a survey on levels of concern, as performed by Building Owners and Managers Association (BOMA) International.

Figure 3. Concern Level of Potential Security Events

	Percent of Responses By Level of Importance: High Level → Low Level				
Security Concern	**5**	**4**	**3**	**2**	**1**
Terrorist Attack	11.9%	7.4%	21.8%	30.2%	28.7%
Workplace Violence	7.9%	18.3%	30.2%	23.2%	20.3%
Crime	16.8%	26.2%	36.1%	13.9%	6.9%
Biohazards	6.9%	8.4%	22.3%	27.7%	34.7%
Building Management Preparedness	42.1%	21.8%	21.3%	9.4%	5.0%
Fire Safety	56.9%	23.8%	11.4%	3.5%	4.5%
Power Distribution	32.7%	26.2%	21.3%	13.9%	5.4%
Building Structural Security	32.7%	26.2%	21.3%	13.9%	5.4%
Civil Unrest	34.7%	13.9%	18.8%	14.9%	17.8%

*Totals may not add due to rounding and/or lack of response sections.

Source: National Survey of Concerns within the Real Estate Industry, Building Owners and Managers Association (BOMA) International

Whether this level of concern translates into interest in – or commitment to – distributed energy is the issue. The market is there. The facilities manager plans, establishes, and maintains a work environment that effectively supports the goals and objectives of the organization. Taking action to maintain a reliable power supply, although it is certainly a concern, is often overlooked by seemingly more urgent matters.

3. DISTRIBUTED ENERGY TECHNOLOGIES

Distributed energy includes technologies for onsite, grid-connected, or stand alone small scale and modular energy conservation and delivery systems. The technologies analyzed for this market assessment include:

- Microturbines
- Reciprocating Engines
- Fuel Cells
- PV/Solar
- Combined Heat and Power

Figure 4 below illustrates the installed base of distributed energy technologies as of 2005.

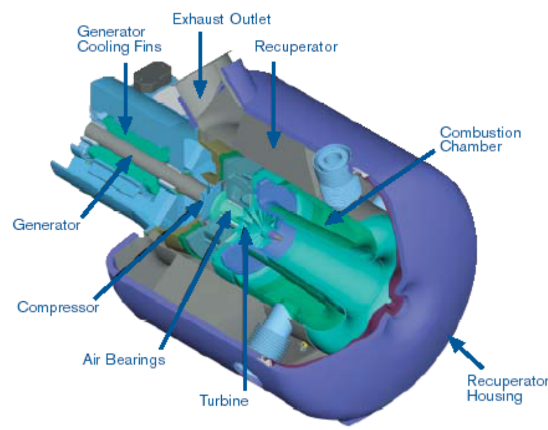
Figure 4: Installed Base of Distributed Generation by Technology

	Microturbine	Reciprocating Engines	Fuel Cells	PV/Solar	CHP
Number of Units	1310	12,280,161	350		20,500
Capacity (MW)	39	192,498	70		34,700
Generation (GWh)	283	109,997	552		136,000
Thermal Output (Billion Btu)	737	100,481	0		929000

Source: DG Monitor, The Installed Base of U.S. Distributed Generation. Resource Dynamics Corporation, 2005 Edition

3.1 Distributed Generation Technologies

Microturbines. These small combustion turbines have outputs of 25 to 1,000 kW. Simple cycle microturbines generally use 30-40 percent more fuel that a recuperated microturbine, but the hot exit gas allows more heat for various cogeneration applications.



Capstone C30 MicroTurbine Generator

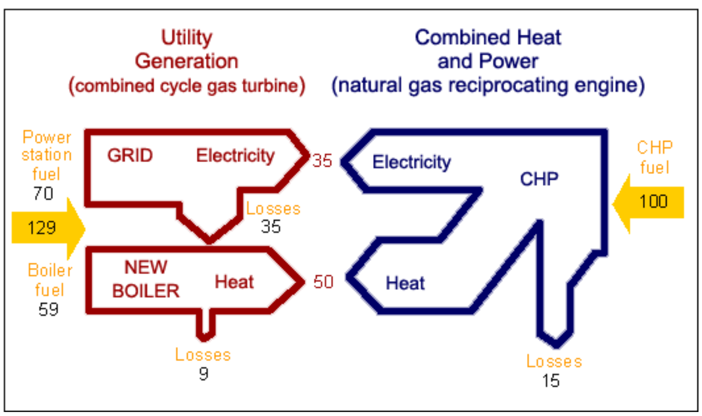
Reciprocating Engines These electric power generation systems range from 0.5 to 10MW, and include both internal combustion (IC) and spark ignition (SI) applications. With efficiencies between 37-40%, these engines provide reliable backup power, and can help shave loads during peak periods.

Fuel Cells This technology offers many benefits for DG applications. With zero or near-zero emissions, and low noise pollution, it is ideal for locations near to homes and businesses. In a fuel cell, hydrogen and oxygen are separated by an electrolyte. This process induces a chemical potential which is converted into DC power. Fuel cell types include phosphoric aid, molten carbonate, solid oxide and proton exchange membrane. Only phosphoric acid fuels cells are available commercially. Fuel cell efficiency can range from 30-55% depending on the type and design. The high-temperature efficiency ranges from 45-55%, and low temperature efficiencies range from 30-40%. When used in a CHP application, the total efficiency increases to near 80%.

A GM stationary fuel cell unit

http://www.gm.com/company/gmability/adv_tec h/500_stationary/index.html

PV/Solar Systems Solar cells convert sunlight directly into electricity. Photovoltaic cells are often used as a baseload power source, in off-grid homes, remote industrial applications (i.e. telecommunication) and road signage. Although limited by geography, solar panels have the ability to generate electricity with no emissions, and require little maintenance.



Energy Savings of CHP - California Energy Commission

http://www.energy.ca.gov/distgen/equipment/chp/performance.html

Combined Heat and Power (CHP)
Combined heat and power (CHP) technologies produce both electricity and steam from a single fuel. CHP systems are normally installed at facilities located on-site or near other consumers. These efficient systems recover heat that normally would be wasted in an electricity generator, and save the fuel that would otherwise be used to produce heat or steam in a separate unit.

CHP offers significant advantages in efficiency and often, lower air pollution than conventional technologies. A wide variety of CHP technologies generate electricity and meet thermal energy needs (direct heat, hot water, steam, process heating and/or cooling) simultaneously, at the point of use.

4. Market Assessment Methodology

This market assessment began with a thorough electronic literature search of distributed energy market analyses conducted to date. Telephone and e-mail interviewers were conducted with developers, architects, facilities managers, and building engineers working in both the new commercial and institutional marketplace and with critical infrastructure facilities. In addition, a 50-state e-mail request for information was sent to all state energy offices, which yielded some responses.

A *DE Market Assessment Questionnaire*, attached to this document as Appendix A, was used to query individuals in both the new commercial and institutional market as well as the critical infrastructure market. As a starting point, we identified trade associations to which these individuals belong, and which provide technical and support services to key decision-makers in these two markets. Telephone interviews were conducted with any many of these individuals as were willing to respond, given that the time period in which the telephone calls were made was that in which Hurricane Katrina hit the Gulf Coast states, causing almost all emergency responder organizations and individuals to be otherwise engaged.

In the commercial and institutional market, interviewees were identified through the following associations:

- American Institute of Architects (AIA)
- American Society of Mechanical Engineers (ASME)
- Association of Energy Engineers (AEE)
- Energy Storage Council
- Institute of Electrical, and Electronics Engineers (IEEE)
- Building Owners and Managers Association (BOMA)
- Association of Shopping Center Owners and Managers
- American Society of Heating, Refrigeration, and Air Conditioning Engineer (ASHRAE)
- U.S. Combined Heat and Power Association (USCHPA)
- International District Energy Association (IDEA)
- American Hospital Association (AHA)
- Health Care Council

In the critical infrastructure market, interviewees were identified through the following associations:

- International Facility Management Association
- Association of First Responders (Potomac, Md.)
- The Network for Call Center Facility Managers
- Association of Public Safety Communications Officials
- National League of Cities
- National Association of Counties
- National Association of City and County Health Officials
- International Association of Chiefs of Police
- International Association of Fire Chiefs
- State Emergency Management Associations

- State Police Associations
- State Sheriffs' and Deputies' Associations
- State Emergency Medical Services Associations
- State Departments of Public Safety

The focus of the questions was qualitative rather than quantitative analysis. Specifically, we tried to ascertain energy concerns; ability to address those concerns at a facility level; interest in distributed energy and combined heat and power as a way to meet shortfall and reliability concerns; and willingness to take steps in that direction through policy and administrative actions.

Sample questions included:

- What are the barriers to the implementation of on-site energy generation at such facilities?
- Have the facility managers considered the impact of power loss on their operations following the events of 9/11/2001, and more recently, the 8/14/2003 Northeast blackout?
- What kind of backup systems do the first responder facilities currently have, and how long would they be able to sustain operations in the event of a disruption?

Architects, engineers, building owners and managers, trade associations, and hospital administrators or trade leaders are familiar with various distributed generation technologies, identifying themselves as either somewhat or knowledgeable about them. They turn to industry trade association leaders for information on energy in general, and to government agencies for information, including meetings, on specific energy issues.

The most effective policies that would support the market for DG include tax credits and accelerated depreciation schedules. Other policies noted in the survey document would have less than an immediate impact, although a number of respondents noted that electricity restructuring was causing them to evaluation possible energy alternatives.

The most important criterion for investment decision-making is the rate of return expected from the investment made. Positive cash flow and the size of capital equipment are also critical. In terms of client concerns, again, the economic advantage or payback is overwhelmingly the most important driver in investing in DG.

DG technologies most often mentioned as possibilities for installation in the next 5 years were load control/demand response systems and reciprocating engines.

Critical infrastructure professionals were much less knowledgeable about DG technologies, identifying themselves as somewhat or not knowledgeable about them. There was an interest, but not familiarity or knowledge. They turn to government most often for information on energy, but were not familiar with incentive policies for installing DG in critical infrastructure sectors.

Because so many first responders and critical infrastructure managers work in public and non-profit sectors of our economy, the need for positive cash flow is not as great as in the private sector and sometimes not needed at all. There is an interest in solar and wind energy, but how to install these technologies within the critical infrastructure sector is extremely difficult. They do understand and anticipate, however, that improved performance and lower cost of these technologies will make them more attractive to their customers and clients.

Additional results of this research effort are presented in Sections 5 and 6 below.

5. NEW COMMERCIAL AND INSTITUTIONAL BUILDINGS MARKET ASSESSMENT

As explained in Section 2, new commercial and institutional buildings are the focus of this assessment because of the growth in the sector, and the sub-sector growth as identified by the Energy Information Administration. Figure 5 below presents the results of research conducted on commercial and institutional facilities that have installed new DG in the last five years:

Figure 5. DE in New Commercial and Institutional Markets (Within the last 5 years)

Technology	Facility	State	Building Type	Energy Production	Year Installed
CHP	Bank of America at One Bryant Park	NY	Commercial	4.6 MW	2006-07[4]
CHP	Wal-Mart Store in Aurora, CO	CO	Commercial	360 kW[5]	2005
Wind				50 kW	
Photovoltaics				134 kWh	
Solar	The Conde Nast Building at Four Times Square	NY	Commercial	15 kW	2000
Fuel Cell				200 kW	
Solar Thermal	Big Horn Home Improvement Center	CO	Commercial	112,000 kWh	2000
Photovoltaics				6,030 kWh	
Photovoltaics	The Brewery Blocks--Brewery Block 4	OR	Commercial	21,600 kWh	2003
Photovoltaics	The Chesapeake Bay Foundation's Philip Merrill Environmental Center	MD	Commercial	2,140 kWh	2000
Solar Thermal				41,000 kWh	
Photovoltaics	Pennsylvania Department of Environmental Protection's Cambria Office	PA	Commercial	17,000 kWh	2000
Photovoltaics	NREL Wind Site Entrance Building (SEB)	CO	Commercial	960 kWh	2002
Wind				378 kWh	
Photovoltaics	Society for the Protection of New Hampshire Forests--French Wing	NH	Commercial	3,600 kWh	2001
Biomass Thermal				670 MMBtu	
Photovoltaics	Environmental Protection Agency Research Triangle Park (RTP) Research Facility	NC	Commercial	8,200 kWh	2001
Photovoltaics	Environmental Tech. Center, Sonoma State	CA	Education	2,440 kWh	2001
Photovoltaics	Oberlin College Lewis Center	OH	Education	59,500 kWh	2000
Photovoltaics	U. of Wisconsin-Green Bay	WI	Education	84,000 kWh	2001
CHP	Dell Children's Hospital	TX	Institutional	4.6 MW[6]	2007[7]

[4] Bank of America at One Bryant Park is under construction; entire project to be completed by 2008.
[5] The Wal-Mart Store in Aurora, CO, utilizes six 60-kW natural gas–powered microturbines and a double-effect absorption chiller. Exhaust from the microturbine is collected in a manifold and used to directly drive the double-effect absorption chiller, where it is used for heating or cooling.
[6] Dell Children's Hospital configuration includes a Solar Turbines 4.6 MW Mercury 50 combustion turbine in combination with a 1000 ton absorption chiller, supplied with steam from a heat recovery steam generator. The system will base load the absorption chiller in combination with a packaged electric centrifugal chiller plant and an 8,000 ton-hour thermal energy storage tank to meet the hospital's chilled water cooling loads. An additional packaged chiller will serve as backup during corrective or preventive maintenance periods.
[7] Dell Children's Hospital is under construction; groundbreaking was in 2005.

Technology	Facility	State	Building Type	Energy Production	Year Installed
CHP	Ronald Reagan Presidential Library and Museum of Flight	CA	Institutional	960 kW[8]	2005
Photovoltaics	San Mateo County Sheriff's Forensic Laboratory & Coroner's Office	CA	Laboratory	283,000 kWh	2003
Solar Thermal	Audubon Center at Debs Park	CA	Recreation	3,430 kWh	2003
Photovoltaics				21,800 kWh	
Photovoltaics	Challengers Tennis Club for Boys and Girls	CA	Recreation	9,410 kWh	2002
Photovoltaics	Colorado Court Affordable Housing	CO	Residential	21,000 kWh	2002
Photovoltaics	20 River Terrace – The Solaire	NY	Residential	34,300 kWh	2003

Sources: U.S. DOE Distributed Energy Case Study Database http://www.eere.energy.gov/de/casestudies/index.asp; Syska Hennessy Group, Inc., http://www.syska.com/; The Durst Organization, http://www.durst.org; U.S. DOE EERE Energy News, November 16, 2005, http://www.eere.energy.gov/news/news_detail.cfm/news_id=9533; Distributed Energy magazine, May/June 2006 issue, http://www.erosioncontrol.com/de_0605_walmart.html; Burns & McDonnell, http://www.chpbmcd.com/Dell.htm.

With few exceptions, these buildings are located either in the state of California or in states along the eastern seaboard, where energy prices have been historically higher and where the state's Renewable Portfolio Standard (RPS) and Public Benefits Fund (PBF) have spurred development activity in distributed energy and CHP. Research results on these drivers indicate, generally, the following:

- Total expected rate of return is the most important issue when making an investment decision, followed by positive cash flow.
- The bottom line is that economic advantage is most important, followed by improved operating reliability and power quality.
- High fuel costs and regulatory barriers are the top issues facing DE developers who are interested in serving the commercial and institutional building market.[9]

A selected group of building owners and operators find some commercial value in being the "good neighbor and business owner", or the "environmentally green" developer. Others take advantage of financial incentives for installing DE or CHP systems – state public benefits funds, incentives such as the California Self Generation Incentive Program, or tax write-offs for solar or wind investment. But for most project developers, the financial return just is not there. In the case of the California market, similar to New York, Wisconsin, Ohio, North Carolina, financial incentives have allowed these projects to "pencil" in the positive cash flow column.

Figure 6 lists states that offer grants, rebates, and tax incentives for the installation of DE technologies and systems. The state and a brief description of the incentive are listed below. A complete explanation of each incentive may be found on the DSIRE website, **http://www.dsireusa.org/**.

[8] *The Ronald Reagan Presidential Library and Museum of Flight CHP system incorporates micro turbine technology with direct exhaust-fired absorption chillers, providing a total of 380-plus tons of refrigeration to the complex. Gas-to-water heat exchangers allow up to 1.4 million Btu/hr of hot water to be used for building space.*

[9] *Top-Line Findings of the First Annual Distributed Energy Market Survey,* DEFG, 2005

Figure 6. State Incentives for Distributed Energy Technologies

State	Incentive
California	Rebate Programs
Connecticut	Property tax exemptions for CHP
Indiana	Loans and Grants for Distributed Generation
Kansas	Grants for energy efficient technology
Mississippi	Grants for energy efficient technology
New York	A number of DG funding opportunities
North Carolina	Grants for energy efficient technology
Ohio	Grants and incentives for air pollution reduction
Oregon	Tax incentives for CHP applications
Virginia	Property and sales tax exemptions for pollution control technology
Wisconsin	Incentives for biomass cofired CHP

Source: http://www.eea-inc.com/rrdb/DGRegProject/Incentives.html

Six major sub-sectors are included in this section for additional evaluation, based on new building growth in these sub-sectors. They include:

- Service buildings
- Food sales
- Religious worship
- Office
- Education
- Healthcare

Service buildings are those at which some type of service is provided, other than food service or retail sales of goods. They include auto service and repair shops; beauty parlor and barber shops; car washes; copy centers; dry cleaners and Laundromats; gas stations; kennels; photo processing shops; post office and postal centers; and repair shops. Although the five-year growth in actual numbers of service buildings is very large, representing a 30% jump, the majority of these buildings are small in terms of actual floor space (less than 5,000 square feet). They use 421 trillion Btu of total energy, or 7% of total energy consumption for all commercial buildings. They comprise 5% of commercial floor space, with total energy intensity above the commercial average.[10]

Despite this energy intensity, the market potential for distributed generation in service buildings is minimal, primarily due to the inadequate or inconsistent thermal load presented by this sub-sector. Most of these service buildings operate during normal business hours, rather than 24/7/365. Regardless of the price of electricity, natural gas, or fuel oil used, these building owners and managers would see a small – or non-existent – return on investment if they installed a distributed energy or combined heat and power system.

[10] *Commercial Buildings Energy Consumption Survey,* Energy Information Administration, 1999

Although financial incentives are available in numerous states for distributed energy installation, service buildings owners are unlikely to take advantage of them, again because the payoff is not high or timely enough.

Food sales buildings are buildings that are used for retail or wholesale sale of food, including grocery stores (“mom and pop” and “big box”) and convenience stores. Almost 80% of food sales buildings are less than 5,000 square feet; slightly more than three-fourths of food sales buildings are occupied by the owner, rather than corporately owned.[11] Both size and ownership play a role in the market potential for DE in this sub-sector.

According to Energy and Environmental Analysis, national supermarket decision-makers in this sector have shown strong preliminary interest in DE, with pilot projects using microturbine-based integrated energy systems.[12]

Supermarkets are a target for dehumidification systems, mostly using desiccants, to prevent front buildup on refrigeration cases and other equipment, and for the comfort of shoppers. According to EEA, targeted opportunities exist for absorption to perform subcooling in refrigeration systems. National account customers (supermarket owners and operators) have asked DE and CHP industry leaders to work with refrigeration system manufacturers to integrate IES with refrigeration systems. As a result, the Department of Energy established seven pilot projects, providing federal funds for design, installation, and maintenance support, to illustrate integrated energy systems in this, and other appropriate, markets.

One such pilot project is the new A&P Fresh Market in Mt. Kisco, N.Y., which opened as a renovated supermarket with an integrated energy system (IES). The new grocery store, featuring organic foods, is the first supermarket in the U.S. to install this system.

The IES significantly reduces the store's dependency on the electrical grid, while providing cooling in summer and heating in winter; sub-cooling for refrigeration system; power for electrical needs; and desiccant regeneration. Customers are benefiting with a better view of the products; the desiccant function lowers humidity inside a grocery store, resulting in less condensation and reduced frost on frozen food display units. The IES system packages four 60-kW microturbines to generate 240 kW of electricity, and 110 tons of chilled water, using an exhaust-fired double-effect absorption chiller; with flywheel energy storage. The CHP system replaces 54% of the store's annual baseline energy usage that would otherwise have been purchased from the local utility, resulting in an annual savings of $44,000. Additional savings in the areas of refrigeration compression, space cooling compression, desiccant regeneration, and space heating total $85,000, for a total annual savings of $129,000.

Although the market for distributed energy in small convenience is poor, based on owner-occupancy and slim profit margins, should a packaged DE product be designed and tested for these types of food sales buildings, the market opportunity could improve significantly.

Religious worship buildings are buildings at which people gather for religious services. Ninety-three percent of religious worships buildings are less than 25,000, and are used

[11] *Ibid.*
[12] *Market Potential for Advanced Thermally Activated BCHP in Five National Account Sectors,* Energy and Environmental Analysis, 2003

primarily on one or two days per week, rather than on a consistent basis throughout the week. Religious worship buildings used 110 trillion Btu of total energy in 1999, which was 2% of total energy consumption for all commercial buildings. Although they comprise about 5% of commercial floor space, religious worship buildings have the second lowest energy intensity of all building types, with only vacant buildings using less energy per square foot.

Thus, from a market opportunity perspective, this building sub-sector is not primed for distributed energy or CHP. Although a number of churches and synagogues have installed energy efficiency, and even passive solar heating systems, no on-site distributed energy or CHP systems have been installed to our knowledge.

Office buildings include buildings used for general office space, professional offices, and administrative offices. For example, an office may be a computer center, bank, consulting company, law office, or medical office. An office building may also be part of a campus or complex, such as an administrative building on a college campus or medical campus. Office buildings have the second largest amount of buildings and floor space, but consume **the most energy of all building types,** accounting for 19% of all commercial energy consumption. They use a total of 1.0 quadrillion Btu of combined site electricity, natural gas, fuel oil, and district steam or hot water. Electricity is the predominant energy source used in office buildings.[13]

Lighting is the major energy user in office buildings, using 29% of energy. Space heating consumers 25%, office equipment 16%, and water heating and cooling each consume 9%, with other end uses using less. Office buildings are thus very energy intensive – more than commercial buildings as a whole, and represent a very large market opportunity for DE and CHP.

This energy intensity, combined with market growth of 11.5% in new construction between 1999 and 2003, make office buildings excellent candidates for DE and CHP. A 2002 Arthur D. Little study, *Cooling, Heating, and Power (CHP_ for Commercial Buildings Benefits Analysis)* studied primary energy consumption intensities of a New York office building using CHP, as a function of generation efficiency, type of heat recovery, and baseline equipment. The analysis suggested that CHP could reduce building primary energy consumption by 10-23%, depending on equipment mix.[14]

Energetics' analysis and interview results show that although office building growth in the last five years has been strong, builders, developers, and building owners of new construction are not installing DE and CHP systems in the office building market. The return on investment still is not advantageous for this market to grow.

For instance, Whiting-Turner Contracting Company, construction managers, general contractors, and design-builders with a large national market share, has no new DE or CHP activity in its office building portfolio. Although the company has looked at possible installations, the cost-benefit has not been there. Another building developer, Equity Office Properties, sees very little market potential in new construction, primarily because building owners pass through utility costs to tenants, and thus have no incentive to install energy efficient or on-site power systems in their buildings. All of Equity's projects in the

[13] *Commercial Buildings Energy Consumption Survey,* Energy Information Administration, 1999
[14] *Cooling, Heating, and Power (CHP) for Commercial Buildings Benefits Analysis,* Arthur D. Little, Inc., April 2002

DE and CHP marketplace are retrofit, where old, poorly functioning HVAC systems are replaced with on-site energy generation and energy efficiency measures.

Among the office building contractors and managers with whom Energetics spoke, the reasons for not installing DC or CHP systems were primarily:

- Interconnection requirements and lack of consistent standards from state to state
- High capital and maintenance costs
- Emission requirements in non-attainment areas
- Lack of experience among building maintenance staff with new energy technologies

Office building owners respond to tenants; developers work with owners, using primarily third-party financing. The most important issues for tenants – which filter up to developers – are operating costs per square foot. Although energy is the primary cost of office space, owners and developers must realize a Return on Investment (ROI), based on economic advantage or payback, reduced business risk, and the size of their capital investment. As long as energy prices are still low – or moderate – investment in new technology will not take place.

A notable exception is the Laclede Gas Building CHP plant installed at the Laclede Gas Building, a 31-floor office building located in downtown St. Louis, Missouri. The building is owned by Stirling Properties, which also owns and operates the power plant. The plant serves the heating, hot water, electric, and cooling loads of the 500,000 square foot building, operating as a stand-alone system. It is not connected to the electric grid through the local provider, Ameren UE. The plant has four 800 kW Waukesha engines, two 550 kW Waukesha engines, one York absorption chiller, and generates 4.3 MW of generating capacity, and 25,000 lbs/hr of low pressure steam. Built in 1969, this facility doesn't "qualify" as a new building for this market study, but does illustrate that an office building can utilize CHP cost-effectively. Laclede Gas saves over $14,000 annually on its gas and electric bill, primarily during summer when steam recovered from the engines provides cooling via the absorption chiller, displacing electric load from the mechanical chiller system.[15]

Educational buildings are the fifth most prevalent commercial building type, with almost 300,000 buildings nationwide. Education buildings include those used for academic or technical classroom instruction, including preschools, elementary schools, middle or junior high schools, high schools, vocational schools, and college or university classrooms. The average education building is 25,100 square feet. There is 7.7 billion square feet of floor space used for education, which is 13% of all commercial floor space in the nation. Interestingly, about a third of all education buildings are less than 5,000 square feet, with a majority of them having one floor and 96% of them with three or fewer stories.[16]

Growth between 1999 and 2003 is moderate, at about 18%; backlog in new construction can be seen on college and university campuses throughout the country, a fair amount of it incorporating CHP for district energy applications.

Because over half of all education buildings are government owned, by either local or state government, the process of funding and constructing education buildings has

[15] Midwest CHP Application Center, *http://www.chpcentermw.org/15-00_profiles.html*
[16] *Commercial Buildings Energy Consumption Survey,* Energy Information Administration, 1999

important implications for DE and CHP. Financing and approval is handled through state and local public budget processes; buildings must meet state and local building codes, meet state and local emissions, siting, and interconnection requirements, and be managed according to state and municipal laws. In recent years, installation of DE and CHP systems at educational institutions has been through "trial" or "case study" process, using state public benefits funds, such as in New York, or federal government monies.

The International District Energy Association (IDEA) conducted a survey in 2001-2002 which identified 675 MW of potential CHP opportunity in college and university markets. Sustainable or "greening" campus movements have been driving clean CHP projects to promote sustainability and to reduce the ecological footprint of campus energy systems. There is significant pressure on university decision-makers to create environmentally satisfying campuses through energy efficiency, sustainable design, and green technologies, such as CHP.

One such campus that has installed CHP is the University of North Carolina at Chapel Hill. The university uses large boilers to make steam, and ties the boilers to a steam turbine which then generates electricity for campus use, reducing dependency on the local grid and saving the campus operating dollars. The electricity also is used to operate electric chillers for cooling, further reducing cooling costs. The remainder of the steam is used for domestic water heating, and space heating for offices, classrooms, and dormitory spaces. The boiler uses fluidized clean coal technology which keeps costs low and produces 18,000 tons of ash per year, which is recycled as material for structural fill and other projects.[17]

In the Midwest, a first-of-its-kind CHP system has been installed at Antioch Community High School, utilizing biogas from a nearby landfill. The system utilizes twelve 30 kW micro-turbine generators with two heat exchangers that recycle the exhaust heat from the turbines. The system runs 24/7 to supply most of the school's electric and thermal load. The primary fuel used for this system is landfill gas, located ½ mile away at a closed landfill. The school, which seats 3,000 students in a 262,000 square foot facility, is saving $165,000 per year.[18] Again, although this project has been shown to be cost-effective, and to provide an excellent return on investment, it is not a new facility, but rather a retrofit installation. The market potential appears very positive, however, not for new construction, and certainly not without financing support.

Healthcare buildings represent perhaps the best opportunity for DE and CHP in new construction. Healthcare buildings are those used as diagnostic and treatment facilities for both inpatient and outpatient care. Doctor's and dentist's offices are considered health care if they use any type of diagnostic medical equipment and offices if they do not.[19]

Health care buildings used 515 trillion Btu of total energy, which was 9% of total energy consumption for all commercial buildings. Since they accounted for only 4% of commercial floor space, this means that their energy intensity was well above average. This also means that they are excellent candidates for CHP and distributed energy systems.

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[17] *International District Energy Association,* **www.districtenergy.org**
[18] *Antioch Community High School, District 117,* Midwest CHP Regional Application Center, www.CHPCenterMW.org
[19] *Commercial Buildings Energy Consumption Survey,* Energy Information Administration, 1999

According to the Midwest CHP Regional Application Center, hospitals are excellent candidates for CHP systems because they have high electrical and thermal energy needs and have significant energy demands 24/7/365. More than 200 hospitals and health care facilities nationwide are using CHP to lower energy costs by up to 50% and decrease power outages and interruptions by up to 95%.[20]

One such facility is the Montefiore Medical Center in New York, which relied on combined heat and power to operate continuously through the 2003 Blackout in the Northeast United States. Owning and operating a 14 MW cogeneration plant allowed Montefiore Medical Center to continue to operate at full capacity despite the blackout on the power grid. The system is run by a 5.2 MW generator set and is run on natural gas, but has dual fuel capabilities allowing it to run on No. 2 Fuel Oil when needed. Approximately 90% of the Moses Campus patient areas are powered via cogeneration and backed up with standby generators. Even during the blackout in August 2003, MMC was able to continue its normal operations as well as provide a comfortable, air conditioned place to rest for the elderly, and a fully operating kitchen to help serve the community.

Although growth has been moderate (1.6%) in the last five years, the opportunity for installation of DE and CHP systems is good because of the need for constant, reliable energy in healthcare facilities. To date, the majority of installations have been retro-fit. DE and CHP in new construction are only minimally cost-effective in most geographic areas of the country.

Based on our research and interviews, the table below identifies target market opportunities for DE and CHP technologies and systems in new commercial and institutional buildings:

Figure 7. Target Market Opportunities for Selected DE/CHP Technologies

Technologies	Service	Food Sales	Health Care	Religious Workshop	Offic e	Education Facilities
CHP/IES	●	●	●		●	●
Microturbines	●	●	●		●	●
Fuel Cells			●		●	●
Reciprocating Engines		●	●		●	●
PV Solar			●		●	●

[20] Midwest CHP Regional Application Center, www.chpCenterMW.org.

6. MARKET ASSESSMENT IN CRITICAL INFRASTRUCTURE AND EMERGENCY SERVICES SECTOR

The complexity of the electric power system, combined with its large geographic extent, makes it vulnerable to natural disasters, human operator errors, and intentional attacks. The events of 9/11, the Northeast Blackout of 2003, and Hurricanes Katrina and Rita, have proven that our electric grid needs to be more resilient. The effectiveness of our critical facilities to carry out their mission during an emergency is dependent on their resilience to power shortages and outages; although they may feature 21st century equipment, these facilities are still relying on antiquated backup technology, primarily diesel generators, with limited staying power and only average power quality.

For the purpose of this market survey, Energetics researched the installation of DE and CHP systems at emergency services facilities, which include:

- emergency management agencies
- fire stations
- police stations

Designers, construction and facilities managers, site managers, and association leaders were asked:

- What distributed energy components and/or systems are being implemented on-site at first responder facilities?
- Do facility managers consider the impact of power loss on their operation, particularly since 9/11, the August 2003 Blackout, or Hurricanes Katrina and Rita?
- What kind of backup systems do first responder facilities have, and how long would they be able to sustain operations in the event of a disruption?
- Are any DE or CHP systems synched with the electrical grid?
- If DE or CHP has not been installed, has it been considered? What barriers have stood in the way?

Our research showed that interruption of electricity can create chaos. After Hurricane Katrina, for example, downed power lines and flooding created interruptions in diesel fuel delivery to smaller generators that were installed to provide backup power when the grid was down. Without electricity, the region was not able to function. Without power, the emergency response system broke down, resulting in a crisis in public safety and loss of human life.

The concept of resilience is clearly set out in the National Infrastructure Protection Plan. The overarching goal of the NIPP is to "enhance protection of the Nation's critical infrastructure and key resources in order to prevent, deter, neutralize, or mitigate the effects of deliberate efforts by terrorists to destroy, incapacitate, or exploit them; and to enable national preparedness, timely response, and rapid recovery in the event of an attack, natural disaster, or other emergency." Resilience to disaster is significantly different from disaster avoidance or protection; it reflects the ability of our infrastructure to recover from what is surely going to be other natural and man-made disasters and attacks on U.S. soil.

Recovery time and process define resilience; distributed energy and CHP can speed recovery and create protection against further chaos. Development and deployment of DE and CHP technologies and systems has been shown to provide resilient electric power, to protect citizens, and to serve the public good. While on-site distributed energy cannot solve **all** emergency power problems, many such energy systems can make a life-saving difference.

The emergency services sector includes five disciplines:

- emergency management
- emergency medical services
- fire and hazardous materials
- law enforcement, and
- search and rescue.

Emergency services personnel – including police, fire, rescue, and ambulance services – are the first line of both defense and response in any terrorist attack or other disaster. As part of their normal operations, they must deploy rapidly into dangerous and often uncertain conditions.

In order to respond quickly, safely, and effectively, emergency services rely on critical communication links. Emergency operations centers, 911 call centers, police and fire stations, and their communications equipment all rely on electricity. Loss of power at these critical locations can lead to increased casualties on the part of both the initial victims of the emergency situation, as well as the emergency responders themselves. Figure 8 below represents the different DE technologies installed in each state by kW and total number of units.

Figure 8. Distributed Energy Installations in Critical Infrastructure

	CHP		Fuel Cell		Recip		Microturbine		Solar	
State	Total kW Installed	Number of Units	Total kW Installed	Number of Units	Total kW Installed	Number of Units	Total kW Installed	Number of Units	Total kW Installed	Number of Units
AK	437,723	86			116898	69				
AL	3,038,260	31							57	2
AR	512,525	13			18,325	4			3768	26
CA	9,179,400	778	2800	11	256185	494	6010	29	1931	24
CO	813,461	22	7	1	1,905	6	190	3		
CT	486,053	79	2050	4	12423	52				
DC	10,000	1								
DE	393,500	4							300	1
FL	3,524,656	68			25,305	10			138	29
GA	1,207,707	35	5	1	18,000	7			40	4
HI	563,033	25			3345	14			21	4
IA	371,799	26			28,540	12				
ID	191,810	14			450	2				
IL	1,235,543				171277	86	570	3	583	33
IN	2,032,323	26			6,300	3	270	3		
KS	118,455	13			11595	3				
KY	120,920	6			400	1			36	1
LA	5,703,035	59			6165	3				
MA	1,824,282	105	450	2	58397	66			2.376	1
MD	841,975	17			10,200	2	75	1		

	CHP		Fuel Cell		Recip		Microturbine		Solar	
State	Total kW Installed	Number of Units	Total kW Installed	Number of Units	Total kW Installed	Number of Units	Total kW Installed	Number of Units	Total kW Installed	Number of Units
ME	1,100,834	27			5	1				
MI	3,100,948	83	315	4	43265	25			28	1
MN	1,045,015	36			4085	4	180	2		
MO	192,560	16			23,610	5				
MS	1,041,025	19							45	2
MT	99,097	10	500	1	350	2			2	2
NC	1,485,504	46			31,525	4				
ND	39,030	6			11,912	7	30	1		
NE	25,412	12	1000	2	6170	6				
NH	79,620	16			67374	123				
NJ	3,455,135	188	950	4	9483	6	710	3	500	1
NM	219,871	17			6,322	3	88	2		
NV	549,322	8			153787	179				
NY	5,704,758	283	3720	12	5,605	7	4840	19	370	2
OH	376,823				8,238	3	300	3	1630	2
OK	1,344,388	18			19,910	12				
OR	2,509,518	49	318	3					2	2
PA	2,508,922	95	580	3	104304	28	690	3	267	10
RI	95,008	13	200	1	1086	5				
SC	1,614,110	16			10,710	2				
SD	2,700	1			2,700	1				
TN	490,420	25	200	1	7,000	1			138	3
TX	16,318,473	137	200	1	50,275	18	60	1		
UT	380,012	17			41,286	6				
VA	2,160,774	46			29680	12			9	1
VT	34,377	12			1317	6				
WA	1,131,832	25	1500	1	7932	4				
WI	1,218,525	47			9480	9	30	1	45	16
WV	380,540	8			3390	2				
WY	59,135	9			225	1	110	2	4	1
TOTAL	81,370,148	2,693	14,795	52	1,406,736	1,316	14,153	76	9,916	168

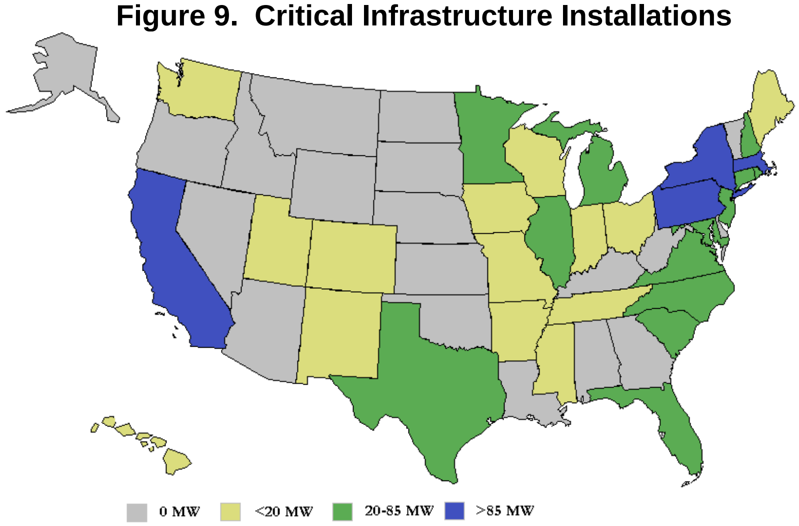
Source: U.S. DOE Distributed Energy Case Study Database http://www.eere.energy.gov/de/casestudies/index.asp

Distributed generation could be indispensable in ensuring that emergency responders can communicate critical information when it is most needed. Microturbines, reciprocating engines, fuel cells, or photovoltaics can provide power to emergency operations centers, call centers, communications equipment, and police and fire stations.

For example, during the northeast Blackout of August 2003, millions of New Yorkers were left in the dark. However, the Central Park Police Station in New York City, which had installed a 200-kW fuel cell at the satellite police precinct station, maintained crucial operations during a dangerous situation by virtue of this single phosphoric acid fuel cell. This fuel cell provided full electricity and air conditioning to the building, allowing officers there to respond to quickly, safely, and effectively in the crisis situation. Located on Transverse Road between Eighth and Fifth Avenues, the historic landmark had an inefficient power supply. With costs nearing $1.2 million to add a new service line from Eighth or Fifth Avenues, not to mention the construction permitting and approval process, this was not an option. The solution was to create the power on-site. Not only is the fuel cell providing power to the 145 year-old building, it helps provide power to recharge the fleet of Honda electric patrol vehicles used to patrol the park.

Furthermore, in 1995 and again in 2003, wildfires destroyed transmission lines that supply power to portions of Utah, leaving thousands of customers without power. However, Heber Light and Power (Heber, UT) was able to supply power to all of its customers, including municipal and county fire, rescue, and police operations, through distributed generation (approximately 20 MW, provided by 14 dual fuel reciprocating engines). In Heber, law enforcement, fire, and rescue services were able to maintain full functionality during a time when their services were most in need, and, at least one hospital maintained normal operations.[21] Furthermore, clean water continued to flow to some 16,000 customers of a district water and sewer consortium; this was made possible by distributed energy. Figure 9 below demonstrates the states with various levels of distributed energy technologies installed at critical infrastructure. As with the new construction installations, the most capacity is found in California, and the northeastern states.

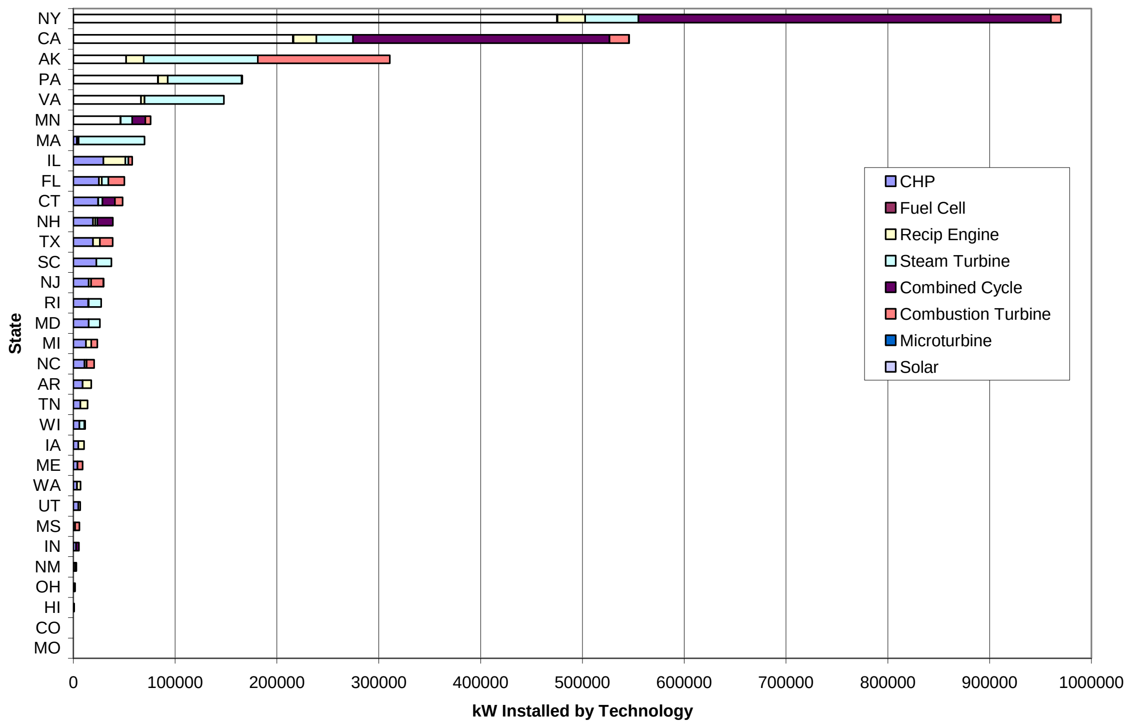
Figure 9. Critical Infrastructure Installations



Source: U.S. DOE Distributed Energy Case Study Database
http://www.eere.energy.gov/de/casestudies/index.asp

[21] Telephone conversation with Craig Broussard, Heber Light and Power, March 1, 2006.

Figure10. DE Installations in Critical Infrastructure



Source: U.S. DOE Distributed Energy Case Study Database http://www.eere.energy.gov/de/casestudies/index.asp

Another example points to photovoltaics as an option for municipal facilities used for emergencies. Twenty PV panels recently installed at the Athens City-County Health Department in Ohio will provide critical backup power. The 2.8 kW solar photovoltaic system will enable the municipal health department to maintain use of key communications equipment during emergencies and ensure the protection of vaccines stored at controlled temperatures. It was designed to provide five full days of power with no electricity or sunlight. In addition, electricity produced on the system during a typical day will be fed back onto the grid, reducing the city's electric bills and improving air quality.

The market for distributed energy and CHP in the emergency services arena is large, yet financing and institutional inertia have to date kept installations low. Emergency services facilities are publicly financed; thus, funding requests are made through local, state, and regional elected and appointed officials – the public sector environment is most heavily biased toward "low bid" contracting and construction practices, rather than long-term life-cycle costs.

Other barriers to DE and CHP in emergency services facilities are similar to those identified in the new commercial and institutional marketplace, including:

- strict utility interconnection requirements
- unreasonable standby or backup tariffs
- environmental permitting
- local distribution system access pricing issues
- contract length and complexity
- insurance and indemnification requirements
- inconsistent requirements and un-timely responses

In this market, however, breaking down these barriers is critically important. Resiliency is not an option – it is a requirement for the 21st century and beyond. Distributed energy and CHP can play a large role as more and more emergency services planners and decision-makers begin to understand the important role they play in making it happen.

7. Conclusions

Despite the challenges and barriers complicating the installation of distributed energy technologies in new commercial and institutional facilities and critical infrastructure facilities, proactive measures will promote the benefits of these technologies and ease their market acceptance.

As interconnection, permitting, and siting become standardized procedures throughout the country, the cost of installation and monitoring and evaluation will become less, improving the cost-benefit for each project. As builders, architects, and others involved in the construction marketplace become more familiar with DE and CHP, investment in projects will grow. And as more systems are packaged, or integrated, and can be more easily and seamlessly installed, first costs will decrease, leading to bottom-line improvements. And as net metering becomes more common throughout the country, reliability on peaking or baseload power will improve, rather than reliance solely on emergency back-up.

What is the value proposition to end users who want to install DE or CHP in their new building plans? How can spark spread be used to best advantage to make projects pencil? If the price of natural gas remains so high that projects are not cost-effective in today's marketplace, can the use of biofuels or alternative fuels make projects cost-effective?

Many individuals and organizations are tackling these issues, and it is hoped that they can be worked out in the coming years. In the meantime, new construction projects in both the private sector and in public facilities will only incorporate large DG and CHP in facilities at which government or corporate financial support is provided

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APPENDIX A – DE MARKET ASSESSMENT SURVEY

Distributed Energy **Market Study**

For New Commercial and Institutional Construction and Critical Infrastructure Facilities

Background:

This questionnaire of critical infrastructure and new commercial and institutional building specialists is funded by DOE's Oak Ridge National Laboratory. The results will be used in a study examining the market potential for distributed generation technologies in these applications. We have contacted you because of your technical knowledge and leadership regarding critical infrastructure and/or new building construction. The questionnaire will take no more than ten minutes over the phone or you may print it out and return it to us by fax [410.290.0377], email [adani@energetics.com], or mail [7164 Columbia Gateway Drive, Columbia, MD 21046]. Thanks very much for your support of this effort. We will be happy to send you the market survey when it is complete.

Part I: Basic information

1.1	Respondent:		
1.2	Title:		
1.3	Affiliation:		
	Contact Information – Phone		
	Contact Information – Email		
1.4	Type of Organization *(Check only one box)*	**Critical Infrastructure** ☐ First Responder ☐ Hospital ☐ Communications Center ☐ Data Processing Facility ☐ Transportation Control ☐ Other (please specify)	**New Construction** ☐ Architect or Designer ☐ Building Energy Manager ☐ Developer ☐ Engineer ☐ Financier ☐ Other (please specify)
1.4	Area(s) of specialization (security, product, energy, design, etc.)		

Part II: Market Assessment of DE for [New Commercial and Institutional Construction] [Critical Infrastructure]

According to the EIA *Commercial Buildings Energy Consumption Survey*, between 1999 and 2003, 203,000 new buildings were constructed in the U.S., with most growth in the service, food sales, religious worship, and education sectors

In 2001 there were 205 million MWh of distributed generation installed in the U.S. compared to 3,737 million MWh of net [traditional?] generation in the nation that same year, some DG installed in these building sectors. For the purposes of this questionnaire and the resulting study, distributed generation includes the following:

- Microturbines
- Reciprocating Engines
- Industrial Gas Turbines
- Fuel Cells
- PV/Solar
- Small Wind Turbine
- Thermally Activated Technologies
- Combined Heat and Power
- Hybrid Power systems

II. 1. The following questions ask you about your level of knowledge about these DG technologies. Which distributed energy technologies do you feel most and least knowledgeable about? (Please check the appropriate box for **each** technology option.)

Technology	1	2	3	4
Microturbines	☐	☐	☐	☐
Reciprocating Engines	☐	☐	☐	☐
Industrial gas Turbines	☐	☐	☐	☐
Fuel Cells	☐	☐	☐	☐
PV/Solar	☐	☐	☐	☐
Small Wind Turbine	☐	☐	☐	☐
Thermally Activated Technologies	☐	☐	☐	☐
Combined Heat and Power	☐	☐	☐	☐
Hybrid Power systems	☐	☐	☐	☐

1. No knowledge of technology
2. Somewhat knowledgeable of technology
3. Knowledgeable of technology
4. Very knowledgeable of technology

II.2. Where do you turn to find information on distributed energy technologies as they relate to your business or your target market? Please list your top three information sources: (i.e. interest groups, local/state/federal government, publications, industry meetings, etc.)

1.

2.

3.

II.3. Please identify the top 3 policies that would support the market for distributed energy technologies in new construction [critical infrastructure facilities] a more viable option in the short term.

☐ Renewable portfolio standards
☐ Tax credits
☐ Retail market restructuring
☐ Capacity payment structure [what is this?]
☐ Interconnection standards
☐ Accelerated depreciation schedules
☐ Elimination of utility standby charges
☐ Net metering
☐ Innovative rates such as real time pricing, time-of-use, etc.
☐ Other (please identify)

II.4. Please identify the three most critical issues or criteria for you when making an investment in distributed energy technologies.

- ☐ Participation of other investors in the market place
- ☐ Safety of capital invested
- ☐ Management experience
- ☐ Positive cash flow
- ☐ Stage of market maturity
- ☐ Size of capital equipment
- ☐ Total rate of return expected

II.5. Please identify the three most important issues for your clients when deciding whether or not to invest in distributed energy technologies.

- ☐ Improving operational reliability and/or power quality
- ☐ Economic advantage or payback
- ☐ Reduction in business risk
- ☐ Size of capital investment
- ☐ Emissions and/or other environmental considerations
- ☐ Reduction in operating costs

II.6. Please identify the particular distributed energy technology(s) that you would most likely install within the next 5 years.

- ☐ Voltage regulators
- ☐ Load control/demand response
- ☐ Wind
- ☐ Micro-turbines
- ☐ Batteries/flywheels
- ☐ Solar
- ☐ Reciprocating engines

II.7. Please indicate the impact you expect each of the following industry factors to have on the future success of distributed energy. (Positive, negative or no effect)

Industry Factor	Positive	Negative	Neutral
Improved performance and lower cost of DE technologies	☐	☐	☐
Electric restructuring	☐	☐	☐
Aging utility infrastructure	☐	☐	☐
Increasing customer demand for energy choices and convenience	☐	☐	☐
Increasing cost of natural gas	☐	☐	☐
Trend toward public policies favorable to DE	☐	☐	☐
Growing customer concerns about utility reliability	☐	☐	☐
Demand response initiatives	☐	☐	☐

Additional Comments:

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Thank you for your participation!