DISTRIBUTED ENERGY RESOURCES AND COMBINED HEAT AND POWER : A DECLARATION OF TERMS

Anna Monis Shipley
R. Neal Elliott, Ph.D., P.E.

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1001 Connecticut Avenue, NW, Suite 801, Washington, DC 20036
(202) 429-8873 phone, (202) 429-2248 fax, http://aceee.org Web site
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EXECUTIVE SUMMARY

It has become clear from several recent meetings of analysts (Energetics 1999a, 1999b) that the distributed energy resources (DER) and combined heat and power (CHP) communities are in need of a common set of definitions to describe segments of the marketplace. Two parameters appear to require inclusion in the taxonomy: (1) system size and (2) system design and operation. Defining the terms is not an academic issue—it has significance for the enumeration of current systems and the estimation of market potential because it will allow analysts to explicitly declare what is included in (and excluded from) their estimates and projections.

Because of the increased demands on the electrical power grid and the incidence of widespread power outages during peak times in the past few years, many utility customers have sought to generate their own power. Businesses are becoming much more dependent on the reliability of their electrical systems and many of these systems also require increasingly high-quality power. The implementation of DER can be beneficial for both the customer and the utility in many ways, but it should be noted once again that the aim of local systems should be to increase the quality and reliability of service. A customer that completely removes itself from the electrical grid faces the possibility of outages and decreased reliability.

DER Taxonomy

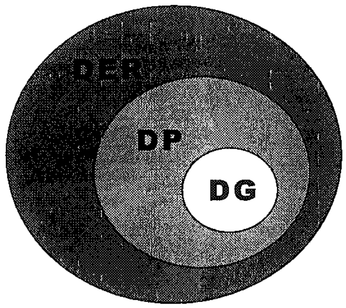
The terms that have been used by the electric industry include distributed generation (DG), distributed power (DP), and DER. We will attempt to clarify and define these terms in a manner that will appeal to the majority of the power generating community and create the groundwork for a unified industry terminology (see Table ES-1 for the definitions we developed). Note that we use DER in this report to refer to the broadest range of technologies that can provide power to the user outside of the grid, and also to cover demand-side measures.

Table ES-1: Definitions of Distributed Energy Resources

Distributed Generation	Any technology that produces power outside of the utility grid.
Distributed Power	Any technology that produces power or stores power.
Distributed Energy Resources	Any technology that is included in DG and DP as well as demand-side measures.

DG is defined as anything outside of the conventional utility grid that produces electricity. DG technologies include internal combustion engines, fuel cells, gas turbines and micro-turbines, hydro and micro-hydro applications, photovoltaics, wind energy, solar energy, and waste/biomass fuel sources. DG also includes non-utility combined heat and power plants.

Figure ES-1: The DER Sphere



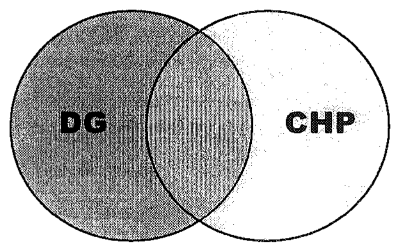
DP encompasses all of the technologies included in DG as well as electrical storage technologies. DP includes batteries, flywheels, modular pumped hydro-electric power, regenerative fuel cells, superconducting magnetic energy storage, and ultracapacitors.

DER includes all technologies in DP and DG and also includes demand-side measures. Under this configuration, power can be sold back to the grid. Figure ES-1 graphically displays the relationships between these terms.

CHP Taxonomy

Combined heat and power technologies represent a special area within the realm of DG. CHP systems that are installed at or near the point of use for off-grid applications are considered to be DG systems (see Figure ES-2). However, large central station CHP units are not included in DG. The size of this type of unit is typically between 40–400 megawatts (MW). This non-DG CHP encompasses about 40 percent of all CHP-produced power (Elliot and Spurr 1999).

Figure ES-2: DG, CHP Overlap



CHP systems are classified according to their size and system design and operation. Table ES-2 displays the six areas of classification for CHP systems.

We are presenting the terms in this report to bring clarification to the growing and complicated areas of distributed energy resources and combined heat and power. The next step in this process is for the industry to adopt this set of terms and to begin to establish a consistency in the language used. Such consistency is necessary for accurate data collection. A global terminology will make possible the development of metrics to track DER and CHP installations and the integration of these systems into the nation's energy portfolio.

Table ES-2: CHP Market Segments

	Typical Size (MW)	Dominant Ownership	Typical Power-to-Heat Ratio	Design Strategy	Power Utilization
Traditional	3–40 (small to medium)	owner operated	0.2 – 1.5	Match existing process thermal base-load	on-site
Regulatory-Driven	50–1,000 (large)	3rd party	> 2 (CTCC) > 0.5 (Steam)	Maximize power generation	merchant
Market-Driven	1–20 (small to medium)	3rd party	0.5 – 2	Balance power and thermal loads	on-site/ merchant
District Energy	1–40 (small to medium)	3rd party	0.2 – 2	Match existing thermal load	on-site/ merchant
Building CHP	0.1–10 (micro-small)	3rd party	0.4 – 2	Match building space conditioning load	on-site
Direct Drive	0.1–4 (micro-small)	3rd party and owner operated	05 – 1.5	Size to driven load with heat recovery	on-site

INTRODUCTION

In recent years, there has been increased interest on the part of electric customers in installing generating facilities at or near their site. Today's businesses rely greatly on electronic equipment, and the need for reliable, high-quality electric power is constantly increasing. At the same time, however, the power delivered by the electrical grid is becoming more and more unreliable. The importance of reliable electrical power cannot be over-emphasized. Nearly 90 percent of small businesses in the United States reported experiencing at least one power outage during 1998. According to a survey sponsored by Allied Signal Power Systems Inc., the 500 small businesses surveyed reported an average of three power outages last year, costing each business an approximate average of $7,500 per day (Allied Signal Power Systems 1999). As a result of these and other findings, businesses are looking to increase the reliability of their electrical systems to as much as 99.9 percent through the installation of distributed energy resources.

As interest in this area grows, and more studies address these various technologies, it becomes very apparent that there are many different terms that are currently being used to describe similar systems and technologies. This brings a great deal of confusion to both customers and suppliers. In this report, we attempt to bring clarity to the most common terms that are being used in the area of extra-grid electricity generation: distributed generation (DG), distributed power (DP), and distributed energy resources (DER).

A special subset of this area is combined heat and power (CHP). Combined heat and power technologies can fall under the category of DG, as will be explained later. CHP terminology is also in need of clarification since many businesses are finding that CHP technology can provide highly efficient solutions to their electrical quality and reliability issues. However, CHP is not only a distributed resource. It has also been used by utilities as a central power generating technology. Since CHP can be tailored to small and large applications and creates two forms of usable energy, it becomes quite difficult to classify the different types of systems.

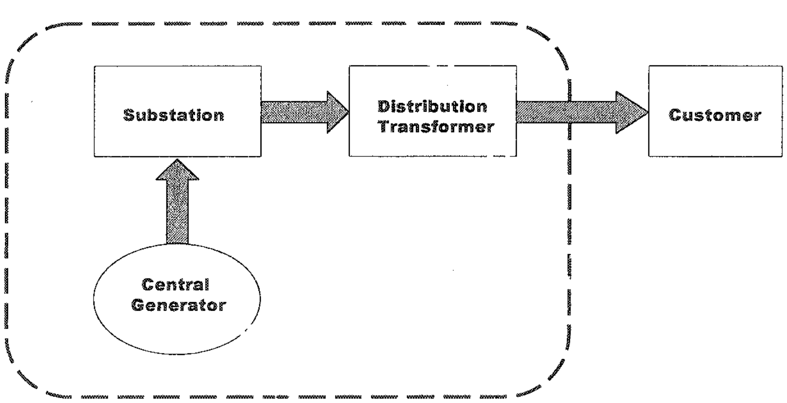
Both DER and CHP are classified according to size, system design, and operation of the power generating source. Because CHP is such an important energy-efficient technology to customers, suppliers, and electric utilities, we have chosen to include a taxonomy of its various systems in this report on distributed resources. We will begin our discussion with an examination and declaration of terms for distributed energy resources followed by the examination of combined heat and power technologies.

DER TAXONOMY

Analysts, scientists, and law makers have been using a wide array of terms (see appendix for examples) for what can be described very generally as electric power generation at or near the point of use. This can include a wide range of technologies that utilize both fossil and renewable fuels to produce energy outside of the conventional utility system. The aims of distributed energy resources are to increase the quality and reliability of the power supply for a customer at a competitive price and to reduce overall environmental emissions.

The current predominant electric system structure in the United States is the central generation system with distributed consumption. Under this configuration, a large utility-owned generating station produces electricity, transmits it to an electric substation, and sends it through a distribution transformer. The voltage of the electricity is reduced at the distribution transformer to a level that is appropriate for the customer. For the purposes of this report, we are limiting the scope of the electrical grid to include the generating station, transmission lines, substation, distribution lines, and distribution transformer. The systems and hardware leading from the distribution transformer to the customer are not included in the definition of electrical grid. Figure 1 provides a simplified illustration.

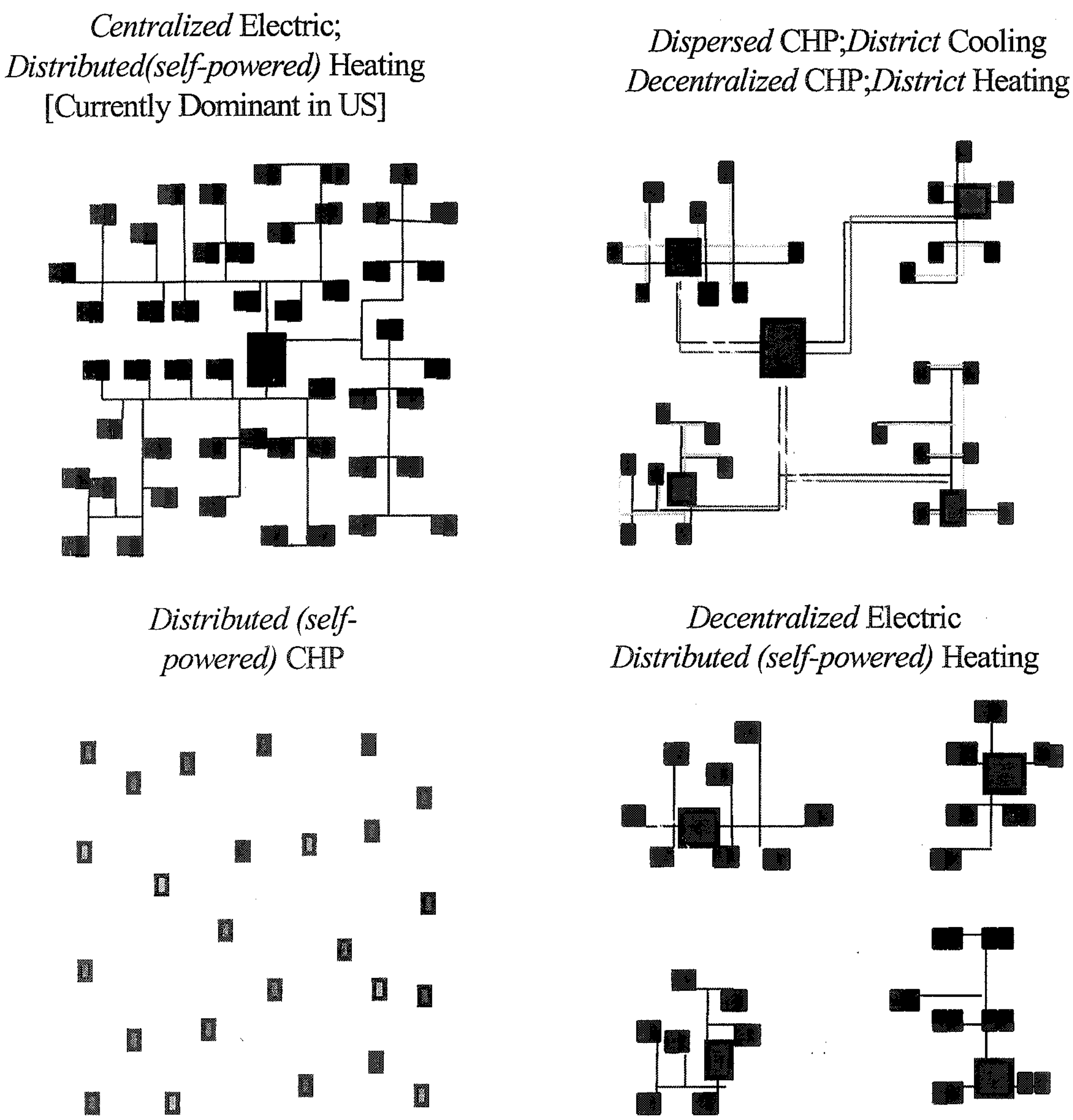
Figure 1: The Electric Power Grid



Due to increased demands and the incidence of widespread power outages during peak times in the past few years, many utility customers have sought to generate their own power. As stated in the introduction, businesses are becoming much more dependent on the reliability of their electrical systems. Many of these systems also require increasingly high-quality power. The implementation of distributed energy resources can be beneficial for both the customer and the utility, but it should be noted once again that the aim of local systems should be to increase the quality and reliability of service. A customer that completely removes itself from the electrical grid faces the possibility of outages and decreased reliability. Figure 2 displays the various configurations that are possible with distributed resources.

The energy produced through distributed energy resources can be utilized by the local user, or it can be sold back to the grid. The terms that have been used by the electric industry include distributed generation, distributed power, and distributed energy resources. We will attempt to clarify and define these terms in a manner that will appeal to the majority of the power generating community and create the groundwork for a unified industry terminology. For the purposes of this report, we will use "distributed energy resources" to refer to the broadest range of technologies that can provide power to the user outside of the grid but also includes demand-side measures.

Figure 2: Electricity Generation Configurations



Source: Kaarsberg et al. (1999)

Why Utilize DER?

With the rise of widespread power outages nationwide during peak demand times, utility customers have been exploring ways to ensure reliable, high-quality power for their facilities. While many customers are responding to the increased electrical supply instability by installing non-environmentally friendly equipment such as diesel generator sets, there is a great opportunity to decrease air emissions through the implementation of clean DER. A recent study found that instead of building new power plants to meet electrical demands, the installation of DER could reduce carbon dioxide and nitrogen oxides emissions by 50 percent or more (Kaarsburg, Gorte, and Munson 1999). This significant amount of pollutant reduction makes DER an attractive option in meeting the demands of an increasingly energy-intensive domestic and global community. While DER may not be right for every customer, it remains clear that under the right circumstances, DER can save money, improve reliability, reduce pollution, and enhance customer service and choice (RAP 1999).

DER Definitions and Terminology

The classification of distributed energy resources depends on the size, system design, and operation of the power generating source. For the purposes of this taxonomic report, we will attempt to segment the market into the following three subheadings: distributed energy resources, distributed generation, and distributed power. Table 1 displays the definitions of each of these terms.

Table 1: Definitions of Distributed Energy Resources

Distributed Generation	Any technology that produces power outside of the utility grid.
Distributed Power	Any technology that produces power or stores power.
Distributed Energy Resources	Any technology that is included in DG and DP as well as demand-side measures.

Our definitions will begin from the most specific, and expand to the most general. Distributed generation is defined as anything outside of the conventional utility grid that produces electricity. DG technologies include internal combustion engines, fuel cells, gas turbines and micro-turbines, hydro and micro-hydro applications, photovoltaics, wind energy, solar energy, and waste/biomass fuel sources. DG also includes non-utility combined heat and power plants. Table 2 displays the properties of various DG technologies.

Table 2: Properties of Various Distributed Generation Technologies

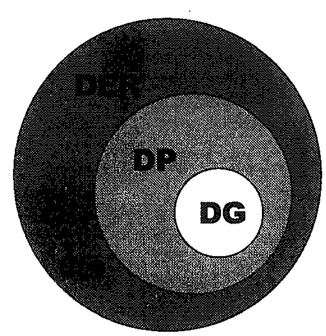
Technology	Size	Installed Cost (dollars/kWh)	O&M Costs (cents/kWh)	Fuel Type	Typical Duty Cycles
Internal Combustion Engines	50 kW – 5 MW	\$800 – \$1,500	0.7 - 1.5	Diesel, propane, NG, oil, and biogas	Baseload
Small Turbines	1 MW – 50 MW	\$700 – \$900	0.2 – 0.8	Diesel, propane, NG, oil, and biogas	Baseload and intermediate peaking
Micro-Turbines	25 kW – 500 kW	\$500 – \$1,300	0.2 – 1.0	Diesel, propane, NG, oil, and biogas	Baseload and intermediate peaking
Fuel Cells	1 kW – 200 kW	~ \$3,000	0.3 – 1.5	Hydrogen, biogas, and propane	Baseload
Photovoltaic	0.30 kW – 2 MW	\$6,000 – \$10,000	Minimal	Solar	Peaking
Wind Power	600 Watts – 1.5 MW	\$900 – \$1,100	1.0	Wind	Varies

Note: kWh = kilowatt-hour, kW = kilowatt, MW = megawatt, and NG = natural gas.
Source: California Energy Commission (1999)

Distributed power encompasses all of the technologies included in DG as well as electrical storage technologies. DP includes batteries, flywheels, modular pumped hydro-electric power, regenerative fuel cells, superconducting magnetic energy storage, and ultracapacitors.

Distributed energy resources include all the technologies categorized as DP and DG, and adds demand-side measures. Under this configuration, power can be sold back to the grid. The complete scope of DER is represented graphically in Figure 3. Demand-side measures focus on altering the level and timing of electricity use at a given site. Such steps can improve energy efficiency, which reduces the total energy consumption, and load management, which reduces energy use during specific periods of high cost.

Figure 3: The DER Sphere



The topic of mechanical drive has been purposefully left out of this discussion. DER may be utilized by a facility to provide mechanical power, such as compressed air for a particular application, displacing grid power, and so might be considered a

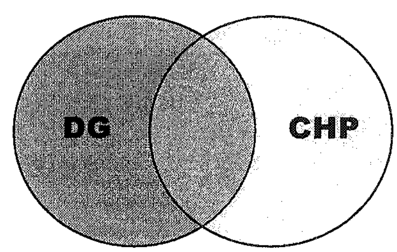
DSM measure. Mechanical drive applications are not included in the definitions of DER, DP, and DG based on the general consensus within in the industry that these terms almost universally refer to electrical power only. It is worth noting, however, that engine-driven air compressors and chillers can offer many of the benefits of on-site electricity generation while avoiding the barriers associated with interconnection to the electricity grid, capital costs, and electrical generation and reconversion to mechanical power. However, since none of the existing databases track this part of the market, we have chosen to not include this application in our definitions.

CHP TAXONOMY

Many experts and analysts (Energetics 1999a, 1999b) agree that the combined heat and power community is in need of a common set of definitions for establishing segments of the CHP marketplace. Two parameters appear to require inclusion in the taxonomy: (1)system size and (2)system design and operation. While this may appear a mundane and academic issue, it has significant importance in the enumeration of current CHP systems and the estimation of market potential, since it will allow analysts to explicitly declare what is included in and excluded from their estimates and projections.

Combined heat and power technologies represent a special area within the realm of DG. CHP systems that are installed at or near the point of use for off-grid applications are considered to be distributed generation systems (see Figure 4). However, large (typically between 40 – 400 MW) utility-owned CHP units are not included in DG. This non-DG CHP encompasses about 40 percent of all CHP-produced power (Elliott and Spurr 1999). A more in-depth look at CHP is included later in this report.

Figure 4: DG, CHP Overlap

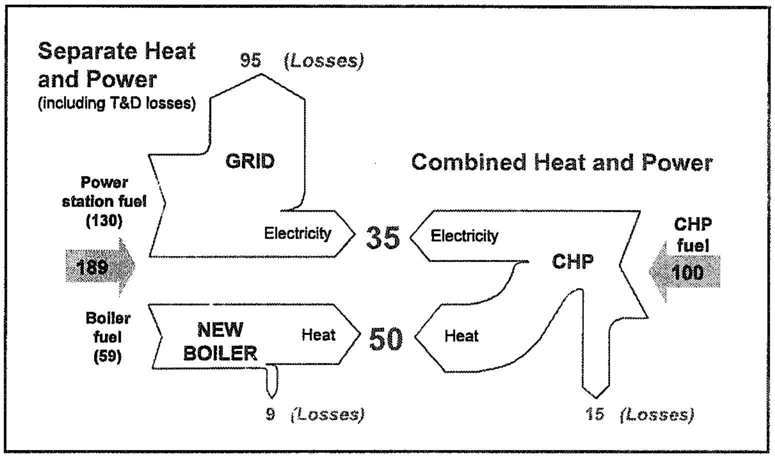


System Size

Determining the size of a CHP system is complicated by the fact that the system, by definition, produces at least two usable forms of energy. The output is generally grouped into two categories: thermal energy (heating or cooling) and power. Among the thermal outputs are direct process heating, steam, hot water, cooling, and chilled water. Among the power outputs are electricity, shaft-horsepower, and compressed air. In conventional, separate heat and power systems, these same outputs are produced by distinct systems (Elliott and Spurr 1999), as shown in the example in Figure 5.

The industry has adopted a convention of sizing systems based on power output. In a system where more than one form of usable power is produced, the outputs should be aggregated to define the size of the system. For example, compressed air can be produced through a combustion turbine, by bleeding the primary compressor stage, while the turbine produces electricity. The total power output for the system would be the created electricity plus the energy value of the compressed air produced.

Figure 5: Energy Flows in a Typical CHP System



Source: Kaarsberg and Elliott (1998)

The thermal output of a CHP system is captured as the ratio of the power manufactured to the usable thermal energy. This parameter, the power-to-heat ratio (α), is the ratio of electrical and mechanical energy to thermal energy, and it varies with equipment selection and system design. This ratio is expressed as:

$$\alpha = \frac{e_{\text{electric}} + e_{\text{mechanical}}}{e_{\text{thermal}}}$$

So, for the example in Figure 5:

$$\alpha = \frac{35}{50} = 0.7$$

Since CHP produces multiple forms of usable energy, conventional approaches to defining efficiency are problematic. A discussion of efficiency in a CHP context appears in Elliott and Spurr (1999).

CHP system design capacities are normally expressed in kilowatts or megawatts. The use of power output reflects the legacy of reporting requirements by the Energy Information Administration (EIA) and the Federal Energy Regulatory Commission (FERC), which require the reporting of electric generating capacity of all plants that connect to the electricity grid. No similar, consistent reporting of thermal output is in place. In addition, reporting of systems with power capacity below 1 MW or that do not generate electricity does not exist. A number of different categories are used by different analysts. Table 3 proposes a set of definitions that attempt to harmonize different analysts' terms.

Table 3: Size Categories of CHP Systems

Category	System Power Size Range
Micro	less than 500 kW
Mini	500 to 2 MW
Small	2 MW to 15 MW
Medium	15 to 40 MW
Large	Greater than 40 MW

System Design and Operation

CHP systems are further characterized by their design and operation. Through analysis of the current CHP literature, it has become apparent that the systems fall into the following six categories: traditional, regulatory-driven, market-driven, district energy systems (DES), self-powered buildings, and direct drive systems. A summary of the six market segments as well as the characteristics of each segment are displayed in Table 4.

Table 4: CHP Market Segments

Market Segment	Typical Size (MW)	Dominant Ownership	Typical Power-to-Heat Ratio	Design Strategy	Power Utilization
Traditional	3–40 (small to medium)	owner operated	0.2 – 1.5	Match existing process thermal base-load	on-Site
Regulatory-Driven	50–1,000 (large)	3rd party	> 2 (CTCC) > 0.5 (Steam)	Maximize power generation	merchant
Market-Driven	1–20 (small to medium)	3rd party	0.5 – 2	Balance power and thermal loads	on-Site/ merchant
District Energy	1–40 (small to medium)	3rd party	0.2 – 2	Match existing thermal load	on-Site/ merchant
Building CHP	0.1–10 (micro-small)	3rd party	0.4 – 2	Match building space conditioning load	on-Site
Direct Drive	0.1–4 (micro-small)	3rd party and owner operated	05 – 1.5	Size to driven load with heat recovery	on-Site

Many analysts divide the CHP market into two categories: traditional and regulatory-based. The division of the CHP market into these two categories resulted from the Public Utilities Regulatory Policy Act of 1978 (PURPA), which created the category of independent power producer for those facilities that used cogeneration (see Elliott and Spurr [1999] for a more detailed discussion of PURPA). Prior to PURPA, cogenerators were discouraged from producing excess power, since there were no ready markets.

Traditional CHP is characterized by Energy and Environmental Analysis, Inc. (EEA 1999) as systems where the host facility's steam demand drives the system design, matching the electricity capacity to existing steam demand. In most cases, all the power produced is used internally. In regulatory-based CHP, a third party satisfies the steam requirements of the "thermal host" customer while maximizing the electric power production. The siting of non-traditional CHP systems is driven by available markets for the electricity.

The nature of the thermal host can vary. Elliott and Spurr (1999) break the market into three classes: industry, district energy systems, and small-scale buildings. Industrial CHP has dominated in large part due to the characteristics and size of the steam loads. New technology, which has made smaller systems economical, has expanded markets in all three areas.

Traditional CHP Systems

Most traditional CHP systems used back-pressure steam turbines to generate electricity, which was used to displace a relatively small portion of the electricity purchased to meet on-site electricity demand. These facilities are predominately industrial (Elliott and Spurr 1999). The average traditional system is about 20 MW (EEA 1999). Generation is usually sized to meet the base steam load during high operating hours. As a result, the generated electricity displaces a portion of the electric base-load demand. More recently, combustion turbines have entered into this market, increasing the power-to-heat ratio that can be achieved. The power-to-heat ratio for these systems are usually modest: Energy and Environmental Analysis, Inc. uses a range from 0.2 for steam turbine-based systems to 1.5 for combustion turbine combined cycle (CTCC)-based CHP systems. The majority of these systems have in the past been owned by the plant.

Regulatory-Driven CHP Systems

Typical non-traditional CHP facilities are greater than 100 MW and are designed to maximize electricity production. To qualify under PURPA, they are required to produce at least 5 percent of their usable energy in the form of steam or hot water. CTCCs have become the preferred technology at these facilities and are almost exclusively third-party owned. Under the PURPA model, the steam is sold to a host customer, usually a large manufacturing facility. The electricity is sold to the local power company under a "buy-back" contract.

These non-traditional facilities have a high power-to-heat ratio. Energy and Environmental Analysis, Inc. uses a lower bound of 0.5 for boiler/steam turbine systems and 2.0 for CTCC systems. Some PURPA-qualifying facilities (QFs) were little more than conventional power plants that made use of a small portion of their waste heat in order to comply with the requirements.

With the passage of the Energy Policy Act of 1992, a new category of independent power producer was created—the exempt wholesale generator. These "merchant" plants sold their power on the wholesale market rather than under contract to the local utility. "Merchant," "independent power producer," and "exempt wholesale generator" are frequently used interchangeably. Though the majority of the new merchant plants are conventional power generators without heat recovery, some plants have been built as CHP facilities. With the restructuring of electricity markets and the introduction of new technologies, such as aero-derivative combustion turbines, the line between these two categories has become blurred. Many of the new CHP "traditional" facilities are third-party owned due to the outsourcing trend in industry where a firm's capital is focused on its core operation.

New technologies have allowed for higher power-to-heat ratios than could be achieved with a steam turbine-based system. A higher fraction of a facility's electric power demand can be met by these systems, and excess power may be available for sale in some cases. Because of reduced equipment unit-cost, designs that provide some degree of load following, both thermal and power, are now economically feasible. These technology developments also allow for the implementation of smaller merchant power plants.

Market-Based CHP Systems

These market and technology developments have created a new category of hybrid systems. These hybrid systems are for the most part third-party owned and serve a single customer facility. They fall within the small and medium size categories, and have a higher power-to-heat ratio than is associated with traditional systems. However, their primary focus is on meeting on-site energy requirements. Many of these systems are modular, and may have the potential for either thermal or power demand load following (i.e., the power production varies with the on-site thermal demand).

District Energy Systems

District energy systems provide steam, hot water, and/or chilled water from a central plant to individual buildings or industrial process areas through a system of pipes. A DES facility's aggregated thermal energy makes it attractive as a way to add CHP at existing facilities (Spurr 1999); this is partly why these systems boast rapid growth in recent years. The size of a DES can fall anywhere between the small to large size categories. The CHP facility could be placed into any of these categories. The aggregation of thermal demand from a number of customers distinguishes it from the industrial CHP facilities.

Self-Powered Buildings

More technologically advanced high-efficiency reciprocating engines and cost-effective micro-combustion turbines are allowing CHP to become a viable option for smaller commercial buildings. These two CHP systems supply part of the electrical requirements for a building while providing heating and/or cooling. Most of the CHP focus has been on the industrial and institutional sectors since they have relatively large and constant steam loads. This creates the high load factors needed to make traditional CHP operating regimes economically attractive. With the emergence of modern, smaller-scaled technologies, a new market for "self-powered" buildings is emerging (Kaarsberg et al. 1998). These are typically at the micro- or mini-scale, such as the reciprocating engines from Waukesha and Caterpillar that have a capacity beginning at 25 kW (Elliot and Spurr 1999). For large buildings, however, the systems may extend into the small size range. While most of the thermal loads for industrial CHP will supply the process of heating, it is anticipated that building CHP will focus on space conditioning loads. Space conditioning is cooling dominated and the systems will focus on cooling technologies such as direct-drive, absorption, and desiccant cooling.

Direct-Drive

The CHP market models discussed so far in this section have focused exclusively on electric power generation. Some people see direct-drive equipment as an emerging CHP market. Engine-driven air compressors and chillers can offer many of the benefits of on-site electricity generation while avoiding the barriers associated with interconnection to the electricity grid. None of the existing databases track this part of the market (Energetics 1999a).

CONCLUSIONS

Traditionally, the terms used in the distributed energy resources and combined heat and power communities were based on system size and design and operation. We believe that we have improved the terminology by creating more comprehensive definitions that include non-electric energy production.

Distributed energy resources and combined heat and power can contribute to the transformation of the energy future of the United States. CHP offers significant, economy-wide energy efficiency improvement and emissions reduction potential. Our existing system of centralized electricity generation charts an unsustainable energy path, with increasing fuel consumption and carbon emissions. Besides saving energy and reducing emissions, distributed generation also addresses emerging congestion problems within the electricity transmission and distribution grid.

The terms that have been presented in this report aim to bring clarification to the growing and complicated areas of distributed energy resources and combined heat and power. The next step in this process is for the industry to adopt this set of terms and to begin to establish a consistency in the language used. A global terminology will make possible the development of metrics to track DER and CHP installations and the integration of these systems into the nation's energy portfolio.

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APPENDIX: DEFINITIONS OF DISTRIBUTED POWER FROM VARIOUS SOURCES

- Southern California Edison Corporation (SCE) defines distributed power as anything under 200 kW.

  [CADER] California Alliance for Distributed Energy Resources. 1998. *Collaborative Report and Action Agenda.* Sacramento, Calif.: California Alliance for Distributed Energy Resources.

- "Distributed power is meant for on-site use only."

  Richard Brent (SolarTurbines, Inc.). 1999. Personal Communication. November.

- "Distributed energy resources are low- or zero-polluting, highly efficient electrical generation and storage technologies. ... They can be installed near or on a customer's site. ... They can be used to meet increased customer demand where it is infeasible to upgrade or install new electric distribution lines."

  [CADER] California Alliance for Distributed Energy Resources. 1998. *Collaborative Report and Action Agenda.* Sacramento, Calif.: California Alliance for Distributed Energy Resources.

- "Distributed resources are demand and supply resources that can be deployed within the distribution system to meet the energy and reliability needs of the customers served by that distribution system. Distributed resources can be installed on either the customer side or the utility side of the meter."

  Regulatory Assistance Project. 1999. *Profits and Progress through Distributed Resources (Draft of July 15).* Prepared for NARUC (National Association of Regulated Utility Commissioners). Gardener, Maine: Regulatory Assistance Project.

- "In most cases, distributed resources will be quite small, ranging from less than 1 kW to only a few hundred kW, but there are examples of larger installation (generally in commercial and industrial settings). The practical size limit for generators in the distribution system is about 35 to 40 MW."

  Regulatory Assistance Project. 1999. *Profits and Progress through Distributed Resources (Draft of July 15).* Prepared for NARUC (National Association of Regulated Utility Commissioners). Gardener, Maine: Regulatory Assistance Project.