The Potential Benefits of Distributed Generation and the Rate-Related Issues That May Impede Its Expansion

Report Pursuant to Section 1817 of the Energy Policy Act of 2005

Background

Section 1817 of the Energy Policy Act (EPACT) of 2005 calls for the Secretary of Energy to conduct a study of the potential benefits of cogeneration and small power production, otherwise known as distributed generation, or DG. The benefits to be studied are described in subpart (2)(A) of Section 1817. In accordance with Section 1817 the study includes those benefits received "either directly or indirectly by an electricity distribution or transmission service provider, other customers served by an electricity distribution or transmission service provider and/or the general public in the area served by the public utility in which the cogenerator or small power producer is located." Congress did not require the study to include the potential benefits to owners/operators of DG units.[1] The specific areas of potential benefits covered in this study include:

- Increased electric system reliability (Section 2 of the Study)
- An emergency supply of power (Section 2 and 7 of the Study)
- Reduction of peak power requirements (Section 3 of the Study)
- Offsets to investments in generation, transmission, or distribution facilities that would otherwise be recovered through rates (Section 3 of the Study)
- Provision of ancillary services, including reactive power (Section 4 of the Study)
- Improvements in power quality (Section 5 of the Study)
- Reductions in land-use effects and rights-of-way acquisition costs (Section 6 of the Study)
- Reduction in vulnerability to terrorism and improvements in infrastructure resilience (Section 7 of the Study)

Additionally, Congress requested an analysis of "…any rate-related issue that may impede or otherwise discourage the expansion of cogeneration and small power production facilities, including a review of whether rates, rules, or other requirements imposed on the facilities are comparable to rates imposed on customers of the same class that do not have cogeneration or small power production." (Section 8 of the Study)

The full study may be found at http://www.oe.energy.gov.

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[1] While there are many documented examples of how DG (particularly from those systems that use renewable energy and combined heat and power technologies) could enhance environmental conditions, Section 1817 does not include an analysis of the potential environmental benefits of DG. As such, the study does not address this issue.

A Brief History of DG

DG is not a new phenomenon. Prior to the advent of alternating current and large-scale steam turbines - during the initial phase of the electric power industry in the early 20th century - all energy requirements, including heating, cooling, lighting, and motive power, were supplied at or near their point of use. Technical advances, economies of scale in power production and delivery, the expanding role of electricity in American life, and its concomitant regulation as a public utility, all gradually converged to enable the network of gigawatt-scale thermal power plants located far from urban centers that we know today, with high-voltage transmission and lower voltage distribution lines carrying electricity to virtually every business, facility, and home in the country.

At the same time this system of central generation was evolving, some customers found it economically advantageous to install and operate their own electric power and thermal energy systems, particularly in the industrial sector. Moreover, facilities with needs for highly reliable power, such as hospitals and telecommunications centers, frequently installed their own electric generation units to use for emergency power during outages. Traditionally, these forms of DG were not assets under the control of electric utilities. However, in some cases, they produced benefits to the overall electric system by supplying needed power to those consumers in lieu of the local electricity provider. In such cases, utility investment for facilities and/or system capacity that would have been used to supply those customers could be re-directed to expand/upgrade the network.

Over the years, the technologies for both central generation and DG improved by becoming more efficient and less costly. Implementation of Section 210 of the Public Utilities Regulatory Policy Act of 1978 (PURPA) sparked a new era of highly energy efficient and renewable DG for electric system applications. Section 210 established a new class of non-utility generators called “Qualifying Facilities” (QFs) and provided financial incentives to encourage development of cogeneration and small power production. Many QFs have since provided energy to consumers on-site, but some have sold power at rates and under terms and conditions that have been either negotiated or set by state regulatory authorities or non-regulated utilities.

Today, advances in new materials and designs for photovoltaic panels, microturbines, reciprocating engines, thermally-activated devices, fuel cells, digital controls, and remote monitoring equipment (among other components and technologies) have expanded the range of opportunities and applications for “next generation” DG, and have made it possible to tailor energy systems to the specific needs of consumers. These technical advances, combined with changing consumer needs, and the restructuring of wholesale and retail markets for electric power and natural gas, have opened even more opportunities for consumers to use DG to meet their own energy needs.

At the same time, these circumstances can allow electric utilities to explore the possibilities of utilizing DG to help address the requirements of a modern electric system. The U.S. Department of Energy (DOE) has supported research and development in an effort to make these “next generation” DG devices more energy efficient, reliable, clean, and affordable. The aim of these efforts has been to accelerate the pace of development of “next generation” energy systems, and promote greater energy security, economic competitiveness, and environmental protection. These “next generation” systems are the focus of this study.

Public Input

Wherever possible, this study utilizes existing information in the public domain, including, for example, published case studies, reports, peer-reviewed articles, state public utility commission proceedings, and submitted testimony. No new analysis tools have been explicitly created for this study. This study attempts to reflect all points of view based on public input and existing materials and publications. In several instances the public inputs offered opposing points of view. In these cases the varying perspectives are presented in the study.

A *Federal Register* Notice published in January 2006[2] requested all interested parties to submit case studies or other documented information concerning DG as it relates to EPACT 1817. Forty-one organizations responded with studies, reports, data, and suggestions. A second *Federal Register* Notice was published in March 2007[3] and requested public comments on the draft study. Fifteen individuals and organizations submitted written comments on the draft report. DOE has reviewed all of this information and is grateful to those individuals and organizations that provided data, reports, comments, and suggestions.

Major Findings

- Distributed generation is currently part of the U.S. energy system. There are about 12 million DG units installed across the country, with a total capacity of about 200 GW. Most of these are back-up power units and are used primarily by customers to provide emergency power during times when grid-connected power is unavailable.[4] This DG capacity also includes about 84 GW[5] of energy efficient, consumer-owned, combined heat and power (CHP) systems, which provide electricity and thermal energy for certain manufacturing plants, commercial buildings, and independently-owned district energy systems that provide electricity and/or thermal energy for university campuses and urban areas. While many electric utilities have (in the course of normal planning and operations) evaluated the costs and benefits of DG, only a small fraction of the DG units in service are used for providing benefits to the electric system. The vast majority of DG units installed in the U.S. today are customer owned/operated and used primarily to supply energy services to their owners.
- There are several economic, regulatory, and institutional reasons why electric utilities have not installed much DG. For example, the economics of DG (as an alternative to investment in traditional infrastructure) are such that financial attractiveness is largely determined on a case-by-case basis, and is very site-specific. As a result, many of the potential benefits of DG are most readily available to consumers since the incentives for customer-owned DG are often far greater than those for utility-owned DG. This has led to the present situation where standard business model(s) for electric utilities to invest profitably in DG have not emerged. In addition, in

2 71 FR 4904 (Jan. 30, 2006).

3 72 FR 9318 (March 1, 2007).

4 These back-up power units mostly use diesel engines and are very rarely called into service. While the total amount of this back-up capacity is impressive, these units do not play a significant role in providing energy services to their owners, and when they are used their relatively poor environmental performance raise issues for local air emission regulations. This back-up power form of DG has not been a significant target of research and development by the U.S. Department of Energy because improving their efficiency and environmental performance would not yield much benefit because of their low level of use.

5 Paul Bautista, Patti Garland, and Bruce Hedman, *2006 Action Plan, Positioning CHP Value: Solutions for National, Regional, and Local Energy Issues,* Presented at 7th National CHP Roadmap Workshop, Seattle, Washington, September 13, 2006.

instances where financially attractive DG opportunities for electric utilities have been identified, lack of experience with DG technologies has contributed to a perception of added risks and uncertainties, particularly when DG is compared to conventional energy solutions. This lack of experience has also contributed to a lack of standardized equipment, operational data, models or similar analytic tools for evaluating DG-grid interoperability, and standard interconnection practices, and is part of the justification for utility reluctance to install DG on their electric systems.

- Nevertheless, DG offers potential benefits to the electric system if integrated into utilities' planning and operations processes. On a local basis there are opportunities for electric utilities to use DG to supplement a distribution system's ability to supply sufficient power during periods of peak demand, provide ancillary services such as reactive power and voltage support, and improve power quality. Using DG to meet these local system needs can enhance overall electric system reliability. For example, several utilities provide financial incentives to customer owners of emergency DG to make the units available during peak demand periods, and at other times of system need. In addition, several regions have employed demand response (DR) programs, where financial incentives and/or price signals are provided to customers to reduce their electricity consumption during peak periods. Some customers who participate in these programs also use DG to maintain near-normal operations while they reduce their use of grid-supplied power.[6]
- Several of the public comments on the draft of this study pointed out that certain forms of DG (e.g., those that use renewable energy resources such as photovoltaics, and energy efficient engines and turbines, and heat recovery equipment, such as those used in combined heat and power systems) often have environmental benefits. There are many documented examples of how these forms of DG can help lower emissions of air pollutants and greenhouse gases.[7] However, Section 1817 did not include environmental benefits as an area of discussion, and so they were not addressed in this study.
- In addition to the potential benefits for an electric system, DG can help decrease the vulnerability of users of the electric system to threats from terrorist attacks, and other forms of potentially catastrophic disruptions. In other words, DG has the potential to increase the resiliency of the grid and other critical infrastructure sectors [as defined in the National Infrastructure Protection Plan (NIPP) issued by the Department of Homeland Security], such as telecommunications, chemicals, agriculture and food, and government facilities. There are many examples of owners and operators of such facilities using DG to maintain "normal" operations when the grid is down during weather-related outages and regional blackouts. However, for a variety of factors, many of these units cannot be relied upon by electric utilities to help the system recover from such events.
- Under certain circumstances, and depending on the assumptions, DG can also have beneficial effects on land use by reducing the size/amount of rights-of-ways that would otherwise be needed to build or upgrade power stations, electric transmission, and electric distribution lines.

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6 U.S. Department of Energy, *Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them: A Report to the U.S. Congress Pursuant to Section 1252 of the Energy Policy Act of 2005,* February 2006

7 See for example: Regulatory Assistance Project "Emissions Rates for New DG Technologies" May 2001; U.S. Department of Energy :Gas-Fired Distributed Energy Resource Technology Characterizations" October 2003; U.S. Environmental protection Agency "Base Case 2006" http://epa.gov/airmarkets/progsregs/epa-ipm/index.html#docs

- Regulation by the States of electric rates; Federal, State and local environmental siting and permitting; and grid interconnection policies and practices can have significant impacts on the financial attractiveness of DG projects. The fact that these rules, regulations and interconnection policies vary by state and utility service territory can, in itself, be an impediment to the expanded use of DG. Satisfying these myriad requirements typically involves a customized approach to the planning, design and siting of DG installations which can increase DG project costs beyond economic viability. In addition, utilities, with the approval of regulators, adopt practices and charges that discourage customers and developers from installing DG. However, there have been actions in recent years to address some of these issues. An example of such an effort is the work of the Institute of Electrical and Electronic Engineers (IEEE) to implement uniform DG interconnection standards. In addition, *Subtitle E – Amendments to PURPA of the Energy Policy Act of 2005*, contains provisions for state public utility commissions to consider adopting time-based electricity rates, net metering, smart metering, uniform interconnection standards, and demand response programs, all of which have the potential to encourage greater use of DG.
- Another key for making DG a viable resource option for electric utilities entails the successful integration of DG into electric system planning and operations processes. Often this depends on whether or not grid operators can readily affect or control operation of the DG units (especially during times of system need). Besides the potential benefits, it is important to point out that under certain circumstances DG could produce undesirable consequences to electric system operations, particularly when units are not dispatchable, when local utilities are not aware of DG operating schedules, or when the lack of proper interconnection and protective equipment causes potential safety hazards. These instances depend on local system conditions and needs and should be properly assessed by a full review of all operational data.

Conclusions

Distributed generation may continue to be a viable source of energy for certain types of consumers, particularly those with needs for emergency power, uninterruptible power, and combined heat and power. DG can also be the source of a variety of benefits (e.g., peak load reduction, voltage support, and power quality improvements) for the Nation's electric grid. However, there will need to be a concerted and cooperative effort for the numerous benefits of DG to be realized and for more DG to be deployed on the grid. This effort may require cooperation among electric system planners, operators, and industry groups; Federal, State, and local government agencies; equipment manufacturers; electricity consumers; and academic, research, and public interest organizations.

There are several conclusions that can be drawn from this study:

- State utility commissions as well as local and regional electric system planning processes, models, and analytical tools could be modified to include DG as potential resource options, and thus provide a mechanism for identifying opportunities for integrating DG into the modern electric system.
- Expanding the role of DG in the grid of the future may require development of better data on the operating characteristics, costs, and the full range of potential benefits (including environmental) of various DG systems so that they are comparable – on an equal and consistent basis – with central generation and other conventional electric resource options.

- Calculating DG benefits is complicated, and ultimately requires a complete dataset of site-specific operational characteristics and circumstances. This renders the possibility of utilizing a single, comprehensive analysis tool, model, or methodology to estimate national or regional benefits of DG highly improbable. However, methodologies exist for accurately evaluating "local" costs and benefits (such as DG to support a distribution feeder). It is also possible to develop comprehensive methods for aggregating local DG costs and benefits for substations, local utility service areas, states, regional transmission organizations, and the Nation as a whole.
- Efforts by the States to implement the requirements posed by *Subtitle E – Amendments to PURPA of the Energy Policy Act of 2005* could affect the consideration of DG by the electric power industry, particularly those provisions that promote smart metering, time-based rates, DG interconnection, demand response, net metering, and fossil fuel generation efficiency. In addition, a number of States have mandates that require utilities to increase the amount of renewable and alternative energy sources in their generation portfolios.
- The *National Action Plan for Energy Efficiency* (Action Plan) was started by the U.S. Department of Energy and the U.S. Environmental Protection Agency to address Section 138 of the Energy Policy Act of 2005, which calls for a study of policies and practices to promote greater use of energy efficiency programs and strategies by the Nation's electric and natural gas utilities. The Action Plan[8] contains recommendations for modifying policies to align utility incentives with the delivery of cost-effective energy efficiency programs, and modifying ratemaking practices to promote greater levels of energy efficiency investments by electric and natural gas utilities. New policies and ratemaking practices by electric and natural gas utilities can be used to improve the financial attractiveness of energy efficient and renewable energy DG to utilities and their customers.

[8] A group of more than 50 leading privately, publicly, and cooperatively owned electric and gas utilities, utility regulators, state agencies, large energy users, consumer advocates, energy services providers, and environmental and energy efficiency organizations participate in the Leadership Group that developed the Action Plan. More information is available at http://www.epa.gov/eeaction plan.