Clean Distributed Generation: Policy Options to Promote Clean Air and Reliability

Interconnection standards, net metering, and demand-side bidding will enable clean distributed generation (DG) to join regional energy supply systems. More ambitious policy initiatives might mandate performance standards for emissions and efficiency, wires charges to support clean DG, and DG aggregation (and ISO recognition of aggregated DG).

Edward M. Meyers and Mannshya Grace Hu

Ed Meyers *is a member of the District of Columbia Public Service Commission (DCPSC). He serves on the Committee on Energy Resources and the Environment of the National Association of Regulatory Utility Commissioners (NARUC) and chairs its Energy Efficiency Subcommittee. He is the Chair of the Board of Directors of the National Regulatory Research Institute and is a member of the Advisory Council of the Electric Power Research Institute and NARUC's Climate Change Working Group. Commissioner Meyers received his Ph.D. in American government from Georgetown University.* **Mannshya Grace Hu** *is Chief Economist with the DCPSC and staff Co-Chair of the NARUC Subcommittee on Energy Efficiency. She holds a Ph.D. in managerial economics and a M.S. in operations research and statistics from Rensselaer Polytechnic Institute.*
The authors gratefully acknowledge reviewers: R. Brent Alderfer, President of Community Energy, Inc.; and Sarah McKinley, Executive Director of the Distributed Power Coalition of America.

To our knowledge, humans are the only creatures that do not measure their collective success by how well they adapt to their environment. Gross domestic product, the Dow or Nasdaq, or maybe our timeless structures, art, music, and novels are indicators of success, yet we too easily accept a filthy river, orange air, and even atmospheric alteration as byproducts of progress. In contrast, any tiger or elephant knows that if its habitat is endangered, then it's in big trouble.

Electric power generation is responsible for about 40 percent of carbon dioxide emissions, a primary contributor to climate change. Carbon emissions at present are not regulated by the U.S. Environmental Protection Agency or anyone else. Despite this regulatory neglect, a quiet evolution is proceeding in electricity generation these days. It looks like we now have a chance to modify not only the way we supply power but also, at least in significant part, the way we humans successfully restore our and the other critters' environment.

  1040-6190/01/$–see front matter PII S1040-6190(00)00180-9

Carl Weinberg paints the broad picture of distributed generation (DG):[1] "Electric systems have altered the course of human history. In this millennium, the forces of competition, environmental need to limit emissions, and the emergence of technology tend to minimize the need for the existing large-scale systems, and develop a system in a more distributed rather than centralized way. These changes not only hold out the possibility to provide electricity to people that are not connected to a grid but also threaten the neat compartments that the electricity system has evolved in the last 100 years. New organizational entities will emerge to take advantage of the new technologies."[2] At some point, buildings, entire blocks of buildings, and downtown districts and neighborhoods could form their own power systems, either independent from the grid or feeding electric sales into it while assuring reliability from the grid. Whether we become grid-free or not, it is clear that we will become less grid-reliant over time.

How big is this revolution? It's not much in the near term. According to Siemens' Jan van Dokkum, the investment in fuel cells is projected to increase from $240 million in 1999 to $380 million in 2003, or 58 percent. van Dokkum projects microturbines to grow at a dramatic pace of 421 percent, increasing from $240 million in 1999 to $1,250 million in 2003.[3] While the growth rate is substantial, the portion of energy to be supplied over the next three years by DG is still small change.

Nonetheless, thanks to DG, we can no longer take for granted that distribution will always be the distribution company's monopoly. Over time, DG will remove some of the need for new generation, new transmission, and new distribution. DG will enhance reliability, and moderate load pockets caused by transmission constraints. The timing and extent of this evolution will be determined by the march of technology and market forces, and hopefully not by excessive government mandates.

How big is this revolution? It's not much in the near term, according to Siemens' Jan van Dokkum.

Does this mean that regulators should stay out of the way while technological improvements determine how fast DG is adopted by industrial, commercial, and residential consumers? No, regulators should stay actively involved in the DG evolution, to assure that DG and traditional electricity provision can compete without bias to one or the other. Moreover, energy efficiency and clean DG should also be able to compete with one another, with equal policy stimuli. Regulators should provide for DG interconnection standards, assure that the price of energy fed into the grid from DG is fair, and assure that the price obtained from the grid is also fair (i.e., free of excessive fixed charges).

Other articles have spoken to these needs for a level playing field.[4] Our task in this article is to relate our energy efficiency policy experience to DG policy. Our premise is that all DG that meets minimal environmental standards should be free of interconnection biases, but that environmentally friendly DG (photovoltaics, fuel cell, natural gas turbine, wind) should receive an additional policy boost. These new incentives would encourage environmentally friendly DG deployment over heavily polluting DG—namely, diesel-fueled reciprocating engines. This policy boost builds in societal benefits of carbon reductions and lowered unhealthy emissions in general.

Technology has reduced sharply the prices of many DG applications, and will continue to find economic applications in the future. Fuel cells have powered spacecraft as far back as the 1960s.[5] Perhaps within a few years, one could drive a fuel cell vehicle to work in the morning and after work drive to a vacation cottage, remove the fuel cell and place it into the cottage to fuel end uses there. One can easily imagine a large office building whose energy needs are satisfied by a combination of fuel cells and rooftop photovoltaics. Indeed, an entire block of buildings or industrial park could be powered locally. The grid need not provide back-up reliability, since reserve capacity could be built into this urban block's power system. And then blocks could connect with one another, and city sectors may sever themselves from the grid.

Not everyone shares this vision. Some, like Gregory J. Yurek, President, CEO, and Chairman of American Superconductor, believe "the grid is here to stay." Yurek believes that microturbines and fuel cells can provide 1 to 2 percent of energy needs in several years, but sees that general level as a ceiling, assuming the grid achieves 99.9 percent reliability. However, Clark Gellings, Electric Power Research Institute Vice President of Retail Energy, projects an "enormous bypass of the grid" unless the grid can find a way to solve power quality problems. Practically speaking, Gellings says, such solutions are not likely, because it may cost $100,000 per kWh for the grid to assure the power quality demands of many customers, including the needs of Silicon Valley.[6]

Power quality standards will influence the growth of DG. Improved standards for the grid will clarify what power quality the grid must achieve and what extra quality levels must therefore be added by customers. Power quality standards for power conditioning interface devices and standardized requirements for end use applications (e.g., appliance chips) will build a market for interface devices working with DG to meet higher power quality standards than customers can today obtain from grid power. Regardless of how precise standards become, DG can be expected to grow substantially to meet the particularized needs of individual customers—especially if regulators remove entry barriers.

I. Barriers to Entry

The Federal Energy Regulatory Commission (FERC) stated in Order No. 2000 that regional transmission organizations (RTOs) must have ultimate responsibility for transmission planning and expansion within their region, in coordination with state authorities. FERC added that, where feasible, an RTO should encourage market approaches to relieve congestion. The Department of Energy (DOE) has promoted distributed resources through research and development funding and the Million Solar Roof Program. Several congressional bills also would stimulate DG. The Clinton administration's bill suggested accelerated depreciation for DG and tax credits for combined heat and power systems.[7] Several bills would require FERC to establish DG safety, reliability, and power quality standards, to expedite DG development. The Institute of Electric and Electronic Engineers (IEEE) is developing DG technical interconnection standards which may be issued by late 2001 or in 2002. In a July 2000 resolution, the National Association of Regulatory Utility Commissioners (NARUC) supported adoption of national interconnection standards developed and adopted by IEEE.[8]

Despite developments that should stimulate distributed generation, barriers to entry comprise the primary problem.

Despite all of these developments, barriers to entry comprise the primary DG problem. For example, a New England fuel cell plant promoter complained that utilities do not want to operate fuel cell plants because state legislation does not allow distributed utilities to own generation. The DG developer thus sought help from the New England power pool, but was rejected on the grounds that a power pool cannot reasonably be expected to dispatch a 200 kW fuel cell plant.[9] The barriers span technical, business, and regulatory requirements, and are both on the retail and wholesale sides.[10]

II. Do we Need Regulation of DG?

Arthur D. Little Inc. estimated there are over 60,000 MW of DG installed in North America in the form of reciprocating engines (diesel) and gas turbines.[11] This is

  PII S1040-6190(00)00180-9

equivalent to 7.3 percent of the total U.S. capacity.[12] Diesel generators have long been used to provide backup power for hospitals or community centers as well as supply routine backup in many buildings where reliability is crucial. However, many of these units can be quite polluting.[13] Diesel generators produce large amounts of NO_x and particulate emissions. The country's annual NO_x emissions could increase by nearly 5 percent if just 0.5 percent of the U.S. demand for electricity were met by uncontrolled diesel engines.[14]

Over the years, energy efficiency and load management have significantly shaved peak load and enhanced reliability. Energy efficiency is emission-free, but much DG is not. Taking societal needs into consideration, regulation should selectively promote DG. Public policy should not encourage the highly polluting DG (chiefly diesel generators) simply because it is DG.

Regulators are often implored not to distort market phenomena, but there may be two DG exceptions. First, government must remove artificial barriers to competition so that DG will have a chance to compete with traditional energy provision. After all, distribution companies, like all monopolies, are experts in creating barriers to entry. In July 1998, NARUC adopted a resolution stating, "State Commissions should remove any unnecessary barriers to interconnection of small-scale generating units."[15] Three states—Texas, New York, and California—have been pioneers in crafting DG interconnection policies.[16] As Brent Alderfer pointed out: "We need an 888-type order to promote an open access distribution network system."[17] Second, regulators can encourage *clean* DG. State "wires charges" fund energy efficiency,[18] but nonrenewable DG does not necessarily have a supply-side funding source. As DG competes with energy efficiency, clean DG should receive incentives to level that playing field as well.

Energy efficiency is emission-free, but much distributed generation is not.

III. DG Benefits

Clean DG has made a compelling case for its inclusion among the nation's energy supply resources.

A. Cleaner Environment

Record temperatures, polar ice cap melting, and many unusual storms and droughts are almost certainly caused in large part by human activities. According to an Intergovernmental Panel on Climate Change report, the global atmospheric concentrations for CO_2 have increased from 278 parts per million in the pre-industrial age to 356 ppm in 1992 (a 28 percent increase), and are estimated to increase to 550 ppm by 2050. It is unlikely that humans can play around with the composition of the air we breathe without dire consequences. The unratified Kyoto Protocol attempted to require reductions in greenhouse gases to 7 percent below the 1990 levels by 2012. The current policy level for carbon is 1,786 million metric tons (MtC) by 2010, a 43 percent increase from 1990 levels. This consumption level would have to be reduced to 1,246 MtC by 2012 if adherence to the Kyoto Protocol were to be achieved. Obviously, we are seeing a huge policy gap between scientists and politicians. Nonetheless, some sincere action will inevitably be required of the human race.

Among distributed resources, energy efficiency as well as wind and solar power are emission-free. Fuel cells provide substantial environmental benefits over central generation, although improvements in carbon emissions from fuel cells are needed.[19]

B. Postponed Generation, Transmission, and Distribution

Transmission investment relative to total energy production declined 5 percent between 1990 and 1996, according to the Energy Information Administration.[20] Independent system operator (ISO) transmission expansion plans have long lead times for add-

  PII S1040-6190(00)00180-9

ing generation to the grid. Some states such as California and New York have asked utilities to look at demand-side management (DSM) and DG as alternatives to major transmission and distribution (T&D) upgrades. DG can postpone new generation, transmission, and distribution, much of which would be uneconomic compared to DG. Thus, DG can be a least-cost planning alternative.[21]

C. Transmission Congestion Relief

The benefits of DG vary with its location. Sometimes a few blocks can make a huge least-cost planning difference. DG helps to resolve load pocket problems when load grows but transmission lines cannot feasibly be added. DG's benefits are maximized if DG is located in congested areas to relieve congestion.[22] Of course, if we use DG as must-run units, these DG may have market power, and thus must abide by ISO rules for must-run units.

D. Increased Reliability

Oregon PUC Chair Ron Eachus indicates, "In five years, I see reliability as a consumer product."[23] Customers will pay for the reliability level they need. The First National Bank of Omaha, for example, responded to a costly computer system crash in 1997 by hooking its processing center up to two fuel cells that provide 99.9999 percent reliability.[24] Today, Silicon Valley is calling for "10-nines" reliability. This means that electricity, at full quality and without a variety of disturbances that we now see, must be available to the microprocessor at least 99.99999999 percent of the time. Exceptional power reliability and quality are critical to our technological future.[25]

Capacity shortfalls, especially during summer temperature spikes, have resulted from delays in adding generation, lack of incentives to build new transmission, and transmission siting difficulties, as well as insufficient DSM programs. DG's peak shaving function enhances reliability. According to Sarah McKinley, "Investment in control equipment is necessary to reconfigure backup equipment into peak shaving capability. This control equipment, costing between $30 and $120 per kW, may have a three-year payback."[26] Aside from cost factors, states may limit the use of on-site diesel generation, because diesels are heavily polluting. California, for example, limits back-up generators to specified hours of operation because of air quality rules.[27] Retrofitting these diesel generators to achieve lower emissions is one option. In any event, economic and environmental regulators must collaborate to maximize DG economic and environmental benefits.

Benefits vary with location. Sometimes a few blocks can make a huge least-cost planning difference.

E. Other DG Benefits

Other benefits of DG include providing ancillary services,[28] adding self-generation to customer options, reducing transmission line losses, as well as enhancing fuel diversity and fuel switching. DG also brings its owners a new revenue source as electricity is sold to the grid.

DG could prove invaluable to developing nations as well. Plug Power's Gary Mittleman reckons that it would cost between $1,000 and $1,500 per kW to build or replace electricity grids in developing countries. Thus, micropower is an attractive option in these countries. "Microfinance" thus looms on the World Bank agenda.[29]

DG such as grid-free renewables may be particularly suitable for remote areas. For example, the Oregon and District of Columbia Public Utility Commissions and the Zambia Energy Regulatory Board have established a partnership through the U.S. Energy Association. Although Zambia has photovoltaic pilot programs operated by energy service companies in three rural districts, many other remote villages are yet to be electrified.[30] Zambia expects a total of 400 photovoltaic applications by 2003. In urban and rural areas in the United States and around the world, DG's future seems limited only by our imaginations.

  PII S1040-6190(00)00180-9

IV. National DG Policies

Several policy reforms would welcome DG to the power community and achieve DG's potential.

A. Uniform National Interconnection Standards for DG

Standardized DG interconnections enable DG to join the grid. National standards will avoid the situation where DG must accommodate a maze of state-by-state standards.[31]

B. National Energy Efficiency and Emission Standards for DG

There are no energy efficiency standards for DG.[32] We have national fuel efficiency standards for cars and federal energy efficiency standards for refrigerators, freezers, clothes washers, clothes dryers, dishwashers, ranges and ovens, room air conditioners, central air conditioners and heat pumps, furnaces and boilers, water heaters, direct-fired space heaters, pool heaters, fluorescent lamps, incandescent reflector lamps, electric motors, commercial air conditioners and heat pumps, commercial furnaces and boilers, commercial water heaters, showerheads, faucets and faucet aerators, toilets, and distribution transformers. We should add DG to the list.

Federal emissions regulations generally only cover non-utility generators down to 1 MW in size.[33] National emission standards should be established, to assure the market penetration of energy efficient, clean DG. If national standards are not adopted, then states and regions could step into the void and adopt clean air standards for DG along with their state and regional interconnection standards.[34]

C. R&D Funding for DG Applications

Additional R&D funding is needed to improve clean DG technologies (fuel cells, photovoltaic

cells, wind, and natural gas turbines) technologies. For example, federal or state research funding can be channeled into DG emission control technologies.[35] Moreover, R&D would be helpful for DG aggregation, communication, metering, and control, so that DG can send and receive price signals from ISOs and regional transmission organizations.

V. State DG Policies

Some policies are well-suited to state implementation. In the absence of national action, states may convene to fill the policy void. In the Energy and the Environment Conference held in St. Louis in September 2000, participants agreed to form a DG task force. Representatives from several agencies strongly support a collaborative approach to resolve regulatory and environmental issues for DG.[36] Such integrated efforts are necessary to balance the goals of reliability, energy efficiency, and clean environment.

A. State "Wires Charge" Policies

States should allow some of their wires charge funds to encourage clean DG technologies. Clean DG is competing with energy efficiency for the same pot of money, so a public utility regulatory commission should perform a cost-benefit analysis to help determine what projects deserve the wires charge funds and determine funding levels by comparing DG and energy efficiency costs and benefits.[37]

B. Stranded Cost Policies

Another issue that influences customers' decisions to own DG is whether DG can bypass stranded costs in the form of competitive transition charges (CTC) or exit fees. For example, California does not impose CTC charges on new loads served by self-generation. In Arizona, CTCs are not imposed on self-generation facilities even when the loads were formerly served by the utility. In New Jersey, on-site generators do not need to pay exit fees until their total kWh production reaches 7.5 percent of the 1999 total kWh distributed by an electric public utility.[38] Many stranded costs policies are still fluid at this stage. We suggest that "clean DG" receive favorable CTC treatment over unclean DG, although again, cost-benefit analyses are needed.

C. Rate Design Incentives

Many utilities do not favor DG, since DG cuts into utility sales. As pointed out by Brent Alderfer *et al.*, many DG developers believe that some utilities use "unreasonable terms, excessive costs, and inappropriate delays to either gain utility advantage or impede the market for distributed power."[39] Utilities may also offer special discounts to customers who are considering the DG option so utilities may outcompete DG promoters.[40] Some utilities are proposing large fixed charges (a large standby, customer, or backup fee) and reduced energy charges.[41] Such a policy may be cost-based, however, when a company supplies its own energy via DG and merely uses the grid for reliability. In these cases, if these sporadic loads on the grid occur during peak load, perhaps such a company should pay a high customer charge or standby charge. Backup power during grid low-demand periods probably would not impose large costs or warrant large charges. One policy response is that if a DG provider meets clean air standards, then it would have its large fixed charge partially or fully waived (e.g., by means of a subsidy from a wires charge). If not, the customer would pay the cost-based high customer charge or standby charge. This policy would coordinate economic incentives with environmental objectives. Currently, standby charges vary considerably from utility to utility.[42] In summary, standby rates should be fair for all forms of DG, while credits on standby charges (flowing from a wires charge) can be offered to clean DG (i.e., DG that meets national or state environmental standards established for DG).

D. State Legislation

Some states' deregulation laws do not allow distribution utilities to own generation, including DG. This policy fuels the competitive fires between DG and distribution utilities. In fact, distribution utilities are most familiar with their distribution network and can identify optimal locations for DG. Distribution utilities can use DG to help reduce capacity problems and to help reduce or eliminate load pocket (transmission constraint) problems. Clean DG could be exempted from the distribution company's generation ownership prohibition. Utilities could also be allowed to contract with a third party to obtain clean DG.

E. Net Metering Rules and Buy-Back Rates

Thus far, 30 states and the District of Columbia have legislated or ordered net metering. With a two-way meter, customers owning an on-site generator can sell back extra energy to the grid. Net metering policies for 14 of the 30 states cover only renewable resources, not including beneficial nonrenewables such as fuel cells and microturbines. To accommodate relatively clean nonrenewable DG, state legislators or public utility commissioners should incorporate clean DG requirements into their net metering policies. Commissions or legislators can further facilitate utility purchases from clean DG by assuring profitable buy-back rates. For example, research may show that retail price would provide a more attractive buy-back rate than would avoided cost. With an attractive buy-back rate, an owner of clean DG is more likely to size the plant so that it provides energy beyond the DG owner's own needs. Moreover, net metering policies in 14 states only cover small DG—equal to or less than 25 kW.[43] The size of generators qualifying for net metering should be reviewed, so that larger clean DG can benefit from such policies. In addition, state permit programs could stream-

  PII S1040-6190(00)00180-9

line their permit processes for clean DG.

VI. Regional DG Policies

A. ISO Demand-Side Bidding

Clean DG may be considered as either a supply-side or demand-side resource, and can create either kWs or "negawatts." FERC should encourage RTOs or ISOs to conduct demand-side bidding. Demand-side bidding enables DG owners to receive a credit (the lowest bid wins) to get off the grid during certain peak load times. Demand-side bidding not only enhances reliability, it also reduces the potential of generators to exercise market power during the peak hours. DG's peak shaving potential equates it to a demand-side tool. Moreover, like DSM, DG defers transmission and distribution expenditures. Thus, DG should be part of a demand-side bidding policy along with traditional load management tools such as curtailable load programs. The Pennsylvania-New Jersey-Maryland (PJM) ISO has established a DG working group to implement demand-side bidding in the near future. In either demand-side or supply-side applications, DG should be able to inform the ISOs about their operations and, similarly, ISOs must send DG price signals to facilitate DG decision-making. Thus, communication between DG and the ISO is indispensable.

B. DG Aggregation

Aggregation of DG supply may be needed at the ISO level, because ISOs cannot now recognize where DG is located, much less provide real-time monitoring. Small DG is currently invisible to ISOs. The communication infrastructure is not completely developed for DG. DG should be able to participate in energy markets to obtain spot market prices, or in the capacity market to boost revenues, and aggregation could help achieve such DG recognition.

ISOs can work with DG coalitions to help stimulate aggregation. To stimulate aggregation for relatively clean DG, a national policy for aggregation and interconnection could include a portfolio requirement for aggregated DG, where aggregated DG would meet environmental standards.

VII. Conclusions: Clean and Competitive DG

Many of the policies discussed above simply enable clean DG to join the regional energy supply systems. Interconnection standards, net metering, and demand-side bidding provide these minimal entry steps.

Other policies require more policy initiative. DG should be subject to performance standards for emissions and efficiency. The standards should be set high enough, in our view, that many of today's diesel generators cannot qualify. Since DG is a building-specific application, building codes should be revised to accommodate clean, efficient DG and prohibit DG that does not meet performance standards.

We have wires charges for energy efficiency and DSM, and we need wires charge support for clean DG, too. R&D should include substantial funding for clean DG, as a least-cost alternative to more onerous carbon reduction policies. FERC and state utility commissions can encourage DG aggregation and ISO recognition of aggregated DG for dispatching and load shaving purposes. Regional collaboratives can plan for clean DG and encourage incentives through state wires charges. Energy service companies will increasingly include clean DG as part of their own customized least-cost plans that they offer clients, especially if incentives encourage them to do so.

These policies are necessary for clean DG to be able to compete in the energy marketplace. Several of these policies may seem a little interventionist. Keep in mind, though, that we have not seen true free enterprise since the days of Adam Smith. Everyone is trying to influence the marketplace: government, corporations, consumers,

  PII S1040-6190(00)00180-9

and a variety of special interest groups, which is why our laws are often hundreds of pages long.

According to the North America Electric Reliability Council, summer-peak electrical demand is projected to grow by about 160,000 MW, or 21 percent, by 2010.[44] According to the American Council for an Energy-Efficient Economy, installation and maintenance practices for residential air conditioning, upgrading existing commercial buildings, strengthening energy efficiency standards for air-conditioning systems, and efficient commercial lighting systems, if aggressively pursued, could meet 60 percent of the expected demand growth over the decade.[45] The Distributed Energy Task Force within the Energy Department's Office of Energy Efficiency and Renewable Energy has established a goal of 20 percent to 40 percent of the new generating capacity to be provided by distributed generation by 2010.[46] With good national/state/regional policies, we can certainly improve the proportion of clean DG throughout our nation's DG portfolio. This combination of energy efficient demand and supply side measures, including *clean* DG, can substantially meet our energy and our quality-of-life demands. ■

Endnotes:

1. Distributed generation technologies include reciprocating engines, industrial gas turbines, microturbines, fuel cells, renewables such as photovoltaics and wind, and energy storage technologies such as batteries and flywheels.

2. Authors' conversation with Carl Weinberg at Regulatory Assistance Project on Sept. 21, 2000.

3. Authors' conversation with Mr. van Dokkum, at Electric Power Research Institute Summer Seminar, Aug. 7, 2000. Mr. van Dokkum is President and Chief Executive Officer of Siemens Power Transmission & Distribution, Inc.

4. For example, Nathanael Greene and Roel Hammerschlag, *Small and Clean Is Beautiful: Exploring the Emissions of Distributed Generation and Pollution Prevention Policies*, ELEC. J., June 2000, at 50.

5. *Washington Post*, July 13, 2000, at A21.

6. Yurek's and Gellings' comments delivered at Electric Power Research Institute Summer Seminar, San Diego, Aug. 7, 2000, and quoted by permission of the speakers.

7. Tax codes may also discourage micropower. Fuel cells, for example, have unfavorable depreciation rates. *Science and Technology: The Dawn of Micropower*, ECONOMIST, Aug. 5, 2000, at 5–6.

8. Resolution Encouraging State Commissions to Adopt Full and Open Access Rules for Distributed Generation Technologies and to Remove Regulatory Barriers and Promote 'Best Practices' that Encourage Economic Development of Distributed Generation Technologies, adopted by the NARUC Board of Directors, July 2000.

9. Authors' "not for attribution" conversation with a presenter at the NARUC Distributed Generation Workshop in Philadelphia, April 15–16, 2000.

10. R. Brent Alderfer, M. Monika Eldridge, and Thomas J. Starrs, *Making Connections: Case Studies of Interconnection Barriers and their Impact on Distributed Power Projects*, National Renewable Energy Laboratory (NREL), NREL/SR-200-28053, May 2000, http://www.nrel.gov/docs/fy00osti/28053.pdf (Jan. 16, 2001).

11. Arthur D. Little, Inc., *Distributed Generation: System Interfaces*, 1999, http://www.encorp.com/wp_ADL_2.pdf (Jan. 16, 2001).

12. The total electric capacity of the United States is around 818,230 MWs. Energy Information Administration, ELECTRIC POWER MONTHLY, Oct. 2000, Table 1, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html (Nov. 2, 2000).

13. Diesel generators are commercially available and have a longer history compared to new, less-polluting DG technologies such as fuel cells and microturbines.

14. *Supra* note 4, at 51.

15. Resolution Regarding Interconnection Standards for Small-Scale Generating Facilities, sponsored by NARUC Committee on Energy Resources and the Environment and the Committee on Electricity, adopted July 29, 1998.

16. New York and Texas Commissions adopted rules on interconnection in 1999, while California's interconnection proceeding was ongoing as of this writing. *Review of Utility Interconnection, Tariff and Contract Provisions for Distributed Generation*, submitted to NARUC by R.W. Beck, Inc., Jan. 2000, at 1.

17. Discussion by authors with R. Brent Alderfer, April 28, 2000.

18. All consumers of electricity would pay into the state wires charge for public benefits such as energy efficiency, low-income support, R&D, and renewables. According to a recent survey by American Council for an Energy-Efficient Economy, 22 states and the District of Columbia have developed system benefits charges.

19. Fuel cells perform better than a combined cycle gas turbine in SO_2 and NO_x

emissions, while the emission performance for microturbines in SO_2 and NO_x is about equal to a combined cycle gas turbine. *Supra* note 4, at 54–55.

20. Energy Information Administration, Financial Statistics of Major U.S. Investor-Owned Electric Utilities, 1996. (DOE/EIA-0437/96)/1 (Dec. 1997).

21. DG is especially cost-effective in large cities with underground systems. DG can cost far less to serve a neighborhood's load growth than it would cost to upgrade the distribution system to import the same power. Jay Morrison, *Distributed Generation*, National Rural Electric Cooperative Association, February 2000, at 3.

22. Areas of high locational marginal price often reflect transmission constraint, and thus, the value of using DG to relieve constraint will also be relatively high. For example, New York State's Orange and Rockland Utilities, Inc., provided capacity payments to DG owners during summer months at specified locations to secure additional needed capacity. *Supra* note 10, at 17.

23. Authors' conversation with Ron Eachus, May 25, 2000.

24. Worldwatch Institute, http://www.worldwatch.org (Sept. 2000).

25. Electric Power Research Institute (EPRI), *Creating the Infrastructure for the Digital Society*, background paper for EPRI Summer Seminar, Aug. 7–8, 2000, at 4.

26. Sarah McKinley, Executive Director of Distributed Power Coalition of America (DPCA), comments filed by DPCA in response to FERC Notice of Interim Procedures to Support Industry Reliability Efforts and Request for Comments, Docket EL00-75-000, June 2, 2000, at 5.

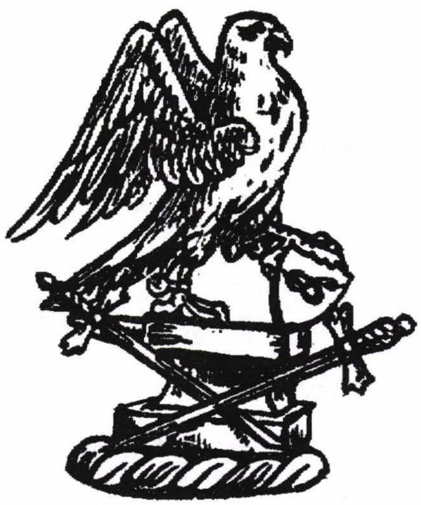
27. Comments filed by NARUC in response to FERC Notice, Notice of Interim Procedures to Support Industry Reliability Efforts and Request for Comments, issued May 17, 2000, Docket EL00-75-000.

28. DG can provide distribution level ancillary services such as voltage support, reactive power, and emergency back-up. California Distribution System Planning and Operations Workshop Report, draft proposal, R. 99-10-025, March 24, 2000, at 38.

29. *Supra* note 7.

30. Meeting with the Zambian Energy Regulatory Board staff, in Lusaka, Zambia, Oct. 26, 2000.

31. NARUC supports the establishment by Congress of national interconnection and power quality standards. Letter from NARUC Executive Director Charles Gray to Sens. Frank H. Murkowski and Jeff Bingaman, June 19, 2000.



32. Conversation with Steve Nadel, American Council for an Energy-Efficient Economy, April 28, 2000.

33. *Supra* note 4, at 51.

34. For example, California has passed legislation to support an emission standard for DG. Presentation by Eric Crotty of Plug Power at Energy and the Environment: The Second National Conference of Policy Makers Working Together, St. Louis, Sept. 24–27, 2000.

35. The state wires charge is a likely R&D funding source for clean DG, as are DOE grants.

36. Energy and the Environment: The Second National Conference of Policy Makers Working Together, St. Louis, Missouri, Sept. 24–27, 2000. These participants include representatives from NARUC, Environmental Council of the States, National Association of State Energy Officials, DOE, EPA, State and Territorial Air Pollution Program Administrators/Association of Local Pollution Control Officials (STAPPA/ALAPCO), and National Council on Competition and the Electric Industry.

37. In our view, a cost-effectiveness test which considers environmental impact needs to be developed. Regulatory commissions used various tools in evaluating or screening DSM; however, an evaluation test for the cost-effectiveness of DG has not been fully researched. Even though many grid-side benefits are hard to quantify (such as providing ancillary service, reduction of line losses, and relief of transmission congestion), lacking such a test to confirm the value of a specific DG project constitutes another entry barrier. Nonetheless, states may conduct cost-benefit analyses to the extent feasible.

38. Review of Utility Interconnection, Tariff and Contract Provisions for Distributed Generation, NARUC report prepared by R.W. Beck and Distributed Utilities Associates, Jan. 2000, at 4–9.

39. *Supra* note 10, at 12.

40. *Id.*, at 27.

41. David Moskovitz at Regulatory Assistance Project, Profits & Progress Through Distributed Resources, NARUC/RAP, Feb. 2000, at 6.

42. For example, standby charges range from $52/kW per year to $200/kW per year among several DG projects located in the state of New York. *Supra* note 10, at 21.

43. Computed from *supra* note 21, Appendix A.

44. North America Electric Reliability Council, *Reliability Assessment 1999–2008* (2000).

45. American Council for an Energy-Efficient Economy, *Electric System Reliability and the Critical Role of Energy Efficiency*, July 2000, at 5.

46. Conference presentation by Dan Reicher. *Supra* note 34.

