

Laying the Groundwork: Lessons Learned from the Telecommunications Industry for Distributed Generation

Preprint

Alison Wise
National Renewable Energy Laboratory

*To be presented at the 2008 CTSI Clean Technology and
Sustainable Industries Conference and Trade Show
Boston, Massachusetts
June 1–5, 2008*

Conference Paper
NREL/CP-670-43015
May 2008

NREL is operated by Midwest Research Institute • Battelle Contract No. DE-AC36-99-GO10337



NOTICE

The submitted manuscript has been offered by an employee of the Midwest Research Institute (MRI), a contractor of the US Government under Contract No. DE-AC36-99GO10337. Accordingly, the US Government and MRI retain a nonexclusive royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for US Government purposes.

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

Available electronically at <http://www.osti.gov/bridge>

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: <mailto:reports@adonis.osti.gov>

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: <http://www.ntis.gov/ordering.htm>



Laying the Groundwork: Lessons Learned from the Telecommunications Industry for Distributed Generation

Alison Wise*

*National Renewable Energy Laboratory-U.S. Department of Energy
1617 Cole Blvd., Golden, CO, 80401, alison_wise@nrel.gov

ABSTRACT

The telecommunications industry went through growing pains in the past that hold some interesting lessons for the growing distributed generation (DG) “industry.” The technology shifts and stakeholders involved with the historic market transformation of the telecommunications sector mirror similar factors involved in distributed generation today. An examination of these factors may inform best practices when approaching the conduits necessary to accelerate the shifting of our nation’s energy system to cleaner forms of generation and use. From a technical perspective, the telecom industry in the 1990s saw a shift from highly centralized systems that had no capacity for adaptation to highly adaptive, distributed network systems. From a management perspective, the industry shifted from small, private-company structures to big, capital-intensive corporations. This presentation will explore potential correlation and outline the lessons that we can take away from this comparison.

Keywords: clean energy, market transformation, distributed generation, telecommunications, public policy

1 REGULATORY PARAMETERS VS. TECHNOLOGY ADVANCES

Economic regulation has been established as a “last resort” (i) for those markets where it is clear that competitive outcomes cannot be achieved by market forces; (ii) where deviation from economic efficiency is deemed socially desirable; (iii) where the social and private benefits are clearly different, including cases where minimum safety standards increase social welfare; and (iv) to allow for coordination in technical standards or market equilibria [1]. In the case of the telecommunications industry, the regulatory measures related to the industry were in parallel to rapid advancement in technologies within the industry. Similarly, distributed generation technology may be evolving in tandem with existing regulatory efforts, and the technology itself may be a defining characteristic of the way this industry matures.

The Telecommunications Act of 1996 was crafted to promote competition and public interest by enhancing the competitiveness of unbundled network elements in local exchanges. Yet, this milestone legislation holds just three

references to the Internet and no legislative direction or framework for the most critical of technical advancements in the sector: Internet telephony, more accurately Internet Protocol (IP)-based telephony or “voice over IP” (VOIP) [2]. The Energy Policy Act of 2005 (EPAct 2005) has just three sections that amend the Public Utilities Regulatory Act (PURPA) of 1978: sections 1251, 1252, and 1254 relating to net metering, smart metering, and interconnection requirements respectively. Each of these elements hold an important leveraging point in the dissemination of distributed generation, so one could argue that this relative lack of legislative attention may signal a potential barrier to distributed generation market growth. However, the technologies that enable the ability of distributed generation to achieve greater market penetration continue to advance.

Twelve years after the approval of the Telecommunications Act of 1996, Verizon Communications is suing companies that are providing VOIP, turning to the courts to decide what was not considered in the original legislation. Distributed generation, should its technology implementation and consumer acceptance mirror the experience of telecommunications, may be facing a comparable future.

2 INFRASTRUCTURE ISSUES

In the most basic of comparisons, the distribution and transmission of information and data depended on the physical laying of transmission lines from a centralized source, relying on the negotiation with government and private citizens about land-use issues to provide the necessary geographic area to build these conduits. With the advent of wireless connectivity, a single federal agency created an avenue for an entirely new way to transmit data [3]. This invisible infrastructure may not have a replicable comparison for distributed generation, but there may be other corresponding infrastructure issues.

It may be an obvious comparison to look at land-use issues as they relate to the growing number of distributed renewable energy generation systems that are beginning to populate our national landscape as well as the transmission and distribution (T&D) lines these new facilities require. Wind power has grown steadily in recent years and increasingly competitive technology such as concentrating solar power (CSP) has generated interest in solar power plants in the Southwest [4]. But more dispersed technology

is gaining market traction as well, with residential and commercial solar photovoltaic (PV) system installation growing and investments increasing [5]. Electricity transmission through our nation's infrastructure has become more congested. The Internet transmission links in the early to mid-90s faced similar bottlenecks, with many Web sites functioning so slowly they were unable to adequately engage in the blossoming digital marketplace. Traditional Internet service providers tried to solve this problem by simply building bigger pipes in their transmission facilities and by enlarging their Web servers. But this solution didn't address the needs of the growing numbers of new customers whose applications were using infinitely more capacity with video and music. So the market introduced a new type of service provider that was able to support local groups of users through a hierarchy of cheap computers and hard drives, essentially providing a distributed structural source to system users. The relatively low costs of computing and storage enabled Web destinations to be digitally transplanted to locales where demand was highest. Competing companies in this space were effectively segmented by this new architecture: Companies that could afford to provide the new, non-congested experience for their customers bought the services of these new providers, while the smaller, less-capitalized companies continued to rely on the less expensive, but more cumbersome service.

The potential lesson here for distributed generation rests on the principle that users may be willing to pay a slight premium to satisfy their needs, especially if the existing system becomes less than satisfactory. Additionally, it is interesting to note that utilities (the established service provider) are addressing their own transmission issues by simply adding capacity and building larger facilities. The new service providers in this arena are companies that are providing generation and storage solutions closer to the point of energy consumption. In this analogy, distributed generation technology companies are the "data generators," and energy-storage developers are making available the energy equivalent of an inexpensive hard drive.

Whether existing utilities embrace a change in how they define their service or whether new entrants capture the bulk of this market remains to be seen. However, with states increasingly adopting renewable portfolio standards that contain "carve-outs" specific to distributed generation [6], and with commercial and industrial entities beginning to more closely examine the need for reliability (energy availability and cost predictability), distributed generation may be poised for accelerated growth supported by both policy and market factors.

3 TRANSITION FROM CENTRALIZED TO DECENTRALIZED: DEFINING THE LOCALE

The fluctuation of generating and storage of data from centralized locations to more distributed ones created much debate and discussion around the appropriate and most

effective location with relation to the end user. If the service system was provided from too close to the core, end-user reliability and performance were negatively impacted. If too many systems were located at too many locales (too close to each existing customer) infrastructure control became laborious, uncontrollable, and more expensive. It initially was the belief of more centralized service providers that it would always be too complex and expensive to manage a mostly decentralized system. In fact, the system that evolved—while admittedly complex—built on a hierarchy of distributed networks that developed alongside the dropping costs of processors and storage capabilities. Ultimately, the end user became the repository for this capacity.

Interestingly, more proactive utilities are engaged in this same debate about distributed energy solutions. Again, taking a cue from telecom, the costs of distributed energy components (generation, storage, and management software) would need to continue to benefit from positive market influences, whether these are a product of better manufacturing economies of scale, more aggressive public policies, or a combination of both. If we were to experience a similar trajectory, distributed applications would have to be implemented by consumers at an accelerated pace (this may also be in relation to declining established service and/or enhanced need for greater reliability).

But utilities that are required to include distributed generation in their energy portfolios are sparking a broader discussion about these issues: Should DG be located at the substation? Or perhaps at the residence or commercial facility? Where are the marginal costs of installation and maintenance competitive with DG solutions? How can the utility address peak-load issues with a distributed generation strategy? As the cost of traditional sources of energy become more expensive (at the time of this writing, crude oil was approaching \$110/barrel) and the costs of transmission continue to increase as new infrastructure and facilities are continually brought online, battery technology and distributed generating capacity may begin to compete on costs as well as reliability. That said, certain segments of distributed energy technology are growing more quickly than others. The next section examines some of these market dynamics and looks at the complexity inherent in network economics.

4 MARKET GROWTH AND METCALFE'S LAW

One of the initial reasons for making the comparison between the telecommunications industry and the distributed generation industry (with a particular focus on renewable energy generation and storage) was the inapplicability of retail economics analysis to such a complex and dynamic market. In particular, an examination of the principle in network economics that a

large and high-value network typically has a significantly smaller incentive to interconnect with a smaller low-value network than the smaller one has to interconnect with the larger one can help us gain a better understanding of some of the fundamental barriers to growth that distributed energy faces. This can easily lead to a refusal by the larger high-value network to interconnect, as was evidenced in the telecom sector. Similarly, smaller energy producers connecting to the larger grid face this resistance; however, given reliability issues as well as the environmental benefits of cleaner energy, this kind of generation is socially desirable. In the face of increasing utility bills and increasing concern about climate issues, it may become increasingly desirable to consumers as well,

Metcalf's Law states that the value of a telecommunications network is proportional to the square of the number of users of the system (n^2). While the law was specifically formulated for communications technology, when examined within the context of the previous observation about network resistance as applied to distributed energy generation, it may hold lessons for this sector as well. In other words, if distributed energy represents just a small number of operators, it is viewed by the larger T&D provider as a burden. The value of this small generation capacity is outweighed by the potential hassle. However, as the distributed generation nodes grow in number—and as they increasingly employ the “intelligent” technology that allows the systems to communicate their generation capacity back to the grid (the larger system)—the addition of each distributed member may exhibit this exponential value accretion.

The significant observation here, however, is that these systems must be able to communicate with the larger system. This is a slight variance to Metcalfe's Law, where the members of the system need to communicate with one another. However, if a distributed energy generation system was to completely displace a centralized system, the grid itself would be comprised of these distributed components and, by necessity, they would communicate with one another. In this scenario, Metcalfe's Law would be entirely applicable. When consumer demand is married with Metcalfe's Law, these two forces create synergy that accelerates the creation of infrastructure. Telecommunications providers grasped this principle; and, armed with this knowledge, aggressively pursued capital with which to deploy large-scale projects. Distributed generation companies may do well to employ this strategy.

5 INVESTMENT TRENDS AND CAPITALIZATION

Entrants into the distributed generation industry have been growing relatively quickly, but these emerging players have, up to this point, been numerous but typically undercapitalized. Take, for example, the domestic solar industry. There are perhaps hundreds of small operators offering myriad installation solutions. The Solar Energy

Industry Association (SEIA) has membership categories distinct for contractors and installers, manufacturers, distributors, solar business services, financial services, law services, and two categories for the technology itself: CSP and PV. And, within this membership, almost all of these operators most likely offer no storage or maintenance solution. An integrated offering that can combine generation capability, storage, and management (as well as potential financing options) could not only make a case for large capital investment but may also be able to break from the rest of the competition.

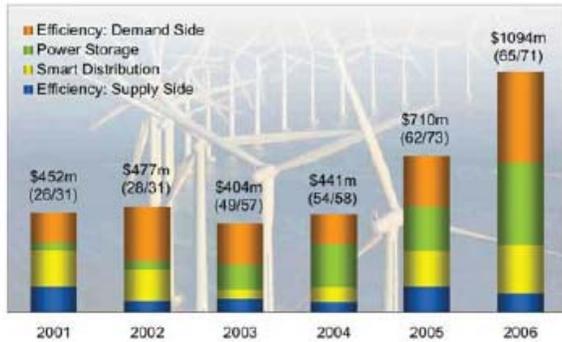
There are some players that want to accelerate their aggregation of capital by positioning themselves as “middle men” between utilities and end users for distributed generation solutions. MMA Renewable Ventures and SunEdison are two examples of firms that are taking a progressive approach to the business model. But there is still a large opportunity for growth here. Indeed, it may be that the emerging interests come not from the entrepreneurial start-up community, but from the existing larger provider sector.

The telecommunications service providers segmented into their respective markets over the course of roughly six years in the mid-'90s. Market leaders in this space tended to have good capital resources, had intimate knowledge about their customer base, and possessed good projection capabilities. They were able to internalize into their strategy and operations the impact that cheaper storage and the central processing unit (CPU) technology was having on their industry. This insight allowed them to position themselves 12 to 18 months ahead of their competitors. By 2003, virtually all of the smaller players had become consolidated under the legacy telecommunications companies.

In essence, the market had invested billions of dollars in the creation of a communications infrastructure whose companies demonstrated extraordinary capital burn rates, modest revenue growth, and generally small customer bases. By the time these smaller players had gone through all of their capital to open these new markets, larger and older companies were able to step in and reap the benefits. With this hindsight, it may be wise for distributed generation interests to either modify their offerings and expand their capitalization to provide integrated solutions at a larger scale, or perhaps to explore alliances with existing, larger utilities that are looking at entering this market.

The distributed energy market is indeed beginning to see an influx of capital. Investments in efficiency technologies, storage, and smart distribution grew by 35% between 2005 and 2006, according to data from New Energy Finance (Figure 1). Investments in individual distributed generation technologies also are experiencing record growth. The wind industry represented \$17.9B in 2006, solar photovoltaics (including modules, system components, and installation) represented \$15.6B, and the fuel cell and distributed hydrogen market is projected to grow from a \$1.4 billion industry (primarily for research contracts and demonstration and test units) to \$15.6 billion

during the next decade [7]. The question remains whether this capital influx will leverage an emerging market that could transform the way we engage with our energy infrastructure, or whether it is a brief surge of technological innovation that eventually will be subsumed into a continuing centralized system.



Note: Grossed-up values based on disclosed deals. The figures represent total investment, and so include PE buy-outs, and investor exits made through OTC market offerings. OTC & PIPE deals are included. Figures in brackets refer to (disclosed deals / total deals).

Source: New Energy Finance

Figure 1: Investment trends for distributed energy industry.

6 CONCLUSION

Because technology development relies on complex and multiple factors, it is difficult to predict how distributed generation will evolve in the near future. Emerging players should examine carefully how their solutions fit into the existing infrastructure, and how they can leverage the tension between consumer demand for distributed technologies and the value that new generation could have to the public good—especially regarding energy security and reliability. The experiences of a similar industry can help guide this new and growing industry.

REFERENCES

- [1] Economides, Nicholas, “The Economics of Networks,” *International Journal of Industrial Organization*, vol. 14, no. 2, pp. 675-699, 1996.
- [2] For the full text of the Telecommunications Act of 1996, visit <http://www.fcc.gov/telecom.html>
- [3] *The Economist*, June 12, p. 26, 2004.
- [4] *Renewables 2007: Global Status Report*, Renewable Policy Network for the 21st Century (REN-21) www.ren21.net
- [5] *Global Trends in Sustainable Energy Investment*, United Nations Environment Programme and New Energy Finance Ltd. 2007 http://sefi.unep.org/fileadmin/media/sefi/docs/publications/SEFI_Investment_Report_2007.pdf
- [6] For details on state approaches to DG, visit: http://go.ucsusa.org/cgi-bin/RES/state_standards_search.pl?states=All&category3=&category7=&category8=29&category32=&category39=&category43=&category51=&submit8.x=19&submit8.y=8
- [7] *Clean Energy Trends*, Clean Edge Inc., March 2007 www.cleandedge.com

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Executive Services and Communications Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.

1. REPORT DATE (DD-MM-YYYY) May 2008		2. REPORT TYPE Conference Paper		3. DATES COVERED (From - To)		
4. TITLE AND SUBTITLE Laying the Groundwork: Lessons Learned from the Telecommunications Industry for Distributed Generation; Preprint				5a. CONTRACT NUMBER DE-AC36-99-GO10337		
				5b. GRANT NUMBER		
				5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) A. Wise				5d. PROJECT NUMBER NREL/CP-670-43015		
				5e. TASK NUMBER 6700.2020		
				5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) National Renewable Energy Laboratory 1617 Cole Blvd. Golden, CO 80401-3393				8. PERFORMING ORGANIZATION REPORT NUMBER NREL/CP-670-43015		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S) NREL		
				11. SPONSORING/MONITORING AGENCY REPORT NUMBER NREL/CP-670-43015		
12. DISTRIBUTION AVAILABILITY STATEMENT National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161						
13. SUPPLEMENTARY NOTES						
14. ABSTRACT (Maximum 200 Words) The telecommunications industry went through growing pains in the past that hold some interesting lessons for the growing distributed generation (DG) "industry." The technology shifts and stakeholders involved with the historic market transformation of the telecommunications sector mirror similar factors involved in distributed generation today. An examination of these factors may inform best practices when approaching the conduits necessary to accelerate the shifting of our nation's energy system to cleaner forms of generation and use. From a technical perspective, the telecom industry in the 1990s saw a shift from highly centralized systems that had no capacity for adaptation to highly adaptive, distributed network systems. From a management perspective, the industry shifted from small, private-company structures to big, capital-intensive corporations. This presentation will explore potential correlation and outline the lessons that we can take away from this comparison.						
15. SUBJECT TERMS NREL; clean energy; market transformation; distributed generation; telecommunications; public policy; Alison Wise						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UL	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON	
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code)	