



RESEARCH REPORT

Executive Summary:

Microgrid Deployment Tracker 4Q12

Campus, Military, Remote, Commercial/Industrial,
and Community/Utility Microgrids: Project Tracking
and Capacity Growth

NOTE: This document is a free excerpt of a larger report. If you are interested in purchasing the full report, please contact Pike Research at sales@pikeresearch.com.

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Section 1

METHODOLOGY AND DATA INSIGHTS

1.1 Introduction to Pike Research's Microgrid Tracker

The federal government-approved definition of a microgrid developed by the U.S. Department of Energy (DOE) is as follows:

"A microgrid is a group of interconnected loads and distributed energy resources (DER) within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected and island-mode."

Pike Research broadened this definition to include remote microgrids in its analysis. Remote microgrids are networks that are not typically interconnected with any utility grid or may interconnect with a highly unreliable grid, therefore, operating in "island-mode" for a majority of the time.

Pike Research's *Microgrid Deployment Tracker 4Q12* is a fourth edition database that is updated biennially and covers five microgrid market application segments and four principal geographies. Unlike many of the other Tracker products offered by Pike Research, this *Microgrid Deployment Tracker* does not list unit sales of devices. Instead, it lists proposed, planned, under development, and operating microgrids – as well as selected projects that lay the foundation for viable microgrids over the next 6 years (in the opinion of Pike Research). This 6-year time interval mirrors the time horizon of Pike Research's annual market forecast updates for microgrids.

The goal of this database is to provide the best up-to-date summary of microgrid projects available globally. It is a working document that will be periodically updated as new projects are announced and then actually come online. Pike Research's ongoing research into this highly dynamic market will also yield data on microgrid demonstration projects that will increase in scale and grow into fully commercial ventures, as well as on the companies and institutions involved with each project.

1.2 Methodology

The data in this global database has been collected from diverse sources. Many of the updates in this (and past) versions of the *Microgrid Deployment Tracker* were derived from interviews performed directly by Pike Research with selected companies and organizations active in this market. Among those companies that provided new project data for this update are SAIC, Honeywell, SMA International, Arista Power, Younicos, Blue Pillar, and Youngblood Capital Group – to name a few.

The prime reason that the Pike Research database on microgrids in North America expanded in this update was based less on learning about multitudes of new projects and more on a survey

by the U.S. Department of Defense (DOD) facilities conducted by the Secretary of Defense. This is the first time the DOD has created an inventory of its onsite electrical infrastructure focused on microgrid deployments. According to the Secretary of Defense, more than 40 DOD military bases currently have operating microgrids, have planned microgrids, or have conducted studies or demonstrations of microgrid technologies. The DOD report recognizes that a majority of these microgrids feature legacy, manual, and predominately fossil-based systems. These fixed installation microgrids have been segregated in to at least four different categories of sophistication.

As a result, Pike Research is revising its internal methodology of forecasting DOD microgrids to better reflect this legacy and diversity. The new methodology recognizes the relevance of these DOD microgrids to the commercial microgrid market's focus on smart controls and integration of resources such as distributed renewables, advanced energy storage, and plug-in electric vehicles (PHEVs). This new methodology will be reflected in a forthcoming report on military microgrids to be published in 4Q 2012.

Most microgrids up and running today are, in essence, retrofit projects, cobbling together existing assets and deriving revenues from an overlay of controls used to enable legacy technology (consisting of the majority of the assets within the microgrid) to talk to the new technology (usually small amounts of solar PV or a new advanced energy storage unit). Today, however, microgrids are beginning to move more into the mainstream with greenfield projects. A majority of new microgrids will increasingly rely upon new distributed generation (DG) installations, along with fresh sales of smart islanding inverters, advanced energy storage, internal forms of automated demand response (ADR), and other technologies.

Pike Research, therefore, published a report in 3Q 2012 entitled *Microgrid Enabling Technologies*, which, for the first time, devised capacity and revenue forecasts for the varied components incorporated into microgrids. The relevance of that report to this tracker is that from this point forward, Pike Research believes the majority of microgrids will feature substantially larger investments in hardware, and, therefore, represent more lucrative business opportunities than previously recognized in Pike Research revenue forecasts focused primarily on networking and integration vendor revenues.

The other main development in the evolving methodology of this database is a partnership with the United Nations Working Group on microgrids. Pike Research has provided this organization – which is seeking to promote microgrids as a key platform to reduce global energy poverty – with its remote microgrid data. In exchange, Pike Research will benefit from the knowledge interchange that results from collaborating with this growing circle of microgrid advocates. The fruits of this collaboration with the UN network will not be fully reflected until the next update, scheduled for 2Q 2013.

Many new microgrids are still under the radar and, consequently, have not yet made it into this database. In the remote segment, in particular, so many organic microgrids are expected to appear in the coming years that Pike Research acknowledges that this database can never be fully complete. Yet by tabulating what data can be gleaned from Pike Research's ongoing

research in this dynamic smart grid space, market players can at least rely on some valid metrics to better judge what might occur over the next 6 years.

1.3 **Segmentation Rationale**

Many of these microgrid projects do not have official designations or titles, therefore, those subscribers researching specific projects are urged to utilize the different search criteria (e.g., by segment or region). The following types of projects have been identified through direct interviews, secondary research, and leads provided by key contacts within the smart grid and renewable energy industries:

- » Commercial/Industrial
- » Community/Utility
- » Institutional/Campus Environment
- » Military
- » Remote Systems

In 2012, Pike Research sliced up the microgrid market in a new way: utility distribution microgrids (UDMs). However, this segmentation overlapped with so many of the other segments that it was decided to keep the original five segments as a matter of consistency. For example, many UDMs are developed by rural cooperatives and are, in essence, also remote microgrids. From a technology development perspective, being classified as a remote microgrid is of greater relevance than knowing that it is operated by a rural cooperative.

Along with these different segments, the database can also be searched by region of the world:

- » North America
- » Europe
- » Asia Pacific
- » Rest of World (including Latin America)

The comprehensive list of microgrid projects (Table 1.10 in the accompanying Excel deliverable) is organized by regional segment, and then alphabetically by country and state (or equivalent). Pike Research does not maintain that this database is complete, but it does represent a good faith effort to track all notable microgrids.

1.4 **Important Caveats Regarding the Tracker**

An important caveat: Not all of the projects profiled in this database meet the strict Pike Research and/or U.S. DOE definitions of a microgrid – though the vast majority do. Projects that do not meet the Pike Research/DOE definitions were included due to their noteworthy features and/or key contributions to the development of technologies critical to the success of the overall microgrid market. In Pike Research's opinion, the ability to safely island

is the key distinguishing feature for smart grid projects connected to a utility grid. As for remote systems, Pike Research screens projects to be included in the database according to the following two criteria:

- » Inclusion of a renewable energy generation resource
- » Some network controls that allow for optimization of generation, loads, and (in most cases) some form of energy storage

Currently, Pike Research does not include remote direct current (DC) telecommunications towers in this database. These systems number in the hundreds of thousands and would be virtually impossible to track on an individualized basis. Furthermore, Pike Research generally looks for a microgrid to feature at least two generation sources and two different buildings (and usually some human occupants of these building structures) as basic criteria for a microgrid – along with the ability to safely island. With these additional criteria in mind, telecommunication towers do not qualify as microgrids. As the microgrid market matures, these screening criteria may be revised. However, the lines between microgrids, virtual power plants (VPPs), and smart grid renewables integration will likely continue to blur. Thus, segmentation of the microgrid market will become increasingly difficult.

1.5 Insights on this 4Q 2012 Update

This update to the *Microgrid Deployment Tracker* is the fourth edition. It again reinforces the premise long held by Pike Research that North America is the world's most fertile environment for microgrids. Connecticut is the first state in the United States to move forward with a policy program to promote microgrids. The state's push for microgrids is in response to Tropical Storm Irene in August 2011 and a rare blizzard in October 2011, both of which led to massive power outages. While the focus of this effort is to identify 150 viable microgrid sites, it is currently limited to a one-time \$15 million grant and loan program covering the interconnection costs of microgrids for police and hospital facilities. Private sector technological and financial innovation will be necessary to create viable business models for this microgrid solution set to take root.

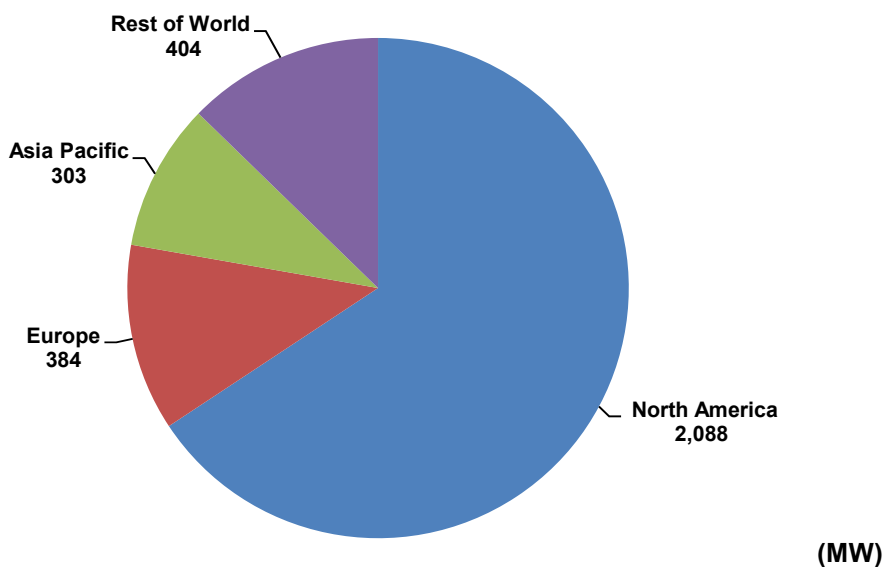
Recent evidence corroborates more severe weather is now business-as-usual – which increases the appeal of the reliability benefits attached to a microgrid. According to the Center for Research on the Epidemiology of Disasters, 100 million to 200 million people were affected by weather-related disasters between 1980 and 2009, with economic losses ranging from \$50 billion to \$100 billion annually. The magnitude 9.0 earthquake in Japan (and corresponding tsunami) was just one obvious example during 2011. (The Sendai 1 MW microgrid at Tohoku Fukushi University operated for 2 days in island mode while the surrounding region was without power.) Such natural disasters underscore the need for resilient infrastructure for vital electricity services – and microgrids.

Pike Research believes that declining solar PV costs are one of the largest drivers for microgrids worldwide, and in terms of numbers of new installations, solar PV will be the market leader. (Combined heat and power (CHP) will lead in terms of total capacity due to the relative

scale of CHP systems compared to solar PV.) With grid parity of solar PV occurring in key markets by 2014 and 2015, the variability of this DG resource will necessitate a greater reliance upon energy storage, as well as the networking function of microgrids.

This fourth edition of the *Microgrid Deployment Tracker* was updated as of October 2012. The result is a much more robust microgrid market than was the case in 2009, when Pike Research first began to develop the world's only database and commercial analysis of this little corner of the smart grid movement. New vendors keep entering this space, and previously undiscovered projects come to the fore. All told, Pike Research has identified a total of 3.2 GW of total microgrid capacity throughout the world, up from 2.6 GW in the previous update in 2Q 2012. Total numbers of new project entries was 67. However, Pike Research is cognizant of several additional microgrids in the planning stages; numerous vendors were unable to provide Pike Research with project data by the October 2012 data submission deadline.

Chart 1.1 **Microgrid Capacity by Region, World Markets: 4Q 2012**



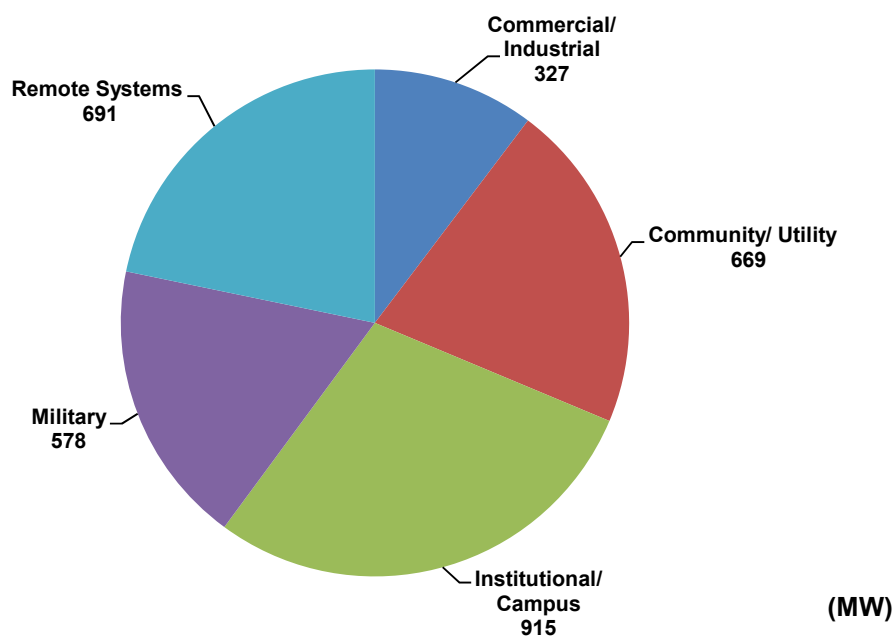
(Source: Pike Research)

As a region, North America is still the world's leading market for microgrids, with overall planned, proposed, under development, and operating capacity totaling 2,088 MW. Compared to 2Q 2012, this is an increase of 36 additional microgrids representing 538 MW of previously unidentified microgrid capacity.

In the 2Q 2012 update, it was remote microgrids that showed the largest numerical and capacity increases. In this update to the Pike Research database, it was the DOD sector that showed the largest gains: 21 new microgrid entries adding up to 350 MW of capacity. The most

stagnant segment was “Community/Utility”, which increased by 5 entries representing a modest 3.55 MW of new capacity.

Chart 1.2 **Microgrid Capacity by Market Segment, World Markets: 4Q 2012**



(Source: Pike Research)

Section 2
ACRONYM AND ABBREVIATION LIST

Automated Demand Response	ADR
Combined Heat and Power	CHP
Department of Defense (United States)	DOD
Department of Energy (United States)	DOE
Direct Current	DC
Distributed Energy Resources	DER
Distributed Generation	DG
Plug-in Hybrid Electric Vehicle	PHEV
United Nations	UN
Utility Distribution Microgrid	UDM
Virtual Power Plant	VPP

Section 3

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Section 5

SCOPE OF STUDY

Pike Research's *Microgrid Deployment Tracker 4Q12* is a fourth edition database that is updated biennially and covers five microgrid market application segments and four principal geographies. The goal of this database is to provide the best up-to-date summary of microgrid projects available globally. It is a working document that will be periodically updated as new projects are announced and then actually come online. Pike Research's ongoing research into this highly dynamic market will also yield data on microgrid demonstration projects that will increase in scale and grow into fully commercial ventures, as well as on the companies and institutions involved with each project.

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SOURCES AND METHODOLOGY

Pike Research's industry analysts utilize a variety of research sources in preparing Research Reports. The key component of Pike Research's analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers, and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain, including but not limited to technology companies, utilities and other service providers, industry associations, government agencies, and the investment community.

Additional analysis includes secondary research conducted by Pike Research's analysts and its staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Pike Research's reports. Great care is taken in making sure that all analysis is well-supported by facts, but where the facts are unknown and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

Pike Research, a part of the Navigant Consulting, Inc. Energy Practice, is a market research group whose goal is to present an objective, unbiased view of market opportunities within its coverage areas. Pike Research is not beholden to any special interests and is thus able to offer clear, actionable advice to help clients succeed in the industry, unfettered by technology hype, political agendas, or emotional factors that are inherent in cleantech markets.

NOTES

CAGR refers to compound average annual growth rate, using the formula:

$$\text{CAGR} = (\text{End Year Value} \div \text{Start Year Value})^{(1/\text{steps})} - 1.$$

CAGRs presented in the tables are for the entire timeframe in the title. Where data for fewer years are given, the CAGR is for the range presented. Where relevant, CAGRs for shorter timeframes may be given as well.

Figures are based on the best estimates available at the time of calculation. Annual revenues, shipments, and sales are based on end-of-year figures unless otherwise noted. All values are expressed in year 2012 U.S. dollars unless otherwise noted. Percentages may not add up to 100 due to rounding.

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