



RESEARCH REPORT

Executive Summary: **Military Microgrids**

Stationary Base, Forward Operating Base, and
Mobile Smart Grid Networks for Renewables Integration,
Demand Response, and Mission-Critical Security

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Section 1

EXECUTIVE SUMMARY

1.1 Military Microgrids Overview

The United States Department of Defense (DOD) is the single largest consumer of petroleum in the world. Likewise, U.S. military operations represent the largest consumer of all forms of energy globally. Efforts by the U.S. DOD may be the most crucial push for the overall microgrid market today, especially in terms of control approaches for these smart grid networks based on a bottoms-up distributed model for its operational and tactical deployments of microgrid technology. The DOD's interest in improving energy security through microgrid technology stems from its heavy reliance upon all forms of fossil fuels, often imported from regions of the world hostile to U.S. interests. Consider this: U.S. military operations in Afghanistan have paid the equivalent of \$400 per gallon of fossil fuel when security, transportation, and mortality costs are tallied up. The largest consumer of fuels in the battlefield is electricity generation.

Microgrids can shrink the amount of fossil fuels consumed to create electricity by networking generators as a system to maximize efficiency. They can also be used to help integrate renewable energy resources (such as wind and solar) at the local distribution grid level. Simultaneously, microgrids enable military bases – both stationary and forward operating bases (FOBs) – to sustain operations, no matter what is happening on the larger utility grid or in the theater of war. These microgrid networks can also provide tactical operations support.

The military's primary concern is disruptions of service from utility transmission and distribution (T&D) lines. Its lack of control and ownership of these lines – and the uneven quality of power service regionally throughout the United States – has prompted the U.S. DOD to reexamine the existing electricity service delivery model. This analysis has led the DOD to the inevitable conclusion that the best way to bolster its ability to secure power may well be through microgrid technology it can often own and control. Furthermore, recent mandates require an increase in the reliance upon renewable energy developed onsite, whether the generation is solar PV or waste-to-energy combustion. A microgrid can tie these disparate and distributed resources together and allow them to be managed locally.

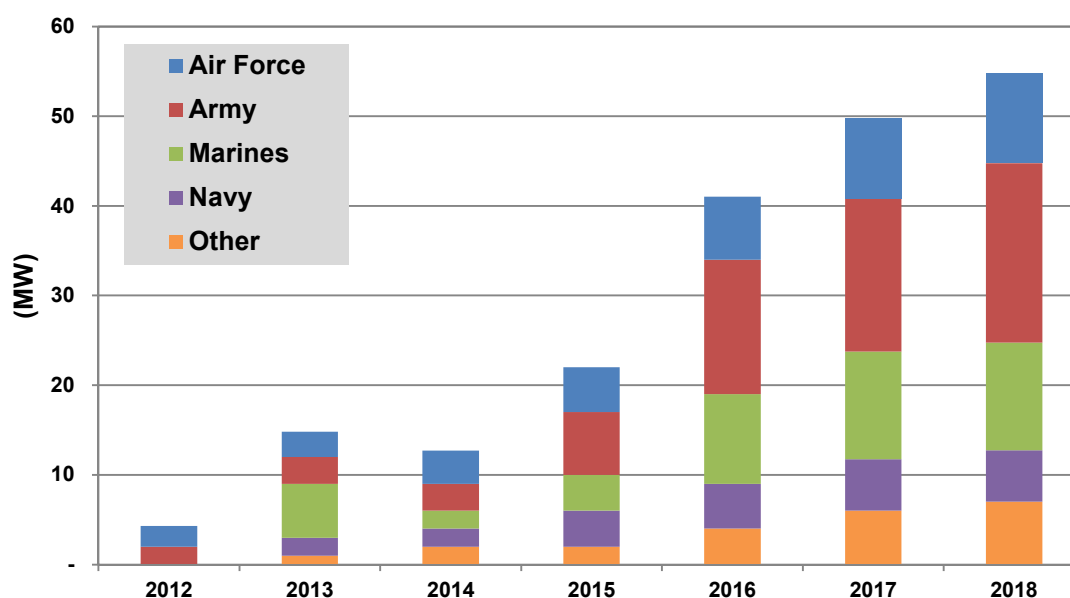
While the DOD is not the only military agency exploring microgrids as a platform to increase physical and cyber security, it is by far the most advanced in its efforts in that regard. Other nations rumored to be examining the potential for microgrids include the United Kingdom, Canada, France, and China. Given the sensitive nature of military operations, little data is available about these non-DOD rumored projects. Pike Research has therefore elected to limit its military microgrid capacity and revenue forecasts in this report to systems deployed by the U.S. DOD.

1.1.1 Stationary Military Bases

As awareness about the electrical grid's vulnerability to terrorist attacks and severe storms has increased in recent times, the U.S. military has become one of the strongest proponents of microgrids. For fixed base military operations, microgrids offer the ultimate secure power supply. Many Army, Navy, Air Force, Marines, and other military-related bases and offices already have vintage microgrids in place. What is new is that these facilities are looking to envelop entire bases with microgrids and integrate renewable distributed energy generation (RDEG) onsite. When capable of safe islanding from the surrounding grid, RDEG offers the ultimate security since fuel never runs out with solar or wind resources.

Pike Research has identified roughly two dozen military facilities in the United States that are currently engaged in smart microgrid implementations. The Marines show the fastest initial capacity growth spurt, but the Army shows signs of longer-term increases in annual capacity. This is because the Army has a larger number of stationary bases requiring microgrid upgrades. Most of these new microgrids incorporate RDEG as a way of increasing reliability and security. The opportunity to help develop these microgrids has attracted a number of powerful technology companies, including Lockheed Martin, General Electric (GE), Honeywell, Boeing, and Eaton.

Chart 1.1 *Stationary Base Microgrid Capacity by Military Branch, Average Scenario, United States: 2012-2018*



(Source: Pike Research)

1.1.2 Forward Operating Base and Mobile Tactical Military Microgrids

The DOD is also responsible for approximately 600 bases located outside the boundaries of the United States, many of them FOBs that face unique logistical challenges. In addition, the DOD

is exploring the role small mobile and tactical microgrids can play in actual combat missions being deployed in the theater of war.

Many of the abovementioned firms – as well as other specialty component providers such as ZBB Energy, SkyBuilt Power, and Princeton Power Systems – are also involved with the two other microgrid segments profiled in this report, FOB and mobile tactical. The definitions of these two segments are as follows:

- » FOB microgrids: Typically remote fossil fuel-based systems that may interconnect to primitive power grids
- » Mobile tactical microgrids: Extremely modular, small systems that may be deployed within a matter of days and then deconstructed and moved to a new location, per tactical mission

The DOD had placed a higher urgency on these latter two microgrid segments in recent years due to heavy casualties related to the provision of fuel in landlocked Afghanistan. However, now the focus appears to be shifting toward stationary base microgrids, which represent an overall larger economic opportunity.

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SCOPE OF STUDY

Pike Research has prepared this report to provide participants in the growing military microgrid market (including military agencies, equipment and hardware vendors, utilities, software companies, installation and service providers, and other balance of system component manufacturers) with a study of the market potential for this, the most focused of all microgrid sectors. Its major objective is to determine the current status of this industry and the potential future growth of stationary, FOB and mobile microgrids. To that end, the report pulls together a review of proposed and currently operating projects globally, identifies the major demand drivers, and profiles key industry players operating within the competitive landscape, with a special emphasis on competing management and microgrid control systems.

The report's purpose is not to provide an exhaustive technical assessment of all of the technologies and industries that may be deployed in microgrids – renewable energy distributed generation (RDEG), storage, inverters, and other components. Rather, it aims to provide a strategic examination of the market for military microgrids within the context of the U.S. Department of Defense's (DOD) initiatives concerning goals for renewable energy deployments, net zero energy base mandates, and the securing of power for mission-critical functions. Pike Research strives to identify and examine new market segments to aid readers in the development of their business models. While all major global regions are considered, this report focuses on the U.S. DOD. Also note that since there is no available public database of microgrid projects, this report draws on original research and a recent (4Q 2012) update of Pike Research's *Microgrid Deployment Tracker* to generate market penetration projections. The global forecast period, focused on the U.S. market, extends through 2018.

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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