



RESEARCH REPORT

Executive Summary:

Grid Edge Intelligence for DER Integration

Operational IT/OT, Distributed Monitoring and Control,
and Communications Networks: Global Market
Analysis and Forecasts

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

Published 2Q 2015

Lauren Callaway

Research Analyst

Alex Eller

Research Associate

Richelle Elberg

Principal Research Analyst

Section 1

EXECUTIVE SUMMARY

1.1 Stabilizing the Grid Edge

The global utility business faces unprecedented challenges—and opportunities—as distributed energy resources (DER) proliferate. Thus, there is a growing need for more intelligence, control, and agility in the distribution grid, particularly at the edge, where many new disruptive resources and loads are located.

To date, utility efforts have been largely reactive, focused on issues caused by renewables intermittency, shifting loads, capacity constraints, and bidirectional power flows. In the longer term, grid edge intelligence and automation will enable the proactive development of markets for aggregated clean resources and services, service-oriented business models, and end-to-end integrated grid management strategies.

This report covers the technologies and strategies that are being adopted to increase the level of monitoring, intelligence, and automation at the grid edge in order to accommodate burgeoning DER. Technologies have been segmented into three broad technology segments:

- » **Operational IT solutions:** Systems hosted by the utility’s central server and used by operators at the control facility for alerting, control, and planning. These systems develop a comprehensive view of the network and manage the entire fleet of distributed resources.
- » **Distributed monitoring and control equipment:** Systems hosted by distributed servers or in the cloud that manage distribution assets and distributed resources based upon localized needs. This is inclusive of IT-only solutions that seek to optimize existing assets or new devices such as advanced sensors or low-voltage (LV) power electronics that have embedded intelligence and/or are optimized by a distributed system of similar devices. Additionally, it includes advanced metering infrastructure, which is being increasingly leveraged for last-mile data and monitoring.
- » **Communications technologies:** Communications networks and control platforms that are able to manage the growing number of connected, data-generating devices within the medium-voltage (MV) and LV distribution networks and can support distributed, centralized, or hybrid control of advanced applications based on this data.

1.2 Market Trends

Among global regions, North America, Europe, and Asia Pacific have experienced the greatest penetrations of distributed renewables and other resources creating disruptive loads. However, due to diverse physical grid infrastructures, policy and regulatory goals (and limitations), and access to technology, market trends have developed differently in different regions. Specific global and regional trends related to grid edge intelligence and automation are discussed in this report.

1.2.1 Exchanges between Vertical and Horizontal Actors

The traditional, vertically integrated utility model has already begun to erode to differing degrees regionally, depending largely upon the regulatory environment. Power management and delivery is increasingly peppered with outside horizontal offerings in the form of both business-to-business and business-to-consumer solutions. Some specific examples include microgrids, smart city offerings, and third-party renewables products and services vendors. In December 2014, the U.S. Department of Energy (DOE) published a report, *The Future of the Grid: Evolving to Meet America's Needs*, recommending utilities develop a framework for collaboration with horizontal entities as a means of pursuing grid modernization.

1.2.2 Regulator Constraint

Solutions vendors consistently agree that the regulatory environment has been a constraint to supply-side technology innovation that supports DER integration and improves reliability in the LV network. However, they also state that policy design is becoming increasingly favorable toward innovation and changes to the utility service model that will accommodate proliferating DER.

1.2.3 Converged Data Approach

Utilities are seeking to leverage investments across previously siloed systems and operating segments. Analytics offerings on the market that incorporate data from advanced distribution management systems (ADMSs), supervisory control and data acquisition (SCADA) solutions, and meter data management systems (MDMSs) are growing, able to offer more granular, timely, and accurate insights. Such integration requires significant IT and integration investments, in addition to change management planning and implementation.

1.2.4 Standardization of Distribution Network Control and Monitoring Solutions

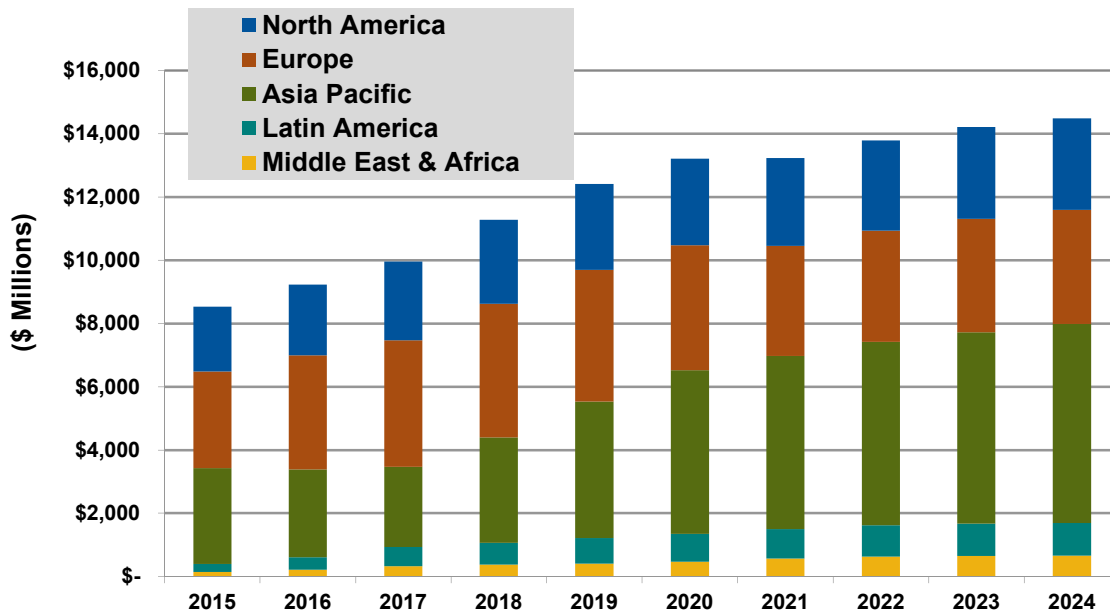
A key overarching trend within all smart grid markets is interoperability. Clunky customization of system interfaces for interoperability has been the norm within the utility industry for years, but more recently, solutions are being developed for interoperability with little to no customization. Like the iPhone or Android platform model, open application program interface (API) development for utility systems is becoming increasingly common. Such interoperability will make the extension of intelligence, connectivity, and automation all the way to the grid edge more feasible and cost-effective for utilities. Regardless, true interoperability between systems still has a long way to go through the adoption of common standards. Internationally, the International Electrotechnical Commission (IEC) has developed a series of transmission and distribution (T&D) standards under the Common Information Model (CIM). In the United States, work is being done under the MultiSpeak specification. Additionally, Duke Energy is developing an open field message bus to enhance interoperability between disparate systems and across vendor solutions.

1.3 Market Forecasts

Grid edge technologies for DER integration are being deployed by utilities for reasons that extend beyond DER integration. For example, these solutions and systems may also help utilities deal with aging grid infrastructure or outages during storms. Nonetheless, advanced solutions deployed for long-term use will support utilities as they face growing DER in their territories.

According to Navigant Research estimates, the market for grid edge intelligence and automation solutions, equipment, and services is expected to be \$8.5 billion, growing to \$14.5 billion in 2024 at a compound annual growth rate (CAGR) of 6.1%. North America, Europe, and Asia Pacific will represent the vast majority of the market through 2024.

Chart 1.1 Grid Edge Technologies for DER Revenue by Region, World Markets: 2015-2024



(Source: Navigant Research)

Section 9

TABLE OF CONTENTS

Section 1	1
Executive Summary	1
1.1 Stabilizing the Grid Edge	1
1.2 Market Trends	1
1.2.1 Exchanges between Vertical and Horizontal Actors	2
1.2.2 Regulator Constraint	2
1.2.3 Converged Data Approach	2
1.2.4 Standardization of Distribution Network Control and Monitoring Solutions.....	2
1.3 Market Forecasts.....	3
Section 2	4
Market Issues	4
2.1 Distributed Energy Resources Poised for Rapid Growth.....	4
2.1.1 DER Defined	5
2.1.1.1 Distributed Generation.....	5
2.1.1.2 Plug-In Electric Vehicles.....	5
2.1.1.3 Microgrids.....	6
2.1.1.4 DR	6
2.1.1.5 Distributed Storage	7
2.2 Disruptive Factors of DER.....	7
2.2.1 The PV Problem	8
2.3 Utility Benefits of Grid Edge Intelligence and Automation.....	9
2.4 Market Drivers.....	9
2.4.1 DER Integration.....	9

2.4.2	Need for Visibility and Control in the Last Mile	10
2.4.3	Policy Drivers	10
2.4.4	New Business Models	11
2.4.5	Smart Cities and Smart Grids	11
2.5	Market Inhibitors.....	11
2.5.1	Insecure Payback	11
2.5.2	Cost of Service Ratemaking	12
2.5.3	Stranded Assets and Technology Obsolescence	12
2.5.4	Complexity and Interoperability	12
2.5.5	Transitioning Infrastructure and Change Management Costs.....	13
Section 3	.....	14
Regional Trends	.....	14
3.1	Overview.....	14
3.2	North America	14
3.2.1	Canada	14
3.2.2	United States	15
3.3	Europe.....	17
3.3.1	Germany	18
3.3.2	France	18
3.3.3	Denmark	18
3.3.4	Netherlands.....	19
3.3.5	United Kingdom	19
3.4	Asia Pacific	19
3.4.1	Japan.....	19
3.4.2	South Korea	20

3.4.3	China/Southeast Asia	20
3.4.4	India	21
3.4.5	Singapore	21
3.4.6	Australia/New Zealand	21
3.5	Rest of World	21
3.5.1	Dubai	21
3.5.2	Mexico	22
3.5.3	South Africa	22
Section 4	.....	23
Technology Issues	.....	23
4.1	Introduction	23
4.2	Enabling the Distribution Network with Intelligence and Automation	23
4.2.1	Distribution Grid Infrastructure	24
4.2.1.1	Regional Grid Infrastructure Differences	24
4.2.2	Value Chain at the Distribution Grid Edge	26
4.2.3	Applications for Grid Edge Technologies for DER Integration	27
4.2.3.1	Stable DG Integration	27
4.2.3.2	Stable PEV Charging Networks Integration	27
4.2.3.3	Energy Efficiency and Dynamic Line Rating	27
4.2.3.4	Energy Efficiency and CVR	27
4.2.3.5	Advanced VVO in the LV Network	28
4.2.4	Operational IT Solutions	28
4.2.4.1	Distribution Management System/ADMS	28
4.2.4.2	SCADA	29
4.2.4.3	MDMS	30

4.2.4.4	DRMS.....	31
4.2.4.5	Distributed Energy Resource Management System.....	32
4.2.4.6	Distribution Grid Optimization Analytics.....	32
4.2.5	Distributed Monitoring and Control Equipment.....	33
4.2.5.1	AMI.....	33
4.2.5.2	Sensing Technologies.....	34
4.2.5.3	Connected LV and MV Power Electronics.....	35
4.2.6	Communications Technologies.....	35
4.2.6.1	Legacy AMI and DA Communications.....	36
4.2.6.2	Communications Requirements for DER Integration.....	37
4.2.7	Standards and Security Considerations.....	38
4.2.7.1	Data Standards.....	38
4.2.7.2	Data Security.....	40
Section 5	.....	41
Key Industry Players	.....	41
5.1	Introduction.....	41
5.2	Large Technology Players.....	41
5.2.1	ABB.....	41
5.2.2	ACS.....	42
5.2.3	Alstom.....	43
5.2.4	GE.....	44
5.2.5	Oracle.....	45
5.2.6	Schneider Electric.....	45
5.2.7	Siemens.....	47
5.3	Standalone IT/OT Vendors.....	48

5.3.1	AutoGrid	48
5.3.2	Battelle Laboratories.....	48
5.3.3	Bit Stew Systems.....	49
5.3.4	Comverge	49
5.3.5	ENBALA Power Networks.....	50
5.3.6	Gridco Systems	50
5.3.7	GridSense	51
5.3.8	S&C Electric.....	51
5.3.9	Tollgrade Communications.....	52
5.3.10	Utilidata	53
5.3.11	Varentec	53
5.4	Communications Vendors.....	53
5.4.1	Cisco Systems.....	53
5.4.2	Itron.....	54
5.4.3	Silver Spring Networks.....	55
5.5	Utilities/Retailers/Distribution Operators	55
5.5.1	Consolidated Edison, Inc.	55
5.5.2	Duke Energy	56
5.5.3	E.ON.....	57
5.5.4	Hawaiian Electric Company, Inc.	57
5.5.5	PG&E.....	57
Section 6	.....	59
Market Forecasts	.....	59
6.1	Introduction	59
6.2	Forecast Methodology and Assumptions	59

6.3	Global Market for Grid Edge Intelligence and Automation	60
6.4	Regional Grid Edge Intelligence and Automation Forecasts	61
6.4.1	North America	62
6.4.2	Europe	64
6.4.3	Asia Pacific	66
6.4.4	Latin America	68
6.4.5	Middle East & Africa	70
6.5	Conclusions and Recommendations	71
6.5.1	Recommendations for Utilities	71
6.5.2	Recommendations for Vendors.....	72
Section 7	.....	73
Company Directory	.....	73
Section 8	.....	75
Acronym and Abbreviation List	.....	75
Section 9	.....	80
Table of Contents		80
Section 10		86
Table of Charts and Figures		86
Section 11		87
Scope of Study		87
Sources and Methodology		88
Notes		88

Section 10

TABLE OF CHARTS AND FIGURES

Chart 1.1	Grid Edge Technologies for DER Revenue by Region, World Markets: 2015-2024.....	3
Chart 6.1	Grid Edge Technologies for DER Revenue by Region, World Markets: 2015-2024.....	61
Chart 6.2	Operational IT Revenue by Solution, North America: 2015-2024	62
Chart 6.3	Distributed Monitoring and Control Revenue by Solution, North America: 2015-2024.....	63
Chart 6.4	Operational IT Revenue by Solution, Europe: 2015-2024	64
Chart 6.5	Distributed Monitoring and Control Revenue by Solution, Europe: 2015-2024	65
Chart 6.6	Operational IT Revenue by Solution, Asia Pacific: 2015-2024	66
Chart 6.7	Distributed Monitoring and Control Revenue by Solution, Asia Pacific: 2015-2024	67
Chart 6.8	Operational IT Revenue by Solution, Latin America: 2015-2024	68
Chart 6.9	Distributed Monitoring and Control Revenue by Solution, Latin America: 2015-2024	69
Chart 6.10	Operational IT Revenue by Solution, Middle East & Africa: 2015-2023	70
Chart 6.11	Distributed Monitoring and Control Revenue by Solution, Middle East & Africa: 2015-2024.....	71
Figure 2.1	Annual PV Installations, United States: 2005-2014	4
Figure 4.1	Simplified European and North American Distribution Network Architectures	25
Figure 4.2	Value Chain for Distribution Edge Intelligence and Automation Technologies.....	26
Table 4.1	Smart Metering Neighborhood Area Network and AMI-Wide Area Network Communications Requirements	36
Table 4.2	Legacy DA Communications Requirements	37
Table 4.3	Advanced Grid Edge Communications Requirements.....	38
Table 4.4	Standards and Specifications from NIST Framework.....	39

Section 11

SCOPE OF STUDY

This Navigant Research report examines the global market for utility-owned grid edge technologies for DER integration. It aims to enable current and prospective electric utility solutions and service providers to understand the drivers for projected demand and likely investment by utilities in DER integration solutions and services. The major objective of this report is to identify and measure the potential market for grid edge technologies deployed to support DER in the electric utility industry worldwide and isolate appropriate segments and market forecasts for IT/OT and equipment-based solutions.

To achieve that purpose, Navigant Research has excluded non-utility spending from the forecast for DER integration support technologies. Specifically, the forecasts in this report do not take into account the outlook for customer-owned technologies such as smart inverters and residential storage, both of which can be leveraged to support DER integration.

While some technical overview is provided, the report is not meant to provide an exhaustive technical assessment of relevant technologies. Rather, it represents a strategic examination from an overall business perspective of appropriate segments for these support markets. The forecast extends through 2024 and includes all major global regions.

SOURCES AND METHODOLOGY

Navigant Research’s industry analysts utilize a variety of research sources in preparing Research Reports. The key component of Navigant 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 Navigant 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 Navigant 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.

Navigant Research is a market research group whose goal is to present an objective, unbiased view of market opportunities within its coverage areas. Navigant 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 2015 U.S. dollars unless otherwise noted. Percentages may not add up to 100 due to rounding.

Published 2Q 2015

©2015 Navigant Consulting, Inc.
1320 Pearl Street, Suite 300
Boulder, CO 80302 USA
Tel: +1.303.997.7609
<http://www.navigantresearch.com>

Navigant Research has provided the information in this publication for informational purposes only. The information has been obtained from sources believed to be reliable; however, Navigant Research does not make any express or implied warranty or representation concerning such information. Any market forecasts or predictions contained in the publication reflect Navigant Research's current expectations based on market data and trend analysis. Market predictions and expectations are inherently uncertain and actual results may differ materially from those contained in the publication. Navigant, and its subsidiaries and affiliates hereby disclaim liability for any loss or damage caused by errors or omissions in this publication.

Any reference to a specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply an endorsement, recommendation, or favoring by Navigant Research.

This publication is intended for the sole and exclusive use of the original purchaser. No part of this publication may be reproduced, stored in a retrieval system, distributed or transmitted in any form or by any means, electronic or otherwise, including use in any public or private offering, without the prior written permission of Navigant Consulting, Inc., Chicago, Illinois, USA.

Note: Government data and other data obtained from public sources found in this report are not protected by copyright or intellectual property claims.