WHITE PAPER

Smart Utilities:
10 Trends to Watch in 2014 and Beyond

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Richelle Elberg
Senior Research Analyst

Neil Strother
Senior Research Analyst

Brett Feldman
Senior Research Analyst

Kris Torvik
Senior Research Analyst

Lauren Callaway
Research Associate

Bob Lockhart
Research Director

Section 1
EXECUTIVE SUMMARY

1.1 2013: A Year of Change

The year 2013 saw several new trends emerge in the smart utilities market – some encouraging, some disturbing. Utilities' traditional business models face threats from all sides. Meanwhile, vendors that sell to utilities are challenged to understand what their future markets may look like based upon all this change. "Business as usual" appears to be a thing of the past.

Some key developments of the past year:

- U.S. utilities spent the last of the stimulus funding from the American Recovery and Reinvestment Act (ARRA) of 2009, leaving vendors to wonder where the next market push will come from in North America.
- Utilities that installed advanced metering infrastructure (AMI) systems with stimulus funding are beginning to use those telecommunications networks for enhanced distribution automation (DA) functions.
- A raging global debate has emerged over net metering and residential feed-in tariffs (FITs). Utilities face a loss of revenue as more residential and business customers generate their own energy. In many cases, utilities are legally mandated to pay customers generously for excess energy generated. Utilities are applying pressure to reduce FITs, for which the utilities are being characterized – rightly or wrongly – as anti-green.
- The deadline for Europe's 20-20-20 by 2020 initiative drew 1 year closer with little measurable progress toward that program's directed outcomes.
- The home energy management (HEM) market finally started showing some signs of life after several successful pilot programs that combined HEM and demand response (DR). While not the level of growth some expected to see by this time, this constitutes at least a viable direction for the HEM market.
- Meanwhile, DR load curtailment numbers are finally becoming significant somewhere besides North America. Outside North America, commercial and industrial (C&I) customers are driving the DR uptake.
- Transmission and distribution vendors continue to innovate in technologies that lead toward more efficient grids, such as conservation voltage reduction (CVR) and hybrid circuit breakers for high-voltage direct current (HVDC) networks.

The following section presents 10 key smart utilities trends to watch during 2014 and beyond. Navigant Research selected these particular topics because they stood out during 2013 research projects as likely to have a business impact for smart grid vendors and utilities.

Section 2

10 Smart Utilities Trends to Watch

2.1 AMI Networks Supporting Distribution Automation

Following the rapid deployment of smart meters that the American Recovery and Reinvestment Act (ARRA) inspired between 2009 and 2012 in the United States (and including some ongoing rollouts), North American utilities are taking a step back and reassessing their investments. Many now see the communications networks installed alongside their advanced metering infrastructure (AMI) systems as a platform to be leveraged for distribution automation (DA) applications, particularly in the low-voltage (LV) distribution network. Forcing the communications network into double duty (for meter data collection and as a new set of eyes and control in the LV network) is expected to improve returns on investment (ROIs), while at the same time reducing grid operating expenses and improving reliability.

Those utilities that have not yet deployed smart meters (both in North America and elsewhere globally) are increasingly planning those networks with multiple uses in mind from day one. While AMI communications vendors caught on to the AMI/DA integration trend some time ago by touting a multitude of DA functions enabled by their systems, the bottom line is that not all legacy communications networks offer the robustness needed for certain DA applications. That said, communications technology continues to evolve. Looking ahead, many applications will be enabled by or benefit from AMI communications, including all but the most critical protection scheme applications:

- **Outage management:** Last gasp messages when smart meters lose power provide operators with a clear picture of where outages exist
- **Restoration verification:** Pinging meters to ensure power restoration can reduce unnecessary site visits by field workers
- **Power quality alarming:** Sends alerts based on high- or low-voltage measurement along the circuit or at the meter; other power quality metrics include total harmonic distortion (THD) and power factor (PF)
- **Load monitoring and profiling:** Circuit sensors in the LV network provide more granular data for dynamic load monitoring and profiling
- **Asset and condition monitoring:** Ongoing data collection and condition alerts in the LV network allow for more efficient maintenance and minimize expensive run-to-fail scenarios
- **Adaptive conservation voltage reduction (CVR):** More finely tuned CVR based on LV network voltage data can double the power savings versus CVR based solely on medium-voltage (MV) network data

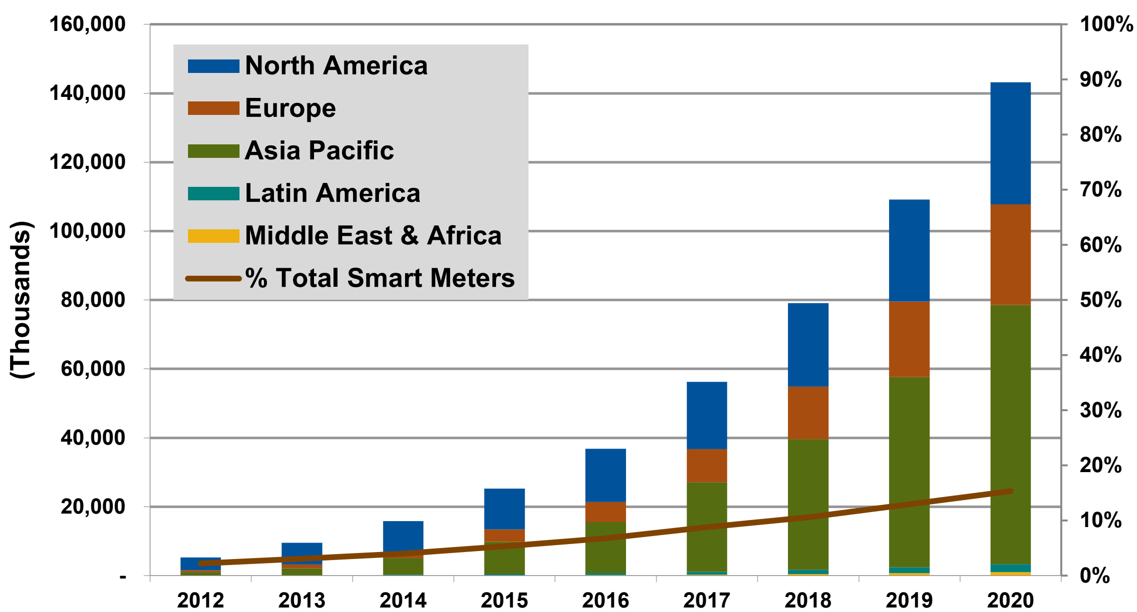
» **Integrated Volt/VAR control (IVVC):** Adds dynamic management of reactive power (measured as VAR, or voltage-ampere reactive); more reactive power is needed to maintain a given voltage on a circuit as line length increases; capacitor banks placed on long lines reduce reactive power losses, and dynamic capacitor control allows such VAR control to be optimized in concert with CVR

» **Fault location, isolation, and restoration (FLISR):** Situational awareness in the LV network can allow for much faster restoration to circuits not directly involved in a fault

» **Distributed generation (DG) integration:** Awareness in the LV network allows operators to adapt dynamically to reverse flow situations that may occur as DG assets like solar panels proliferate

Navigant Research believes that use of AMI networks for DA applications is in its infancy but expects that it will grow rapidly through the end of the decade. Specifically, use of AMI smart meter endpoints for the DA applications described above is expected to grow from just 2% of endpoints in 2012 to 4% in 2014 and more than 15% in 2020, driven primarily by North America, Europe, and Asia Pacific. Over that time, 4G LTE-based wireless networks will rise to the fore as one of the most robust networks available to support time-sensitive DA applications.

Chart 2.1 Smart Meters for DA Applications Installed Base by Region and Percentage of Total Smart Meters, World Markets: 2012-2020



(Source: Navigant Research)

2.2 Net Metering Brouhaha Escalates and Possible Solutions Emerge

Net metering is a blanket term describing the compensation a utility most provide to customers who generate their own energy and deliver their excess energy to the grid. With net metering, a customer's meter begins to spin (or record) backwards when his system is generating more power than is being consumed on the premise. In Europe, independent energy generation is generally compensated under feed-in tariffs (FITs). Globally, the growing capacity of independent generation is placing heavy strains on utilities and, in many cases, on the utility's non-DG customers as well.

This could be the year that a solution to the growing controversy over net metering policy emerges; if nothing else, expect a flurry of proposed formulas designed to deal more intelligently with the problem. The stakes are high and growing higher for utilities, which have been largely demonized in the debate over how to compensate the fast-growing number of independent energy producers worldwide. These prosumers are generating their own electricity primarily with solar panels, but a myriad of policies also cover wind generation, biofuels, and other DG.

In the United States the problem is compounded by the state-level regulatory environment under which utilities work – there may be multiple compensation schemes per state. However, utilities that have argued for changes to existing policies are maligned as waging a "war on solar." Overseas, businesses that were created based on FITs established just 2 years ago are now struggling as regulators have, in some cases, cut those tariffs to just one-third of their original levels.

Meanwhile, governments are not about to scale back their demands for increased renewable energy resources in the national mix. A few promising proposals for net metering reform have been batted about, but to date none have been universally embraced. As the crisis coalesces, Navigant Research believes that a handful of standout solutions will begin to emerge over the next year.

2.3 Smart Grid IT Spending on the Rise

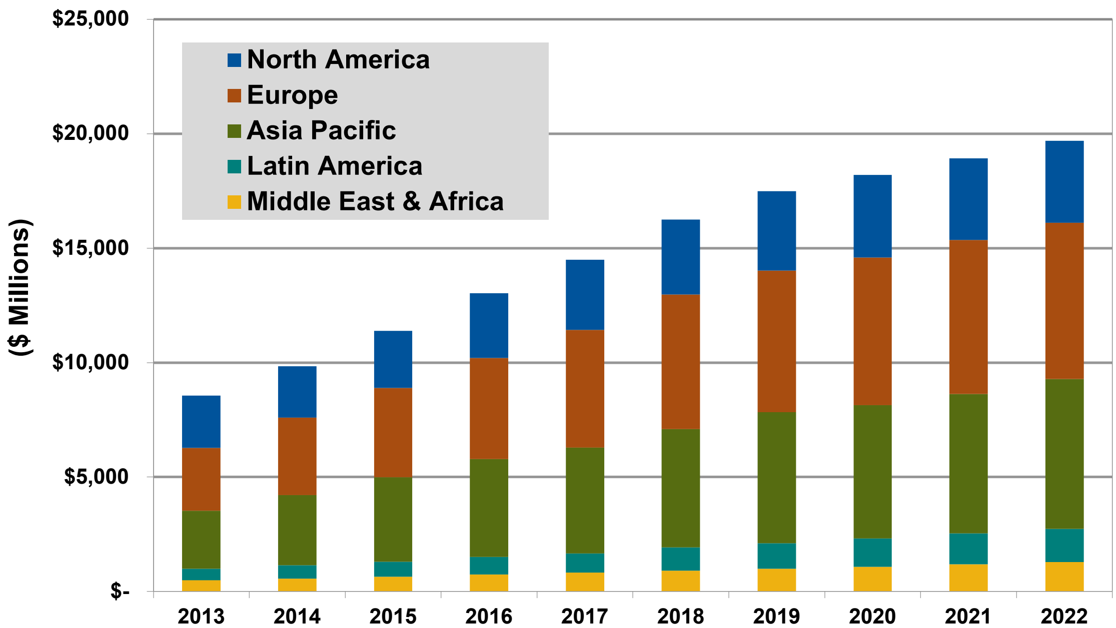
As the one-way electric grid of old is upgraded with communications, sensors, and control devices, the amount of data available to utilities is growing exponentially. And while access to such granular information holds great promise, without intelligent information technology (IT) to manage and route that data – and in some cases make autonomous operating decisions – the grid is not really smart but rather just more complex and more expensive.

In response, IT solutions are emerging and advancing at a breathtaking pace. Analytics components are being added into traditional solutions such as customer information systems (CISs) and outage management systems (OMSs), to name but a few. Additionally, solutions that cut across once siloed operations and departments are emerging, and the notion of IT/operational technology (OT) convergence is one of the most talked about trends in the industry. Advanced distribution management systems (ADMSs) are taking once discrete systems like DMS and OMS and merging them into sophisticated systems that can not only help utilities manage their distribution networks but also provide better reliability and faster outage response for consumers.

In short, the market for utility IT systems is large and growing rapidly. Challenges in interoperability and integration are substantial, but the economic and regulatory pressures utilities face today will result in increased investment in new systems and more rapid upgrade cycles for existing systems over the next decade.

Navigant Research projects the market for utility IT systems to grow at a nearly 10% compound annual growth rate (CAGR) between 2013 and 2022, from more than $8.5 billion to nearly $20 billion by 2022. Nascent systems like distributed energy resource management systems (DERMS) and demand response management systems (DRMS) will be among the fastest growing segments over the next decade; analytics solutions will grow to become the largest system type of the dozen systems analyzed.

Chart 2.2 Smart Grid IT Software and Services Spending by Region, World Markets: 2013-2022



(Source: Navigant Research)

2.4 Utilities' Business Models Are Shifting

Recent market changes have introduced new pressures upon utilities' traditional business models. Net metering, discussed earlier in this white paper, is one example. On a policy level, energy efficiency and carbon dioxide (CO_2) emissions reduction targets have forced utilities to increase their use of cleaner but more costly forms of generation, often with no offsetting increase in their rate structures. On the customer side, more sophisticated tools for home energy management (HEM) such as smart thermostats and energy efficient appliances yield intentional reductions of energy use. In addition, the growth of distributed energy resources have complicated load forecasting and grid stability, as well as opened up a number of policy-related questions that challenge the economic structure of the energy industry. Utilities' roles in this brave new world could change in a number of ways:

- In one scenario, the utility would act as a highly localized private grid operator that would manage grid conditions and stability and profit from delivery of electricity along the distribution grid. With an increased level of local control, grid integrators could more effectively manage wholesale supply with local resources and storage. Similarly, these operators would maintain increased control over customer systems through demand response (DR) mechanisms. Through this model customers experience greater variability in electricity costs, in theory contributing to increased awareness surrounding usage.
- Utilities become electric services providers. These entities would manage sales of electric power that are bundled with distribution and energy efficiency services. These utilities would be increasingly incentivized by state and federal regulators to meet energy efficiency targets. Rate structures would favor increased customer awareness through highly localized unbundling of services. At the extreme, prices could be unbundled for specific uses, meaning that customers pay for task-oriented electricity such as lumens for lighting. Also, such a model could include real-time cost information exchanged between utilities and HEMs, with the HEM autonomously making energy consumption decisions based upon the current energy cost, time of day, ambient temperature, and possibly other factors.
- Legislations and regulation can affect utilities' economic models, possibly most profoundly of all influencers. In deregulated markets, some large utilities have already divested generation resources, allowing third-party transmission system operators and distribution systems operators to purchase electricity based on current loads and lowest marginal cost. In some jurisdictions, such as the Netherlands, it is illegal for the same company to manage energy transmission and energy distribution.

In order to favor more progressive integration of renewables and clean energy, regulators of deregulated markets have been pushed (or in some cases legally required) to encourage wholesale electricity purchases from more sustainable generation facilities. Regions that remain heavily regulated must also consider policy as a mechanism to favor energy efficiency and stronger renewables integration. In either case, the utility profit will remain bound to regulation, making it more important than ever for regulators to improve conditions for utilities to adapt to this quickly changing environment.

2.5 Distributed Energy and Microgrids Begin to Affect Utilities

Traditionally, electric utilities manage power generation and grid control assets. These utilities have long been granted monopoly power over local areas based on economic efficiencies and guarantees to provide non-discriminatory service. Over the past 40 years, the regulatory structure in many jurisdictions has shifted toward deregulation on varying levels to allow for differing levels of competition in sales of wholesale or retail power based upon markets led by centralized generation facilities.

More recently, the growth of DG and microgrids have disrupted utilities' remaining profit-generating grid management assets. In previous years, and especially in the United States, the vast majority of customers received energy directly from a utility distribution system. With environmental and technological drivers, more residences have deployed isolated generation resources. Similarly, recent years have seen an increase in commercial buildings and small communities that are engineered to be energy independent.

On one hand, the growth of DG resources and microgrids allows for an increased level of grid flexibility. DG also provides a level of energy security by eliminating dependence upon a single large and easily attacked generation facility. Utilities can use distributed resources for DR during peak loads (for example, after a power outage on a hot summer day) and can also act as a provider of small electric loads to the central grid. On the other hand, as seen with recent controversy over net metering and FIT policies, in aggregate these resources pose a threat to utilities' profit bases.

Policy surrounding distributed energy resources and microgrids will remain controversial while utilities maintain business models that suffer from aggregate declining demand and potential high net metering payments for individual DG sites. However, individual market drivers such as growing investment in the DG market and technological advances are likely to force utilities to adopt models that improve distributed energy management and support increased DG resources on the grid.

Ironically, large utilities in the leading global economies may have to look to the developing economies as a source for business models that support microgrids and DG resources at scale. In regions currently lacking a central grid utilities adopt flexible business and grid management models. The models that prevail will be ones that can leverage these resources to lower overall fixed costs associated with centralized generation while maintaining high reliability on the grid.

2.6 Utilities' Secret Weapon in Energy Efficiency: Conservation Voltage Reduction

Between 1991 and 2010 American utilities spent over $43 billion on electric energy efficiency (EE) measures according to the 2012 annual report from the U.S. Department of Energy (DOE) and the Energy Information Administration (EIA). The total annual average spending was $1.9 billion between 1991 and 2005. Since 2005, EE spending has grown consistently by roughly $0.5 billion per year and broke $4 billion in 2010.

Most of the EE programs at utilities are associated with demand-side management (DSM) and rebates for customers who are willing to change their energy consumption behavior. These programs are problematic for utilities because they normally require customer opt-in, which in turn normally requires that some incentive be given to each customer. For example, the most successful HEM pilots in the United States have involved giving a free smart thermostat to each customer that opts in to the program. However, CVR is different. It is a non-invasive EE program that benefits all customer classes without any change in customer behavior.

Research by the Electric Power Research Institute (EPRI), Pacific Northwest National Laboratory (PNNL), and the National Renewable Energy Laboratory (NREL) has confirmed that motors and other electrical devices work well and use less energy at lower than typically delivered voltages. Loads run most efficiently when they are served at their nameplate rating. However, research shows that most loads in the United States are served with above-optimal voltage due to antiquated distribution systems, which require higher energy inputs to ensure that the entire network remains within the mandated safety bands.

CVR dynamically optimizes voltage levels to the lower range of American National Standards Institute (ANSI)-acceptable levels in order to continuously reduce energy consumption and demand during peaks when electricity prices are inflated. Even if the voltage is only reduced a few percent, the total energy savings from all the lights, motors, and air conditioning systems can be substantial when measured across an entire distribution network. CVR can benefit a utility and their customers substantially at a relatively low cost of implementation. Even customers benefit because they pay for voltage consumed regardless of the nameplate ratings of their devices. Energizing the grid at lower voltages will result in lower energy consumption by all customer classes.

Advanced, dynamic CVR is made possible through recent improvements in sensors, communications, control algorithms, and information processing technologies that monitor voltage levels throughout the distribution system. This information is sent to devices that can adjust voltage regulating equipment and capacitor banks on distribution feeders in near real-time, enabling quick adjustments in response to constantly changing load and voltage conditions. Adjustments to individual devices and systems can also be coordinated so that voltage levels can be optimized along feeder lines.

Navigant Research studied recent smart grid investments in 100 utilities in conjunction with several reports: *Distribution Management Systems*, *Distribution Automation*, and the forthcoming *Conservation Voltage Reduction* report. Approximately 4% of U.S. distribution circuits have been modernized using stimulus funding since 2009. In this program utilities spent $1.5 billion spent on DA assets. Navigant Research concluded from interviews that about $450 million was spent on Volt/VAR (IVVC/CVR) equipment, evenly split between hardware and implementation costs.

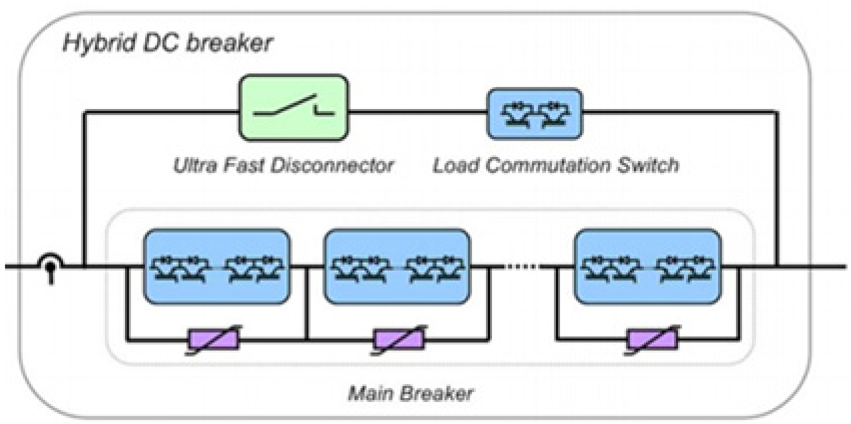
At present the largest market for CVR is in the United States where distribution networks are often energized in the higher limits of the permitted safety bands. By comparison, European grids are typically energized more efficiently, at lower points in the safety bands, reflecting both a scarcer supply of energy and a more geographically dense customer base.

2.7 Hybrid HVDC Breakers Bring Innovation and Efficiency

In late 2012, ABB unveiled a new direct current (DC) breaker, a hybrid of mechanical- and semiconductor-based switches that enables flexibility in high-voltage direct current (HVDC) topologies at high transmission efficiency. Siemens and Alstom are developing their own solutions with the same target in mind: to stop DC fault currents in 5 ms.

The currently used single-phase alternating current (AC) breakers modified to withstand DC voltages used in point-to-point HVDC systems are not fast enough to protect the multiterminal VSC sufficiently. Solid-state circuit breakers are fast but have high transfer losses. Thus, they are an inefficient solution by themselves. However, a hybrid breaker marries the speed and high breaking capacity of a large solid-state circuit breaker (main breaker) with the efficiency of a mechanical switch (ultra-fast disconnector) in series with a smaller solid-state switch (load commutation switch). Figure 2.1 depicts this concept.

Figure 2.1 Hybrid DC Breaker Concept



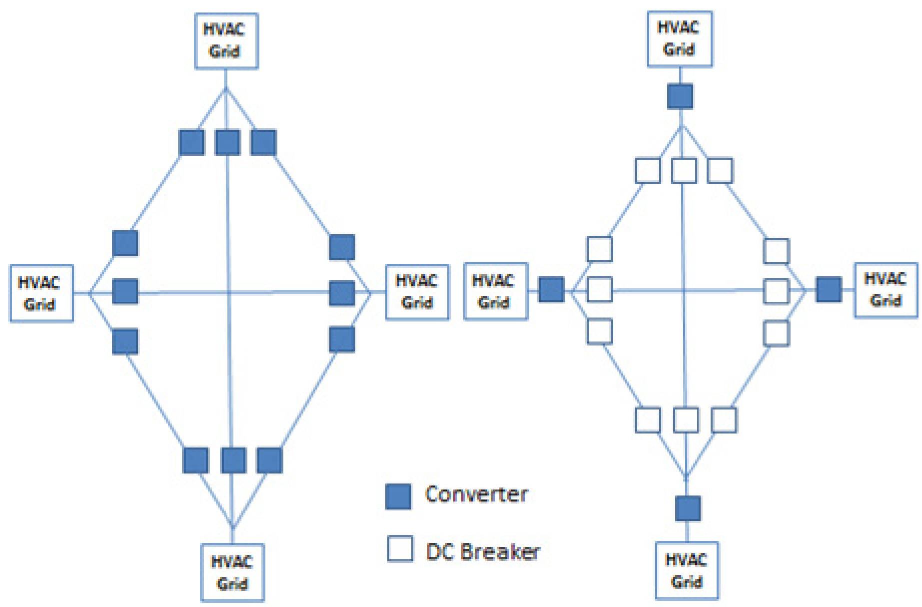
(Source: ABB)

The leg with the mechanical switch serves as a parallel bypass that allows current to flow through at low loss under normal operating conditions. When a fault is detected, the mechanical leg trips first while the fault current immediately commutates and continues to flow through the solid-state breaker for a moment before the semiconductors in the main breaker finally block the large current to clear the fault.

Hybrid HVDC circuit breakers can also be useful in multiterminal configurations, which allow for power feed-in or feed-out at different locations along the HVDC line. A feed-out terminal is the functional equivalent of a generating station of similar capacity where they are connected to the local high-voltage AC grid. Although there are only a handful of multiterminal installations, this type of operation has been proven and allows for much broader uses of HVDC beyond point-to-point transmission of bulk power and presages the potential for HVDC grid configurations.

In practice, the hybrid HVDC circuit breakers can dramatically reduce the number of converters necessary for multiterminal HVDC applications. This is illustrated in the hypothetical HVDC multiterminal grids shown in Figure 2.2.

Figure 2.2 Multiterminal Operation with and without Circuit Breakers



(Sources: Navigant Research and Institute of Electrical and Electronics Engineers)

In this case, the use of breakers would eliminate nine converter stations. In a case with a three-node grid, such as Atlantic Wind Stage 1, the number of converters would be reduced by one compared with building two point-to-point connections – a 25% reduction in converter costs. Converter stations represent a major cost element in HVDC systems, thus any reduction in converter requirements translates to substantial savings in the capital needed for an HVDC system.

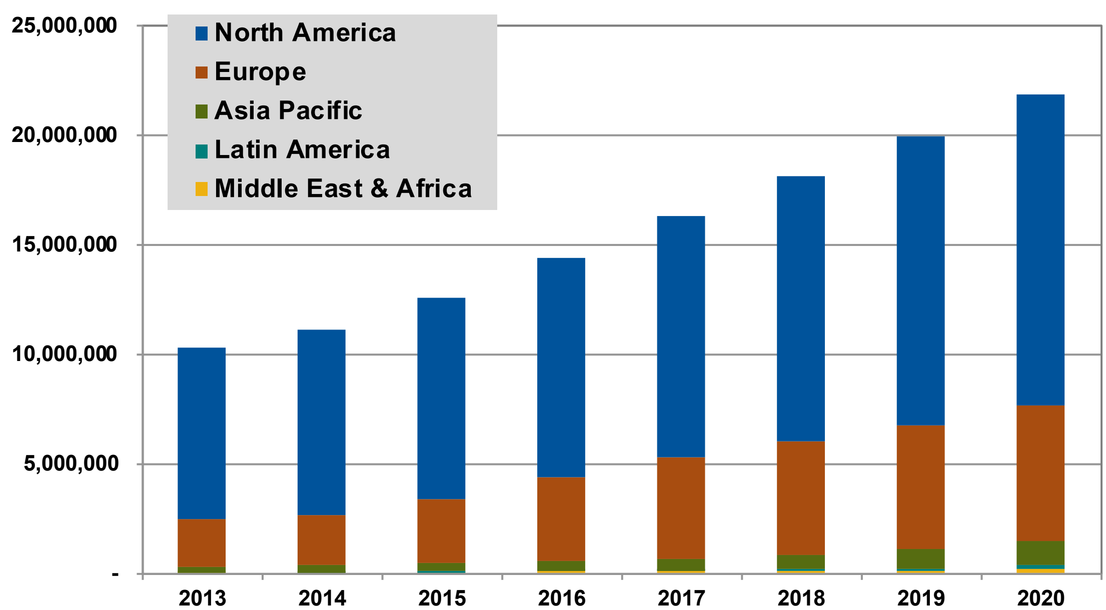
2.8 Demand Response outside North America Will Begin to Grow

The vast majority of DR takes place in North America today, but activity in Europe and Asia Pacific will grow at a faster rate over the next several years. Total load curtailment in the world from DR programs in 2013 is estimated to be 57,764 MW; North America contributes roughly 71%. By 2020, global load curtailment is expected to reach 140,472 MW at a CAGR of 13.5%.

Forecasts show strong growth for the global DR market, especially in the emerging geographies. The adoption of automated demand response (ADR) looks especially promising in Asia Pacific, which will most likely leapfrog directly to the more advanced ADR technologies as their initial DR deployments. Japan specifically is turning to DR in light of its dearth of natural resources for electricity and the halt in the nuclear industry following the Fukushima Daiichi disaster.

In Europe, governments are realizing the importance of DR to meet the European Union's (EU's) energy efficiency and carbon emissions mandates and to address the need to balance the grid to manage the integration of intermittent renewables like wind and solar power. In particular, the EU's 20-20-20 energy mandate is having a considerable impact. Furthermore, several major countries and geographic areas in Europe, including the United Kingdom, France, and Ireland, are planning to introduce a capacity market that will further increase the adoption of DR.

Chart 2.3 Total DR Sites by Region, World Markets: 2013-2020



(Source: Navigant Research)

Based upon the number of DR-enabled sites – residential and commercial and industrial (C&I) – North America has 75.8% of DR participation as of 2013; Europe follows at 21% and then Asia Pacific at 2.8%.

The North American and European DR markets are strongly influenced by the participation rate of residential households. Meanwhile, other regions have little or no residential DR involvement as of 2013. When looking solely at C&I participation, regions other than North America and Europe become more significant. This suggests that the C&I sector will continue to play the most important role for DR in the emerging markets despite an increasing number of residential DR programs in these regions. It is noteworthy that in Asia Pacific the C&I sector enjoys a much larger share in terms of DR participation than Europe. The sheer number of commercial sites in Asia Pacific is the primary reason for this development.

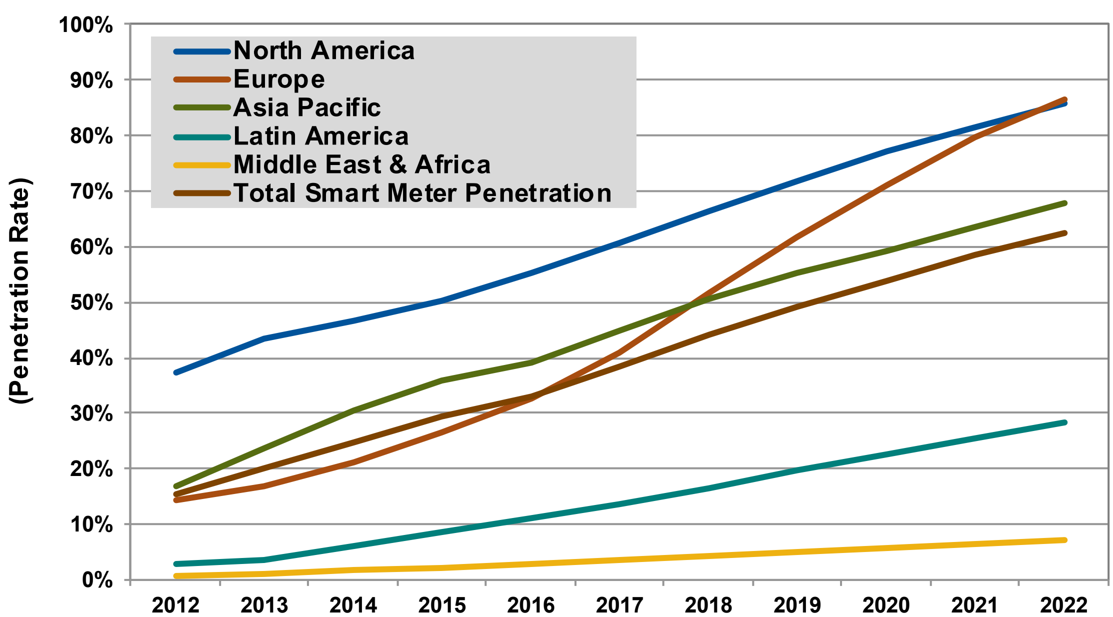
2.9 Smart Meter Market to Expand Globally

For much of the past few years, deployments of smart electric meters have taken off in North America and China, creating a frenzy of market activity and expectations of fast growth in other regions. Chinese utilities continue to deploy meters at a rapid clip as they seek to install some 300 million meters by mid-decade. However, the pace has slowed in the United States as federal stimulus money for projects has nearly run its course. For the next 10 years, the new focus for smart metering will shift to Europe where Great Britain and France are just starting major deployments that combined will amount to some 65 million devices. Japan will also be a new focus of smart meter rollouts, with Tokyo Electric Power Company (TEPCO) making plans to install 27 million smart meters.

Besides the operational benefits of smart metering for utilities, the new devices will give utilities the opportunity to offer greater customer engagement through enhanced HEM services like DR. From a networking infrastructure perspective, the steady deployment of smart meters will present public cellular providers an opportunity to leverage their assets as an alternative to proprietary solutions, particularly as cellular pricing has grown more competitive.

Deployments of smart meters will lead to a smart meter penetration rate surpassing 80% in North America by 2020. Similarly in Europe, smart meter penetration is forecast to match that level by the end of the forecast period. Driven primarily by China, the forecast penetration rate in Asia Pacific will reach nearly 70% by 2022. Latin America and the Middle East & Africa will show significantly lower smart meter penetration rates through the forecast period.

Chart 2.4 Smart Meter Penetration Rate of All Electric Meters by Region, World Markets: 2012-2022



(Source: Navigant Research)

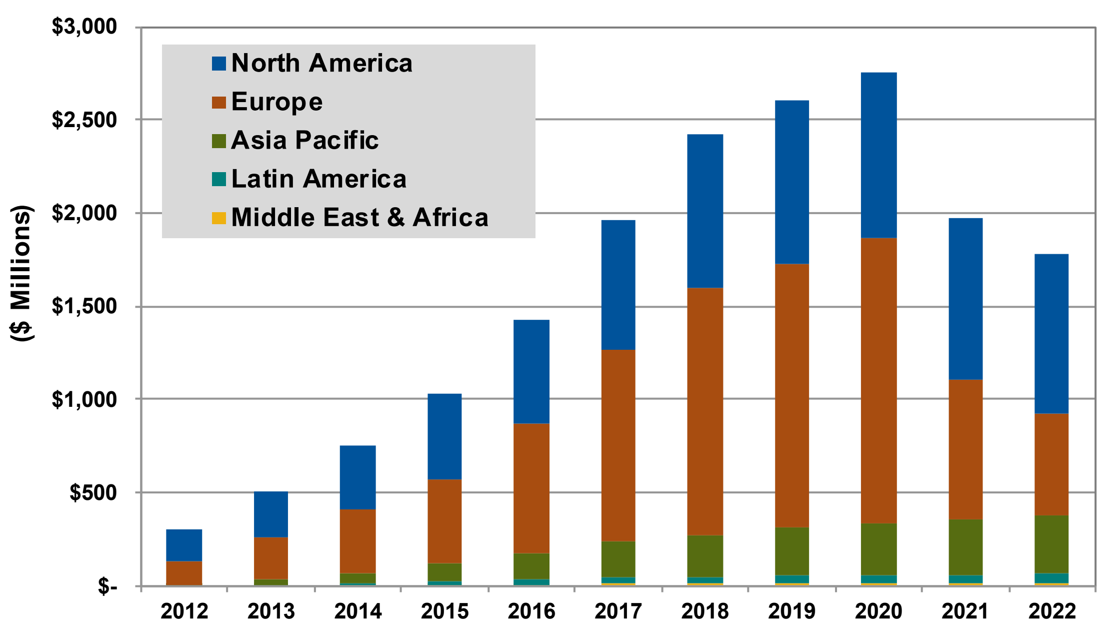
2.10 Home Energy Management Market Will See a Steady Uptick

During the next 10 years, the HEM market is likely to expand at a steady pace, as new industry participants introduce innovative products. Utilities are likely to mimic what Oklahoma Gas & Electric, NV Energy, and Baltimore Gas and Electric have begun by offering HEM products or services linked with DR programs. In Europe, Great Britain has mandated that each home receiving new smart electric and gas meters will get in-home displays (IHDs) as well, which the U.K. government hopes will drive greater consumer awareness of energy use and encourage greater efficiency.

Worldwide shipments of HEM devices (standalone systems, IHDs, and networked HEM devices) are forecast to grow at a steady rate over the next 10 years driven by consumer demand for tools to help manage consumption and new market entrants such as broadband service providers (BSPs) like Comcast and AT&T in the United States and Swisscom in Europe. After 2020, though, global shipments will fall from the peak since no other significant catalyst is foreseen.

Navigant Research expects global annual revenue attributed to HEM shipments to grow from $300.7 million in 2012 to $1.8 billion in 2022, with a CAGR of 19.5%. Revenue will peak in 2020 when the mandate to have HEM equipment installed along with smart meters in Great Britain ends.

Chart 2.5 HEM Revenue by Region, World Markets: 2012-2022



(Source: Navigant Research)

Section 3

ACRONYM AND ABBREVIATION LIST

Advanced Distribution Management System .... ADMS

Advanced Metering Infrastructure .... AMI

Alternating Current .... AC

American National Standards Institute .... ANSI

American Recovery and Reinvestment Act .... ARRA

Automated Demand Response .... ADR

Broadband Service Provider .... BSP

Carbon Dioxide .... CO_2

Commercial and Industrial .... C&I

Compound Annual Growth Rate .... CAGR

Conservation Voltage Reduction .... CVR

Customer Information System .... CIS

Demand Response Management System .... DRMS

Demand Response .... DR

Demand-Side Management .... DSM

Department of Energy (United States) .... DOE

Direct Current .... DC

Distributed Energy Resource Management System .... DERMS

Distributed Generation .... DG

Distribution Automation .... DA

Distribution Management System .... DMS

Electric Power Research Institute .... EPRI

Energy Efficiency .... EE

Energy Information Administration (United States) .... EIA

European Union .... EU

Fault Location, Isolation, and Restoration .... FLISR

Feed-in Tariff .... FIT

High-Voltage Direct Current .... HVDC

Home Energy Management .... HEM

Information Technology .... IT

In-Home Display .... IHD

Integrated Volt/VAR Control IVVC

Long Term Evolution .... LTE

Low-Voltage LV

Medium-Voltage .... MV

Megawatt .... MW

Millisecond .... ms

National Renewable Energy Laboratory .... NREL

Operational Technology .... OT

Outage Management System .... OMS

Pacific Northwest National Laboratory .... PNNL

Power Factor .... PF

Return on Investment .... ROI

Tokyo Electric Power Company .... TEPCO

Total Harmonic Distortion .... THD

United Kingdom .... U.K.

United States .... U.S.

Volt-Ampere Reactive .... VAR

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SCOPE OF STUDY

Navigant Research has prepared this white paper to provide current and interested stakeholders in the smart utilities market, including technology companies, service providers, utilities, investors, and policymakers, with an overview of 10 key trends that will affect the smart utilities market during 2014 and beyond. Navigant Research segments the smart utilities market into five key application areas: transmission upgrades, substation automation, distribution automation, information and operations technology, and smart metering. The major objective of this white paper is to provide an understanding of some of the key market developments and movements that are likely to occur during 2014 and beyond. Note that this white paper does not intend to offer an exhaustive assessment of smart utilities trends and their impacts. Navigant Research will provide comprehensive analyses in more in-depth reports during 2014.

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:

CAGR = (End Year Value ÷ Start Year Value)$^{(1/steps)}$ – 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 2013 U.S. dollars unless otherwise noted. Percentages may not add up to 100 due to rounding.

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1320 Pearl Street, Suite 300
Boulder, CO 80302 USA
Tel: +1.303.997.7609
http://www.navigantresearch.com