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HARNESSING DEMAND SIDE RESOURCES IN ELECTRICITY MARKETS

EVIDENCE FROM THE UNITED STATES

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Summary

> There is evidence from the United States that demand side resources can be both a reliable and cost competitive alternative to generation capacity.

> The use of these resources also offers the potential to avoid significant volumes of electricity demand in the future as well as opportunities for new business models and products that will benefit consumers.

> Top down mandates and support from federal and state legislation, regulatory reform and public funding have been critical in driving forward the demand side of the electricity market.

> Barriers remain and electricity market rules still favour conventional supply. But deeper reform efforts are underway in New York and elsewhere with the intention of capturing the full potential of demand side resources.

Introduction

The European Union has recognised that there is an urgent need to make better use of demand side resources in order to cost-effectively and reliably deliver decarbonisation of the power sector. Demand side resources in this case refer to demand reduction (or energy efficiency), demand response, and distributed generation.

There is evidence from the US that demand side resources can be both a reliable and cost competitive alternative to generation capacity, and offer the potential to avoid a significant volume of electricity demand in the future.

It is clear that the application of state and federal targets and policies, efforts to develop interoperability standards and federal stimulus funding from the American Recovery and Reinvestment Act (ARRA) have been essential in allowing the demand side to participate on equal footing with supply.

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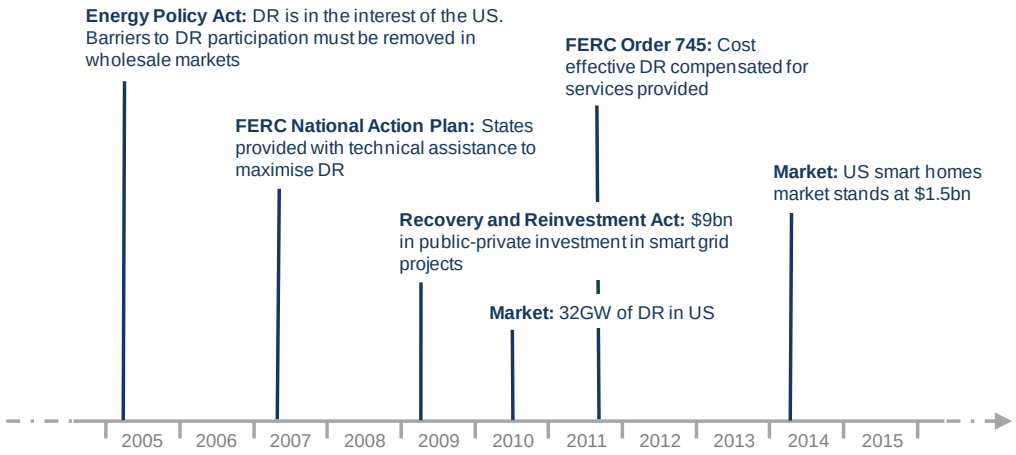
The drivers behind demand side resources in the US

The use of demand side resources in the US is driven by a diverse mix of factors including federal policy guidance and stimulus funding, state level regulation, technological innovation, the changing economics of the utility industry, and the impact of extreme weather events.

Federal policy and guidance: The Energy Policy Act of 2005 made clear that demand response was in the policy interest of the US and encouraged the removal of barriers to demand response participation in organized wholesale energy markets.[1]

The Federal Energy Regulatory Commission (FERC), which is responsible for regulating all inter-state wholesale electricity markets in the US, released Order 745 in 2011 mandating that when dispatch of demand response is capable of system balancing and is cost effective, the resource must be compensated for the service it provides to the energy market.[2] The Energy Independence and Security Act of 2007 also directed the FERC to develop a National Action Plan that provides technical assistance to states to allow them to maximise demand response, a national communications programme that includes customer education and support, and analytical tools and other support materials for use by customers, states, utilities and DR providers.[3]

Figure 1: Federal policies in favour of Demand Response – An early start



Source: Various

The deployment of smart grid technologies was a significant part of the American Recovery and Reinvestment Act (ARRA) of 2009, the $831bn economic stimulus package that was launched as a response to the economic and financial crisis. Under the ARRA roughly $9bn in public-private investment in smart grid projects has been committed through 2015 including in Advanced Metering Infrastructure (AMI), sensing, communications, and control technologies with field devices in distribution systems, and advanced sensors and high-speed

[1] http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/NCEP_Demand_Response_1208.pdf

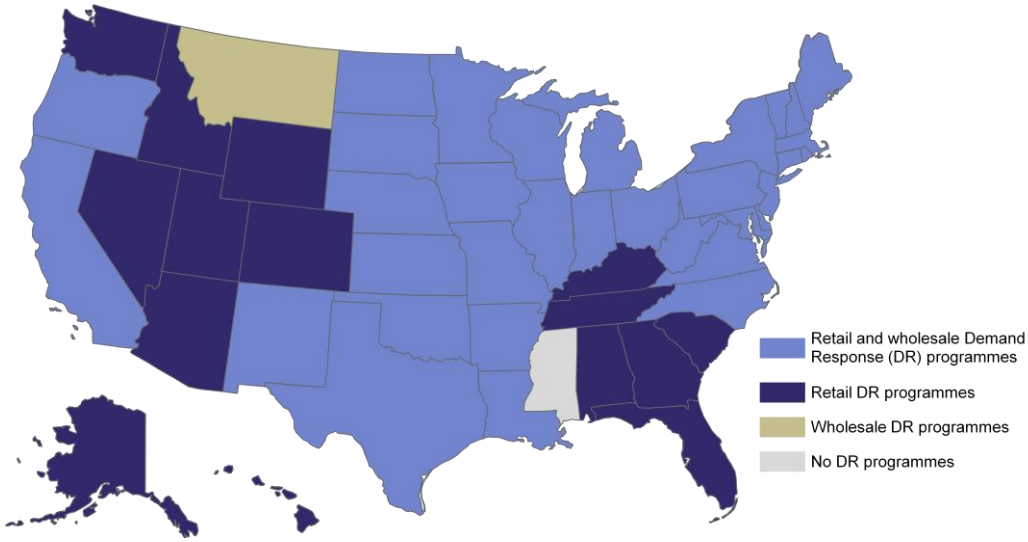
[2] FERC had already passed an Order (719) to allow for participation of demand response resources in RTO and ISO ancillary service markets and had also approved tariffs for RTOs and ISOs that included provisions regarding participation of demand response resources in their capacity markets

[3] http://www.ferc.gov/legal/staff-reports/06-17-10-demand-response.pdf

communications networks on transmission systems. The Energy Independence and Security Act of 2007 also included government-led initiatives for smart grid investments, such as coordinated research, development, demonstration, and information outreach efforts.[4]

State level polices: Many states have also recognised the importance of demand side resources in delivering least-cost electricity as well as in meeting environmental goals (See Figure 2). More than half of US states have binding energy savings targets, known as Energy Efficiency Resource Standards (EERS). Some states also have targets for the deployment of cost-effective demand response programmes to achieve a reduction in their peak energy demand.[5]

Figure 2: Demand response programmes in the US



Source: Institute for Building Efficiency[6], E3G

Technology Innovation: Smart devices and Home Automation Systems (HAS): The 'smart homes' market has developed steadily over the past 10 years and now stands at $1.5bn in the US. It involves the sale of Home Automation Systems (HASs) with a variety of connected products and services. These include Home Energy Management Systems (HEMS). The HAS can be physically installed in the home or involve the communication of data to cloud-based systems. Forecasts suggest this market will grow at a CAGR of 38% over the period 2015-2019[7] and will be worth over $4 billion by 2017 (see Figure 3).[8]

Initial developments in HEMS were driven by IT companies such as Google and Microsoft that were particularly focused on using smart products to enable energy consumers to reduce their energy costs by providing detailed analysis and advice based on their consumption data. In

[4] https://www.smartgrid.gov/federal_initiatives/legislation

[5] http://www.institutebe.com/smart-grid-smart-building/demand-response-us.aspx

[6] http://www.institutebe.com/smart-grid-smart-building/demand-response-us.aspx

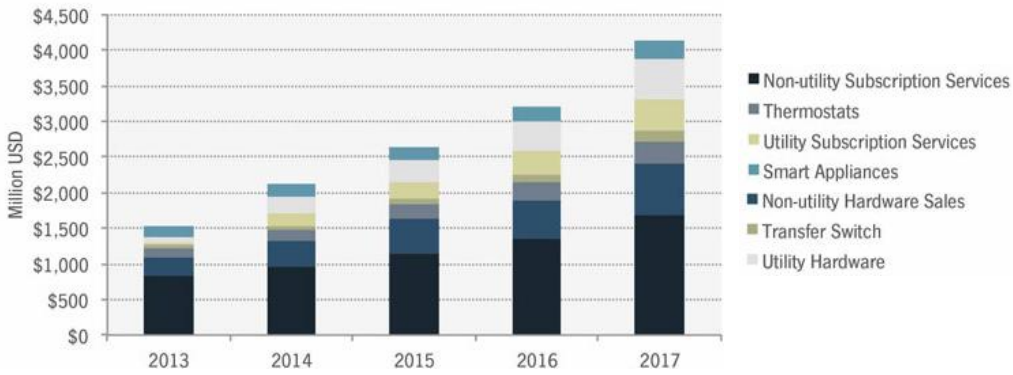
[7] http://finance.yahoo.com/news/united-states-smart-home-m2m-145818756.html;_ylt=AwrBT9fXpkNVrGIATbdXNyoA;_ylu=X3oDMTEzZ2loaXV1BGNvbG8DYmYxBHBvcwM5BHZ0aWQDVklQNjIwXzEEc2VjA3Ny

[8] http://www.greentechmedia.com/articles/read/home-energy-management-systems-market-to-surpass-4-billion-in-the-us-by-201

one recent and significant market development Google acquired NEST for $3.2bn. Rather than developing a broad-based system, the NEST strategy involved concentrating on a single device, the smart thermostat and associated operating platform, and focusing on ensuring it is a product that is attractive to customers. This device could then be used as the basis for selling other smart products - Google is now planning to use the device as a hub for a HEM that integrates all the various applications. The NEST strategy has shown some success – it now sells 50,000 units a month including through utility programmes.

Utility companies have not been at the heart of the development of the smart home market and non-hardware solutions for reducing energy demand, such as the information services provided by Opower, have often proved more attractive than IT-based solutions. Where utilities have developed their own HEMS approach, it has largely been focused on delivering household demand response and the largest programmes exist in regulated energy markets where the additional spend can be justified under the regulatory agreement. Although there was initially some concern on the part of utilities over partnering with other companies, given the potential to lose ownership of the customer relationship, utilities are increasingly willing to leverage existing HASs to provide demand response services – particularly through controlling heating and cooling load. One of the US's largest utilities, Southern Co., recently announced it plans to offer roughly 10,000 Nest thermostats to customers willing to adopt time-of-use rates.[9] By introducing a new set of competitors, HASs have forced utilities to re-evaluate their business model and nature of their customer relationships.

Figure 3: Growth in the US smart homes market – Home Energy Management Systems total market forecast 2015-17



Source: GTM research

Renewables and the changing economics of the utility industry: In recent years renewables have become increasingly cost-competitive with conventional generation technologies.[10] The price of wind and solar PV has dropped over 58% since 2010[11] and 18 GW of renewables are expected to be built in the US in 2015 alone – higher than the previous record of 17.1 GW in 2012.[12] Solar is the fastest-growing renewable generation source, with total capacity having

[9] http://www.eenews.net/energywire/stories/1060019211/search?keyword=southern+co

[10] http://www.lazard.com/PDF/Levelized%20Cost%20of%20Energy%20-%20Version%208.0.pdf

[11] http://www.lazard.com/PDF/Levelized%20Cost%20of%20Energy%20-%20Version%208.0.pdf

[12] BNEF (2015) Medium-term outlook for US power http://about.bnef.com/content/uploads/sites/4/2015/04/BNEF_2015-02_AMER_US-Power-Fleet-De-Carbonisation-WP.pdf

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grown by 30 percent in 2014.[13] Distributed solar power combined with battery storage is likely to be cheaper than grid connected power within one or two decades at least in parts of the US.[14] These developments are another challenge to the traditional utility business model and demand major market reform, including the use of demand response which could reduce the cost of integrating renewables into the electricity system.

Climate impacts: The increasing incidence and cost from weather-related disasters in the US has also led to growing interest in investments that will improve the reliability and resilience of the electricity grid. The $65bn in damages caused by Hurricane Sandy was one of the factors that prompted New York to launch its Reforming the Energy Vision (REV) process, arguably the most extensive electricity market reform effort underway which will prioritise efficiency, demand response and distributed generation.[15]

Demand response – Mature markets for large consumers and growth in residential programmes

'Demand resources have reduced system peak demand by as much as 10-12%'

A number of Regional Transmission Operators (RTOs) and Independent System Operators (ISOs) are responsible for operating wholesale electricity markets in Northeast and Midwestern states and regions.[16] In many of these markets utilities and third party demand "aggregators" are able to bid demand side resources into energy markets, capacity markets and in some cases as ancillary services. Annual forward capacity market auctions account for the highest share of revenue for demand resources, which have reduced system peak demand by as much as 10-12%.

'Demand response provides net availability in the high 90%s'

Experience from these RTO and ISO markets shows that demand side resources are as reliable as and cheaper than conventional supply side resources. Data from the US ISOs suggests that the net availability of demand response is actually in the high 90%s which represents far superior performance than that provided by generation.[17] In the PJM ISO demand-side resources have been credited with reducing the unit clearing price from $178.78 to $16.46 in unconstrained zones — a savings of $162.32/MW- day.[18] Demand response resources made significant contributions to system balancing during extreme weather events in 2013 and 2014 including up to 2500 MW of demand response on several extremely cold days in January 2014 in the PJM ISO.[19]

FERC Orders and state policies have been essential in driving the use of demand response in ISO/RTO markets, as has the fact that DR services generally have short-duration curtailment periods. Crucially, in ISO markets where demand response has been most successful, third party aggregators are allowed to bid directly into forward auctions. In other markets

[13] http://www.eenews.net/greenwire/2015/05/27/stories/1060019172

[14] Rocky Mountain Institute (2014) The Economics of Grid Defection: When and Where Distributed Solar Generation Plus Storage Competes with Traditional Utility Service.

[15] http://www.greentechmedia.com/articles/read/winds-of-change-hurricane-sandy-is-ushering-in-a-smarter-power-system

[16] ISOs and RTOs are responsible for ensuring equitable and reliable access to the transmission grid and for promoting fair transmission pricing.

[17] PJM Demand Response Monthly Activity Reports. Available at: http://www.pjm.com/markets-and-operations/demand-response.aspx

[18] Meg Gottstein and Lisa Schwartz. The Role of Forward Capacity Markets in Increasing Demand-Side and Other Low-carbon Resources: Experience and Prospects. Regulatory Assistance Project. May 2010.

[19] FERC (2014) http://www.ferc.gov/legal/staff-reports/2014/demand-response.pdf

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'Smart meters will be installed for more than a third of electricity consumers by 2015'

aggregators must enter into bilateral contracts with utilities, which has limited the potential of demand response as a resource.

Commercial and industrial customers along with wholesale purchasers comprise most of the load enrolled in wholesale programmes. However the deployment of Advanced Metering Infrastructure (AMI) or "smart meters" in recent years has brought with it increased use of dynamic pricing, with many utilities now offering at least one dynamic pricing option to residential and small commercial customers.[20] An estimated 65 million smart meters will be installed nationwide by 2015, accounting for more than a third of electricity customers. AMI investments have been driven largely by state legislative and regulatory requirements for AMI, ARRA funding, and by specific cost recovery mechanisms in certain regions.[21] It is difficult to assess the results of pilot projects given they follow a wide variety of approaches. But evidence suggests that residential customers do reduce consumption when electricity prices are high.[22]

Demand reduction (Energy Efficiency) – Standards and mandates are driving reductions in energy use

'More than half the states have binding energy savings targets (EERS)'

Twenty-six states have enacted binding Energy Efficiency Resource Standards (EERS)[23] – covering 62% of electricity sales in the US. Achieving these targets to 2020 would yield savings equivalent to over 6.3% of 2011 electricity sales nationwide.[24] In 2013, states with an EERS achieved incremental electricity savings of 1.1% of retail sales on average, compared to average savings of 0.3% in states without an EERS.[25] Most states with an EERS have met or surpassed their targets: savings of 18 million MWh of electricity were planned in 2012 while savings of over 20 million MWh was achieved.[26] Studies show that energy efficiency resources are acquired on average at about one-half the cost of the typical new power sources.[27]

There are also other types of utility efficiency policies in place including mandates that utilities must pursue all cost effective efficiency resources. These regulations are projected to increase spending on electric and gas efficiency programmes from $4.8bn in 2010 to $9.5bn in 2025 and would likely offset the majority of load growth in retail electricity sales in that time period. Success with efficiency programmes has been the result of state building energy codes, a national efficiency labelling programme (ENERGY STAR®), and tax credits. Most states have also implemented Integrated Resource Planning (IRP) which requires utilities to adopt long term plans that assess a broad range of resource options, including specified levels of energy efficiency resource acquisition.

[20] MIT (2014) http://mitei.mit.edu/system/files/Electric_Grid_7_Engaging_Electricity_Demand.pdf

[21] http://www.energy.gov/sites/prod/files/2014/08/f18/SmartGrid-SystemReport2014.pdf

[22] MIT (2014) http://mitei.mit.edu/system/files/Electric_Grid_7_Engaging_Electricity_Demand.pdf

[23] An Energy Efficiency Resource Standard (EERS) is an energy savings targets for utilities, often with flexibility to achieve them through a market-based trading system or a buyout-option to purchase credits at a default price.

[24] http://aceee.org/files/pdf/policy-brief/eers-07-2014.pdf

[25] http://aceee.org/sites/default/files/eers-04072015.pdf

[26] http://aceee.org/research-report/u1403

[27] http://www.epa.gov/cleanenergy/documents/suca/napee_chap6.pdf

Smart grid deployment – stimulus funding has led to significant improvements in the grid

The electricity industry spent approximately $18bn on smart grid technology from 2010 through 2013.[28] Smart grid investments under the ARRA accounted for about half of this total—around $8 billion.[29]

This funding has been critical for demonstration projects that can help evaluate a suite of technology options on a cost basis. Many utilities have launched small scale test and pilot projects but there are also some examples of larger-scale smart grid deployment. Projects that have received funding are required to evaluate and report on progress and lessons learned. Progress reports show important gains have been made, including:

> cost savings from the deployment of smart meters of between 13 and 77%;

> peak demand reductions that can exceed 30% depending on the rate design and type of customer system being used;

> deployment of automated feeder switches and supporting sensors, communications equipment, and control systems is showing reliability improvements that include shorter (up to 56%) and less frequent (11%–49%) outage.[30]

Barriers to demand side participation

The regulatory framework in the US still focuses predominantly on cost-of-service recovery, leading to an inherent bias in favour of traditional supply side resources. Public Utility Commissions (PUCs) have, to varying degrees, instituted reforms intended to yield non-traditional grid investments but regulated utilities remain highly risk averse.

In addition, the US Court of Appeals recently ruled that demand response is a retail product and as such is exclusively within the states' jurisdiction to regulate, effectively overturning FERC Order 745 which mandated compensation for demand side resources. Following the ruling, participants in the PJM capacity market filed a complaint requesting that all portions of a tariff allowing PJM to include demand response as suppliers in its capacity market be removed (the capacity market accounts for more revenue than does participation from wholesale energy markets).[31] The case will soon be taken up by the Supreme Court.

Home Automation and Home Energy Management Systems are also still relatively immature, and there is a lack of customer awareness of the availability and benefits of these systems.

Reform efforts underway

Several state ISO markets have launched reform programmes that are designed to increase the use of demand response. Legislation has been introduced in Texas that would require state regulators to promote the development of demand response participation in electricity

[28] Bloomberg New Energy Finance (BNEF) 2014

[29] Department of Energy (DOE) 2014. http://energy.gov/oe/technology-development/smart-grid/recovery-act-smart-grid-investment-grants

[30] https://www.smartgrid.gov/sites/default/files/doc/files/SGIG_progress_report_2013.pdf

[31] http://www.jdsupra.com/legalnews/federal-appeals-court-vacates-ferc-order-29752/

markets and to remove regulatory barriers to provide reliability and economic benefits to the grid. After years of failing to meet its targets for penetration of demand response, California has recently passed legislation to open markets to third party aggregators.

One of the most ambitious efforts underway is New York's REV. The New York Public Service Commission proposed to transform New York's electric industry to "make energy efficiency and other distributed resources a primary tool in the planning and operation of an interconnected modernized power grid." Under this plan existing utilities will run distributed system platforms to manage bids from distributed energy providers (rather than create a new independent DSP institution). The REV is following two tracks: 1) examine the role of distribution utilities in enabling market-based deployment of distributed energy resources; 2) examine changes in current regulatory, tariff, and market designs and incentive structures to better align utility interests with achieving the Commission's policy objectives. It is too early to draw many conclusions but the REV proposal represents a significant attempt to remove barriers and prioritise the demand side of the market.

Conclusion

US electricity markets can serve as a useful example of the potential for accessing demand side resources. The capacity markets in the Northeast and Midwest ISOs in particular represent a critical measure in the context of stimulating demand side resources, and have proven that demand response can serve as a reliable and cost effective alternative to supply. Where the demand side of the market has been successfully accessed, national and state level policies and stimulus funding has been essential in removing barriers.

However, the US has also suffered from a fragmented regulatory environment and, more recently, challenges to federal policies on demand response. Some states that have shown impressive political commitment have struggled to meet targets for demand response, suggesting that deeper regulatory reform is necessary. These and other barriers have meant that the full potential value of the demand side of the market is not captured by existing frameworks. Currently most of the value of demand response for example is measured in avoided generation, while stability and ancillary services at the distribution level is not always compensated.

Several states have launched reform initiatives which may provide additional valuable lessons for the European Union, including New York's REV which appears to be the most extensive attempt to provide political commitment towards ensuring that demand can compete on a level playing field with supply.

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