JAPAN'S APPROACH TO DEMAND-SIDE MANAGEMENT

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CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

SECTION 1. EXECUTIVE SUMMARY

The events of the 11 March 2011 Great East Japan Earthquake and subsequent Tsunami, unveiled structural flaws in Japan's power sector. Since the tragic natural disaster, Japan has undertaken a significant restructuring of the power sector with greater emphasis on demand side-management. This report examines changes made and progress thus far.

- As Japan's economy rapidly grew from 1950 onward, the power sector – built on a vertically integrated regional monopoly model – also rapidly expanded to meet the country's increasing demand. The power sector achieved high levels of reliability and quality. However, despite partial market reforms, the market structure remained in favour of incumbents who pursued a strategy of self-sufficiency resulting in over-investment in generation capacity, and under-investment in inter-regional transmission links as well as demand-side management.
- The 11 March 2011 unveiled three structural flaws: 1) lack of smart meters prevented targeted blackouts in the immediate aftermath, 2) lack of real-time consumption data limited the ability of the residential and smaller business sectors to contribute to demand reduction when needed and 3) little inter-regional transmission capacity limited the ability to transfer power from regions with excess generation capacity to regions with the most demand.
- To address the aforementioned challenges, the government undertook three steps: 1) it began providing grants and subsidies for demand-side management technologies such as home energy management systems (HEMS) and building energy management systems (BEMS), 2) it reached an agreement with the utilities to rapidly conduct competitive tenders to deploy smart meters with standardised direct communication functionality for consumers, 3) it launched an extensive electricity market reform process.
- The subsidy and grant programmes for HEMS have been very successful leading to over 200,000 units installed in two years under the subsidy programme. Housing developers have started bundling HEMS with their standard offerings to gain a competitive advantage. Together with offerings from ICT service providers, the HEMS market has now become sustainable without subsidies. The BEMS programme was not as successful as the HEMS programme, and achieved less than 10% of its initial target of 65,000 buildings.
- The new smart metering roadmap is already well on its way to being implemented. All the utilities have issued competitive tenders. They have also committed to inclusion of a communication module to enable direct consumer access to the smart meter using a standardised application interface based on ECHONET Lite, an IP-based communication interface standard pending certification by IEC. Smart meters will be read every one hour for low voltage customers and every 30min for high-voltage customers. If the consumer switches retailers, the local vertically integrated utility owning the advanced metering infrastructure (AMI) is required to provide access to the AMI data at the same rate to the other retailer.
- Legislation for the two components of electricity market reform – full deregulation of the electricity market and establishment of a national system operator – has already been carried out leading to greater competition among electricity retailers and emergence of new partnerships focused on demand-side management as a competitive differentiating feature. The final step of electricity market reform – unbundling of the vertically integrated utilities – is set to be considered by the Diet, Japan's parliament in Q1 2015.
- Overall Japan has achieved a remarkable investment in demand-side management in a short period. Early signs have been promising, but how far demand-side management will contribute to Japan's energy mix remains dependent on future policies.

SECTION 2. INTRODUCTION

2.1. JAPAN'S CURRENT ELECTRICITY SYSTEM

Table 1: Japan's pre-2011 electricity structure

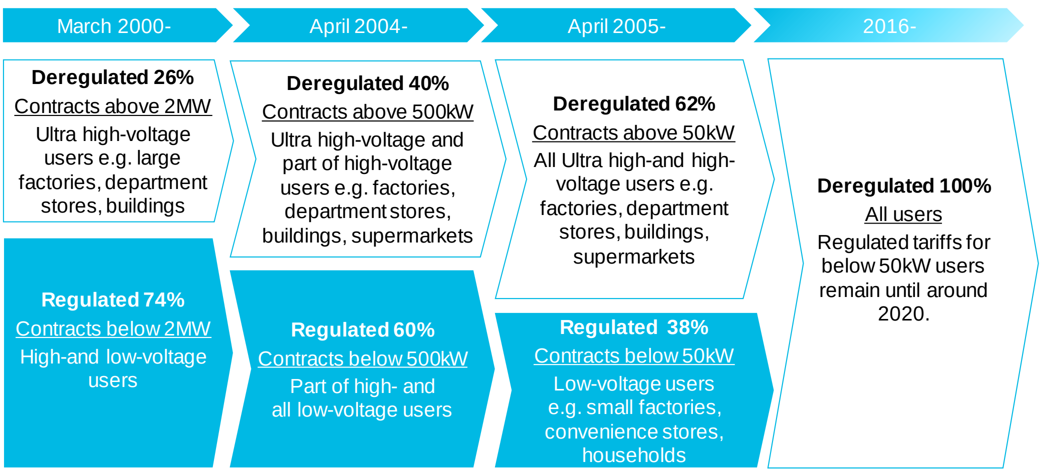
Feature	Type
Electricity rate	Cost based calculation for regulated portion (<50kW)
National system operator	None, ESCJ sets overall rules
Independent regulator	None, METI has overall responsibility
Operating frequency	East: 50Hz West: 60Hz
Retail market structure	Below 50kW limited to regulated regional monopoly
Supply source	Each utility aims for self-sufficiency
Utility structure	Primary vertically integrated

Source: Bloomberg New Energy Finance

The fundamental structure of Japan's current electric power industry was formed in 1951, when nine vertically-integrated electric utilities – referred to as general electricity utility (GEU) – were established[1]. The firms were structured to sell electricity as regional monopolies in their designated areas (Figure 2). Separately, public and private power producers were formed to generate and sell power solely to those regional monopolies. Retail prices were regulated by the Electricity Business Act under supervision of the Ministry of Economy Trade and Industry (METI). This structure enabled stable electricity supply but led to higher power prices than in other developed countries. Concerned over the international competitiveness of Japanese industries, the national government in 1995 initiated partial deregulation.

The 1995 change paved entry to the wholesale generation market for new players. This allowed the GEUs to purchase electricity not only from the wholesale electricity providers but also from independent power producers (IPP) through public tenders. In 2000 (Figure 1), the retail market for industrial facilities and commercial buildings was liberalised leading to a new class of retailers (Table 2).referred to as power producer and supplier (PPS). Three years later brought the creation of Japan Electric Power Exchange (JEPX), a wholesale electricity trading platform. JEPX provides spot and forward trading opportunities for all utilities. Subsequently in 2004, the Electric Power System Council of Japan (ESCJ) was formed as the rule making body for the grid. While transmission and distribution assets remain properties of the vertically integrated utilities, they follow rules set by ESCJ, whose members include representatives from each type of utility company (Table 2) and academia. ESCJ sets rules for development, access, and operation of the grid, and resolves disputes that arise. Prior to the reforms of 1990s, the GEUs had virtual monopolies over specific regions (Figure 2). As a result the GEUs favoured a strategy of self-sufficiency leading to greater emphasis on investment in their own generation assets as opposed to inter-regional transmission links (Figure 3). The limited inter-regional transmission capacity is one of the flaws that became apparent on 11 March 2011.

Figure 1: Japan's deregulation history of electricity retail market



Source: Bloomberg New Energy Finance

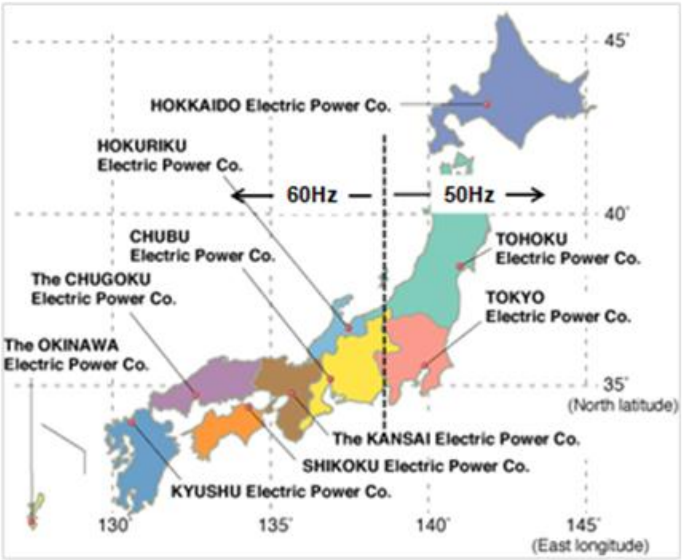
[1] The tenth vertically integrated utility, Okinawa Electric was established in 1972.

Table 2: Summary of Japan's power industry players

Category	Generation	T&D	Retail	Description
General electricity utilities (GEU)	✓	✓	✓	10 vertically integrated utilities originally formed as regional monopolies
Wholesale electricity utilities (WEU)	✓	✓		Two large wholesalers with minimum 2GW of power generation capacity: J-Power, Japan Atomic Power Co.
Specified-scale electricity utilities called "Power Producer and Supplier" (PPS)			✓	New entrant after deregulation in 2000. Some companies own generation capacity. Examples include: Ennet and Summit Energy
Specified electricity utilities	✓	✓	✓	Entities that generate and sell power in a specified areas; consist less than 1% of power demand and supply. Examples include: JR East, JFE Steel
Wholesale suppliers	✓			Municipality-owned hydro and independent power producers. Examples include: Kimitsu Cooperative,

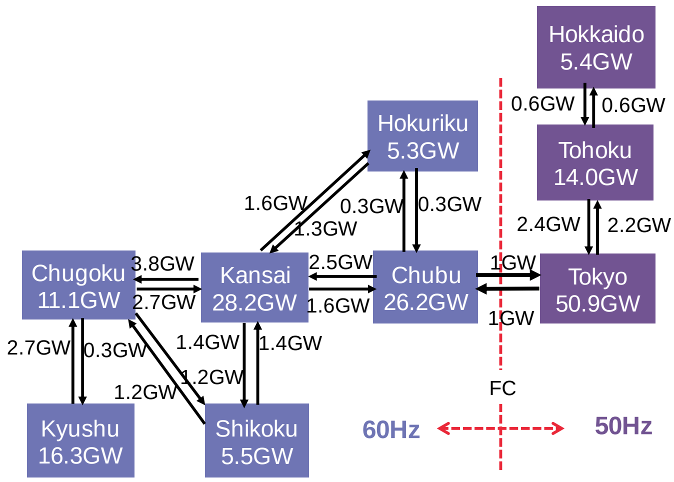
Source: Bloomberg New Energy Finance. Note: T&D stands for transmission and distribution

Figure 2: Map of Japan's electric utilities by service area



Source: The Federation of Electric Power Companies of Japan

Figure 3: Peak demand in each service territory and inter-utility transmission capacity, FY2013



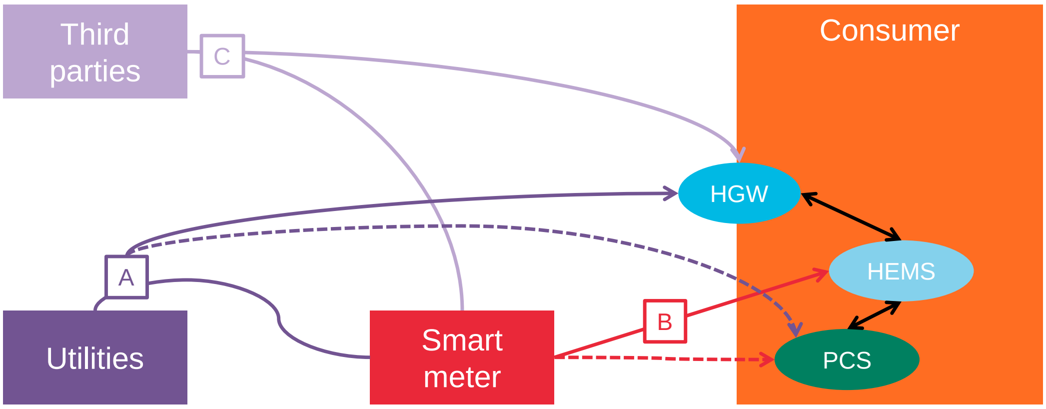
Source: Electric Power System Council of Japan

2.2. SMART GRID PLANS PRIOR TO 11 MARCH 2011

Before 2011, Japan prided itself on the performance and reliability of its electricity system. The momentum for smart grid in Japan was focused on launching smart community demonstration projects to develop technologies primarily for export. In 2010, spearheaded by METI's energy R&D agency, NEDO, four large scale smart community projects were launched with a combined proposed budget of JPY 126bn for four years to be funded via public-private partnership. Concurrently, Japan Smart Community Alliance was set up in April 2010 as a public-private partnership to foster collaboration towards development of smart grid related technologies.

While US and European utilities had already started deployment of smart meters, Japanese utilities - with the exception of Kansai Electric – were only conducting limited demonstration experiments. In May 2010, METI launched an advisory committee with stakeholders representing both electric and gas utilities, as well as consumer appliance manufacturers, ICT players, and academia to come up with a roadmap for smart meter deployment.

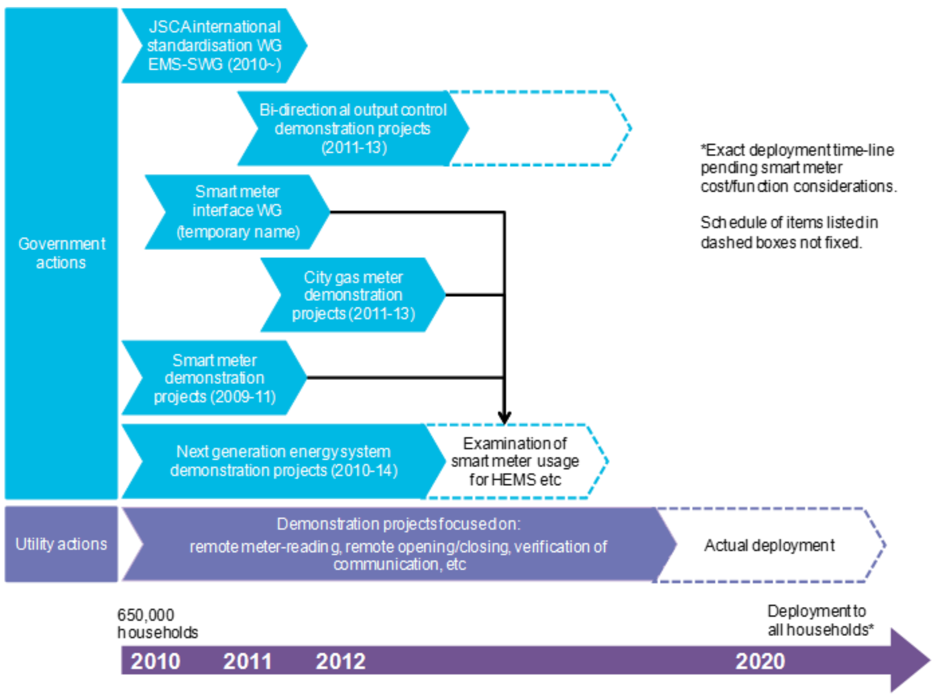
Figure 4: Smart meter communication routes



Source: METI. Note: HGW: home gateway. PCS: power conditioning system.

During the smart meter advisory committee meetings, the most contentious issue was communication routes with the smart meter as shown in Figure 4. Route A, requires all communication with the smart meter to be processed by the utilities. Route B allows the consumer to interact directly with the smart meter. In route C a third party is the intermediately between the smart meter and applications at the consumer end. The GEUs heavily favoured route A and did not want inclusion of requirements for route B and C. The electric utilities tried to formulate their preference for route A on the basis of cost and data security. In the end, the advisory committee did not make a specific requirement on the communication route. In its final meeting on 17 February 2011, a roadmap was adopted that tied smart meter deployment timeline to distributed solar PV goals at that time as shown in Figure 6.

Figure 5: Japan's pre 11 March 2011 smart metering roll out plan



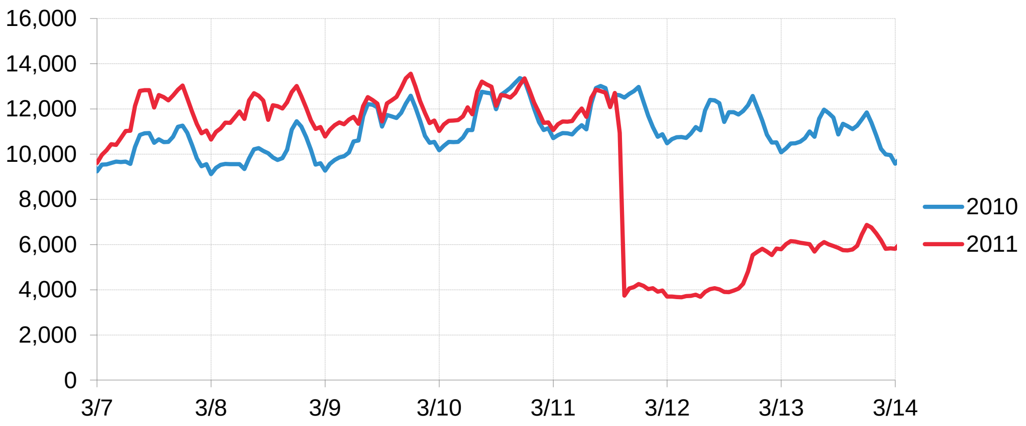
Source: METI. Note: EMS stands for energy management system. WG stands for working group

2.3. IMPACT OF THE GREAT EAST EARTHQUAKE AND TSUNAMI

Immediate impact

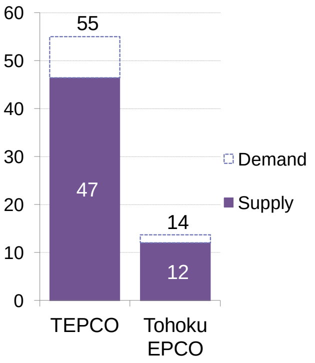
On 11 March 2011 as the tsunami waters receded back to the Pacific Ocean, Japan's largest utility, Tokyo Electric Power Company (TEPCO) was left with a generation capacity of 31GW against an expected peak demand of 50GW. Tohoku EPCO, the utility whose service area included the epicentre of the disaster went from balancing 11GW of demand to 4GW in mere moments (Figure 6). For Tohoku EPCO as its generation assets and customers are both in the Tohoku region, the disaster resulted in reduction of both supply and demand. As the utility gradually restored its T&D network, it was able to restore supply capacity in line with demand, and managed to maintain grid stability without the need to resort to rolling black outs.

Figure 6: Tohoku electric's daily demand 7-14 March 2010 vs 2011 (MW)



Source: Tohoku Electric

Figure 7: Summer forecast as of April 2011



Source: TEPCO, Tohoku Electric

TEPCO's customer-base is out of the direct impact area; however it maintains generation and associated transmission lines in the Tohoku region directly affected. TEPCO had sufficient supply capacity to meet weekend demand right after the disaster, but had to institute rolling black outs from the following Monday. While excess generation capacity was available elsewhere in Japan, differences in frequencies in the Eastern region and Western region as well as limited inter-regional transmission capacity (Figure 3) limited the amount of transferable power. The apparent lack of inter-regional transmission capacity in turn became one of the primary drivers for another round of electricity market reform.

Summer 2011

While TEPCO initially forecasted an extensive month-long rolling black out program, it only conducted rolling black outs for 10 days in a limited region of its service area. TEPCO's initial grim forecast was partly due to poor data on demand as the utility did not have any smart meters for customers below 50kW that could provide reliable data on consumption patterns. The public response to reduce electricity consumption and TEPCO's faster than anticipated pace of supply restoration also helped in shortening the blackout period. However by mid-April, TEPCO and Tohoku EPCO realised they could not supply enough electricity to meet summer demand. TEPCO's and Tohoku EPCO forecasts for the summer supply-demand gap was 8GW and 2GW respectively ie, exceeding expected supplies by 17% each (Figure 7).

Table 3: Mandated demand reduction program

Category	Description
Customer type	500kW or higher
Reduction requirement	15% relative to 2010 level
Period	Weekdays 9:00-20:00
Start date	1 July
End date	Tohoku: 9 September TEPCO: 22 September
Violation penalty	Up to JPY 1m per hour

Source: METI

To avoid another round of rolling black outs, the government instituted a plan to mitigate the expected supply-demand gap. The government outlined a two pronged approach. On the supply-side it issued a decree waiving the regular approval process required for installing gas turbine generators and restarting mothballed thermal generators. On the demand side the government instituted mandated (Table 3) and voluntary measures. As a result, average peak-demand relative to the previous year decreased by 19% for TEPCO and 18% for Tohoku EPCO. For TEPCO a mild summer, faster expansion of available supply and significant demand reduction resulted in an average reserve capacity of 10%. Tohoku EPCO also managed to maintain grid stability however it had to rely on support from TEPCO and Hokkaido EPCO, as it lost hydro generation capacity due to damage by torrential rains at the end of July.

METI invoked its authority based on the Electricity Business Act to mandate TEPCO and Tohoku EPCO customers with contracts of at least 500kW to reduce their demand during weekdays by 15% relative to previous year's consumption. For Tohoku EPCO the end date was set for 9 September (due to cooler climate of its service area) and for TEPCO 22 September. Any intentional violation was subjected to fines of up to JPY 1m per hour. Exemptions were granted for essential facilities such as hospitals. Without smart meters, real-time enforcement was not possible, but as large C&I customers were equipped with electronic meters, post-verification of compliance was feasible.

Thanks to an unprecedented degree of cooperation – especially by auto manufacturers and their suppliers – the 500kW and above category achieved an average demand cut of 27% in TEPCO's service area and 18% in Tohoku EPCO's service area exceeding the 15% target. For all other TEPCO and Tohoku EPCO customers, the government had set a non-binding target of 15% demand reduction relative to last year. To encourage customers to reduce demand, TEPCO and Tohoku EPCO started to provide hourly updated forecasts of supply and demand via multiple communication platforms eg, Twitter and displays at all train and subway stations. METI, the utilities and various businesses also provided tips on how to reduce demand. Specifically to lower air-conditioning demand, METI expanded its annual 'Cool Biz' summer dress code campaign, dubbing 2011 year's campaign 'Super Cool Biz' encouraging all businesses to adopt a relaxed dress code eschewing suits in favour of short sleeve polo shirts and setting thermostats at 26ºC or higher. METI also positioned its HQ in central Tokyo as a showcase for demand reduction achieving 32.6% demand reduction. Commercial customers in the below 500kW category – primarily retailers and commercial buildings – attempted to reduce demand via various measures such as reducing window-display lighting, modifying operating hours, using on-site generators, reducing the number of elevators and escalators in operation, and issuing extended holidays for staff. Retailers also tried to take advantage of the conservation drive where possible to increase revenue. Appliance retailers heavily marketed LED lighting and electric fans. Several battery manufacturers also launched products for demand reduction and backup power. Commercial customers under 500kW managed to cut demand by 19% in TEPCO's area and 17% in Tohoku EPCO's area.

While residential customers were generally supportive of reducing demand, lack of timely consumption data proved to be problematic. Without smart meters, residential customers were unable to readily measure and verify the impact of their actions. TEPCO's residential customers were able to achieve only 11% demand reduction and missed the 15% target. An exception in the residential segment was a set of nine condominiums managed by NTT Facilities with electricity supplied by its affiliated Ennet. All 300 households in these condominiums were equipped with smart meters, and NTT Facilities took this opportunity to offer the residents a summer demand response programme: for every 1kWh consumers reduced during designated periods, the consumers' bill was credited JPY 20. About 40 out of 300 households signed up and managed to reduce demand by 30% based on day-ahead e-mail notices.

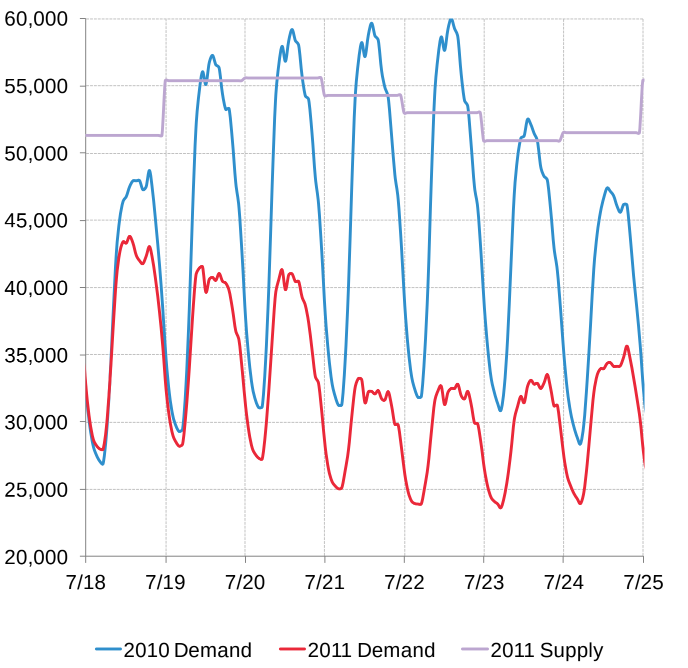
Table 4: Summer 2011 demand reduction results

Demand reduction	TEPCO	Tohoku EPCO
Overall relative to 2010	19%	18%
500kW or above category	27%	18%
Businesses under 500kW	19%	17%
Residential consumers	11%	18%*

*Source: TEPCO, Tohoku EPCO, METI. Note: *As reduction is relative to last year's demand, Tohoku EPCO's values do not take into account non-existent residential customers as a result of 11 March disaster.*

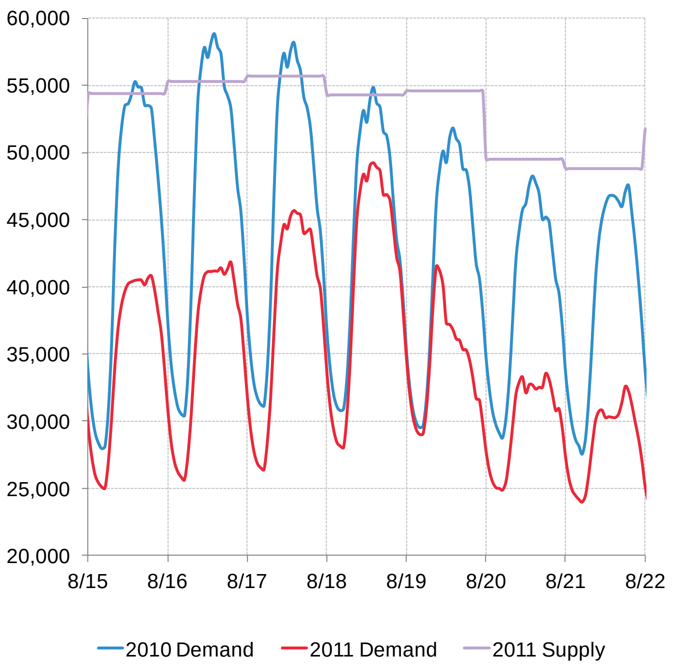
While demand reduction was successful in the summer of 2011, the results were achieved by suspending or shifting significant industrial activity that would have not been sustainable over a long-time period. Additionally as apparent in Figure 8 and Figure 9 demand reduction was not targeted to when needed most ie, during peak times, rather overall consumption had declined.

Figure 8: TEPCO's 2011-supply, 2011-demand and 2010-demand



Source: TEPCO, Bloomberg New Energy Finance. Note: 2010 dates are shifted to match with 2011 weekdays and weekends (7/23 and 7/24). 22 July represents 2010 maximum peak-demand.

Figure 9: TEPCO's 2011-supply, 2011-demand and 2010-demand



Source: TEPCO, Bloomberg New Energy Finance. Note: 2010 dates are shifted to match with 2011 weekdays and weekends (8/20 and 8/21). 18 August represents 2011 maximum peak-demand.

Winter 2011 onwards

While TEPCO and Tohoku EPCO worked hard to restore generation capacity lost to the 11 March 2011, the public's strong opposition to nuclear power in the aftermath of the Fukushima disaster led to the decision to suspend restart of nuclear plants once shutdown for regular maintenance after 13-months of operation. The temporary loss of nuclear generation led to expansion of supply shortage from Eastern Japan to the rest of the country. As all of Japan became affected by supply-demand imbalances, calls for shift to demand-side management grew.

SECTION 3. SHIFT TO DEMAND-SIDE MANAGEMENT

3.1. GOVERNMENT ACTION

To address short-term electricity supply-demand gaps and long-term structural challenges uncovered by the 11 March 2011 disaster, the government led by METI launched several measures to support demand-side management. Government's actions can be classified into three categories:

- Short-term funding for demand-side management technologies
- Standardised smart meter deployment
- Another round of electricity market reform

Aside from support mechanism for demand-side management, the government also introduced a feed-in tariff programme to support development of renewables.

3.2. FUNDING FOR DEMAND-SIDE MANAGEMENT

Starting with the reconstruction/recovery extraordinary budget approved in November 2011, and then followed up by subsequent regular annual budget allocations, METI launched several new grant and subsidy programmes (Table 5) to support deployment of demand-side management (DSM) technologies such as home energy management systems (HEMS), and building energy management systems (BEMS).

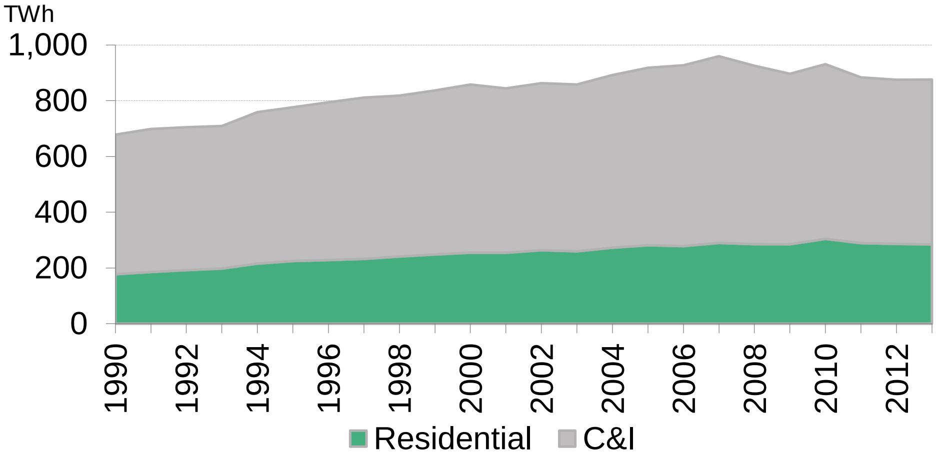
Table 5: Select DSM-related programmes funded by METI

Programme	FY2012, JPY bn	FY2013, JPY bn	FY2014, JPY bn
Subsidy for renovation of existing C&I facilities for energy efficiency	34.3	31	56
Subsidy for HEMS/BEMS installation	30*	FY2012 budget	
Subsidy for installation of lithium-ion batteries by residential and C&I users	21*	FY2012 budget	10
Funding for introduction of energy efficient measures aimed at saving power in buildings eg, efficient lighting, air conditioning	15		
Subsidy for installation of HEMS at multi-dwelling housing units (MEMS)		13	
Funding for the four main smart community projects (Keihanna, Kita-Kyushu, Toyota, Yokohama)	10.6	8.6	6
Funding for energy efficiency technology development	10.2	9	9.3
Subsidy for installation of energy efficient technologies (Zero Emission Home / Zero Emission Building)	7	11	12.6
Funding for large-scale (10,000 units) HEMS demonstration project			4.03
Subsidy for cloud based energy efficiency test projects at SMEs			3.5
Funding for smart community technology development	2.78	2.18	1.25
Interest subsidy for regional banks to support investment in energy efficiency by SMEs	1.5	1.7	2.4
Funding for standardisation activities on energy efficient technologies (eg BEMS) and promotion of standards internationally for adoption		0.81	2.79

*Source: METI. Note: Programmes marked in red are administrated by SII. *Some FY2012 programme where funded through the reconstruction and recovery extraordinary budget.*

METI aimed to tackle peak power demand by improving energy efficiency in the residential and commercial sectors by encouraging installation of lithium-ion batteries and HEMS/BEMS at such facilities. Sustainable Open Innovation Initiative (SII), an NPO established in 2011, was selected as the subsidy programme administrator (red programmes in Table 5). To be eligible for the subsidy programmes, vendors need to apply to SII for certification of their product. Vendors are required to have a base in Japan to provide services such as warranty, repair and support.

Figure 10: Japan electricity demand, FY1990-FY2013

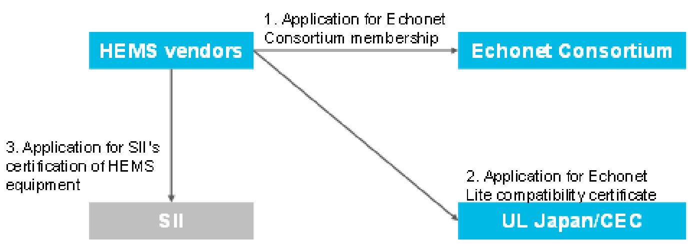


Source: The Federation of Electric Power Companies of Japan

HEMS/MEMS

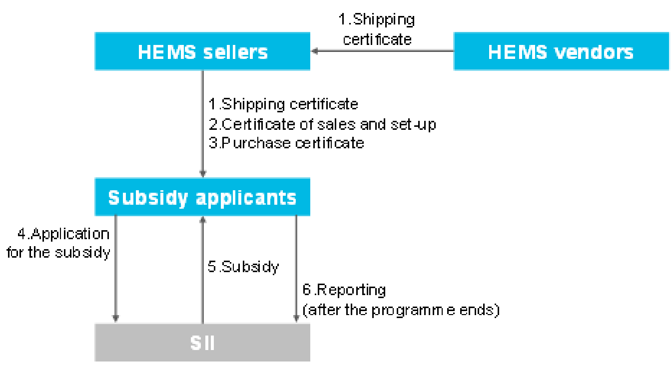
For HEMS, the equipment must comply with the ECHONET Lite standard. As discussed later ECHONET Lite is an IP-based application-level communication standard. Figure 11 shows the application process for HEMS vendors. First, HEMS vendors are required to apply for membership of ECHONET Consortium, which costs JPY 300,000 per year. After becoming a member, vendors need to apply for ECHONET Lite certification to one of the two standard testing firms (UL Japan or CEC). Application costs JPY 55,000 per HEMS equipment and takes one to two weeks to get certified. Once the certificate is issued, vendors need to submit the certificate and additional documentation to SII. No expense incurs at this stage. It takes about one to two months for SII to process the application and grant the certificate. The process of becoming certified is not unduly expensive nor onerous when compared to other international standard certification programmes. As of October 2014, there are 7,048 HEMS products by 25 companies (Table 6) registered with SII. The Smart House Research Center established in October 2012 at Kanagawa Institute of Technology, provides free software development kits (SDK) as well as testing facilities for developing ECHONET Lite compliant devices.

Figure 11: Subsidy application process for HEMS vendors



Source: SII, Bloomberg New Energy Finance

Figure 12: Subsidy application process for HEMS users



Source: SII, Bloomberg New Energy Finance

Figure 12 shows the subsidy application process for HEMS users. If equipment is leased, leasers are the applicants. HEMS users need to install the HEMS equipment before applying for the subsidy. Once applicants install HEMS products at their home, they can apply for the subsidy – up to 100,000 JPY or one-third of the HEMS cost. This HEMS subsidy programme was concluded[2] in September 2013, however other programmes such as the subsidy programme for installation of HEMS at multi-dwelling condominium referred to as MEMS continue.

Table 6: Selected SII certified HEMS vendors

Business category	HEMS vendor
Consumer electronics manufacturers	Kyocera, Mitsubishi Electric, Panasonic, Sharp, Toshiba
Real estate developers	Daiwa House, Ichijo, Misawa Home, Mitsubishi Estate Home, Toyota Home
Others	Eneres, EPCO, Denso, Edion, Mediotec, NEC, Smart Power System, Toyota Media Service Tranceboot

Source: SII

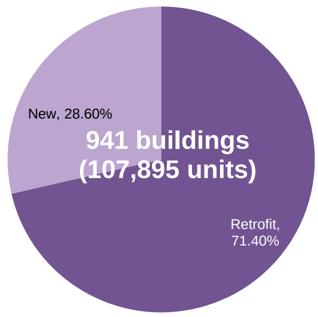
Statistics reported by METI as of June 2014, shows that the HEMS subsidy programme led to installations at 90,000 single-detached houses by the end of September 2013, when that HEMS subsidy programme was terminated. The still-active subsidy programme for MEMS has led to installations at 110,306 units (977 buildings) by the end of May 2014. Interestingly METI's statistics show that the MEMS market has been primarily driven by installations at existing buildings (Figure 13). For HEMS, the market is dominated by new homes as a result of smart homes offered by the home builders listed in Table 6. METI's stats show that buildings having between 51 to 300 units (Figure 2) are the most common for MEMS installations. Such buildings exceed the 50kW demand threshold thus eligible to be served by deregulated electricity contracts. Among the MEMS providers (Table 7) there are entities such as Eneres, NTT Facilities, and Orix who have registered as PPS. These players can bundle the MEMS service as part of an electricity retail package lowering the upfront cost associated with the technology.

Table 7: Selected SII certified MEMS aggregators

Company name
Anabuki Power and Lease
Eneres
Family Net Japan
Fuji Electric
Haseko
Hitachi
IP Power Systems
Itochu
Jupiter Telecommunication
Kyuden Technosystems
Mitsubishi Electric
NTT Facilities
Orix
Showa Shell
Toshiba

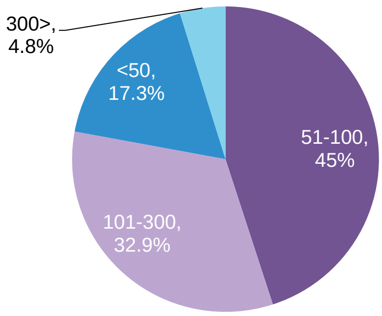
Source: SII

Figure 13: Comparison of existing vs new apartment buildings for MEMS installations



Source: METI

Figure 14: Comparison of number of units per building for MEMS installations



Source: METI

BEMS

METI originally planned to allocate JPY28bn out of the combined HEMS/BEMS subsidy programme towards BEMS. BEMS subsidies were available for commercial buildings in the 50 to 500 kW electricity contract category. As electricity retail in this segment is already deregulated, the programme envisioned “BEMS aggregators” that would act somewhat similar to demand response players common in some parts of US; albeit Japan does not have a capacity market and the wholesale market is not open to direct trading of electricity demand ie, “negawatts”.

[2] The programme was concluded earlier than planned due to the original source of funding being the reconstruction budget. The Diet made a decision in summer of 2013 to cease funding from the reconstruction budget for programmes outside of the disaster affected region.

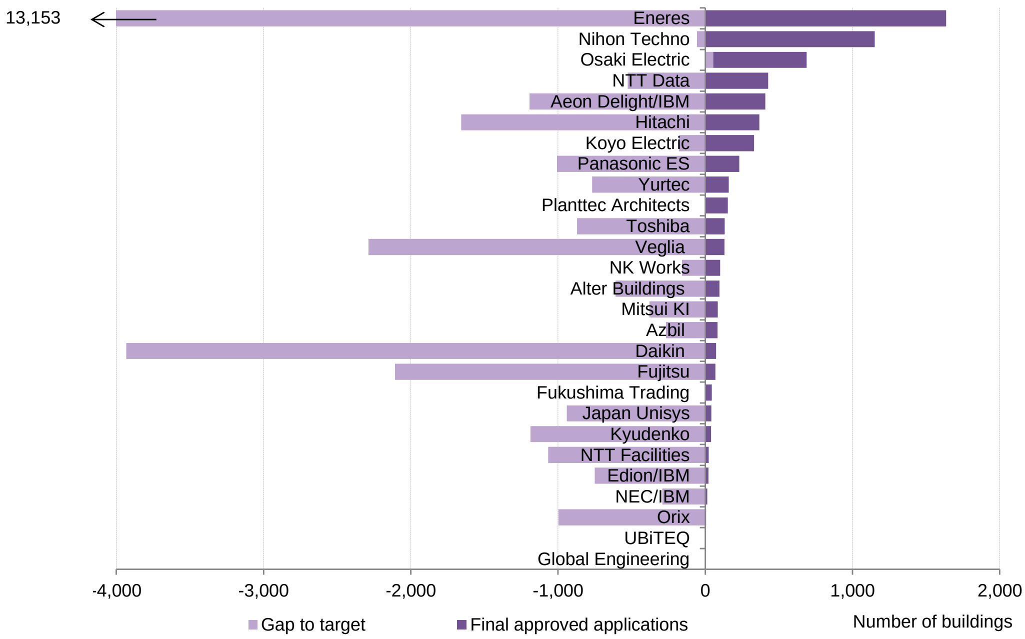
Buildings in the 50 to 500 kW are small to medium-size commercial buildings and are the most important contributing factor to peak-demand in urban areas. For example in the Kanto region (including Tokyo) such buildings account for 30% of total peak demand in TEPCO's service area during summer-time. While larger newer buildings are generally equipped with BEMS when they are constructed, most small- to medium-size commercial buildings do not have BEMS installed.

To qualify as a BEMS aggregator, service providers had to propose a system that would reduce peak demand of buildings by at least 10% relative to current performance. It also had to accept responsibility for at least 1,000 buildings to qualify; this requirement prompted building owners/operators and BEMS technology vendors to form consortiums. Each BEMS project was eligible to be subsidised for up to one-third of its installation cost (maximum JPY 1.7m) unless the project involved real-time systems, in which case it was eligible for up to half the cost (maximum JPY 2.5m).

The consortiums initially planned to install BEMS at 14,000 buildings by the summer of 2012, increasing to 41,000 by April 2013 and 65,000 by April 2014. The BEMS aggregators expected to achieve peak-demand reduction of 196MW by the end of summer 2012, expanding to 910MW by April 2014. However it quickly became clear that the original targets were too optimistic. The total target was reduced to 43,120. SII's final report showed that installations at only 6,471 buildings (Figure 15) ie less than 10% of the original target were carried out through the programme.

Figure 15: Final BEMS subsidy applications approved and gap to target

Number of buildings



Source: SII. Note: original targets for Planttec Architects, Fukushima Trading, UBiiTEQ and Global Engineering are unavailable.

3.3. STANDARDISED SMART METER DEPLOYMENT

TEPCO's inability in the immediate aftermath of the 11 March 2011 to conduct targeted rolling blackouts as well as poor demand forecasting, led to METI, JSCA and the utilities to revisit the smart metering roadmap. Three critical changes to the prior roadmap were made:

- **Faster deployment timeline:** METI and the utilities agreed to a goal of having 60% of Japan's electricity demand processed by smart meters by March 2017.

- **Competitive tenders:** METI encouraged utilities to forego traditional preference for sole-sourced contracts and instead conduct transparent competitive tenders via request for proposals (RFP) to lower procurement cost.
- **Inclusion of direct communication route with consumer:** To take advantage of smart meters for demand-side management in the residential and SME sectors, inclusion of Route B (Figure 3) in all smart meters was recommended.

On 24 February 2012, JSCA's smart house standardisation committee, released a new plan (Table 8) with the critical requirement of adoption of ECHONET-Lite as the common consumer application interface standard to be used by all smart meters in Japan for route B.

Table 8: Recommended smart electricity meter-HEMS interface communication protocol

OSI Layer/Communication media	Low power RF 920MHz	Wireless LAN	PLC
Application Layer	SMA Certification		
Layer 5-7	ECHONET Lite (Pending IEC certification)		
Layer 4	TCP, UDP	TCP, UDP	TCP, UDP
Layer 3	IPv6, 6LoWPAN	IPv6	IPv6, 6LoWPAN
Layer 2	IEEE 802.15.4 IEEE 802.15.4e	IEEE 802.11 IEEE 802.11b RCR STD-33 ARIB STD-T66	G3-PLC/IEEE 1901.2 PRIME ECHONET
Layer 1	IEEE 802.15.4g ARIB STD-T108		

Source: JSCA. Note: OSI stands for Open Systems Interconnection, developed by the International Organization for Standardization as means to characterise and standardise communication systems.

TEPCO became the first utility to conduct a competitive RFP based on the new recommendations. Its initial specifications drew some criticism as being favoured towards TEPCO's own preferred vendors; as a result of the responses to its request for comment (RFC) TEPCO revised its specification (Table 9). Specifically, TEPCO committed to deploying an advanced metering infrastructure (AMI) based on open standards and utilising IP as the protocol from meter to the utility back end. On communications, TEPCO has committed to adopting "the right network for the right place" ie it will not build its own fibre optic network, but will rather utilise existing communication channels including those of telecom operators. On the smart meter to HEMS front, data types and communication intervals will be devised to enable applications such as demand response. The MDMS will have an open standardised interface that would ensure open access by third parties such as demand response providers. TEPCO has already started smart meter deployment and is on track to deploy 1.9m meters by April 2015.

Table 9: TEPCO's smart meter deployment specification

Item	Details
Smart meter to home area network	• Real time access to smart meter data available for HEMS applications using ECHONET Lite • Additional information such as price signal, current limit change and PV control signal is included to enable features such as demand response and PV output curtailment
Smart meter	• Smart meter has IP address • Data format based on open standards
FAN	• FAN communication relies on RF mesh, 3G/LTE or PLC. The choice is based on cost effectiveness of the solution for that specific area. TEPCO's initial deployment is leading towards 70% RF mesh (urban areas), 20% 3G/LTE (rural areas) and less than 10% PLC (high-rise) • TCP/IP protocol is used
MDMS	• An open standard interface eg IEC 61968 is adopted • Energy management service providers such as demand response providers to have access to MDMS
WAN	• Based on the most cost effective communication network available in that specific geographical area eg, existing fibre optic networks (primarily in Tokyo metropolitan area)

Source: TEPCO.

Other utilities have all now either concluded RFPs or are in the process of evaluating responses to their RFPs (Table 11). The tenders thus far have been dominated by Japanese players and a few of their international partners eg, Itron via Mitsubishi Electric and GE via its joint venture with Fuji Electric. All utilities have also committed to provide consumers access to metering data (at least 30min interval data) as well as variable retail tariff choice starting in 2016 at the latest.

Table 10: Summary of smart metering plans of Japanese electricity utilities as of September 2014

Utility	Total meters	Vendors	Deployment plan
TEPCO	27.68m	• Comms & MDMS: Toshiba-led consortium (includes NEC, NTT Group) • Meters: GE Fuji Electric Meter (30A, 60A) Mitsubishi Electric (60A, 120A) Osaki Electric (30A, 120A) Toshiba Toko Meter Systems (30A, 60A)	TEPCO has selected all vendors and started deployment with the goal of deploying 1.9m by the end of FY2014: 30A (residential): 460,000 60A (residential): 1,260,000 120A (C&I): 180,000 It plans to achieve complete deployment by the end of FY2020.
Kansai EPCO	13.14m	Current vendors: Enegate, GE Fuji Electric Meter, Mitsubishi Electric, Osaki Electric, Toshiba Toko Meter Systems	Kansai initially started deployment in 2002. It plans to reach 50% deployment by the end of FY2017 and 100% by the end of FY2022.
Chubu EPCO	9.5m	• Comms: Mitsubishi Electric (Itron) • MDMS: Hitachi • Meters: TBD (preferred vendor is Osaki Electric) Note: group firm Chubu Seiki has primary responsibility for smart meter network O&M.	RFP process concluded in 2013. Chubu has already installed smart meters at industrial customers (above 500kW) and since January 2012 has been installing smart meters at C&I customers with the goal of completion by the end of FY2016. It started installation for residential customers in October 2014 and plans reach 100% deployment by the end of FY2022.
Kyushu EPCO	8.17m	• Comms: Fujitsu • MDMS: Hitachi • Meters: GE Fuji Electric Meter, Mitsubishi Electric, Osaki Electric, Toshiba Toko Meter Systems	RFP process launched in July 2013. Kyushu has already equipped all C&I customers with smart meters, and plans to reach half of its residential customers by the end of 2019, and 100% by the end of FY2023.
Tohoku EPCO	6.75m	TBD (preferred vendors are Hitachi and Osaki Electric)	RFP process for meters and comms launched in October 2013; and RFP for MDMS started in June 2014. Tohoku plans to start installation in January 2015, reaching all its customers by the end of FY2023.
Chugoku EPCO	4.95m	TBD (preferred vendors are GE Fuji Electric, Mitsubishi Electric and Toshiba)	RFP process launched in November 2013. Plans to commence deployment from October 2015, reaching 100% of its customers by the end of FY2023.
Hokkaido EPCO	3.68m	TBD (preferred vendors are GE Fuji Electric, Mitsubishi Electric and Toshiba)	RFP process launched in January 2014, and winners to have been informed by August 2014 (winners have not been publicly disclosed). Plans to commence deployment in FY2015 and achieve completion by the end of FY2023.
Shikoku EPCO	2.72m	TBD (preferred vendors are GE Fuji Electric, Mitsubishi Electric and Toshiba)	Shikoku EPCO launched its RFP process in August 2013 and conducted an information session on meter specifications in January. It plans to start deployment in the second half of FY2014, reaching 100% of its C&I customers by the end of 2016 and 100% of all customers by the end of FY2023.
Hokuriku EPCO	1.81m	TBD (preferred vendors are GE Fuji Electric, Mitsubishi Electric and Toshiba)	RFP process launched in September 2013. It plans to commence deployment in July 2015 and reach 100% deployment by the end of FY2023.
Okinawa EPCO	0.86m	TBD (preferred vendors are GE Fuji Electric, Mitsubishi Electric and Toshiba)	RFP process launched in June 2014. It plans to start deployment in FY2016 and reach all its customers by the end of FY2024

Source: Respective utilities, METI, Bloomberg New Energy Finance. Note: Japanese fiscal year runs from April to March.

The utilities have agreed to utilise communication infrastructure that will support hourly meter reading for low-voltage users (residential and SMEs) and half hourly meter reading for high-voltage users (C&I). Access to this data will also be provided to other retailers in case a customer switches to a different retailer. The motivation behind such high sampling rates is to support new demand side management initiatives – including customer feedback – as well as provide better information for supply-demand balancing. The high sampling rates would be in-line with best practices in the largest metering deployments in North America, such as metering roll-outs by BC Hydro in Canada, and PG&E, Southern California Edison and Florida Power and Light in the US. Those utilities have all deployed systems that can support 15min intervals.

ECHONET LITE STANDARD AND SMA CERTIFICATION

ECHONET Lite is an open standard to facilitate communication between applications based on typical electric devices and home appliances. The standard traces its origin to prior proprietary standards developed by Japan's ECHONET Consortium for home automation. There were two considerations in METI and JSCA's decision to require inclusion of an ECHONET Lite compliant and SMA certified communication module in all smart meters to be deployed in Japan:

- As shown in Table 11 existing standards available appeared to have limitations in either devices that could be controlled or the physical communication medium required
- Without a requirement, some GEUs may have not included direct HEMS communication functionality (route B) in their smart meters. And even in cases direct communication functionality was included, the communication interface used could have limited consumer choice to certain products and applications

Table 11: Comparison of availability of devices controllable by different energy management communication interface protocols

Device	ECHONET Lite	KNX	ZigBee SEP 2.0	Z-Wave
Dish washer and dryer				
Floor heater				
Fuel cell				
Heat pump water heater				
HVAC				
IH Cooking Heater				
Lighting				
Microwave oven				
Solar PV				
Storage battery				
Washing machine				

Source: standard bodies. Notes: Green means product using the protocol is already available, yellow means product using the protocol under development. Red means product using the protocol currently not available.

The Japanese government considers inclusion of a standardised communication module in all smart meters essential in ensuring that smart meter deployment will lead to unlocking the potential demand-side management for the residential segment. As of October 2014, there are 219 ECHONET Lite certified devices including adaptors that enable ECHONET Lite non-compliant devices communicate with ECHONET Lite compliant devices. For the full list of compliant devices, please refer to the ECHONET Lite Site. ECHONET Lite is currently undergoing IEC certification: communication protocol (ISO/IEC 14543-4-3), appliance control commands (IEC 62394 2nd edition), middleware adaptor I/F (IEC 62480).

To ensure interoperability, for smart meters and the HEMS controller, in addition to ECHONET Lite compliance, SMA certification is required. SMA certification covers the interface specifications for the application layer relying on communication between the smart meter and the HEMS controller. SMA certification is done via the Smart House Center at Kanagawa Institute of Technology. Currently Toshiba and Mitsubishi Electric have already received certification for modules to be used in TEPCO and Chubu Electric's smart meter deployments.

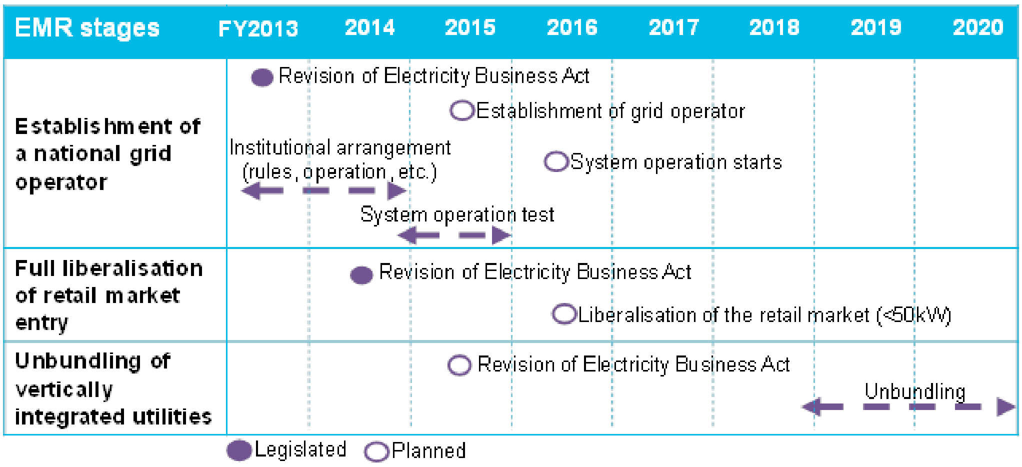
3.4. ELECTRICITY MARKET REFORM

The events of 11 March 2011 laid bare three major structural flaws in Japan's electricity regulatory framework:

- Over-investment in generation capacity and under-investment in inter-regional transmission
- The cost plus model for regulated electricity rates did not encourage GEUs to invest in DSM
- The existing structure had stifled competition and slowed down business model innovation

To address these issues, METI launched an 'electric power system reform committee' to draft proposals to modify the Electricity Basic Act. The essence of the proposals recommended by the committee is to develop an efficient market by developing competition across the country. The panel concluded that the electricity market has not been competitive enough through the gradual deregulation that has taken place since 1995 and found it was crucial to unbundle grid operation to provide open and fair access to power producers and retailers. There are three steps in the proposed reform process: establishment of a national electricity system operator, full liberalisation of the retail market and unbundling of the GEUs (Figure 16).

Figure 16: Japan electricity market reform schedule



Source: Bloomberg New Energy Finance, METI

National electricity system operator

On 13 November 2013, Japan's Diet passed a revision to the Electricity Business Act to create an impartial national grid operator referred to as Koiki-kikan *(広域機関) or "Organization for Cross-regional Coordination of Transmission Operators: OCCTO".* Since then under METI's supervision a preparation association of more than 50 companies including the GEUs, PPS entities such as Ennet and Marubeni have worked on drafting the rules for establishing the entity. On 22 August 2014, METI approved the rules put forward by the preparation association. The grid operator will be formally set up in April 2015. It will then assume responsibility for the operation of Japan's electricity system after April 2016, a major change from the current structure where each of the 10 GEUs is in charge of system operation in its own region. Koiki-kikan will also be in charge of reviewing power companies' supply plans and demand projections as well as craft a nation-wide grid investment plan. All electricity business operators must become a member of Koiki-kikan to engage in any electricity generation, transmission, distribution or retail activity. Koiki-kikan will also manage a one-stop system where consumers can apply to switch from one retailer to another.

Full retail market liberalisation

On 11 June 2014, Japan's Diet passed a revision to the Electricity Business Act to fully liberalise the retail electricity market starting in 2016. This revision to the Electricity Business Act removes the regional retail monopoly that the GEUs have enjoyed in serving clients under 50kW (mostly residential consumers). The GEUs continue to bear the responsibility for ancillary services such as frequency regulation as well as construction and maintenance of T&D assets – albeit under new oversight by Koiki-kikan. They will also continue to be responsible for serving retail clients in remote areas where no other retailer is active. All retailers will also be required to procure sufficient electricity supply to meet their clients' needs. The revised Act does not immediately remove the GEUs' regulated tariff system for users under 50kW, instead the regulated tariffs will be phased out by 2020; new retailers can offer unregulated tariffs from April 2016.

Unbundling of GEUs

The final step of the reforms – unbundling of the vertically integrated utilities – has started with a METI committee holding discussions on drafting a bill to be submitted to the Diet by Q1 2015. While METI is committed to unbundling, political support is unclear. Nevertheless the GEUs starting with TEPCO have started to reorganise their business units in preparation for unbundling.

3.5. FEED-IN TARIFF PROGRAMME

Starting from July 2012 a technology-specific feed-in tariff programme came into effect in Japan, replacing a prior renewable portfolio standard programme in place since 2003. Implementation of the FiT programme was one of the platform policies of the Democratic Party of Japan when it came to power in 2009; DPJ believed a FiT programme would accelerate adoption of renewable energy in Japan faster than the existing renewable portfolio standard (RPS) approach. Legislation was already planned when the 11 March 2011 Great East Earthquake, resulting Tsunami and subsequent Fukushima nuclear disaster occurred. The disaster resulted in an accelerated support for renewables, and passage of legislation setting up the framework for the FiT programme by August 2011.

Table 12: FiT rates for solar and wind, FY2014

Sector	Capacity threshold	Rates (JPY/kWh)	Term (year)
Solar	10kW+	32	20
	(surplus buyback) <10kW	37	10
Onshore wind	20kW+	22	20
	<20kW	55	20
Offshore wind	-	36	20

Source: METI. Note: Rates exclude sales tax (Sales tax increased to 8% from 5% on 1 April 2014.). Other technologies covered by the FiT programme are geothermal, small hydro (including repowering) and biomass.

Under the FiT legislation, METI is tasked with setting FiT rates based on the cost associated with each technology. The FiT burden is directly passed onto electricity consumers based on a surcharge tacked onto their electricity bill. An advisory committee to METI reviews the FiT rates annually and recommends changes if needed. Renewable energy project developers with projects approved under the FiT programme have to provide cost data to METI; this cost data is used for the annual FiT review. Thus far only solar FiT rates have been changed as solar is the only sector showing cost reduction.

SECTION 4. PROGRESS THUS FAR

4.1. RAPID DSM TECHNOLOGY DEPLOYMENT

Japan has already become by far the largest HEMS market in the world. It has also gone from being a laggard in smart meter deployment to a leader. The rapid technology deployment has not been without challenges as seen with the lack of success with the BEMS programme. The underlying factors for success – or failure in the case of BEMS – are partially linked to the unique stakeholders involved in each of these technologies as well as the deployment approach chosen.

SUCCESS IN HEMS / FAILURE IN BEMS

In terms of subsidies the BEMS programme benefitted from more financial support yet it is the HEMS programme that has become self-sustainable. Based on the data available, and interviews with key stakeholders, our view is that there are four key factors in success of Japan's HEMS market:

- **Housing developers using HEMS as a competitive advantage:** Japan's single detached housing market is one of the most competitive markets globally due to the large number of existing players. As the population shrinks, these housing developers are competing for an ever decreasing market size. Increasing consumer awareness of energy issues in the aftermath of 11 March 2011 – in particular a preference for reducing energy consumption – led to real estate developers bundling HEMS, as well as rooftop solar PV and home energy storage systems as part of their housing offerings. These housing developers have now become the primary sales channel for HEMS, leading to uptake of HEMS outside of subsidy programmes.
- **Bundled HEMS offerings by ICT service providers:** For ICT service providers, HEMS has offered a potential means to increasing revenue from their existing customer base, and also attracting new clients. For example NTT East, part of the NTT group, Japan's largest telecom operator, offers a HEMS service called Flet's Mierune which relies on its broadband internet service Flet's Hikari. Another example is me-eco, offered by Family Net Japan (FNJ), an affiliate of TEPCO, which is also an internet service provider. FNJ mainly targets multi-unit housing complexes and provides integrated building management services including security.
- **Rapid residential PV uptake:** Japan was already one of the world's leading residential solar PV markets, thanks to support programmes in effect for over 10 years. Greater awareness of energy issues and the launch of the feed-in tariff (FiT) programme in July 2012, have led to continued uptake of residential PV. Most consumers buying solar PV systems are now opting to buy bundled HEMS platforms to better optimise their energy consumption and buy-pack revenue through the feed-in tariff programme.
- **Consumer choice:** While Japan's large consumer electronics manufacturers were already developing HEMS and smart appliances before 2011, the subsidies offered by METI attracted a far larger number of players to the market including new ventures. Consumers in Japan can now choose from bare-bones software based offerings to full-on home-automation systems including virtual reality concierge services. In Japan, HEMS has gone from being about energy efficiency to being cool – with many offerings based on Android and iOS smart phones – even benefiting from advertisements including famous celebrities.

Based on the data available, interviews with key stakeholders and our knowledge of demand response and energy efficiency programmes in other parts of the world, our view is that there are four key factors to the lack of success for the BEMS programme:

- **Lack of economic benefit/incentive for owners/managers of small- to middle-size buildings**: Small to medium-size building owners and managers typically want to recover the initial BEMS cost within a short timeframe (often as little as a year or two). Without a real demand response or energy efficiency incentive that monetises curtailments or energy savings, the business case for BEMS installation is weak. Only four of the aggregators were registered as PPS that would have enabled them to offer incentives as part of an electricity retail service. Unlike for the HEMS market where factors such as comfort can overcome a relatively weak economic case, BEMS investments are measured purely on their financial returns.
- **Too ambitious goals**: The installation goals were too ambitious. First, they were not based on realistic estimates, but simply on existing customer bases of the aggregators' main business lines. Second, aggregators were placed in a position where they had to propose high targets (at least 1,000 buildings or at buildings with over 50MW of total contracted power) to participate in the subsidy programme, with no penalty for failing to deliver. In effect, they had to aim high or not bother applying at all.
- **Timing of the subsidy launch**: Building owners had difficulties securing enough budget for BEMS installations before summer 2012 when peak demand was expected. One reason was timing: the subsidy was launched right after the start of the fiscal year in April, after companies had already set their budgets for 2012-13.
- **Lack of customer engagement and energy services experience:** It is telling that SII introduced a new requirement for the second round of BEMS solicitations: that aggregators must have prior experience in energy management service businesses such as demand response. One of the key barriers to commercial energy efficiency investments in general has always been a lack of knowledge and enthusiasm amongst building managers, tenants and owners, the ultimate customers. The ability to educate, motivate and structure an attractive offering for such customers is a major differentiator between energy service companies and simple providers of equipment, and this appears to have been lacking in some cases.

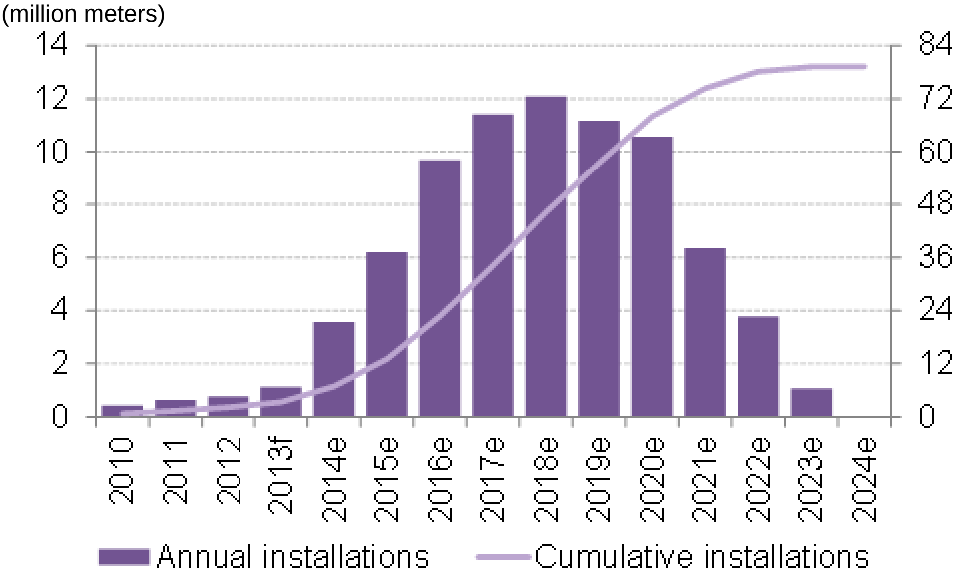
SMART METERING

The change in the smart metering roadmap can be primarily attributed to the events of 11 March 2011 leading to a significant shift in the general public's perception of the GEUs. Overnight the GEUs went from being some of the most respected institutions in Japan to somewhat unfairly bearing the brunt of the public's criticism for the Fukushima nuclear disaster. The shift in public perception leading to pressure from politicians resulted in METI utilising its executive authority to cajole the utilities to speed up deployments and commit to inclusion of route B with a standardised communication interface. The government also utilised its effective majority control over TEPCO via the Nuclear Damage Compensation and Decommissioning Facilitation Corporation to set up TEPCO as the model to be emulated by other utilities. The new roadmap will certainly lead to Japan having one of the most advanced smart metering infrastructure by 2020 (Figure 17), however two aspects of this approach have created some misunderstandings:

- **Legal framework over smart meter deployment plans:** In both US and EU smart meter deployments have been carried as part of clear legal frameworks. In EU, member states are required to carry out a national cost benefit analysis on rolling out smart metering and proceed with deployment if the results are positive. Countries that have opted to proceed have done so under clear national legal regulatory frameworks, particularly around areas such as cost recovery. In US, smart meter deployments are governed under the legal framework of each states' public utility commission, with deployments generally requiring a new motion to be approved by the public utility commission. These frameworks have helped provide clarity around roles, responsibility and cost recovery mechanism for the roll-out. In Japan there is no specific legal framework for smart metering deployment. Instead the executive authority granted to METI as part of the Electricity Basic Act is broadly interpreted to give it authority to regulate smart meter deployment. Japan is certainly not a litigious society and under current circumstances it's highly unlikely that any utility will legally challenge METI. Nevertheless not clearly defining a legal framework can lead to unnecessary uncertainty. For example in the case of Kansai Electric which had already deployed over 1m smart meters – without an Echonet Lite compliant route B communication module– when the new roadmap was adopted, it is not clear how fast the utility will have to replace those meters and who will be responsible for the replacement cost.

- **Adoption of ECHONET Lite compliant route B:** the decision to require an Echonet Lite compliant route B has been a topic of confusion both in Japan and beyond. Within Japan some have touted route B as a unique advanced feature of smart metering in Japan. In reality inclusion of functionality to enable the smart meter to communicate directly with the consumer is fairly common in US and Europe. The majority of meters installed so far in the US include the Zigbee Smart Energy profile for home area network communications. Outside of Japan, the Echonet Lite standard has been perceived as an attempt to protect local industry at the expense of international vendors. While one can debate the merits of launching a new standard, Echonet Lite is an open standard soon to be certified by IEC. In the end the benefits of inclusion of direct consumer communication functionality with a standardised application interface far outweighs these misunderstandings even if Echonet Lite remains an open standard limited to Japan.

Figure 17: Smart meter deployments in Japan, FY2010-FY2024e



Source: Respective utilities, Ministry of Economy Trade and Industry, Bloomberg New Energy Finance. Note: Japanese fiscal year runs from April to March.

4.2. INCREASED COMPETITION IN ELECTRICITY RETAIL

While the electricity retail deregulation is about liberalising the below 50kW market, in the short term the 50kW+ market is experiencing the most change as the GEUs finally start to compete in each other's service areas. The GEUs could have competed with each other since 2000, however they had primarily refrained from direct competition. Throughout the last 14 years, there was only one known case of direct competition. However the current round of EMR and the increasing number of PPS players have changed the calculation for the incumbents. The larger utilities have already decided that the best way to defend their market share is to go on the offensive (Table 13). Typically PPS players have offered electricity plans that effectively lower the customer's cost by 5% to 10% compared to the plan offered by the local regional monopoly. The rival GEUs are therefore likely to try to match these plans. Ultimately their ability to offer lower rates will depend on whether they are able to restart their nuclear assets. In the short term, similar to the existing PPS players, the GEUs are likely to offer plans including energy management and/or demand response measures to lower their customers' electricity bill.

Table 13: Current status and BNEF view on cross-regional competition

GEU	Competition status
TEPCO	Started nationwide electricity retail from October 2014
Kansai	Started electricity retail in TEPCO's area from April 2014
Chubu	Started electricity retail in TEPCO's area from August 2013 via Diamond Power, it is also building power plants in TEPCO area
Kyushu	Likely to start targeting Kansai's area by early 2015, once it restarts Sendai nuclear plant by the end of 2014
Tohoku	Likely to compete in TEPCO's area if able to restart its Onagawa nuclear plant
Chugoku	Likely to compete in Kansai and Kyushu areas, considering building coal power plant in TEPCO area
Shikoku	Likely to proceed targeting Kansai and Kyushu if able to restart its Ikata nuclear plant
Hokkaido	Unlikely to engage in competition given its financial situation
Hokuriku	Likely to proceed targeting Kansai if able to restart its Shika nuclear plant
Okinawa	Unlikely to engage in competition due to its limited size and geographical isolation

Source: Bloomberg New Energy Finance. Note: Peak demand refers to peak demand in FY2013.

EMERGENCE OF COALITIONS BEYOND ELECTRICITY RETAIL

An additional phase change underway is the emergence of alliances and partnerships aimed at electricity retail for the residential market as part of services beyond sale of electricity. Electricity retailers are forging alliances with energy services specialist as well as information communication technology service providers whose existing client relationships and content delivery platforms enable value-added services. An early example was TEPCO's partnership with US energy data analytics provider Opower in October 2013. TEPCO customers with smart meters are now able to receive personalized energy usage analysis, and energy savings recommendations from Opower via TEPCO's free web service Denki Kakeibo.

Another example is Rakuten, Japan's largest e-commerce operator. Rakuten has formed a partnership with Ennet – the largest PPS – and Ennet's parent NTT Facilities for a summer demand-response programme aimed at multi-dwelling residential units. When Ennet's customers participate in a demand response event, they can gain points redeemable for cash equivalent on Rakuten's e-commerce site as well as credit at merchants, restaurants and hotels that participate in Rakuten's travel group.

These partnerships are crucial for the residential segment, as it is challenging to simply offer a cheaper electricity plan than the local GEU to induce residential customers to switch. While the approach of bundling payments for various services - the most common being cable TV, internet and phone services - can work, the marginal economic benefit of bundling various bills into one may not induce large number of consumers to switch. The crucial factor is added value services. These ICT service providers can certainly choose to directly engage in electricity retail; however it is far more likely that they will choose partnerships with existing PPS and GEUs over direct electricity retail on their own. By partnering with existing electricity retailers, the ICT service providers can expand their existing service offerings into a new domain without having to face additional regulation or significant upfront costs to secure electricity supply for their customers.

4.3. POTENTIAL SOLUTION TO INTEGRATION OF SOLAR PV

Since launch of the FiT programme in July 2012 until the end of June 2014, METI has approved FiT applications amounting to 72GW. During the same period, commissioned capacity under the FiT programme stands at 11GW (15% of applications approved). Solar PV has by far dominated all other sectors covered by the FiT programme. Solar applications approved stand at 69GW ie, 96% of all applications made to the programme. Solar commissioned capacity stands at 11GW ie, 98% of commissioned renewable energy capacity. The local utility's permission is required to connect a renewable energy project to the grid. The utilities (Table 14) faced with large volumes of solar FiT applications approved have already started to suspend responding to more grid-connection requests on the basis that they are concerned about stability of their grid based on the current volume of applications already approved. The utilities argue the intermittent nature of solar PV threatens the stability of their grid, particularly as currently only installations above 500kW+ are directly under real-time control by the utility.

Technologically there are various options to accommodate intermittent renewables ranging from simply building more T&D lines to increasing grid automation and utilising energy storage. DSM technologies specifically smart meters can also be useful as Japan's pre-11 March 2011 smart metering roadmap had envisioned. Depending on the features included in the smart meter, the smart meter can be utilised to curtail output from a PV system installed behind the meter. For example smart meters being deployed by TEPCO have this feature. Additionally the timely data provided by the smart meter coupled with variable electricity tariffs can enable peak load shifting to help better match supply and demand. For end users, deployment of HEMS/BEMS coupled with energy storage can enable solar PV output to be purely used for self-consumption without any impact on the grid. Of course the challenges associated with intermittent renewables are not purely about technology rather there are also financial, regulatory and commercial considerations. METI has just launched a new committee to put forward recommendations by the end of the year. While it is too early to say what the committee will decide it is highly likely that the committee will look at what DSM can offer for renewable integration.

Table 14: Utilities suspending further grid access requests for renewables

Utility	Action	Commissioned (GW)	Remaining approvals (GW)	2013 peak demand (GW)	2013 peak demand in low-demand season (GW)
Kyushu Electric	On 25 September 2014, announced it will indefinitely suspend responding to more grid access applications for renewable energy projects (excluding <10kW solar).	3.6 - solar 3.2 - wind 0.4	15.5 - solar 15.5 - wind 0.0	16.3	8.9
Tohoku Electric	On 1 October 2014 announced it will indefinitely suspend responding to more grid access applications for solar (50kW+), hydro, geothermal and biomass projects.	1.6 - solar 0.9 - wind 0.6	10.8 - solar 10.2 - wind 0.5	13.7	9.4
Shikoku Electric	On 1 October 2014, announced it will indefinitely suspend responding to more grid access applications (excluding <10kW solar).	0.9 - solar 0.8 - wind 0.1	1.9 - solar 1.8 - wind 0.1	5.5	3.1
Hokkaido Electric	On 1 October 2014, announced it will indefinitely suspend responding to more grid access applications (excluding <10kW solar).	1.6 - solar 1.3 - wind 0.3	2.7 - solar 2.6 - wind 0.1	5.5	4.1

Source: Kyushu Electric, Tohoku Electric, Shikoku Electric, Hokkaido Electric, METI. Note: Commissioned capacity includes both pre-FiT projects and FiT approved projects installed by the end of June 2014.

4.4. OUTLOOK

In the short term, government action in the form of subsidies, grants and roadmaps has certainly had the effect of rapid deployment of the crucial technological components needed for demand-side management namely smart meters and HEMS. The increased competition in the electricity retail market as a result of the electricity market reform process is also supporting emergence of business models around demand-side management. There are three remaining factors that will determine the future scope of DSM in Japan:

Decoupling of utility revenue from kWh sold: Currently the GEUs' revenue is directly tied to the volume of electricity sold. While under current circumstances the GEUs are under some pressure to help their customers save electricity – due to their nuclear assets being offline – in general for GEUs helping their customers save electricity is not an attractive business proposition. To entice a utility to invest in energy efficiency on the demand side, the utility's profit needs to be decoupled from the volume of electricity sold. Decoupling is partially achieved by having a competitive retail market, as well as having an independent system operator; steps that Japan is taking. An additional crucial step is creating a regulatory framework that obligates utilities to invest in energy efficiency on the demand-side but also enables them to recoup this investment based on the value of kWh saved. Reference examples are EU's Energy Efficiency Obligation Scheme as well as Energy Efficiency Resources Standards adopted by many US states. Both of these programmes have significantly boosted spending on energy efficiency, including some demand side management measures. Prior METI advisory committees had considered decoupling, and a new energy efficiency committee launched in June 2014 is likely to consider the topic albeit what actions if any it may recommend are unclear.

Market mechanism for trading demand: Demand response in Japan is currently limited to bilateral contracts and there is no market mechanism for trading negawatts. Electricity systems whereby the demand-side is treated in the same way as the generation-side, and the market structure includes a capacity market in addition to an energy market have shown far higher uptake of demand side management as exemplified by the PJM-interconnection in US. PJM typically has between 6-10% of total peak demand met through demand response as a result of this market structure. Several other capacity markets in the US have also increased demand side participation and other countries such as France and the UK are in the process of implementing similar mechanisms. The original EMR framework envisioned negawatt trading on the energy market and creation of a capacity market. The outcome relies partly on the rules to be set by koiki-kikan, the fate of the unbundling proposal as well as recommendations by the aforementioned energy efficiency committee.

Long-term energy mix: The extent Japan needs DSM depends very much on the country's future energy mix. Since the Fukushima nuclear disaster, Japan has not been able to formulate a long-term energy plan due to political uncertainty around nuclear generation. The new independent Nuclear Regulation Authority (NRA) created post Fukushima has legal authority to determine which plants are deemed safe to restart. However once a plant is deemed safe by NRA, the decision to restart rests with political actors: the host community's government, and the government of the host prefecture, in addition to METI. As for the decommissioning process of reactors deemed unsafe by NRA, the process is still unclear. In June, METI launched a new nuclear committee to tackle these issues. The results of the nuclear committee together with the aforementioned energy efficiency committee as well as committees evaluating renewable energy policy are to be used to form a new long-term energy plan. The initial goal is to have the plan ready in time to submit Japan's emission reductions target to the UN climate change conference (UNFCC) in Paris in December 2015. The UNFCCC secretariat has set a deadline of March 2015 for target submission however it is unclear if Japan will able to meet that deadline.

In summary, Japan has achieved a remarkable investment in demand-side management technology in a short period. Early signs suggest the DSM market is becoming self-sustainable however how far DSM will contribute to Japan's energy mix remains dependent on future policies.

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