

GSGF >> REPORT

DEMAND RESPONSE STATUS AND INITIATIVES
AROUND THE WORLD

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Flexibility working group, 2016

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After the new emission targets of the COP21 summit last year, many countries in the world are making a serious effort in reducing greenhouse gas emissions by integrating more renewable energy sources in their system. However, this is not straightforward, as important sources of renewable energy, such as solar power and wind, are inherently variable and difficult to forecast. Therefore, there is an increasing need for flexibility in the system to compensate for the variable output of renewable energy generation. Traditionally, flexible gas turbines are used to maintain the stability of the grid. However, with increasing shares of renewables and hence increasing flexibility needs, back-up gas turbines might not be the most cost effective or sustainable option. Other alternatives such as pumped hydro storage are used to cover periods with high demand or few renewable energy production, however in some regions the availability of this storage source is geographically limited.

Therefore, an interesting alternative is to shift the peak demand to periods with more renewable production like solar power. In fact, demand sources have been proven to be a fast responsive, reliable and cost effective alternative to conventional generation flexibility. Today, flexibility at the demand side is becoming an essential part of the energy system.

The ability to spread flexible demand in time can have many different applications. First, the customer can use it to reduce its energy bill by consuming only at periods with low prices. Currently, this is usually reserved for large industrial consumers connected to the wholesale market. Similarly, a so-called Balancing Responsible Party (BRP) can shift demand to balance his portfolio in case e.g. his wind generation is producing less than expected. In addition, the flexible demand can be offered to the system operator, either ancillary services for the Transmission System Operator, either local grid management for the Distribution System Operator. Depending on the market model in the region in question, the flexible demand can be contracted commercially by an independent aggregator, or by the utility.

In this report, the global smart grid federation presents the status of demand response integration in different parts of the world. The contributions from the Global Smart Grid Federation regions consist of several parts:

- Some short information of the market model of the country or region in question. In this report we limit ourselves to some basic issues, for more information in Europe for instance we can refer to the report of the Smart Energy Demand Coalition .
- Which barriers towards implementation of demand response and dynamic pricing schemes exist in the region.
- A few important research and demonstration projects on demand response and dynamic pricing.

This information is given for several countries, where the energy system is often very different (regulated vs. liberalized, unbundled vs. vertically integrated, etc). In the subsequent discussion section, we extract some main trends and challenges that we see in various regions worldwide.

¹ More info on <http://www.smartenergydemand.eu/wp-content/uploads/2015/09/Mapping-Demand-Response-in-Euro>

Demand response is happening in all parts of the world in regions with very different market structures

Based on the responses and discussion in this report, we can conclude that demand response is one of the main priorities for drastic reforms of the energy system in different parts of the world. However, we observe that demand response is being performed in liberalized and unbundled systems as well as in regulated systems (e.g. Taiwan). In America, Europe, and Asia we find regions with more and less advancement towards integrating demand response in the market.

Involvement of small consumers is hampered by lack of adequate measurement and verification mechanisms

No region or country has reported that dynamic pricing schemes are existing outside pilot projects. In general, involvement of the smaller end consumer is one of the major challenges tackled in research and demonstration projects. Commercial deployment is hampered by lack of measurement and verification mechanisms. This often relates to smart meters, but also in countries where the smart meter rollout is close to completion, such as Norway, we expect the introduction of hourly prices in the coming years.

Market regulation often presents a barrier for demand response

Many of the countries reported that regulation is not always supportive for the integration of demand response. In Asia, several countries are in the process of reforming their market to a more liberalized structure, opening the door for independent aggregators to contract flexible sources. In Europe, the countries have a liberalized and unbundled structure, however even then access to certain flexible market products may be restricted to demand sources, due to a large minimum bid size or a symmetry requirement for up/down regulation, favoring conventional generation flexibility.

Customer engagement and dynamic pricing studies are important topics of demonstration projects

A lot of demonstration projects report investigating dynamic pricing and customer engagement, i.e. how to best approach the smaller customers and how to technically communicate energy information and their impact on the market. What appears to be covered less in research and demonstration projects worldwide is the usage of demand response for local grid management by the DSO.

1 BELGIUM

- Country/region: Belgium
- Peak consumption (GW): ~13GW

Organization of the energy system:

The Belgian electricity sector is liberalized and unbundled, conform the Third Energy Package of the EU. Demand response is commercially active in the country, supporting several business models. Independent aggregators exist. Belgium is quite advanced at integrating flexible demand in the market, with 'R3-DP' flexible demand market products and interruptible contracts for large consumers. This stems from a historical 'sense of urgency' for structural shortages, related to a possible phase-out of nuclear installations and growing unreliability of the nuclear units at the end of their lifetime.

However, dynamic pricing schemes are not possible within the current regulatory framework, where retailers can only change their tariffs four times a year, aside from a day/night price difference.

Flexible consumption is valorized as follows:

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment: Usually this is limited to large industrial consumers

- Correct imbalance in the portfolio of a Balancing Responsible Party

Comment: Although this is possible, it is currently not used as the main valorization track for demand response in Belgium.

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment: Ancillary services are the primary source of valorization for aggregators in Belgium. Demand response is enabled in primary and tertiary reserves, not (yet) in secondary reserves.

- Strategic reserve or capacity market

Comment: Belgium has a strategic reserve system, i.e. back-up generation capacity is contracted by the TSO should a structural shortage on the market occur.

- Contracted by DSO (for grid operation or other objectives)

Comment: The DSO is not (yet) contracting flexible consumption for grid operation. The absence of smart meters in Belgium is a barrier for this.

- Other:

Order of magnitude of demand response products

Below, a table is given with the demand response products that are available for ancillary services and strategic reserve. This does not include demand response for arbitrage or correcting portfolio of a balancing responsible party.

Product (name + description)	Power (MW)
Ancillary services: Primary frequency control	variable as it depends on short term auction (weekly) results (total need R1 is 73 MW) http://www.elia.be/en/suppliers/purchasing-categories/energy-purchases/Ancillary-Services-Volumes-Prices

Ancillary services: tertiary frequency control	398 MW with yearly contracts (189 MW as 'Interruptible clients' ICH and 209 MW as 'R3-DP' market product) + 3- 70 MW with monthly contracts
Strategic reserve	Winter 2014-15: 96,7 MW Winter 2015-16: 358,4 MW Winter 2016-17: 0,0 MW

Barriers and challenges

The following barriers are perceived in Belgium

- The absence of smart meters hampers the use of flexible demand for grid operation in the LV grid
- Absence of appropriate Measurement & Verification mechanisms for consumers connected to the LV and MV grid
- For R3-DP market products, the DSO has to prequalify if the consumption can be contracted by the aggregator. So the DSO can refuse participation of the customer on the market if there are concerns that a local grid congestion might occur in certain circumstances.

Research and demonstration projects on demand response

Short facts on the Linear project

The Linear demand response project involved 250 families in Flanders, Belgium, where innovative technologies, business cases and user acceptance on a large scale were investigated. The full results of the Linear project are available on www.linear-smartgrid.be. The households had smart washing machines, tumble dryers, dishwashers, domestic hot water buffers and electric vehicles. In addition, the flexibility was used to balance the portfolio of a balancing responsible party, and keep the voltage of the local network within limits.

Partners in the project covered the entire value chain, with research institutes like EnergyVille, iMinds and Laborelec, the two DSO's Eandis and Infrax, the energy supplier Luminus, the in-home management systems of Fifthplay and the suppliers of the home appliances. The project recently finished in 2015 and had a budget of ~30M€. Some of the main conclusions were:

- Users are effectively able to schedule their devices away from the peak hours, but only if the technology is provided to automate this process. The users that had to respond manually to dynamic energy prices quickly gave up.
- A large user survey allowed the results to be scaled up and indicated that smart appliances were perceived to be without loss of comfort.
- Reliability of communication and cost of installation are key bottlenecks for implementing residential demand response, aside from regulatory constraints.
- Although some effect on the grid voltage was measured, it is concluded that controlling grid voltage or increasing hosting capacity of renewables will not be the main drivers for residential demand response.

[1] www.linear-smartgrid.be

Are there certain initiatives, regulatory or otherwise, that promote demand response in your country?

On a Belgian level, the DSO's are developing a clearing house, the 'Atrias' platform, which should facilitate new market processes, including flexibility integration and trading.

2 CANADA - ONTARIO

- Country/region: Ontario, Canada
- Peak consumption (GW): ~26GW in 2015

Organization of the energy system

The energy sector in Ontario, Canada is liberalized and unbundled. Demand response is commercially active in this region and independent aggregators exist.

Approximately 96% of the residential customer base is on Time of Use (TOU) pricing with three pricing tiers (on-, mid-, off-peak)¹. Additionally pilots that explore further dynamic pricing options are held in Ontario. For example, Hydro One Networks Inc., Ontario's largest distribution utility is examining a range of TOU rates, hourly real time, as well as variable and critical peak pricing options. The near universal roll-out of smart meters (with a minimum interval of one hour) creates the opportunity for different dynamic pricing options.

How can flexible consumption be valorized in your country?

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment: Some load resources can submit dispatchable energy bids into the real-time market.

- Correct imbalance in the portfolio of a BRP

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment: Dispatchable loads can provide 10 and 30 minute operating reserve to the electricity market.

- Strategic reserve or capacity market

Comment: Demand Response resources are procured through an annual DR Capacity Auction

- Contracted by DSO (for grid operation or other objectives)

Comment: DR Pilot underway to test load following and unit commitment

- Other:

If applicable, what is the order of magnitude of demand response programs in your country?

Product (name + description)	Power (MW)
Dispatchable Load resources (large industrial loads bidding in energy market)	579MW
Hourly Demand Response	551MW
PeakSaver (Residential DR)	163MW
Pilot Programs	70MW

*depending on time of day, there may be some double counting of capacity between programs

¹More information is available on <http://www.ontarioenergyboard.ca/oeb/Consumers/Electricity/Electricity%20Prices#seasons>

Barriers and challenges for further integration of demand response

- Until recently Ontario did not have a market for demand response, other than as a dispatchable load who can participate in the operating reserve market. With the DR auction implemented in December 2015, DR now has the opportunity to compete on an annual basis to provide DR capacity.
- There is currently a limited need for new capacity to meet resource adequacy requirements in Ontario which reduces the short-term reliability demand for additional DR capacity.
- Registration, measurement and verification requirements are currently challenging for aggregation of large numbers of low volume (i.e. residential and small business) contributors.
- Some DR resources are finding it difficult to meet system requirements which require a DR resource to be fully integrated into IESO (Independent Electricity System Operator) energy markets.
- Regulatory framework continues to incent network infrastructure investments limiting interest from distributors in developing DR as a viable alternative.

Recent and running projects on demand response and dynamic pricing

Dynamic Pricing Pilot

<http://www.energy.gov.on.ca/en/smart-grid-fund/smart-grid-fund-projects/mcmaster-university/>

Hydro One and McMaster University are conducting a pilot to evaluate electricity conservation, shifting, and bill savings of dynamic pricing options. The pilot will also evaluate the impacts of different levels of enabling devices (WiFi enabled thermostats) and real time usage feedback through an IHD and online energy portal.

Up to 1,600 participants in western, central, and eastern regions of Ontario will be involved testing 12 different dynamic pricing options including TOU, variable peak pricing (VPP), critical peak pricing (CPP) and real-time pricing (RTP).

The pilot has been in market since July 2015 and will continue until June 2017. Results will be made available at the end of the pilot.

Demand Response Pilot Program

<http://www.ieso.ca/Pages/Participate/Demand-Response-Pilot/default.aspx>

The pilot is aimed at better understanding the capabilities of DR to provide service currently provided by generators and other suppliers:

- Five-Minute Load Following: responding to real-time market prices and adjusting power consumption on a five-minute basis as Ontario's demand for electricity fluctuates throughout the day
- Hourly Load Following: responding to hour-ahead market prices and adjusting power consumption on an hourly basis as Ontario's demand for electricity fluctuates throughout the day
- Unit Commitment: committing to load curtailment day-ahead or four-hours ahead of real time in return for certain guarantees

This project has just started delivering into the energy market in May 2016 and will run for two years.

Demand Response Auction

<http://www.ieso.ca/Pages/Participate/Demand-Response-Auction/default.aspx>

The IESO recently held its first annual DR Auction, which is a transparent procurement platform used to select DR Capacity based on cost. The first auction was considered a success as it procured more MW than was existing at a lower \$/MW-year cost.

Future Projects

The IESO is interested in expanding participation in demand response particularly from residential load. The IESO is also interested in studying the use of Demand Response to meet needs of local regions.

Are there certain initiatives, regulatory or otherwise, that promote demand response in your country?

The IESO established the Demand Response Working Group (DRWG) in 2014 to assist in the evolution of DR. It is an open membership forum with an enduring advisory role to assist in the evolution of DR in the IESO-administered markets.

Currently in the DRWG, the IESO is working with stakeholders on ways to expand participation from wider technologies and sectors in demand response particularly from residential load.

<http://www.ieso.ca/Pages/Participate/Stakeholder-Engagement/Working-Groups/Demand-Response-Working-Group.aspx>

3 FRANCE

- Country/region: France
- Peak consumption (GW): ~91.6 GW (2015)

Organization of the energy system

The French energy system is liberalized and unbundled. Demand response is commercially active. Only simple peak and off-peak hour pricing exists at the moment for residential consumers.

How can flexible consumption be valorized in your country?

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment: An experimental program (NEBEF) was conducted in 2014 to allow aggregators to bid curtailed load in wholesale markets. This program is open to all eligible aggregators today.

- Correct imbalance in the portfolio of a BRP

Comment:

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment: Since July 2014, industrial customers can modify their consumption to offer reserves to RTE (the French TSO).

- Strategic reserve or capacity market

Comment: France does not have a strategic reserve, or a capacity market (opening in 2017).

- Contracted by DSO (for grid operation or other objectives)

Comment: The largest DSO (ENEDIS) is currently evaluating the various opportunities for flexibility in distribution networks. A decree was passed related to experiments on local flexibility by DSOs on the 31st of May 2016.

- Other:

If applicable, what is the order of magnitude of demand response programs in your country?

According to the regulator, there is limited or no development of explicit demand response beyond the balancing market.

Ancillary Service	Total Capacity Contracted ³
Primary Control (FCR)	600 – 700 MW
Secondary Control (FRRa)	600 – 1000 MW
Fast Reserve (FRRm)	Maximum 1000 MW
Complementary Reserve (RR)	Maximum 500 MW
Demand Response Call for Tender (DSR-RR)	Maximum 1800 MW

Barriers and challenges for further integration of demand response

- Before 2010, the French institutional framework is made in such a way that demand response players want to access the same market as energy suppliers. Given that the EC demands full participation of DR, a specialized market with a compatible design may be required for DR.

³ Mapping Demand Response in Europe Today 2015 - Smart Energy Demand Coalition (SEDC). Retrieved from: <http://www.smartenergydemand.eu/wp-content/uploads/2015/09/Mapping-Demand-Response-in-Europe-Today-2015.pdf> (Accessed on 26/08/2015)

- The regulatory framework in France fully supports DR participation and commercialization. Technical barriers are the main barriers that exist.
- Small companies and residences connected to distribution have a barrier for participation, either due to the lack of smart meters, or due to the lack of confidence in the data provided by them. The Linky project aims to install 35 million smart meters by 2021, and this should pave the way for easier participation in DR.

Recent and running projects on demand response and dynamic pricing

Short facts on the Greenlys project

With a target of several hundred residential tester consumers and several dozen commercial sites in Lyon and Grenoble, GreenLys is an experimental Smart Grid project which heralds the energy model of the future. It was selected as part of the first investment programme for the future, following a call for expressions of interest launched by the French Environment and Energy Management Agency (ADEME) in 2009. 43 million euros will be invested over the period 2012-2016, including 9.6 million euros of funding from the ADEME.

Approved by the competitive cluster TENERRDIS (Technologies Energies Nouvelles, Energies Renouvelables Rhône-Alpes, Drome, Isère, Savoie), GreenLys is also supported by the cities of Lyon and Grenoble.

Website: www.greenlys.fr

Short summary of main results of the project

The results of an experimental campaign on demand response with an office building in Grenoble were presented at the 2015 IEEE 15th International Conference on Environment and Electrical Engineering (EEEIC). The paper is attached with this report.

Other reports in the project:

"COMMERCIAL SITES ARE TRIALLING AN INNOVATIVE SMART ENERGY MANAGEMENT SOLUTION" <http://greenlys.fr/wp-content/uploads/2015/03/2-tertiaire-2015.pdf>

Are there certain initiatives, regulatory or otherwise, that promote demand response in your country?

The Commission de Régulation de l'Énergie (CRE) mentions that it is fully and actively promoting the development of demand side flexibility. In effect, the French market rules today allow (at least on paper) for participation from all types of demand-side resources (from large industrial customers to the smallest household).

4 IRELAND

- Country/region: Ireland
- Peak consumption (GW): ~7GW

How is your energy system organized?

The energy system in Ireland is unbundled and liberalized. Demand response is commercially active, and independent aggregators exist. A dynamic pricing system is currently not possible, as it is contingent on the roll-out of smart meters.

How can flexible consumption be valorized in your country?

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment: Available, through Demand Side Units, registered in the market. Large industrial processes as well as smaller consumers (e.g. commercial freezers) are contracted down to 20kW

- Correct imbalance in the portfolio of a BRP

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment: Not at present but currently engaging in a number of trials to prove provision of a range of flexibility services

- Strategic reserve or capacity market

Comment: Demand Side Units can participate in the capacity market

- Contracted by DSO (for grid operation or other objectives)

Comment:

- Other:

The 'Demand Side Units' mechanism was heavily supported and promoted by TSOs at request of regulatory authorities. A residential DSM project will be commencing soon to ascertain the benefits of demand response at residential level. Qualification trials for demand side providing ancillary/system services will commence in the next year.

If applicable, what is the order of magnitude of demand response programs in your country?

Product (name + description)	Power (MW)
Demand Side Units (DSU) operating in energy and capacity markets	300 MW
Short-Term Active Response (STAR) – Interruptible load providing reserve ancillary service	90 MW
Powersave (Emergency reserves in the case where not enough generation to meet demand)	5 MW (reducing as many sites moving to DSUs)

Barriers and challenges for further integration of demand response

Currently, demand response is only available to demand sites with interval metering, so larger commercial and industrial customers (approx.. 14,000).

Apart from STAR, no demand response loads are taking part in ancillary/system services market. This technology is not yet proven in Ireland, but plans exist for qualification trails to prove.

Recent and running projects on demand response and dynamic pricing

- RealValue is a €15.5m European energy storage project funded by Horizon 2020. The project consortium, which consists of 12 partners, received €12m funding from the EU. RealValue involved three physical deployments of Smart Electric Thermal Storage (SETS) appliances in 1,250 homes in Germany, Latvia and Ireland, each representing unique market conditions, representative of the diversity of EU energy markets (Glen Dimplex manufacturers SETS appliances – Smart Home space and water heating devices). To validate the model at large scale, RealValue will use modelling and virtual demonstration to prove the technical and commercial potential of local small-scale energy storage in millions of homes across representative EU regions. RealValue spans the entire value chain, from householders through supply, distribution, transmission and generation to system operators. The business case for small-scale storage would be evaluated and the barriers associated with its integration into the electricity grid and energy markets will be identified.
- In 2015, EirGrid launched a competition for a Residential Demand Scheme to provide flexibility services. The project, known as Power Off and Save, has been developed with Electric Ireland, who were awarded the contract to provide the service to EirGrid based on the open tender competition in late 2015. The objectives of the Power Off and Save project are to have a residential consumer-based demand response project, with a capability of between 2 and 5MW of demand response, from either load reduction or on-site generation via either remote control and/or direct consumer action. The demand response can be achieved through:
 - modifying on-site electrical demand in the home, including kitchen appliances, lifestyle devices, electrical heating and/or electric vehicles;
 - and/or engaging on-site generation including heat pumps and solar PV panels.

Power Off and Save will involve 1,500 residential customers over an 18 month-period. Those who sign up will be asked to switch off appliances for about 30 minutes on ten occasions. Customers will be rewarded with up to €100 off their bill. Identifying the technical, commercial and contractual barriers to residential consumers participating in Demand Side Management is a key outcome of this project.

- FINESCE (Complete) - ESB Networks completed FINESCE, a €15m EU FP7 funded program, with an aim of appraising the potential value of distributed loads and aggregated loads in the form of eMobility vehicles over a 2 year period. From a physical technology level the capabilities of 100 vehicles were appraised and vehicles were synthetically operated in sympathy with market pricing and signals. It was then possible to appraise what services can be presented to a flexibility market by the eMobility sector (i.e. frequency response peak load shed arbitrage etc.)
- Based on these findings a report on the value of such a service based on a penetration of 100,000 electric vehicles was published.
- PlangridEV (Complete) - ESB Networks as part of a EU consortium conducted a study into the implication of large controllable loads at a residential level in rural LV networks. This was completed to gain an appreciation of what types of activities can currently be supported as well as what services will be needed to from a flexibility context to allow the distribution system to best support future flexible loads.
- SUCCESS – SUCCESS is a €5m H2020 project looking primarily at the best way to securely control flexible loads in the transmission and distribution system. DSO ancillary services will be called upon in specific areas of network due to local constraints. This necessitates that the service has a higher availability and integrity than the majority of traditional TSO level services. However, this requirement is coupled with the necessity of the service being extremely cost effective as it will be considered mass roll out.
- DistriHost – The purpose of this project is to enable the DSO to perform distribution system-wide hosting capacity assessments in an efficient and automated way using existing planning tools and data. This will allow the DSO to technically assess the ability of the system to support flexibility services and also highlight areas which could potentially avail of such services for active grid management and active grid support.
- SERVO – In brief, the aim of the Servo platform is a service allowing DSM aggregators the greatest possible freedom to control load without compromising network performance and integrity. It operates as a mechanism ensuring that 100% of network availability is exposed to customers and aggregators without incurring unavoidable increases in electrical network costs.
- StoreNet – StoreNet is a €1m Science Foundation Ireland funded project looking at opportunities associated with the implementation of small scale residential battery storage in the distribution system. Engagement from a DSO perspective allows a full appreciation of the opportunities presented by storage, flexibility services and DSM located deeply within the MV/LV system.

5 JAPAN

- Country/region: Japan
- Peak consumption (GW): ~152.7GW (Total of 10 large utilities in 2014)⁴

How is your energy system organized?

The energy system in Japan is liberalized, but still vertically integrated energy companies are operating. Japan is on the way to an unbundling of the utility structure by the year 2020. Demand response is not yet active in Japan on a commercial level, and dynamic prices are currently not enabled either.

How can flexible consumption be valorized in your country?

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment: Since JPEX (Japan Electric Power eXchange) is comprised of Day-Ahead Market (Spot Market) and Real-Time Market (Hour-Ahead Market), it is explained that arbitrage is theoretically possible⁵.

- Correct imbalance in the portfolio of a BRP

Comment: Market design is under consideration.

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment:

The Japanese market design is under consideration.

Japan does not have an ancillary market at this moment but conventionally, vertically integrated utilities have reserves (primary, secondary, tertiary⁶):

-“Syundo Yobiryoku” 3% (Approximately equal to primary reserve)

-“Unten Yobiryoku” 3~5% (Approximately equal to secondary and tertiary reserve)

- Strategic reserve or capacity market

Comment: Currently, neither of them exists.

- Contracted by DSO (for grid operation or other objectives)

Comment: It is vertically integrated and DSO does not exist in the current system.

- Other:

General comments:

Toward full liberalization of the electricity market in 2020, stakeholders are discussing the market structure after unbundling of generation, transmission and distribution.

Which flexible consumption sources are especially exploited? (e.g. boilers, EV, industrial processes...)

In Japan, supply-demand adjustment contract was introduced for high voltage customers. Thus, industrial customers adjust their electric power usage in response to advanced notification and during peak hours in summer, for example in the daytime on weekdays, adjust the demand based on a contract to reduce their power usage according to a predetermined plan. Besides, for general customers, electricity rates are designed for peak-shifting, making night-time charging of heat pump water heaters and electric vehicles less expensive.

⁴ More info on <http://www5.fepc.or.jp/tokei/>

⁵ More info on <http://www.jepx.org/english/index.html>

⁶ https://www.occto.or.jp/oshirase/kakufuiinkai/files/cyousei_01_05.pdf

These rate menus are likely to be reviewed depending on progress toward electricity liberalization and changes in Japan's energy mix.

If applicable, what is the order of magnitude of demand response programs in your country?

Product (name + description)	Power (MW)
N/A (implemented only in the demonstration project)	

Barriers and challenges for further integration of demand response

An electricity system reform has been in progress in Japan: the electricity retail market was fully liberalized in April this year (2016). In addition, unbundling of generation, transmission and distribution will be carried out in four years. Under this circumstance, the design of demand response itself has become an issue in Japan, and the creation of a demand response market is being discussed as well as the aforementioned Japan's electricity system reform.

Recent and running projects on demand response and dynamic pricing

Example of Dynamic Pricing Demonstration Project

While the smart community demonstration project was carried out in Kitakyushu-city, Kyushu prefecture from 2010 to 2014, peak-shaving effects of dynamic pricing were examined for studying energy management involving consumers. In this project, 5-tiered price setting (JPY15/kWh; JPY50/kWh; JPY75/kWh; JPY100/kWh; JPY150/kWh) was applied to afternoon (between 13:00 and 16:00) in summer (from June to September); morning (between 7:00 and 9:00) and night-time (between 18:00 and 19:00) in winter (from December to March). A maximum of 201 households and 45 offices participated in this project and as a result, peak-shaving effects were around 20% in overall residential sector and about 50% in the HEMS installed households.

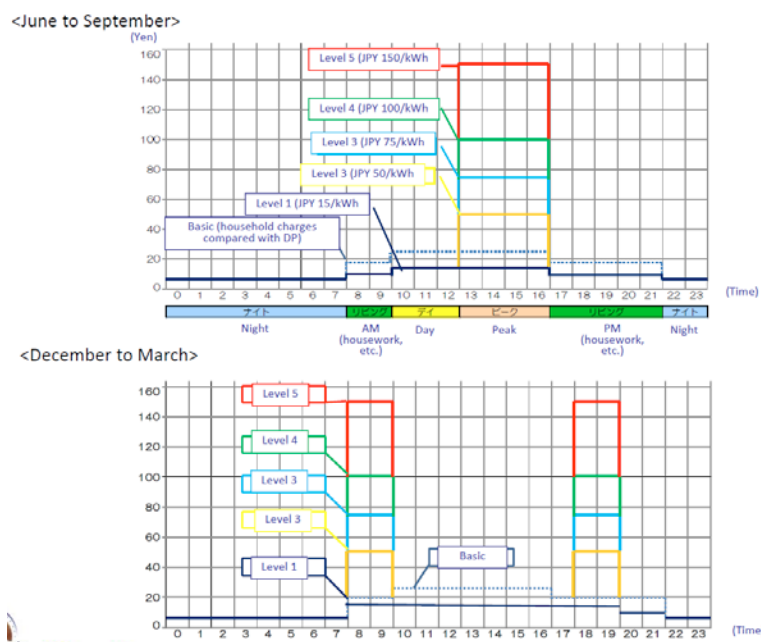


Figure Price Setting of the Demonstration Project

Source: https://www.smart-japan.org/english/vcms_cf/files/Kitakyushu_Project_English.pdf
 Smart Community Summit 2015 Presentation Material "Result of the Kitakyushu Smart Community Creation Project", June 18, 2015

Example of Demand Response (DR) Demonstration Project

Background and objective

In addition to demand response which attempts to achieve peak-shaving effects through changes in electricity rates, another effort is made in Japan to introduce demand response of negawatt trading, which manages the amount of electricity saved (negawatt) quantitatively to be traded in the market. Such negawatt trading scheme includes not only peak-shaving and peak-shifting but also ancillary services such as reserve procurement and frequency regulation.

Against such a background, demonstration projects are being implemented for establishing a DR system in collaboration with Japanese utilities and assessing effectiveness of negawatt trading by using this system, funded by the Ministry of Economy, Trade and Industry (METI). In these projects, utilities in three regions called DR events between 1pm and 5pm from August to October; between 9am and 11am and between 5pm and 7pm from November to January with three types of DR menu, namely 10-minute/1-hour/1-day advanced notification. They examined DR effects based on their predetermined contracted capacity and supplied capacity. Furthermore, DR menu of 10-minute advanced notification provided incentives of JPY6,500/kW year and JPY20/kWh. Similarly, incentives of JPY5,000/kW year and JPY20/kWh were introduced for 1-hour advanced notification DR menu and JPY30/kWh for 1-day advanced notification DR menu.

Source: Final Report of "FY2014 Subsidies for project expenses for the demonstration of next-generation energy technologies (FY2014 supplementary budget)"
http://www.nepc.or.jp/topics/2016/0330_1.html

Outcome

Though outcomes of the projects demonstrated that DR brought about demand saving effects, some issues were also identified, for example, achievement rate (ratio of the supplied amount to the contracted capacity) was low; achievement rate significantly fluctuated; the amount of supply largely exceeded contracted capacity. In this project, the point was to find out whether DR system could react as well as generators in response to commands from a DR server. Unfortunately, it can be said that the DR system's reliability was not equivalent to that of generators and there is room for improvement in terms of accuracy of the DR system toward DR implementation. To achieve such accuracy, following items should be considered: increasing the number of participating customers; building a portfolio for each aggregator based on every customer's consumption characteristics; considering fully automated control system.

6 NORWAY

- Country/region: Norway
- Peak consumption (GW): ~24GW

How is your energy system organized?

The Norwegian market is liberalized and partly unbundled. Today, only companies with more than 100 000 customers are obligated to corporately and functional unbundling (i.e. unbundling of legal form, organisation and decision making) of the DSO from other vertically integrated activities such as generation/retail. The Parliament has decided to introduce corporately and functional separation for all DSOs within 2021. There is a partial opening for demand response, but independent aggregators are not commercially active yet. Smart Meter rollouts are now close to completion (deadline 1.1.2019) and it is a mandated requirement that dynamic hourly pricing should be made available to all consumers. Large customers (>100 MWh/year) already have an hourly measurement.

How can flexible consumption be valorized in your country?

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment: Flexibility sources have a significant participation in the Spot Market

- Correct imbalance in the portfolio of a BRP

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment: Primary reserve is recently open for demand response, secondary reserve is legally open for demand response, but participation is practically unfeasible. Tertiary reserve is open for demand response, also included in option market tertiary reserves. In all Primary, Secondary and Tertiary Reserves, aggregation is legally possible, but still difficult to implement, and some market developments are required.

- Strategic reserve or capacity market

Comment: Norway has not developed a capacity market for demand-side participants.

- Contracted by DSO (for grid operation or other objectives)

Comment: The DSO is not (yet) contracting flexible consumption for grid operation.

- Other:

General comments:

Which flexible consumption sources are especially exploited? (e.g. boilers, EV, industrial processes...)

Norwegian demand response potential is estimated to be 5000 MW, where over 2000 MW is industry. On the other hand, large industry is already active in reserve markets and is to some extent providing price sensitive bids in the spot market. The remaining questions are therefore if there are additional volumes that may be activated in the case of capacity shortage – and what it takes to provide such response. Through pilot projects the potential of demand response from 50% of water heaters at residential customers have been estimated to 600 MW in the peak hour (hour 9), but this is not implemented. Larger electrical boilers are also sources for flexibility, and they have been utilized for demand response through a specific grid tariff, but this tariff is not offered to new customers today.

Barriers and challenges for further integration of demand response

- **Independent aggregator.** Not possible to participate independently in the market as an aggregator. Demand-Side Resources mainly participate through the Regulating Power Market (specific balancing market common to Nordic countries and operated by the power exchange, NordPool Spot) and can participate in the spot market.

- **Bid size:** The main remaining barrier in the balancing market is the 10 MW minimum bid size. The minimum bid size represents a barrier for Demand Response and several other technical requirements appear as generation-oriented. The aggregator needs to be able to start with a small portfolio.
- **Real time measurement** is a barrier to access the Regulated Power Market (RPM), especially for small units. Smart meters will represent an important step in the right direction in order to facilitate new products and services.
- **Manual processes** in the balancing market (RPM): The RPM is still largely based on manual calls (using telephones), which restricts the potential of Demand Response, especially for small loads.
- **Geographic scope:** different price areas in various markets.
- **Aggregated bids:** Currently it is not practicable with aggregated bid in reserve markets.
- **Design of products:** Many markets have been set up with demands for symmetrical bid. This makes it difficult for the consumption side to participate unless you have the energy store to play on. Normally participating consumption since only with upregulation and therefore should products redesigned / divided up so that one can bid for only one adjustment direction for all markets.
- **Duration** of different products is also an important parameter that should be taken into consideration. Shorter durations in bids (15 minutes) will open access to far more reserves when many industrial loads represent much flexibility in a shorter horizon than one hour.
- **Available price signals:** The fact that the end customer is not yet sufficiently exposed to price signals or that price fluctuations are not sufficient for the end user to respond to.
- **Baseline Calculation:** A big discussion in Europe has centered on the profile the settlement shall be related to. In its simplest form, this can be based on the balance market settlement, but if one is to drop to several small loads behind a connection point and these affect the load profiles for reconnection, it may be more appropriate to run the settlement as a difference between the measured load profile and a theoretical load profile describing how load outlet would be without disconnection.

Recent and running projects on demand response and dynamic pricing

Demo projects: Demo Steinkjer, Smart Energi Hvaler, Demo Lyse, Demo Statnett FoU

R&D projects: DeVID, FlexEITerm, ChargeFlex, ZEB/Skarpnes

DeVID – Demonstration and Verification of the future Intelligent Distribution grid. (2012-2015)

Running R&D projects:

- **FlexNett** - Flexibility in the future smart distribution grid. (2015-2017). The main objective of the project is contributing to increased flexibility in the future smart distribution grid by demonstration and verification of technical and market based solutions for flexibility, on different grid levels and for different stakeholders
- **SmartTariff** – The main objective of this project is to develop the future tariffs for both the distribution grid and the energy contract. (2014-2017)

Recent:

Research Council's major energy program - ENERGIX - handing out a total of NOK 500 million for 58 new projects on green energy in December 2015. Three exciting smart grid -related projects received funding:

- Competence project in Businesses (KPN)- Modelling Flexible Resources in Smart Distribution Grid . (2016-2019). Project Manager: SINTEF Energy.
- Innovation Project for the business sector (IPN)- Control Centre Platform for Synchrophasor and PMU Applications, Integration and Data Exchange. Project manager: Statnett
- Smarter Asset Management with Big Data. Project manager: Statnett

For more projects: <http://smartgrids.no/fou/>

Are there certain initiatives, regulatory or otherwise, that promote demand response in your country?

DSO's can recover costs related to R&D and demo projects up to 0,3% of the companies' book capital.

In addition, the revenue cap for utility company's incentives to increase efficiency and cut costs. Another incentive for Smart Grid and demand response is to postpone reinvestments or new investments in the grid due to overload.

Smart Meter rollouts are now close to completion (deadline 1.1.2019) and it is a mandated requirement that dynamic hourly pricing should be made available to all consumers.

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- "Demand Response From Household Customers: Experiences From a Pilot Study in Norway", Hanne Sæle and Ove S. Grande, IEEE TRANSACTIONS ON SMART GRID, VOL. 2, NO. 1, MARCH 2011
- CIRED Workshop - Rome, 11-12 June 2014, Paper 0317, "NETWORK TARIFFS AND ENERGY CONTRACTS WITH INCENTIVES FOR DEMAND RESPONSE", Hanne SÆLE, Jan A. FOOSNÆS, Vidar KRISTOFFERSEN, Tor Erling NORDAL, Ove S. GRANDE, Bernt A. BREMDAL
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Pluss Thema:

(Thema, 2016), english summary on page 8, <http://www.thema.no/wp-content/uploads/2016/04/TE-15-37-Teoretisk-tiln%C3%A6rming-til-en-markedsI%C3%B8sning-for-lokal-fleksibilitet-FINAL.pdf>

7 SINGAPORE

- Country/region: Singapore
- Peak consumption (GW): ~7 GW

How is your energy system organized?

The energy system in Singapore is liberalized. Demand response currently only with respect to participating in the ancillary services as an interruptible load. Loads are not yet able to compete in the wholesale market. However, the theoretical framework for their inclusion in the wholesale market is complete. According to latest reports, demand response will be integrated into the National Electricity Market of Singapore in 2016.

As for dynamic pricing, consumers (mainly commercial and industrial) are classified as either contestable or non-contestable, depending on their level of electricity usage. Contestable consumers, with average monthly consumption of more than 2000 kWh may choose to purchase electricity from a retailer, or directly from the wholesale market or indirectly from the wholesale market through the SingaporePower (SP) Services. Non-contestable consumers are supplied by SP Services.

Hence, residential consumers, due to their low consumption are not exposed to dynamic pricing. However, there are discussions for lowering AMC, for achieving higher contestability in the future.

How can flexible consumption be valorized in your country?

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment: In Singapore, the market is operated on half-hourly intervals. However, large commercial facilities and industrial are natural candidates for this. Furthermore, with the recent introduction of future markets, market participants have opportunities to hedge risks and improve their business model.

- Correct imbalance in the portfolio of a BRP

Comment: Due to a manageable size of the power system of Singapore, dispatch is already performed near real-time. In particular, dispatch solution is calculated 5 minutes before the half-hour trading period. Hence, there are no BRPs in Singapore.

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment: Ancillary services are the primary source of valorization for aggregators in Singapore. Interruptible load is able to participate across all primary, secondary and contingency reserves.

- Strategic reserve or capacity market

Comment: There is no strategic reserve or capacity market in Singapore.

- Contracted by DSO (for grid operation or other objectives)

Comment: There is no DSO contracting flexible loads in Singapore. However, options to obtain higher end use visibility (smart metering) are being investigated through advanced metering pilots.

- Other:

If applicable, what is the order of magnitude of demand response programs in your country?

Product (name + description)	Power (MW)
Interruptible Load: Primary and Secondary Reserves	23.2MW
Interruptible Load: Contingency Reserves	33.2 MW

Barriers and challenges for further integration of demand response

- The deployment of smart meters is the biggest technical challenge along the path of adopting demand response programs.
- A challenge also exists in the form of material and constructional composition of buildings in Singapore. This is very important for the case of Singapore, where space conditioning presents the largest available potential for demand flexibility.
- Energy Market Authority (EMA) is working towards a framework for introducing the demand response program. However, apart from technical challenges, there is also the need for innovative market mechanisms, in order to establish a business-model-friendly demand response program.

Recent and running projects on demand response and dynamic pricing

The interruptible load programs have been established since their allowance by the EMA. However, most of the contracted loads are industrial, which makes the publicly available data regarding these programs difficult to find.

To facilitate the demand response program (yet to start), EMA together with the Singapore Power started the Intelligent Energy System (IES) pilot in 2009. The main goals of this pilot were to harness the advancements in communication technology to further enhance its electricity transmission and distribution networks.

The general information regarding the IES pilot can be found under the link below:

<https://www.ema.gov.sg/cmsmedia/Newsletter/2012/04/eyeon-emaIES.html>

Singapore's Intelligent Energy System Pilot Project, doi: 10.1109/APEMC.2012.6237950

The results/findings from this project have not yet been made publicly available.

Initiatives towards implementation of demand response

In Singapore, (1) EMA's demand response market framework, (2) IES Pilot and (3) future markets can be considered as major steps towards establishing a demand response program. However, in the future, in order to promote demand response, EMA is also working towards full retail competition. This means that in the future small households will be able to purchase energy from retailers.

Relevant documentation

The latest release from the Energy Market Authority regarding the implementation of demand response in Singapore can be found under:

https://www.ema.gov.sg/cmsmedia/Electricity/Demand_Response/Final_Determination_Demand_Response_28_Oct_2013_Final.pdf

8 SOUTH KOREA

- Country/region: Korea
- Peak consumption (GW): ~83GW

How is your energy system organized?

The energy system in Korea is regulated. However, demand response is active since 2014 and independent aggregators exist. Dynamic pricing however is currently not possible.

There are two types of Demand side management in Korea.

- **“DR(Demand Response)” system** based on incentives and charges
 - Demand bid and DR operated by KPX(Korea Power Exchange)
 - Weekly forecast, emergency power cut by KEPCO
- **“EE(Energy Efficiency)” system** focusing on supplying high efficiency devices and etc.

How can flexible consumption be valorized in your country?

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment: Currently there is a market only competing with power generation resource, via demand resource bidding 1 day ahead. Only large industrial companies and buildings can participate, ways to activate small and medium electric consumers are under consideration.

- Correct imbalance in the portfolio of a BRP

Comment: Existing program is to solve imbalance of supply and demand in real time, and it is for emergency countermeasures of demand and supply. But there is no market-related frequency regulation and electric power reserve.

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment:

- Strategic reserve or capacity market

Comment:

- Contracted by DSO (for grid operation or other objectives)

Comment:

- Other:

If applicable, what is the order of magnitude of demand response programs in your country?

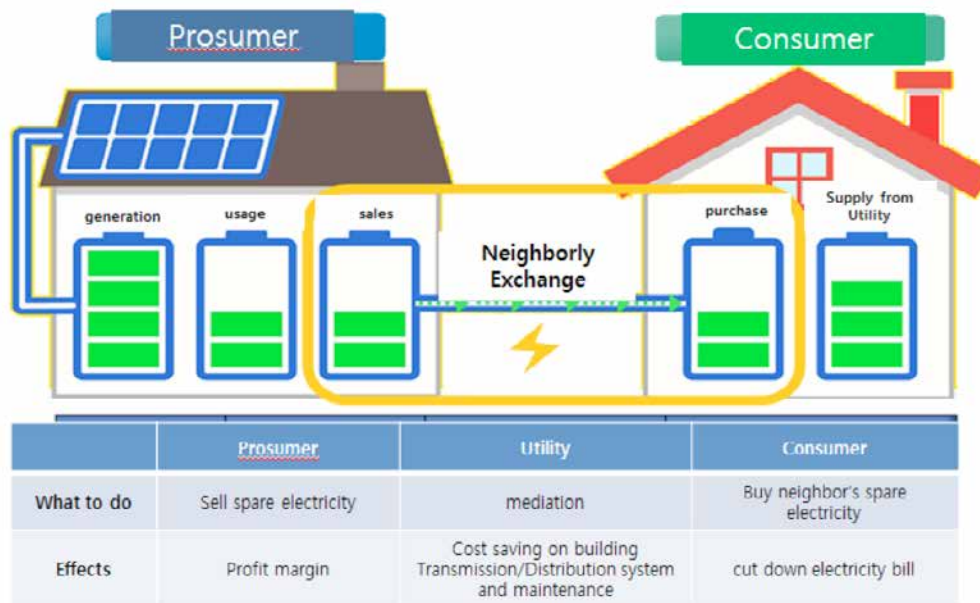
Product (name + description)	Power (MW)
Peak reduction DR (real-time load dispatch)	3,272MW
Bill reduction DR (market 1 day ahead)	More than 1M, maximum scale is no limit (only the resources, listed on peak reduction DR, are allowed to participate)

Barriers and challenges for further integration of demand response

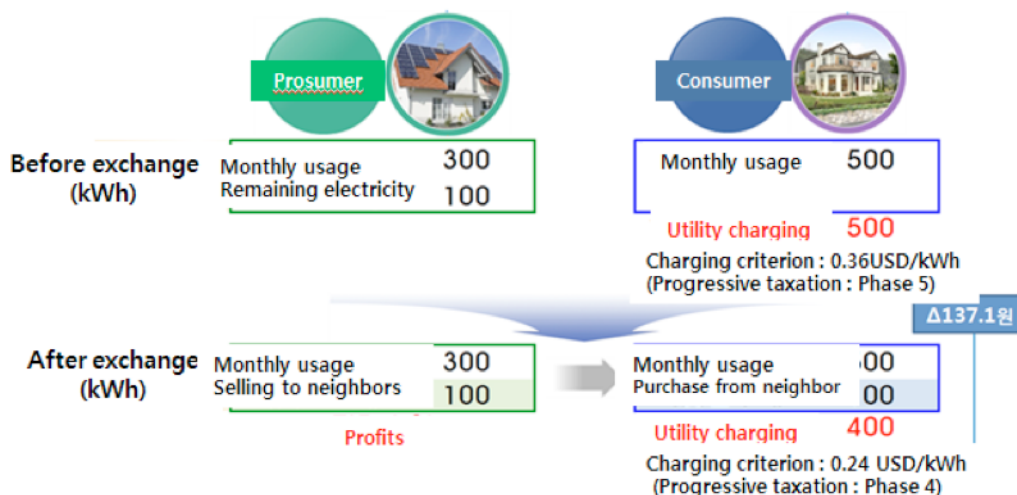
- Utility's market participation, business operator's participation restriction, reliability and etc.
- Accurate pricing of load reduction, shrinkage of investment due to uncertainty about DR business's sustainability...

Recent and running projects on demand response and dynamic pricing

- MOTIE-KEPCO "Power exchange among Prosumer Neighbors" Business



Neighbourly exchange Model



Expected effect (example): Ease the burden of progressive taxation by purchasing electricity from neighbors

- **Are there certain initiatives, regulatory or otherwise, that promote demand response in your country?**
- MOTIE (Ministry of Trade, Industry and Energy) announced “a Long-Term Strategy for ‘Negawatt market’ Promotion” aiming to assign demand resources 5% of peak power by 2030.
 - ‘Negawatt market’: Through this initiative, the electricity consumer (residential, commercial facility, factory and school) could make a contract with DR management businesses and earn money by selling the saved energy to the power market, in case of high pricing and an incident in power system during peak hours. For national participation, small scale user engagement escalation could allow home/commercial building/school to sell saved energy.
 - For that, in the short run, a pilot project is expected to start next year aimed at the homes and the business areas which have metering infrastructure in place. Also the evaluation method on electrical use reduction and incentive levels will be studied.
 - For the longer term, technology development and equipment similar to public utility is supported and active metering infrastructure (AMI) will be deployed
 - For the market promotion, an application collecting information on which districts have great DR potential will be developed by 2017.
 - To foster stable investment environment, analysis on whole country DR market potential and the outlook for DR market scale will be conducted once in two years.
 - Opportunities for industry to participate in various pilot projects will be granted. In this way, small/medium DR businesses can discover and utilize demand resources from smart grid and micro grid etc.
 - Expanding joint business models with existing businesses will encourage companies to develop into integrated energy service.
 - For enhancing transparency and public information, the government will reinforce disclosure of information on such as each business’s performance and market surveillance for consumer protection and fair competition.
- The ‘Energy prosumer’ energy exchange market will be created and opened in 2017
 - A small amount of energy could be gathered and sold in the energy prosumer market, produced energy by general home can be sold to the market. Prosumers sell saved energy to neighbors who need to lessen electricity billing due to progressive taxation. Both of them have energy cost reduction effect.
 - Based on the system, Korea aims to expand energy prosumer business around the country by 2030. For that, Micro grid projects will be significantly expanded in college/industry districts/islands.
 - Trial application of Zero energy building (combined Renewable energy and insulation technique) to public housing. From 2025, new buildings should be obligatorily built as zero energy buildings.

9 TURKEY

- Country/region: Turkey
- Peak consumption (GW): ~43 GW

Organization of the energy system:

Turkish distribution operations have been unbundled from the vertically integrated Turkish Electricity Company in 1993. In 2001, further unbundling of the remaining company assets resulted with separate transmission, generation and wholesale companies. Especially after 2010, the Turkish system has been experiencing an increase in effective reserve with installed capacity additions of more than 4000 MW/year. Overall, the Turkish electricity sector is in line with EU market regulations.

Since rapid demand growth and chronic investment shortage were the main properties of Turkish market before 2001, -old school- demand side management is well known in Turkey. Even changing the time slot of popular TV programs to shift demand has been experimented with. However, price incentivized demand side management has been recently considered as part of ancillary mechanisms. In 2013, a pilot study to test the flexibility through steel, cement producers and industrial zones has been discussed. Flexible demand is also studied by Turkish appliance manufacturers. However, the recent supply boom with plenty of CCGT with low capacity utilizations has inhibited further developments.

Although the regulations pave the way for such a scheme, the financial constraints limit the extent of experimental programs. Recently, the EMRA (Turkish regulator) has awarded pilot demand side projects to distribution companies through R&D budgets. US companies are expected to demonstrate another pilot project involving a shopping mall in Kayseri. The Turkish TSO is expected to sign contracts for demand side management under the ancillary services framework from aggregators.

Flexible consumption is valorized as follows:

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment: Trade companies advice the consumer side to shift their demand for extra discounts. Also companies with large demand and supply items offer incentives for day-ahead flexibility when wholesale prices shoot up.

- Correct imbalance in the portfolio of a Balancing Responsible Party

Comment:

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment: Ancillary services are currently the only regulation allowing demand side management, although limitations exist.

- Strategic reserve or capacity market

Comment: The transmission operator is considering separate contracts for demand response.

- Contracted by DSO (for grid operation or other objectives)

Comment: Currently the issue is overlooked by transmission operators.

Order of magnitude of demand response products

It is estimated that in 2012, during the natural gas crises, over 600 MW of day ahead load shedding have been achieved via communicating with parties (phone calls, emails).

Barriers and challenges

The main barriers for demand response in Turkey are perceived to be the costs, excess supply capacity, overall stagnating demand, lack of regional pricing possibilities and lack of infrastructure.

10 TAIWAN

- Country/region: Taiwan, ROC
- Peak consumption (GW): ~35GW (in 2015)

How is your energy system organized?

The energy system in Taiwan is regulated. Taiwan Power Company (Taipower) was established on May 1, 1946. It is a vertically integrated electrical power utility company. Its business scope includes generation, transmission, distribution and sales of electricity.

As of 2014, the Taipower system (including independent power plants, IPPs) had a total installed capacity of 40.79 GW. Its main energy sources comprise thermal and nuclear power, combined with hydro and other forms of renewable energy. Demand

Despite the fact that independent aggregators don't exist in Taiwan, demand response is integrated into the system. The related time-based pricing program is proposed by the power company, but not approved by government yet.

[Reference website] http://www.taipower.com.tw/e_content/index.aspx

How can flexible consumption be valorized in your country?

Arbitrage on the day-ahead/intraday wholesale energy market

Comment:

Correct imbalance in the portfolio of a BRP

Comment:

Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment: Actually, Taiwan has only one vertical integrated power company providing all power service. The ancillary service is operated by the company for itself.

Strategic reserve or capacity market

Comment:

Contracted by DSO (for grid operation or other objectives)

Comment:

Other:

General comments:

Taipower has practiced load management for more than 30 years, from real-time liberalized-market pricing and demanded trading to demand-based response measures that balance the system. All these approaches have been continually improved. In 2014, peak clipping was 4.57 GW, accounting for 13.1% of the peak load at 34.821 GW, which mitigated the pressure of power demand during peak times.

If applicable, what is the order of magnitude of demand response programs in your country?

Product (name + description)	Power (MW)
Scheduled Load Reduction	~1,500
Demand Bidding	~500
Emergency Load Curtailment	~10

Barriers and challenges for further integration of demand response

- There are two main obstacles needing to be overcome in Taiwan's promotion of DR: one is regulation and the other one is market incentive.
- In order to expand Taiwan's overall DR quantity and provide reliable DR source, Taiwan is researching and formulating the system for the promotion of DR Aggregator, but due to the limitation in Electric Act, non-electric industry cannot execute the DR Aggregation business.
- Taiwan's DR incentive is low and the domestic industry has low willingness for the participation in DR.

Recent and running projects on demand response and dynamic pricing

The current Demand Response Project promoted by Taiwan is totally classified into 4 types, including 7 projects:

- Scheduled Load Reduction: it is divided into 3 projects in accordance with the scheduled outage time. The current participative DR quantity is about 1,500MW, and participative consumers exceed 1,000:
 - Selected 8-days (6 hrs on weekdays)
 - Summer-basic (2 hrs on weekdays)
 - Summer-pro (7 hrs on weekdays)
- Emergency Load Curtailment: the current participative DR quantity is about 10MW, and the number of participative consumers is about 15.
 - Emergency 1: aimed at consumers of manufacturing industry, the emergency shall be noticed and executed 2 hours ahead.
 - Emergency 2: in accordance with the notice time, the emergency shall be noticed ahead of 30min, 1 hour, 2 hours and 16:00 in the previous day.
- Demand bidding: consumers determine the price by themselves for bidding, and the winning bidder shall be noticed ahead of 18:00 in the previous day and the project shall be executed at 13:00-17:00 in the next day. The current participative bidding quantity is nearly 500MW, more than 400 consumers.
 - Reliable, providing basic feedback for basic charges and energy charge deduction
 - Volunteer, providing energy charge deduction
- HVAC direct control: aimed at the non-productive power consumers, the direct control system is installed to start and stop air conditioning equipment periodically.

[Reference website] <http://dbp.taipower-ami.com.tw/>

- Country/region: USA
- Peak consumption (GW): ~472GW

How is your energy system organized?

The energy system in the United States is very different from state to state, with regulated systems as well as liberalized markets. Providing an overview of all market systems is beyond the scope of this report, we refer to the website of the USA 'Federal Energy Regulatory Commission' (FERC) for a national overview on the different market zones in the USA⁷:

'Traditional wholesale electricity markets exist primarily in the Southeast, Southwest and Northwest where utilities are responsible for system operations and management, and, typically, for providing power to retail consumers. Utilities in these markets are frequently vertically integrated – they own the generation, transmission and distribution systems used to serve electricity consumers. They may also include federal systems, such as the Bonneville Power Administration, the Tennessee Valley Authority and the Western Area Power Administration. Wholesale physical power trade typically occurs through bilateral transactions, and while the industry had historically traded electricity through bilateral transactions and power pool agreements, Order No. 888 promoted the concept of independent system operators (ISOs).

Along with facilitating open-access to transmission, ISOs operate the transmission system independently of, and foster competition for electricity generation among wholesale market participants. Several groups of transmission owners formed ISOs, some from existing power pools. In Order No. 2000, the Commission encouraged utilities to join regional transmission organizations (RTOs) which, like an ISO, would operate the transmission systems and develop innovative procedures to manage transmission equitably. Each of the ISOs and RTOs have energy and ancillary services markets in which buyers and sellers could bid for or offer generation. The ISOs and RTOs use bid-based markets to determine economic dispatch. While major sections of the country operate under more traditional market structures, two-thirds of the nation's electricity load is served in RTO regions'.

How can flexible consumption be valorized in your country?

- Arbitrage on the day-ahead/intraday wholesale energy market

Comment:

- Correct imbalance in the portfolio of a BRP

Comment:

- Ancillary services for TSO: primary reserve, secondary reserve, tertiary reserve

Comment:

- Strategic reserve or capacity market

Comment:

- Contracted by DSO (for grid operation or other objectives)

Comment:

- Other:

If applicable, what is the order of magnitude of demand response programs in your country?

For this question, we refer to the 'Demand response & smart metering' staff report of the FERC, published in December 2015.

⁷ <http://www.ferc.gov/market-oversight/mkt-electric/overview.asp>

Table 1: Table from ⁸: Potential Peak Reduction from retail demand response programs by NERC region⁹

RTO/ISO	2013		2014	
	Potential Peak Reduction (MW)	Percent of Peak Demand ⁸	Potential Peak Reduction (MW)	Percent of Peak Demand ⁸
California ISO (CAISO)	2,180 ¹	4.8%	2,316 ⁹	5.1%
Electric Reliability Council of Texas (ERCOT)	1,950 ²	2.9%	2,100 ¹⁰	3.2%
ISO New England, Inc. (ISO-NE)	2,100 ³	7.7%	2,487 ¹¹	10.2%
Midcontinent Independent System Operator (MISO)	9,797 ⁴	10.2%	10,356 ¹²	9.0%
New York Independent System Operator (NYISO)	1,307 ⁵	3.8%	1,211 ¹³	4.1%
PJM Interconnection, LLC (PJM)	9,901 ⁶	6.3%	10,416 ¹⁴	7.4%
Southwest Power Pool, Inc. (SPP)	1,563 ⁷	3.5%	48 ¹⁵	0.1%
Total ISO/RTO	28,798	6.1%	28,934	6.2%

Sources:
¹ CAISO 2013 Annual Report on Market Issues & Performance
² ERCOT Quick Facts (Nov. 2013)
³ ISO-NE Demand Response Asset Enrollments (Jan. 8, 2014), p. 2.
⁴ 2013 State of the Market Report for the MISO Electricity Markets, p.72. This figure excludes 366 MW of emergency demand response that is also classified as LMR.
⁵ 2013 Annual Report on Demand Side Management programs of the New York Independent System Operator, Inc., ER01-3001, et al. (Jan. 15, 2014)
⁶ PJM 2013 Demand Response Operations Markets Activity Report, pp. 3-4 (Apr. 18, 2014). Figure represents "unique MW."
⁷ SPP Fast Facts (as of Dec. 2013)
⁸ Sources for peak demand data include: California ISO 2013 & 2014 Annual Reports on Market Issues and Performance; ERCOT 2013 & 2014 Demand and Energy Reports; ISO-NE Net Energy and Peak Load Report (Apr. 2014 & Apr. 2015); 2013 & 2014 State of the Market Reports for the MISO Electricity Markets; 2013 & 2014 State of the Market Reports for the New York ISO Markets; 2013 & 2014 PJM State of the Markets Reports, Vol. 2; SPP 2013 State of the Market Report; SPP Fast Facts (Dec., 2014).
⁹ CAISO 2014 Annual Report on Market Issues & Performance, Table 1.3, p. 32 (June 2015)
¹⁰ ERCOT Quick Facts (Dec. 2014)
¹¹ ISO-NE Demand Response Asset Enrollment, presented at Demand Resources Working Group Meeting (Jan. 7, 2015) (data as of Jan. 1, 2015), p. 2.
¹² 2014 State of the Market Report for the MISO Electricity Market (June 2015)
¹³ 2014 Annual Report on Demand Side Management Programs of the New York Independent System Operator, Inc., ER01-3001 (Jan. 15, 2015), Table 1, p. 7
¹⁴ PJM 2014 Demand Response Operations Markets Activity Report (Apr. 2015), p. 5. Figure represents "unique MW."
¹⁵ SPP Fast Facts (as of Dec. 31, 2014).

Note: Commission staff has not independently verified the accuracy of the RTO, ISO and Independent Market Monitor reports. Values from source data are rounded for publication.

The total flexibility managed by the ISO/RTO (distribution/transmission operator) presents more than 6% of the peak demand.

Barriers and challenges for further integration of demand response

Currently, more than 37% of the meters in the USA are smart meters, where the penetration degree varies from state to state from less than 5% to almost complete¹⁰. Dynamic pricing is expected in the near future in regions with a high penetration of smart meters. For instance, the California Public Utilities Commission is requiring that the three investor-owned utilities establish default time-of-use rates for residential customers in 2019.

Recent and running projects on demand response and dynamic pricing

Currently, customer education and engagement studies are being performed in various states of the USA. As part of the Smart Grid Investment Grant Program, the U.S. Department of Energy (DOE) is partnering with ten utilities to conduct studies estimating the impact of several types of time-based rates, recruitment approaches (i.e., opt-in or opt-out), customer information systems (e.g., in-home displays), and customer automated control systems (e.g., programmable communicating thermostats) on peak demand, electricity consumption, and customer bills. The studies will provide new information for

⁸ Report available at <http://www.ferc.gov/legal/staff-reports/2015/demand-response.pdf>

⁹ NERC stands for North-American Electric Reliability Corporation

¹⁰ See the report <http://cleandedge.com/reports/3rd-Annual-Grid-Modernization-Index> and www.gridwise.org

¹¹ See U.S. DOE, Interim Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies, June 2015, available at http://energy.gov/sites/prod/files/2015/06/f24/ARRACBS_interim_program_impact_report_June2015.pdf.

improving demand response program designs, implementation strategies, and evaluations, as well as facilitating customer education and overall program engagement. Information on the results of these pilots can be found in¹¹.

Regulatory actions in states to promote demand response and dynamic pricing

Below we summarize some examples from¹², where the regulatory actions of a few states are briefly summarized.

California. In July 2015, the California Public Utilities Commission (CPUC) unanimously approved⁹³ a proposal to, among other things, reduce the number of residential rate tiers from four to two, establish default time-of-use (TOU) rates for residential customers starting in 2019 (with an option to remain on the simplified tiered rates), add a “Super-User” surcharge for very large electricity users, and require the state’s three investor-owned utilities (IOUs) to create an outreach program to educate customers in the lower usage tiers about no-cost and low cost energy efficiency measures. As part of the transition to default TOU rates, California’s IOUs must immediately begin designing pilots to test both default and opt-in TOU rate structures for their residential customers. The utilities must file their proposals for rate changes on January 1, 2018. In addition, the CPUC decision rejects a proposal made by the utilities for a fixed monthly charge that would have applied to all residential customers, but leaves open the possibility that such a charge could be considered in some form after TOU rates have been implemented. Instead of requiring customers to pay a fixed monthly amount, the IOUs must propose and implement an amount that is equal to or less than the fixed monthly charge (i.e., a “minimum bill”) this year.

Hawaii. As noted in the 2014 staff report, the Hawaii Public Utilities Commission (HI PUC) ordered the Hawaiian Electric Company (HECO) and its subsidiaries to establish comprehensive goals and metrics for their demand response programs, and to consolidate existing and planned programs into an integrated portfolio. As of the most recent order in the same docket, the HI PUC was still reviewing the Integrated Demand Resource Portfolio Plan (IDRPP) submitted by HECO in July 2014, and subsequent comments, to assess whether the plan complies with previous directives. Because it has yet to issue an order on the IDRPP, the HI PUC found that the existing demand response programs may continue without modification for the 2015 program year.

Illinois. Commonwealth Edison (ComEd) has partnered with Comcast and Nest to offer its customers a choice of smart thermostat demand response programs: Xfinity Home’s “Summer Energy Management Program” or Nest’s “Rush Hour Rewards.” The program allows ComEd to remotely adjust thermostat settings on peak days, but gives customers the ability to override the temperature setting at any time. The first 10,000 customers that enroll by the end of May from either program receive an incentive of \$40 on top of any energy savings.

Michigan. The Michigan Public Service Commission (MPSC) in June 2015 directed DTE Electric and Consumers Energy to implement time-based rate tariffs for their customers. The MPSC directed DTE Electric to, by January 1, 2016, make TOU rates and dynamic peak pricing available on an opt-in basis to all customers with an AMI metered installed for at least one year.¹⁰⁴ Similarly, Consumers Energy must make TOU and dynamic peak pricing rates available on an opt-in basis to its customers by January 1, 2017, subject to further action from the MPSC on the company’s advance meter roll-out in the pending rate case.¹⁰⁵ In addition, both utilities must file a plan within 90 days outlining plans for education, outreach, marketing and customer support related to TOU rates dynamic peak pricing.

¹² <http://www.ferc.gov/legal/staff-reports/2015/demand-response.pdf>

This report compares various regions in the world and their status in demand response. Clearly, the previous chapters show that there are large differences in the application of flexible demand between the regions. In most countries, a combination of arbitrage and ancillary services exists, either by independent aggregators operating commercially in the market, either by a regulated party contracting the demand sources. The amount of arbitrage is often difficult to estimate, in principle large industrial consumers which are active on the wholesale market can shift their consumption to optimize their energy bill, however the exact comparison to a baseline scenario is difficult. What can be estimated however, is the contracted flexible capacity to support the transmission system operator. This can be done either through operational reserves (primary/secondary/tertiary) to stabilize the grid frequency, either through strategic reserves in case of unforeseen events or structural shortages. In the graph below, we compared roughly the available capacity for ancillary services and strategic demand reserves to the peak consumption in the country:

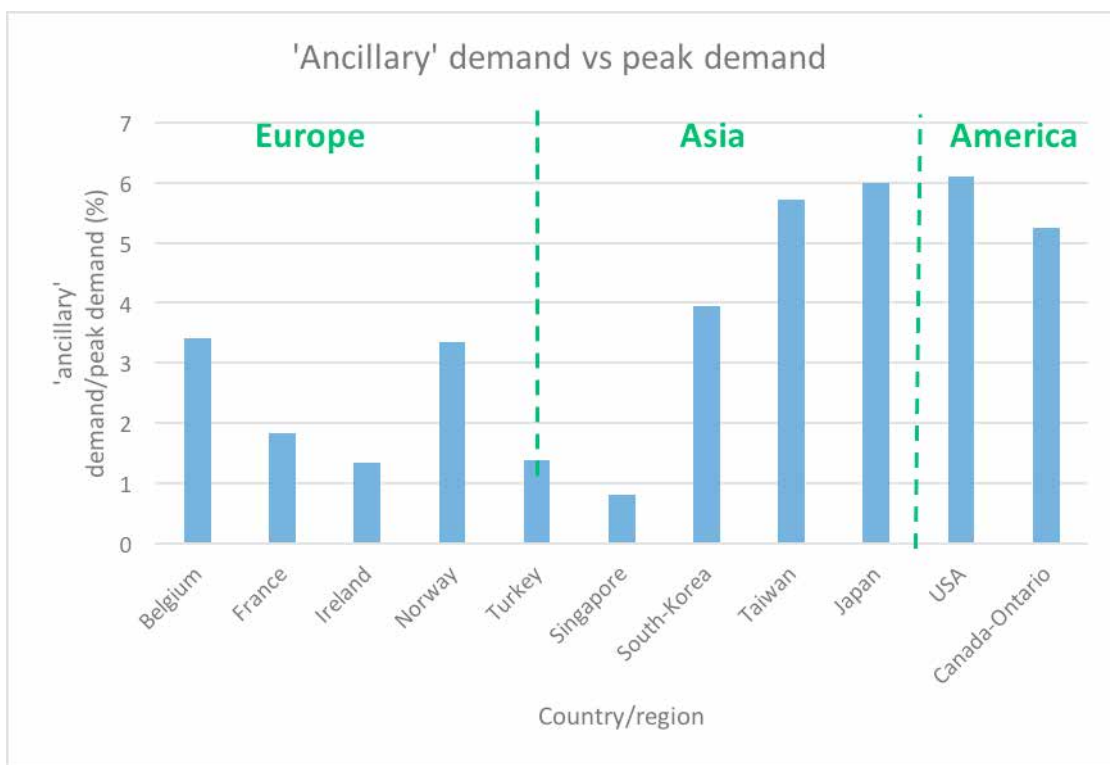


Figure 1: Flexible demand available for ancillary services/strategic reserves as a percentage of the peak consumption.

It has to be noted that this graph aims to compare order of magnitudes rather than taking into account market dynamics and timing or location of the available peak power. For instance, during summer the peak power in France is a lot lower than in winter, due to the large penetration of electric boilers.

As apparent from the graph, in many regions demand is integrated in one way or another into the energy system. The amount is dependent on the specific country, and from these data it is impossible to conclude that one region or continent (Europe, America, Asia) is ahead of another on the aspect of demand side management. However, some interesting observations can be made. For instance, the region of Taiwan does not have a liberalized or unbundled system, and yet a large share of demand sources are contracted within a regulated framework. Also within the USA, different market structures are integrating high levels of demand response. Some Asian countries, like Japan, are in the process of reforming the market to an unbundled market, paving the way for participation of aggregators and flexible demand.

For many of the countries, increasing the share of demand side management was listed as a main priority.

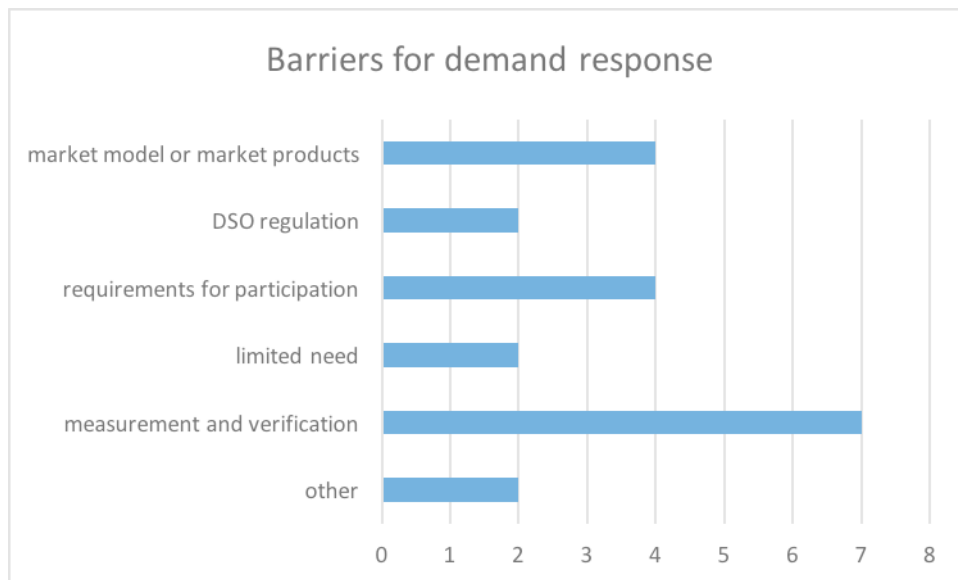


Figure 2: Barriers identified by the GSGF members for further development of demand response in their country

The barrier which was mentioned most was the absence of measurement and verification mechanisms. This can either relate to smart meter deployment, or other measurement of the consumption which can register a time stamp. This is also the main reason why dynamic pricing is still not in place in any of the countries in this report, other than in pilot projects. Overall, the involvement of the small consumer is listed as one of the major challenges in all countries.

A second issue is the absence of a suitable market model, or available market products. This is mainly in issue in the Asian countries, many of which are making structural changes to their energy system, aiming to facilitate aggregators and flexible demand integration. In Europe, the markets are already liberalized and unbundled, however often still barriers exist for demand sources to participate in ancillary services. For instance, participation of demand sources may be hampered by a minimum bid size, a symmetric (up and down regulation) requirement, or even explicitly forbidden for some products.

In some regions, the need for additional demand sources as reserves is limited. This barrier was mentioned by Canada-Ontario and Taiwan, which report already a strong involvement of demand in their system. Another mention was the DSO regulation, this concerns either the DSO having to give an agreement to independent aggregators before flexible demand sources can be contracted, or the DSO not being given the correct incentives to make use of flexible demand ¹³.

To face these challenges, a lot of R&D and demonstration projects are being set up. From the information given in the report, we conclude that for most of the countries, the extension of demand response mechanisms towards small consumers presents one of the main challenges. Evidently, cost-effective measurement and verification mechanisms are a key topic. Including small consumers is not only a matter of appropriate regulation, , since technical challenges still exist and are experienced by the many demonstration projects on this topic. In line with connecting and including small consumers, dynamic pricing pilots are also being performed. Here the societal effect of these prices is important as well; consumer behavior is not only a technical issue and might vary in different parts of the world.

A use case that seems less prominently addressed is the usage of demand response for local grid management. Despite the fact that a working system where the DSO uses flexible demand is still not available at country level, market integration of flexible demand seems to be the primary driver for demand response rather than local grid management.

In most of the regions, dynamic pricing is not yet in place, as it requires appropriate measurement and verification mechanisms. Based on the large amount of pilots investigating customer impact of dynamic prices and the continuing rollout of smart meters worldwide, this is expected to change in the coming 5 years.

¹³ For Europe, there is a good overview and discussion on this topic in a report of Eurelectric: http://www.eurelectric.org/media/285583/innovation_paper-2016-030-0379-01-e.pdf

