# Demand Resource Policy and Program Design for Electricity Market in Korea

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## Abstract

Demand Resources have played an important role in Korea more than 20 years. For reducing peak demand during summer and winter, DR programs and the operation system have been researched and implemented as a demonstration since 2010. According to the research report, 4 types of programs - reliability, economic, emergency and ancillary service - are suggested as a DR program. In 2014, commercial and industrial customers are able to sell their reduced demand in the electricity market like supply resources. 'The $6^{th}$ Basic Electricity Plan' in Korea presents the target of DSM program peak reduction to 15,854MW, 12.5% of peak demand by 2027. The current peak cutting programs in Korea consist of traditional billing incentive programs and new DR programs. However, the new DR program will be substituting existing legacy programs and contributing to DSM target in the future. This DR program initiated by government at the first stage will be move towards Demand Resource Bidding in the electricity market. Korean government focuses on maintaining supply adequacy and mitigating price volatility in the electricity market. The key factor in DR program is to evaluate peak load potential and system benefit during the planning period. In this paper, we suggest an approach to the demand resource assessment and  sum of the demand resource potential, planning and cost effectiveness. Then, we introduce the key concept of DR program design and procurement scheme in the wholesale market after the revision of 'Electricity Act' and "Market Operation Rules' in 2014. Finally, we suggest several issues focusing on DR policies and the regulatory framework to overcome market barriers and expand DR business as a one of key solution for smart grid industry.

## Introduction

Korea has confronted unique phenomenon in electricity in contrast to most of advanced nations. During the period of 2000 to 2013, our electricity demand almost has doubled from 40,071MW to 76,522 MW. According to 'the $6^{th}$ Basic Electricity Plan', the system peak load will be increased to about 130,000MW in 2027.

In this paper, we assess DSM program potential target for the resource planning in Korea. This paper focuses on demand reduction and energy saving estimation during the planning horizon more than 10 years. Our study relies on an analysis of historic annual data and demand forecast by government sources, including the data derived by the resource planning committee. The first step in the analysis is to develop a forecasting approach of peak reduction and energy savings by the program. Next is to conduct a simulation of alternative scenarios. Finally, we suggest a DSM performance target for a long term resource plan. For these purposes new measurement & evaluation mechanism is being prepared for evaluating programs. It is required that the direction and goal of DSM programs should incorporate sustaining reduction of the peak load for preparing electricity supply/demand imbalance and expanding energy efficiency

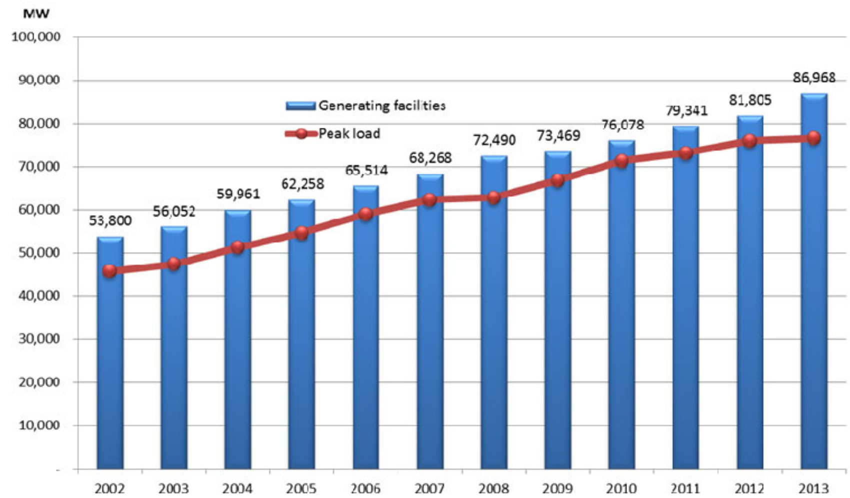


Figure 1. Generating facilities and system peak loads in Korea

program for energy conservation and environment issues. Under this background, establishing goals and implementation mechanism of DSM should be preceded and developing effective program and strategy for achieving the above goals become major emerging issues in the electricity industry. In particular, since the government wants to maintain adequate DSM resources through DSM investment, it is necessary to develop a new approach and program based on supply/demand balance analysis reflecting demand resources.

Demand response (DR) is increasingly recognized as an essential ingredient to well-functioning electricity markets. Following the definition given by the U.S. Department of Energy [1], demand response is any "change in electric usage by the end-use customers from their normal consumption patterns in response to change in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized." A few DR potential studies have been carried in comparison with many of the concepts and approaches used for energy efficiency (EE) potential studies. One of the most fundamental is that EE and DR potential studies are based on analyses of customer-level data of various types, not utility system load data such as load duration curves.

On April 2014, legislation was passed in Korea allowing demand response to participate in its wholesale capacity market. With electricity consumption growing at a rapid rate and a reliance on fuel imports to meet nearly 100% of its needs, Korea is actively promoting demand response to help ensure reliability, encourage competition, and develop an ecosystem of IT-based energy business. The enablement of demand response is one of the requirements of Korea's 'Creative Economy' initiative, which in the energy sector is broadly revolved around measures to deal with domestic energy demands and to respond to global climate change. The other focus areas, for which the government is mapping out business models and policy support packages, are new renewable energy, electric vehicles, carbon capture and storage, smart grids, energy storage, energy management systems, and energy saving companies (ESCOs).

## DSM Performance and Target in the Resource Planning

### DSM programs and Performance in Korea

The DSM programs in Korea have been implemented starting with progressive stage system of electricity rates in 1974 and seasonal time differentiation rate program in 1977. Since then, in 1990s energy efficiency technology development was promoted such as electric ballast, compact fluorescent, thermal energy storage system and cooling storage system. In 2001, 3 new programs such as an inverter, high efficiency motor, DLC (Direct Load Control) have been implemented.

Since 1990s, due to high growth of peak load, difficulty of power plant financing, emergence of the environment and siting issues, the construction of new power plants has become difficult. As shown Table 2, the peak load from 2002 to 2011 in Korea has increased continuously. In case of the performance of peak reduction, the ratio of peak reduction relative to system peak load was about 6.0% in 2002 and increased to 7.3% in 2005, decreased to 5.2% in 2010.

Table 1. DSM Performance in Korea

| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| Peak Load(MW) | 45,773 | 47,385 | 51,264 | 54,631 | 58,994 | 62,285 | 62,794 | 66,797 | 71,308 | 73,137 |
| Average Load(MW) | 34,985 | 36,805 | 39,057 | 41,625 | 43,513 | 46,018 | 48,082 | 49,498 | 54,184 | 56,722 |
| Reserve(%) | 13.9 | 17.1 | 12.2 | 11.3 | 10.5 | 7.2 | 9.1 | 7.9 | 6.2 | 5.5 |
| Peak Reduction By DSM | 2,746 | 3,020 | 3,209 | 3,978 | 3,738 | 4,091 | 4,450 | 3,817 | 3,716 | 3,939 |
| DSM Performance (%) | 6.0 | 6.4 | 6.3 | 7.3 | 6.3 | 6.6 | 7.1 | 5.7 | 5.2 | 5.4 |

※ Generating Capacity and Reserve Margin is based on summer peak load.

### DSM Target in the Resource Planning

Government reflects the performance of DSM on 'the 6th Basic Electricity Plan' made every 2 years. That is, the government overviews the performance of programs first and it applies to baseline demand forecast and maximum demand is determined by reflecting the performance of DSM.

The target of DSM varies at every planning and shows a trend that the ratio of DSM relative to system maximum load is continuously increasing. For example, 'the 5th Basic Electricity Plan' established in 2010 had 5 new DSM programs and expanded energy efficiency programs, It targeted 12,399MW of peak reduction in 2025, which is 11.5% of projected peak load.

Table 2. Target of DSM in Korea

| Long Term Power Plan | Peak Load (MW) | | DSM Target (MW) | Demand Reduction Portion (%) | Target Year |
|---|---|---|---|---|---|
| | Before DSM | After DSM | | | |
| 1st Plan ('02) | 74,784 | 67,745 | 7,039 | 9.4 | 2015 |
| 2nd Plan ('04) | 79,266 | 68,737 | 10,529 | 13.2 | 2017 |
| 3rd Plan ('06) | 83,424 | 71,809 | 11,615 | 13.9 | 2020 |

| | | | | | |
|---|---|---|---|---|---|
| 4th Plan ('08) | 93,126 | 81,805 | 11,321 | 12.1 | 2022 |
| 5th Plan ('10) | 107,437 | 95,038 | 12,399 | 11.5 | 2025 |
| 6th Plan ('13) | 126,740 | 110,886 | 15,854 | 12.5 | 2027 |
| 7th Plan ('15) | ? | ? | ? | - | 2029 |

※ Plan = The National Plan of Long Term Electricity Supply & Demand

In 2013, 'the 6th Basic Electricity Plan' was established. In the target year 2027, the target of DSM programs is 15,854MW, which is 12.5% of projected peak load. Table 5 shows the DSM target outlook of 'the 6th Basic Electricity Plan'.

Table 3. DSM target outlook of 'the 6th Basic Electricity Plan' in Korea

(Unit : MW)

| | 2013 | 2016 | 2020 | 2023 | 2027 |
|---|---|---|---|---|---|
| Demand-BAU | 80,374 | 86,919 | 102,205 | 113,065 | 126,740 |
| DSM target | 79,912 | 84,576 | 95,316 | 100,807 | 110,886 |
| Reduction target | 662 | 2,343 | 6,889 | 12,258 | 15,854 |
| Load Management | 95(14%) | 187(8%) | 957(14%) | 2,094(17%) | 2,484(16%) |
| Energy Efficiency | 371(57%) | 1,072(46%) | 2,240(33%) | 3,901(32%) | 5,722(36%) |
| Smart Grid | 196(29%) | 1,084(46%) | 3,692(54%) | 6,263(51%) | 7,648(48%) |

## DR Potential Estimation

### Estimation methodology of DR Potential

We suggest a range of achievable potential for demand response in the Korean commercial sector. The approach for deriving achievable potential is predicated on first establishing the theoretical constructs of technical potential and discounting them based on market constraints. Utilities have primarily estimated DR potentials using one or more of the following approaches : (1) Making projections based on their recent DR program results (2) Using the results from other utilities' long-running and successful DR programs (3) Customer survey approaches (4) Computer modeling approaches. We adopt the third approach for estimation of DR potential.

In order to estimate the potential of the DR resources, we first need to determine the configuration of load reduction compared to the peak load by building type. In terms of technical potential, many customers have the physical capability of shutting off most or all of their facilities; however, for the vast majority of customers, this level of curtailment is not practical. Still, it is practical to assume 100% participation of a customer segment to provide a "reasonable technical potential". Achievable potential is the load reduction that customers are willing to provide at a given level of incentives and with a given set of available technologies.

In this study, the results of the survey and analysis performed at the KERI (Korea Electrotechnology Research Institute) are used to estimate DR potential and scenario analysis at the national level. The research reports are "DR resource potential survey and analysis of commercial and industrial sectors, 2010", "The controllable load resources investigation and potential analysis, 2011", and "The load behavior of commercial and industrial customers and survey of the DR resources, 2009".

The technical and achievable potential based on the survey and analyses performed in previous studies are shown in Table 5. The technical and achievable potential display as the available amount of load reduction compared to the peak load by building type.

As shown in the table 4, the percentages of technical potential and achievable potential are not necessarily proportional to each other.

Table 4. Technical and Achievable Potential as a Percentage of Peak Demand

| Segments | Technical Potential | Achievable Potential |
|---|---|---|
| Retail | 13.7% | 7.7% |
| Hotel | 17.2% | 4.5% |
| Restaurant | 13.3% | 4.8% |
| Office | 16.2% | 7.1% |
| Education | 8.0% | 3.5% |
| Hospital | 9.7% | 2.9% |
| Sports & Culture | 13.0% | 5.1% |
| IDC | 13.0% | 6.5% |

**Estimating DR Achievable Potential in the Commercial Sector**

As described above, DR achievable potentials in the Korean commercial sector are derived by peak demands, the proportion of achievable potential and end-use by building type. Moreover, the scenario of achievable potentials considering the changes of participation rate can be constructed.

Table 5 shows the final achievable potential estimates by building type and end-use in the Korean commercial sector for the year 2016. As can be seen in Table 2, retail trades provide the greatest opportunity for load reduction due to a large peak demand. The office buildings provide the second largest potential.

Table 5. Achievable potential by building type and end-use, 2016 (unit : MW)

| End-use [MW] | Retail | Hotel | Rest. | Office | School | Hospit al | Sports/ Cultur e | Total |
|---|---|---|---|---|---|---|---|---|
| Lighting | 83 | 6 | 74 | 272 | 10 | 8 | 22 | 476 |
| HVAC | 449 | 63 | 249 | 245 | 12 | 41 | 65 | 1,124 |
| Motor | 42 | 20 | - | 127 | 1 | - | 14 | 205 |
| Etc. | 230 | - | - | - | - | 8 | - | 238 |
| Total | 803 | 88 | 324 | 644 | 24 | 56 | 100 | 2,039 |

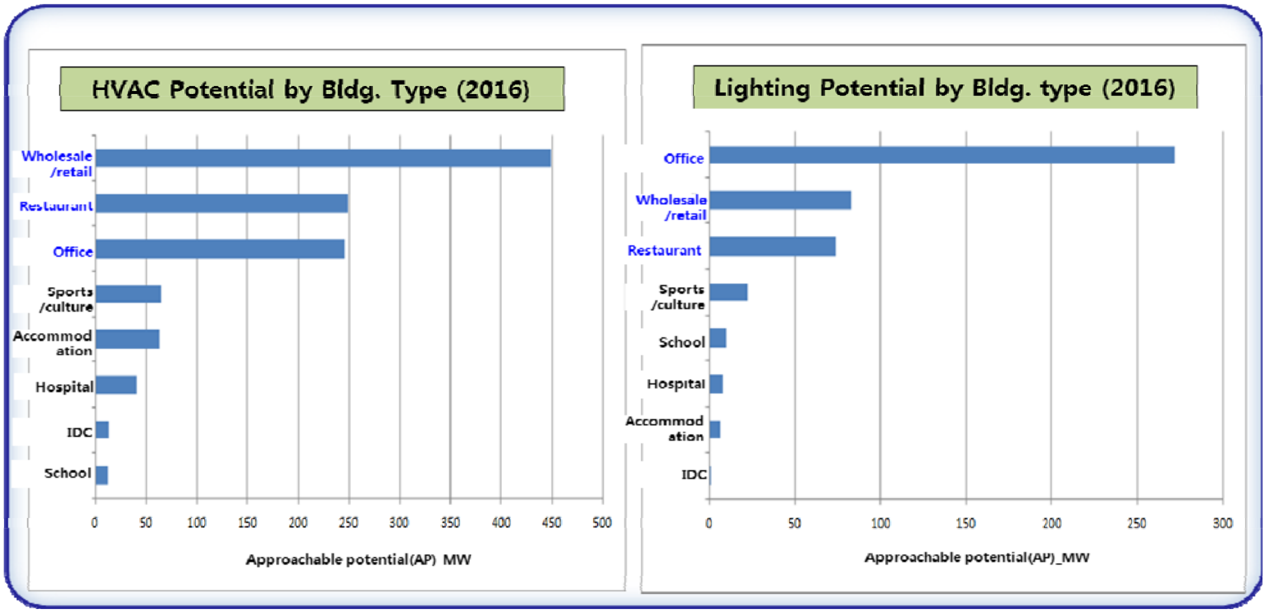


Figure 2. HVAC and Lighting potential by building type in Korea, 2016

Table 6 shows the achievable potential projections by end-use in the Korean commercial sector. As can be seen in Table 3, among the end-uses of commercial sector, HVAC provides the largest potential and lighting the second one.

Table 6. Achievable Potential projections by end-use for Korean commercial sector (MW)

| End-Use | 2012 | 2014 | 2016 | 2018 | 2020 |
|---|---|---|---|---|---|
| Lighting | 342 | 359 | 477 | 602 | 626 |
| HVAC | 825 | 865 | 1,137 | 1,428 | 1,485 |
| Motor | 147 | 154 | 205 | 259 | 269 |
| Other | 170 | 179 | 237 | 300 | 312 |
| Total | 1,484 | 1,556 | 2,055 | 2,590 | 2,692 |

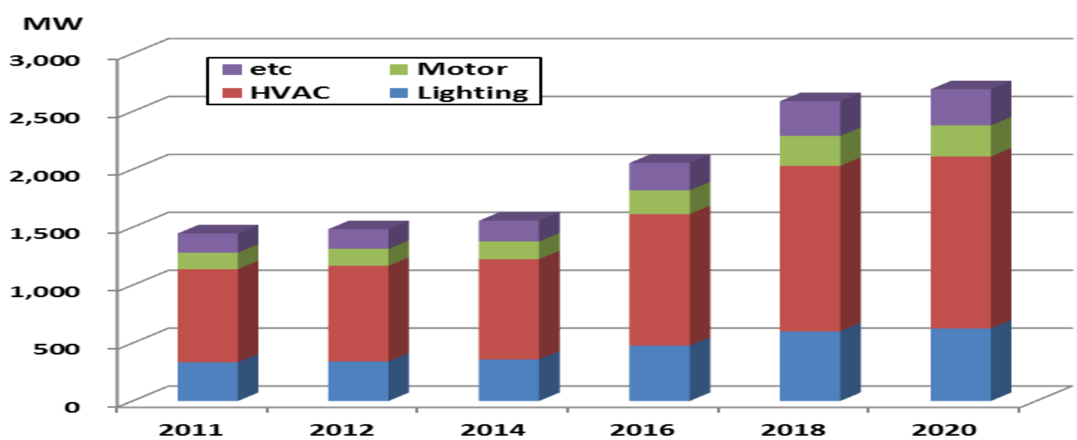


Figure 3. Achievable Potential projections by end-use for Korean commercial sector

 

## DR Program Design and Implementation

### The Purpose of Program Design and The Types of DR Programs

In the Korean electricity industry, it is extremely critical to maintain a 15% reserve margin. In recent times, the reserve margin has been shrinking due to increasing growth in electrical demand. In that context, demand response (DR) is increasingly playing an important role in addressing the problem of shrinking reserve margin. Therefore, we have studied and designed 4 types of DR program - Reliability, Emergency, Economic and Ancillary Service.

The options under which DR assumes relevance in the Korean context can be summarized as:

- **Option I**- ***'Reliability'***: This option incorporates permanent peak load reduction strategies during the summer and winter peak period. The objective is to bring down the level of the entire peak load during the peak hours of 13.00-18.00 during weekdays for the specified time period.
- **Option II**- ***'Economic***: This option incorporates peak load reduction strategies during times of high market prices for electricity. This situation typically occurs during the winter season.
- **Option III**- ***'Emergency or Operational Reliability'***: This option incorporates peak load reduction strategies during times of system emergencies or other contingencies that can occur at any time of the year. This scenario, in turn, can be thought of as being composed of two sub-scenarios, defined as 'Emergency I' and 'Emergency II'.

'**Emergency I**' incorporates peak load reduction strategies during system emergencies with notification times ranging from one day to as little as 30 minutes, while '**Emergency II**' incorporates peak load reduction strategies during system emergencies with very short notification times of less than 30 minutes. The reason for this classification is that the type of participating load and system configuration requirements differs by these two categories.

In this paper, we suggest the key design parameters of 'capacity program' and 'emergency program' , which are reliability-based DR programs. Table 7 shows the capacity program and emergency program applicable in Korea. The goal of capacity program is to avoid generating and transmission facilities in the long run. The target amount is 5% of peak demand in 2020. The goal of the emergency program is to maintain system reliability in emergency condition, which is to secure operating reserve over 3,000kW according to electricity market rule.

Table 8 shows the settlement process formula of capacity program. The settlement amount means the settlement amount of available demand reductions and for real demand reductions. The settlement amount of real demand includes settlement for planned demand reductions and additional settlement in the case of reducing demand by event call of KPX (Korea Power Exchange).

Table 7. Capacity Program and Emergency Program

| Item | | Capacity Program | Emergency Program |
|---|---|---|---|
| Participant requirement | Minimum load | - Minimum 300kW | - Minimum 300kW |
| | Minimum reduction | - Minimum 100kW or 20% of Max load | - Minimum 100kW |
| | Duration | - Minimum 2 hours | - Minimum 2~4 hours |
| | Annual event call | - Maximum 60 hours/year | - Maximum 10 events/year |
| | Load Aggregator | - Yes | - Yes |
| | Event notification | - Day ahead, 2 hour, 1 hour (Different incentive level) | - Instant (Auto-DR)<br>- 30min~1hour (Semi-Auto) |
| | Operation unit | - 30 min. | - 30 min. |
| | Contract type | - Seasonal contract(2 times a year), mandatory | - Annual contract, mandatory reduction |
| Event call | Peak reduction | - If forecasted load is higher that targeted load | - No |
| | Reserve relief | - If operating reserve is less than 5,000MW | - If operating reserve is less than 4,000MW |
| Incentive | Capacity | - Seasonal capacity contract (Summer, Winter)<br>- Total incentive : Based on avoided cost<br>- Total capacity incentive level : 54~64 $/kW (Differed by minimum notification time) | - Based on outage cost<br>: (Option 1) Macro economic method,<br>(Option 2) Micro economic method,<br>(Option 3) Analytic method<br>: Total incentive shared equally for capacity and energy payment |
| | Energy | - SMP at load reduction time : 20~30 c/kWh | |
| | Penalty | - No capacity payment under 50% of contracted load reduction | - No capacity payment under 50% of contracted load reduction |
| Metering | CBL calculation | - Mid 6 out of 10 days | - Participants load 5 min. prior to event call |

Table 8. Settlement process formula

| | Settlement process formula |
|---|---|
| Calculation Settlement | TPi = ∩Pi + PCPi + ACPi<br>Where, TPi = settlement amount<br>∩Pi = settlement for available demand reductions<br>PCPi = settlement for planned demand reductions<br>ACPi = additional settlement in case of reducing demands by order of KPX |
| Calculation Settlement for available demand reductions | $CAP_i = \sum_{t} \sum_{b=1}^{15} (BQ_{t,b} \times BPF_b \times AP_{ref}) \times APC_i$<br>Where,<br>CAPi = daily settlement amount for available demand reductions of i trader<br>BQt,b = available demand reductions of b bidding price section at t time zone<br>BPFb = bidding price coefficient of b bidding price section<br>APref = capacity price<br>APCi = average performance coefficient of i trader |

## DR Implementation Process and Structure

On April 2014, legislation was passed in Korea allowing demand response to participate in its wholesale capacity market. Figure 4 shows an electricity market system before and after introduction of DR in Korea. Before the introduction of DR in Korea, only generators could bid in the electricity market. However, after introduction of DR, DR resources also became to be able to bid in the electricity market equally with supply resources. Therefore, expensive power generators that operate in high demand period can be replaced by inexpensive DR resources and power supply cost can be reduced.

Considering the role of key players in the changing electricity market, KPX (Korea Power Exchange) plays a role in DR system management, event call, monitoring and calculations. LAs (Load Aggregators) play a role in the procurement of participants, registration & operation of DR resources, event call, monitoring, bidding, and load shed assessment. Participants make a contract with LAs and reduce their loads according to event call.

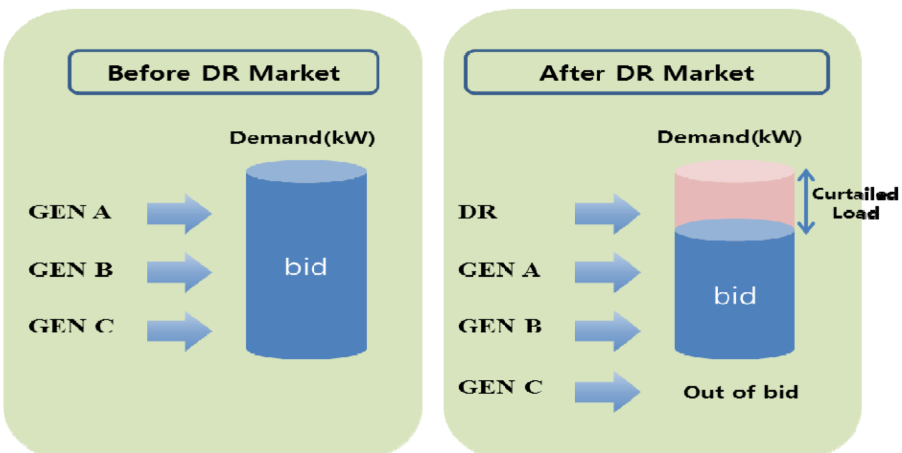


Figure 4. Electricity market system before and after introducing DR

Table 9 shows the key parameters of real-dispatchable reliability DR in Korea. The electric power trade market meeting the requirements of demand resources opened October, 2014. A total of 11 load aggregators took part in the market. The number of load aggregators will increase to 19 in this year. The energy ministry estimated that the trade market scheme will be saving about 1.9 million kilowatts of electric power by 2017, equivalent to the electric power generated by two nuclear power plants.

Table 9. Reliability DR implementing in Korea

| | Reliability DR |
|---|---|
| Trigger | Emergency, Peak reduction, High prices |
| Minimum load required | > 10MW of demand |
| Maximum load required | < 500MW of demand |
| Capacity criteria | Mandatory curtailment load<br>(Maximum curtailment load) |
| dispatch obligation | Yes |
| Trade commodity | Mandatory curtailment load(kW)<br>Amount of energy reduction (kWh) |
| Implementation time zone | 9:00~ 20:00 on weekdays |
| Max./Min. reduction time period | Max. 4 hours / Min 2 hours |
| Numbers of reductions | Max. 2 /one day |
| Evaluation criteria | CBL |
| Event notification | Notified by 1 hour before of demand reduction starting time |
| Participant incentives | Fixed capacity payment plus energy payment |

**Implementation Structure**

Implementation mechanism of DSM programs after the restructuring needs to change from duo-structure of government and utility to multilateral structure of government, program manager, evaluation entity, etc.. It is absolutely necessary to reestablish DSM implementation mechanism by clarifying the functions of DSM programs. It is needed that we may achieve improved efficiency and objectivity by introducing competitive bidding mechanism in selecting program implementation. Some program administered by KEPCO needs to continue 2~3 more years for a smooth transition.

Table 10. Implementation Structure of DSM Programs

| DSM Programs | Before the Introduction of DR | After the Introduction of DR |
|---|---|---|
| Energy Efficiency | - Government Initiatives | - Government Initiatives<br>- ESCOs |
| Load Management | - Government Initiatives | - Government : funds<br>- ISO : System Operation<br>- Utility : Program Implementation |
| DR | - Pilot Programs implementation by Government support | - ISO : System Operation<br>- LA : Bidding |
| Load management Tariff | - Government Support | - Supplier Initiative (linked with Tariff System) |

Under the competitive market system, the basic direction for DSM programs is to retain demand resource in the short run, especially focusing on load resource and to sustain energy conservation and prepare for environmental issues in the long run. The DSM policy so far was to focus on load reduction. However, it needs to switch to energy efficiency and invest more in energy efficiency programs, and it is desirable that load management programs should be sustained at the current level for the purpose of continuity of DSM programs.

On the contrary, it is necessary that current DSM programs should be reorganized as the government-leading DSM programs and the utility-leading DSM programs after the restructuring. In this case, government-leading DSM programs should cover only pure public purpose DSM programs. Distortion of resource allocation should be prevented by prohibiting government from voluntary participating utility/ISO-leading program or market-leading program.

In the case of detail classification of DSM by functions, the government determines the DSM policy, funding, establishing targets, designing DSM programs and DSM specialist advisory committee support. The new funding organization administers in charge of program management and each program manager of program. In implementation, programs are divided with competitive and non-competitive sectors. In the former sectors, administrators are selected through the bidding process and in the latter sectors, programs are selected through an evaluation process of the utility's business plan. And, in the evaluation process, an independent evaluation entity is established in order to design DSM programs, measure and verify DSM performance. It is desirable that the transparency and systemization of DSM M&V would be ensured by establishing an evaluation entity which will perform a function of supporting in reliable evaluation.

## DR Policy and Regulatory Structure

### Direction of DR Policy

The contents of DR are based on objects and program target. First, DR programs are classified depending on whether it targets load management or energy efficiency and different kinds of measures and promotion policy for the same goal. Load management by DR and energy efficiency programs will be supported device installation cost through rebates in the case of the technology chosen. Peak reduction program by end-user response supports can compensate through market or rate discount.

After introducing DR, DSM need to re-classification and coordination of programs by implementer and characteristics are basically required, but partially readjusted based on the existing DSM program classification in the short run. However, in near-term (after 2015), comprehensive restructuring of DSM program will be continued based on program type, supporting instrument, program objectives. For these, program design and selection of evaluation system should be rearranged in accordance with DR program.

There are studies being made to introduce DR programs for large customers as a tool of compensating electricity supply/demand balance by market function. DR program is likely to play an appropriate role at the following aspects in the electricity market in Korea;

- Removal of uncertainty and mitigate during an electricity supply/demand imbalance

- Compensation of legacy program malfunctioning (e.g. load management rebate program, summer vacation rebate program, etc.)

- Functioning as a social insurance to prepare for shortage of generation resources

It is possible to design DR programs in terms of implementing or purposes. KPX (Korea Power Exchange) can administer DR programs as a tool for cutting standing system peak load and establishing system load and direct load control resources via bidding mechanism. The current DR program is administered by KPX. However, from now on, it will be expanded with the real time DR program through modification of the legacy program. Table 11 shows the future direction for implementing DR programs, implementing purposes and methods for obtaining resources.

Table 11. Strategies for Implementing DR Type Programs by Objects & Methods

| DSM Subject | Program Implement Object | Object | | | | Compensation | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Capacity Reserve | Supply Cost | System Operation | Supply service | PGC | Tariff | Market (Bidding) | Regulation |
| ISO | Reliability DR | ◎ | | △ | | △ | | ◎ | |
| | Emergency DR | ◎ | | △ | | △ | | | ◎ |
| | Ancillary DR | | | ◎ | △ | | | ◎ | |
| | Economic DR | | ◎ | | | | | ◎ | |
| Utility | Reliability DR | | | | ◎ | ◎ | | | △ |
| | Economic DR | | ◎ | | | | | ◎ | |
| | Technical assistance | | | | ◎ | ◎ | △ | | |

◎ major impact, △ minor impact

## Regulatory Structure

The DR programs in Korea now expect a new administrative system differing from the past due to change in the electricity trading system, unbundling of electricity business caused by the restructuring of the electricity industry.

First of all, it is necessary to change the main role of the administrator from utilities to various entities, i.e. from utilities-oriented in the past to electricity supplier, load aggregators, system operator and government after introducing DR. Moreover, the DR implementation system should be prepared for improvement of efficiency by reinforcing evaluation and verification of DR programs.

DR programs should be restructured to contribute to mitigate price volatility and supply/demand imbalance in the electricity market. In other words, it should be done that utility-oriented program in the past should be reclassified in accordance to implementing entity, purpose and quantified by measuring and verifying program performance.

In particular, it appears that current existing load management programs will not be valid after introducing DR. Hence, various types of DR Programs are need to be developed include economic DR. The EE programs running as a pilot program should be studied more in detail with respect to the purpose and an entity. The rational development of demand resource by evaluating achievable potentials by customers should be done immediately from now.

## Conclusion

The Korean government has achieved appreciable success in load management by Demand Side Management programs. Although DSM programs have shown impressive performances, there are some defects and drawbacks on in. To address these problems, South Korean government decided to shift policy drive forces from DSM to Demand Response. In this paper, we summed up the outcomes and problems of DSM, and introduced DR program development in Korea to prepare the smart grid environment. In Korea, the long-term power development plan is very important as a tool in establishing the resource adequacy target and energy balance nationally. Especially the target after implementing DSM is critical to determine the total amount of capacity and technology selection. The long-term peak reduction target and forecasting approach in the major programs would be measured and testified objectively through this study.

This Paper contained following topics; firstly, we assessed DR potential by commercial building type. Through the survey and estimation methods, the achievable potential in the commercial sector was estimated to around 2,700MW in 2020. According to our 'the 6$^{th}$ Basic Electricity Plan', we should reduce 12% of BAU demand until 2027. DR will be contributing to reduce 40% of them. Secondly, we designed DR programs for implementation. We suggested 4 types of DR programs - capacity, emergency, economic and ancillary service - by purpose and procurement process. Most of the key elements - amount, eligibility, infrastructure, M&V etc. - of DR are suggested for implementation. Then we recommended DR policies and regulatory framework for Korea government. For this, we should eliminate some market barriers which might be disturbed a new DR business for DR players in a smart grid environment. In addition, we should scrutinize relationship with other regulatory policies like RPS, EERS and Cap & Trade in Korea.

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