

Strategy for Designing DSM Program after the Restructuring in Korea

Chang-Ho Rhee,

Keun-Dae Lee,

In-Seung Jo

Korea Electrotechnology Research Institute
Uiwang-city, Gyeonggi, 437-808, KOREA

ABSTRACT

To maintain supply adequacy and mitigate price volatility in electricity market, the necessity for obtaining demand-side resource is increasing and obtaining demand-side resource is set as a priority of electricity policy. For this purpose, we introduce a new DSM mechanism and program development strategies based on customer response and electricity industry efficiency. Especially we introduced DLC(Direct Load Control) technology via two-way communication scheme for large customer. This DLC program targets interruptible load that covers large customer in commercial and industrial sector. This program can retain demand reserve that does not interrupt process in plant or business along with real-time monitoring load condition of end-use and interrupt load by pre-determined procedures, if necessary. This analysis shows that electricity boiler, pump, blower, HVAC can save energy during some time. In addition, developing system to monitor end-use load and interconnecting it with MOS(Market Operation System) should be established as infrastructure in DSM.

1. INTRODUCTION

The DSM(Demand Side Management) program has been administered by KEPCO(Korea Electric Power Corporation) and the Korean government played key role in the program since two oil shocks in 1970s. However, since the restructuring in electricity industry took place in 2000s, KEPCO, a monopoly until now, has been being unbundled and privatized. That is, the generation sector is already separated from KEPCO and in 2003, the distribution and power sales business will be unbundled as well. Post-KEPCO will run transmission business only. Due to restructuring, DSM programs are going through substantial changes in several aspects such as financing, implementation mechanism, designing program, etc.

First of all, funding of DSM programs provided by utility's revenue is being provided by System Benefit Charge(SBC) paid by rate-payers. Due to this, the administrative entity in DSM programs is switched from KEPCO to government. Accordingly, it is necessary to reestablish implementation mechanism and procedures in DSM programs. In the past, under the government's indirect supervision, KEPCO did all the work in areas of management, implementation and evaluation of DSM programs. However, a special organization exclusively managing DSM programs is borne under the actual government's supervision and guidance. And a new measurement & evaluation mechanism is being prepared for evaluating programs and maintaining transparency and objectivity of

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 program for energy conservation and environment issues.

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

2. DSM before restructuring

2.1. DSM program

The DSM program in Korea has been implemented starting with rebate program in 1974, and seasonal time differentiation rate program in 1977. Since then, in 1980s energy high 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 inverter, high efficiency motor, Direct Load Control(DLC) have been implemented.

DSM programs largely consist of load management rebate program, load management equipment program, energy efficiency program and current

Table 1. DSM Status in Korea

| DSM Program | | Purpose | Applicable Sector | |
|------------------|-------------------|--|---------------------|------------------------------------|
| Existing Program | Tariff System | Summer vacation period coordination rate | Peak Load Shedding | Commercial & Industrial customer |
| | | Voluntary Energy Conservation Rate | Peak Load Shedding | Commercial & Industrial, Education |
| | | Load Transfer | Peak Load Shedding | Commercial & Industrial Customer |
| | Load Management | Cool Storage System | Peak Load Transfer | Commercial & Education Customer |
| | | High Efficient Vending Machines | Peak Load Shedding | Commercial Customer |
| | | Direct Load Control | Peak Load Shedding | Commercial & Industrial Customer |
| | | Remote control Air Conditioner | Peak Load Shedding | Residential & Commercial Customer |
| | Energy Efficiency | Energy Efficient Lamp | Energy Conservation | Customer Above 6kW Saving |
| | | Energy Efficient Inverter | Energy Conservation | Industrial Customer |
| | Others | Gas Cooling System | Load Substitute | Commercial Customer |
| New Program | Load Management | Direct Load Control | Peak Load Shedding | Commercial & Industrial Customer |
| | | Peak Load Management System | Peak Load Shedding | Commercial & Industrial Customer |
| | Energy Efficiency | Energy Efficient Motor | Energy Saving | Industrial Customer |

programs are shown in Table 1.

2.2. Investment

The investment volume in DSM has been increased 1.8 times from 33.6 billion won(\$28 million) in 1995 to 61.5 billion won(\$50.4 million) and about 140 billion won(\$117 million) in 2001. Among them, the volume of load management equipment program has been increasing from 14% in 1995 to 30~40% of total DSM investment in 2001.

Table 2. Investment of DSM in Korea
(Unit : 10⁸ Won)

| DSM Measures | | 1995 | 1998 | 1999 | 2000 | 2001 |
|----------------------|----------------------------------|------|------|------|------|------|
| Tariff System | SVPC | 66 | 51 | 60 | 150 | 205 |
| | VCER | 14 | 81 | 81 | 71 | 90 |
| | Load Transfer | 8 | 34 | 49 | 5 | 5 |
| | Sub Total | 88 | 135 | 146 | 226 | 300 |
| Load Management Tool | Cooling Storage | 17 | 31 | 36 | 80 | 85 |
| | Heat Storage | 19 | 156 | 253 | 595 | 380 |
| | Energy Efficient Vending Machine | | | 14 | 2 | 8 |
| | DLC | | | | | 41 |
| | Remote Control Air conditioner | | | | 10 | 13 |
| | Sub Total | 46 | 187 | 289 | 687 | 527 |
| Energy Efficiency | Lamp | 22 | 71 | 100 | 112 | 124 |
| | Inverter | | | | | 38 |
| | Sub Total | 22 | 71 | 100 | 112 | 162 |
| R&D/Others | | 179 | 222 | 356 | 334 | 411 |
| Total | | 336 | 615 | 890 | 1360 | 1400 |

1) SVPC = Summer vacation period coordination rate program

2) VEER = Voluntary Energy Conservation Rate Program

3) \$1 = 1,200won

On the contrary, energy efficiency program accounts for 10% of total DSM programs, which remains relatively at a small scale.

The DSM policy in Korea has focused on load management rather than energy efficiency because the stabilization of supply/demand imbalance through peak load reduction is top priority in energy policy decision-making.

2.3. Performance

In 1990s, due to high growth of peak load, difficulty of power plant financing, emergence of environment and siting issues, the construction of new power plant became difficult. Hence, the target of DSM peak reduction increased gradually. In 1991, the ratio of peak reduction relative to maximum load was about 3.6% and increased to 6.7% in 1995, 11.4% in 2000, and 13.9% in 2001, respectively. The target of load management was 5,981MW in 2001.

Table 3. DSM Performance
(Unit : MW, %)

| Items | 1993 | 1995 | 1997 | 1999 | 2000 | 2001 |
|-----------------------|--------|--------|--------|--------|--------|--------|
| Capability | 24,405 | 31,968 | 38,452 | 43,418 | 46,078 | 48,699 |
| Reserve | 10.4 | 7.0 | 7.3 | 16.4 | 12.4 | 12.9 |
| Demand before DSM | 23,234 | 32,014 | 39,735 | 41,900 | 46,262 | 49,109 |
| Peak Load After DSM | 22,112 | 29,878 | 35,851 | 37,293 | 41,007 | 43,125 |
| Peak Reduction By DSM | 1,122 | 2,136 | 3,884 | 4,607 | 5,255 | 5,981 |
| DSM Performance(%) | 4.8 | 6.7 | 9.8 | 11.0 | 11.4 | 13.9 |

Performance by DSM programs is shown in Table 4. The results of peak load reduction show that load management programs such as summer vacation period coordination rate program, tariff structure,

voluntary energy conservation rate account for more than 90% of total peak reduction. As stated above, in the measurement of DSM programs' performance, only peak reduction capacity, MW is verified.

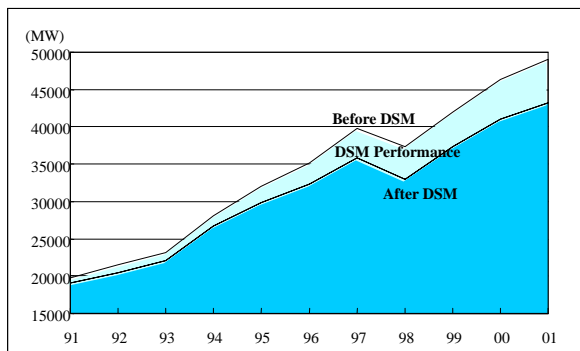


Figure 1. Trends of Peak Load Reduction in Korea

Table 4. Performance by DSM Programs

(Unit : MW)

| Year | SVPC | VECR | Cooling Storage System | Energy Efficient Devices | Load Management Rate System | Gas Cooling System | Total |
|------|-------|------|------------------------|--------------------------|-----------------------------|--------------------|-------|
| 1991 | 183 | - | 6 | - | 389 | 126 | 704 |
| 1992 | 316 | - | 9 | - | 594 | 175 | 1,094 |
| 1993 | 280 | - | 18 | - | 594 | 230 | 1,122 |
| 1994 | 498 | - | 29 | 3 | 594 | 287 | 1,400 |
| 1995 | 653 | 140 | 43 | 15 | 929 | 356 | 2,136 |
| 1996 | 839 | 388 | 58 | 44 | 1,062 | 430 | 2,821 |
| 1997 | 835 | 698 | 75 | 82 | 1,678 | 516 | 3,884 |
| 1998 | 594 | 993 | 100 | 132 | 1,983 | 555 | 4,357 |
| 1999 | 694 | 987 | 125 | 193 | 1,983 | 605 | 4,587 |
| 2000 | 1,069 | 698 | 139 | 258 | 2,396 | 695 | 5,255 |
| 2001 | 1,180 | 763 | 185 | 335 | 2,644 | 770 | 5,891 |

- 1) SVPC = Summer vacation period coordination rate program
- 2) VECR = Voluntary Energy Conservation Rate Program

2.4 Target of DSM

The Korean government reflects the performance of DSM to electricity demand/supply planning made every 2 years. That is, the government overviews performance by programs first and it applies to baseline demand forecast and maximum demand is determined by reflecting the performance of DSM.

DSM programs' target varies in every planning and shows a trend that the ratio of DSM relative to system maximum load is continuously increasing. For example, 5th long-term power development plan established in 2000 had 5 new DSM programs and expanded energy efficiency programs, It targeted 7,430MW of peak reduction compared to 6,460MW

in 1998.

Table 5. Goal of DSM in Korea

| Long Term Power Plan | Peak Load (MW) | | DSM Goal (MW) | DSM Performance Rate (%) | Target Year |
|----------------------------|----------------|-----------|---------------|--------------------------|-------------|
| | Before DSM | After DSM | | | |
| 2 nd Plan ('91) | - | 48,155 | 1,930 | 3.4 | 2006 |
| 3 rd Plan ('95) | 70,852 | 65,642 | 5,210 | 7.4 | 2010 |
| 4 th Plan ('98) | 76,036 | 69,572 | 6,460 | 8.5 | 2015 |
| 5 th Plan ('99) | 74,939 | 67,509 | 7,430 | 9.9 | 2015 |
| Basic Plan ('02) | 74,784 | 67,745 | 7,039 | 9.4 | 2015 |

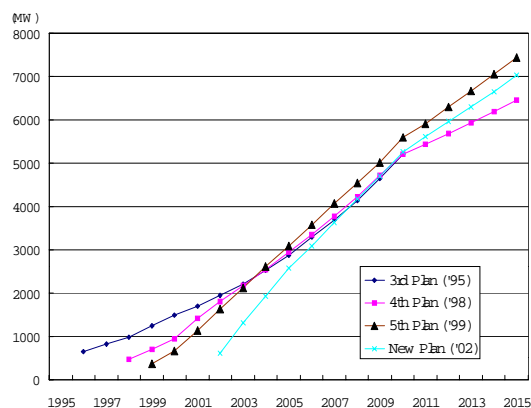


Figure 2. Goal of DSM Activities by Plan

2.5 Investment plan

The Korean government tries to implement load management program effective in supply/demand balance at the beginning of restructuring and expand energy efficiency programs gradually in the future. The introduction of market trading system brings uncertainty of power plant construction, so the government tries to design new program and increase spending on existing programs such as promotion of cooling storage system, direct load control. And at the later stage of restructuring, energy efficiency program benefiting end-user directly will be expanded.

For this, the government plans to spend DSM 117.7 billion won in 2001 and 143.3 billion won increased by 21.7% in 2002. And it also plans DSM investment volume to account for 1% of total electricity sales. DSM programs can be classified largely 5 sub programs. They are load management program, energy efficiency program, rate rebate program, advertising/evaluation, load programs and each program accounts for 33.8%, 21.3%, 25.5%,

4.0%, an d15.3%, respectively. The energy efficiency program volume will be increased gradually in the future.

Table 6. DSM Investment Plan
(Unit : Million Won)

| DSM Activities | | FY 2002 | FY 2003 |
|------------------------|----------------------------------|---------|---------|
| Load Management | | 31,902 | 48,520 |
| | • Cool Storage system | 19,345 | 23,174 |
| | • Direct Load Control | 9,307 | 21,421 |
| | • Remote Control Air Conditioner | 3,250 | 3,725 |
| | • Demonstration | - | 200 |
| Energy Efficiency | | 26,100 | 30,522 |
| | • Efficient Lamp | 16,017 | 15,197 |
| | • Efficient Vending Machine | 682 | 825 |
| | • Inverter | 6,550 | 9,132 |
| | • Motor | 1,394 | 3,751 |
| | • Demonstration | - | 290 |
| | • Audit | 1,457 | 1,327 |
| M&E | | 3,943 | 5,700 |
| | • Public Information | 2,909 | 3,500 |
| | • Education | - | 500 |
| | • M&E | 800 | 1,000 |
| | • Survey | 235 | 700 |
| Load Management Tariff | | 34,806 | 36,625 |
| | • Summer Vacation & Maintenance | 22,234 | 23,510 |
| | • Vuntary Saving | 11,995 | 12,852 |
| | • Load Transfer Discounting | 577 | 263 |
| Loan | | 21,000 | 22,000 |
| Total | | 117,751 | 143,367 |

\$1 = 1,200Won

3. Direction after the restructuring
3.1 Basic direction

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 environment 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 to energy efficiency programs. But, 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 government-

leading DSM programs and 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.

Table 7. Implementation Structure of DSM Program

| DSM Program Type | Short Term | Long Term |
|------------------------|---|---|
| Energy Efficiency | -Government Initiatives | -Government Initiatives |
| Load Management | -Government Initiatives | -Government: Reserve : -ISO :System Operating -Supplier : Bidding |
| Electricity Audit | - Government Support (Electricity Sector) | -MarketTransformation -Supplier : reinforcing Service |
| Load Management Tariff | - Government Support | -Supplier Initiative (linked with Tariff System) |

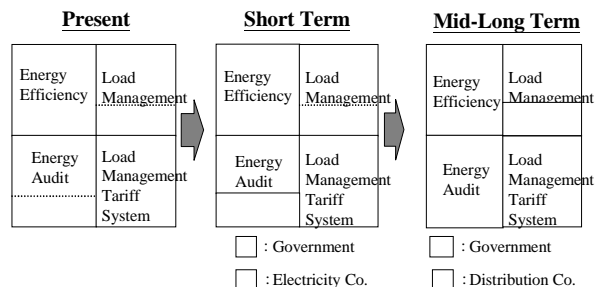


Figure 3. Implementation Structure of DSM Activities

3.2 Implementation mechanism

Implementation mechanism of DSM programs after the restructuring needs to change from duo-structure by government and utility to multilateral structure by government, program manager, evaluation entity, etc. It is absolutely necessary to reestablish DSM implementation mechanism by clarifying functions of DSM programs. It is needed that we may achieve improvement 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 smooth transition.

Table 8. DSM Program in the Future (•2003)

| DSM Program | Program Purpose | DSM Program |
|--------------------------------|--|--|
| Load Management | - Load shedding and transfer using DSM facilities | - Cooling & Heat Storage Facilities - Direct Load Control etc. on . |
| Energy Efficiency | - Energy Saving using DSM Measures | - High Efficient Apparatus - Design of Building & Process with Energy Efficiency |
| Peak Reduction | - Peak Load shedding by Rate Incentives & Subsidy | - Load Management Tariff System - Voluntary Energy Conservation - Load Shedding |
| Public Information & Education | - Diffusion and promotion of DSM technology through advertising, education, technology support | - Public Information - Education - Energy Audit |
| MA&E | - Improvement of efficiency of resource allocation and performance of program through M&V | - Method and Procedure Evaluating the Performance of DSM Program - Building DSM DB - Developing Factor and Model |

- Governance : MOCIE
- Administration : program manager
- Implementation : utilities
- Assessment: special organization for evaluation and supporting entity (independent organization)

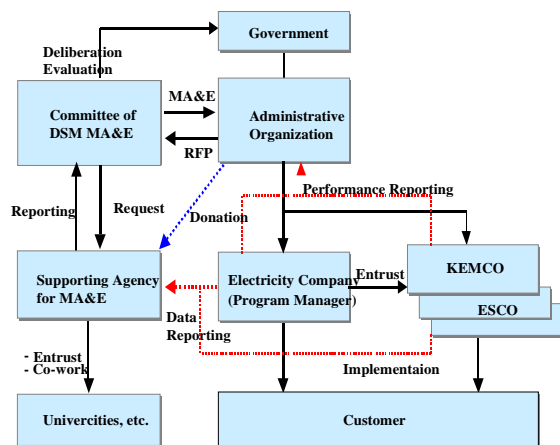


Figure 4. Implementation Structure of DSM after Restructuring

In case of detail classification of DSM by functions, the government determines the DSM policy, funding, establishing target, designing DSM programs and DSM specialist advisory committee support and consult the government in above areas. New funding organization is in charge of program management and each program manager by program administers program. In implementation, programs are divided with competitive and non-competitive sectors. In the former sectors, administrators are selected through bidding process and in the latter

sectors, programs are selected through evaluation process of utility’s business plan. And, in evaluation process, an independent evaluation entity is established in order to design DSM programs and select administrators and measure & 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 evaluation necessary for DSM DB, M&V modeling development.

4. Implementation Strategy of DSM Program

4.1 Contents of DSM program

The contents of DSM are based on objects and program target. First, DSM programs are classified depending on whether it targets load management or energy efficiency and different kinds of measures and promotion policy for same goal. Load management by DSM technology and energy efficiency programs support equipment installation cost through rebate in case of technology chosen. Peak reduction program by end-user response supports can support by compensation or rate discount. Re-classification and coordination of programs by implementer and characteristics are basically required, but partially readjusted based on the existing DSM program classification in short run(~2003).

- new program addition : M&E-M&V program
- program change : peak reduction program, advertising, education program

However, in near-term (after 2003),

comprehensive restructuring of DSM program is necessary based on program type, supporting

of the following; First, centering on public building, school, public organization, establish DSM incentive

Table 9. DSM Programs by Sector

| Program Purpose | Strategies | Sector |
|----------------------------|---|---|
| Advancing Existing Program | Promotion and diffusion of high efficiency equipment | Building, multi-family home |
| | Promotion and diffusion of high efficiency equipment | Industrial customer, large customer |
| | Introduction of market transformation | Change of support mechanism |
| | Comprehensive change of load management rate system | Selective contracting method |
| | Expansion of market participants through standard performance contract | Cost +performance reward |
| Developing New Program | Small-scale, discriminatory program diversification | Commercial and residential |
| | Development of efficiency standards of materials and standardization | Supporting program implementer |
| | Structural change of electricity consumption by conservation-oriented building standard | Lighting, cooling & heating standard |
| | Conservation program for public building/facility | Link with budget compensation mechanism |
| | Replacement support program of industrial out-worn facility | Allocation of performance |
| Retaining DSM Resources | Voluntary load reduction program | Lump sum Compensation |
| | Direct load control | Link with system operator |
| | Selective load interruption | Imposing penalty in case non-compliance |
| | Retaining reserve program for alleviating load | Alleviating load if necessary |
| Improving Rule | Construction of DSM infrastructure(DB, modeling, procedure, examine) for performance measure & evaluation | Nursing neutral specialist institute |
| | Placing mandatory insulating standard for new building construction/retrofit | Insulating window material |
| | Provision of energy information for energy heavy consumption household | Notice of actual energy usage |
| Others | Criteria and support system for activation of ESCo, Aggregator | Procedure, volume, contract, etc |

instrument, program objectives.

- Program design and selection by evaluation system and procedures
- Reflection of demand intention survey such as ESCO, Vender, specialists, etc
- Selection of implementer by competitive bidding mechanism and determination of energy savings goals and investment volume

4.2 Implementation procedure

4.2.1 Program Selection

List DSM Measure Library based on high possibility of implementation.

- Survey of DSM program and technology/tool used in advanced country
- Classification by customer characteristics and end-use

By technological/economic evaluation standard and procedures, establish DSM programs and priority and select programs based on DSM policy goal and performance.

4.2.2 Supporting Method

It is desirable that the supporting method consists

mechanism and induce technology diffusion and market at early stage

- provision of energy evaluation support and technology selection for new building
- consultation for retrofit of energy consumption intensive facility

Second, apply the differentiated promotion tool and confirmation method for performance by customer having different pattern, applicable technology.

- providing pre-determined rebate in case of installation of certified high energy-efficiency equipment
- providing compensation per unit with conservation effect for load reduction at energy supply/demand level
- providing fixed price by performance contract for retrofit or replacement of industrial customer
- providing customer-choice on-stop package in new building construction, improvement of process

Table 10. Strategies for Implementing DLC Programs by Objects & Methods

| DSM Subject | Program Implement Object | Object | | | | Method | | | |
|-----------------|---------------------------------------|-----------------|----------------------|----------------------|---------------|---------|--------------|-----------------------|------------|
| | | Ensure Capacity | Market Stabilization | System Stabilization | Profit-making | Subsidy | Compensation | Self-supply (Bidding) | Regulation |
| ISO | Standing load cutting | . | . | | | . | . | | |
| | Emergency load shedding | | . | . | | . | . | | |
| | Retaining system load | | | . | . | | | . | . |
| | Securing supplementary resources | | | . | . | | | . | . |
| Supplier | Peak load shedding | | | | . | . | | | . |
| | Retaining emergency resources | . | . | | | | | . | . |
| | Ensuring capacity | . | | | | | | | . |
| Load Aggregator | Aggregating supply & demand resources | | | | . | | | . | |
| | Retaining supplementary resources | | | | . | | | . | |
| | Developing new resources | | | | . | | | . | |

Third ; differentiate supporting tools according to program goal, program characteristics, program process stage

- Rebate : development of cost-effective DSM program and early promotion
- Subsidy : provision of rebate for load reduction based on conservation unit(kW)
- Reward for performance : provision of incentive for over-achieving performance contract
- Loan : market diffusion and market transformation
- Rate discount : provision of rate discount for voluntary participation

4.3 Development of Program

It is studied to introduce DLC program for large customer as a tool of compensating electricity supply/demand balance by market function. DLC program is likely to play an appropriate role at the following aspects in electricity market in Korea;

- Removal of uncertainty following the restructuring and mitigation of electricity supply/demand imbalance
- Compensation of DSM program malfunctioning due to change in market conditions (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 a DLC program in terms of implementer or purpose. For example, Korea Power Exchange can administer DLC program as a tool for cutting standing system peak load and establishing system load and direct load control resource via subsidy or demand bidding mechanism. The entities for implementing DLC program, implementing purposes and methods for obtaining resource are the following.

The current DLC program is administered by KEPCO since 2001. However, from now on, it will be expanded with DSM programs through modification of the DLC program and. The future direction for improving current DLC program is summarized at Table 10.

5. Conclusion

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

First of all, it is necessary to change the main role of

the administrator in DSM program from utilities to various entities, i.e. from utilities-oriented in the past to electricity supplier, load aggregator, system operator, government, etc after the restructuring. And, DSM implementation system should be prepared for improvement of efficiency by reinforcing evaluation and verification of DSM programs.

DSM program should be restructured to contribute to mitigate price volatility and supply/demand imbalance in 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 previous DSM programs' performance.

In particular, it appears that current existing load management programs will not be valid after the restructuring. Hence, new program such as DLC needs to be developed. The DLC program implementing as a pilot program should be studied more in detail with respect to its purpose and entity. The rational development of demand resource by evaluating DSM potentials of DSM, i.e. demand reserve should be done.

REFERENCES

Barakat & Chamberlin, Inc, "Principles and Practice of Demand-Side Management", Aug. 1993

Barakat & Chamberlin, Inc., "Demand-Side Management Option study", Final Report submitted to Associated Electric Cooperative, Inc., Jan. 1993

KERI, "A Study on Modeling for Evaluating the Effects of Demand Side Management Programs, 2000
KERI, "A Study on the Demand-Side Management Pricing Policy after Deregulation, 2001