The global Demand Side Management Map,
a tool for DSM strategy and planning

A Report of Task 1
International Database on Energy Efficiency Programmes

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THE GLOBAL DEMAND SIDE MANAGEMENT MAP: A TOOL FOR DSM STRATEGY AND PLANNING

ABSTRACT

Demand Side Management (DSM) refers to programs that influence the usage of energy for improved economic efficiency and reduced environmental impact. The International Energy Agency (IEA) DSM Agreement is an international collaboration with fifteen IEA Member countries, working to clarify and promote opportunities for DSM. One Task under this agreement is collecting, analyzing, and disseminating information on DSM programs. The International Database on Energy Efficiency Programs (INDEEP) was developed to facilitate this process. Efficient energy usage comes from coordinated action on the input side (government, utilities and non-governmental organizations), the output side (energy end users), and by actors that affect throughput (designers, equipment providers, and energy service companies). DSM programs deliver economic benefit by improving infrastructure utilization through flattening the load curve (for example by using thermal-storage water heaters), and/or by cost-effectively reducing energy requirements while providing the same end-use benefit (for example by installing high-efficiency lighting systems). DSM programs make use of four methods: information; subsidies; contracts; and, tariffs. Due to their different characteristics, DSM programs are normally designed separately for each of the three market sectors of residential, commercial, and industrial users. Combining the objectives, DSM methods, and market sectors together, we have the Global DSM Map with sixty potential DSM program areas. Using the INDEEP database, we find significant international experience for forty-four of these program areas, and high or moderate proven value for twenty-two of the program areas. Using the Global DSM Map as a starting point, a utility can develop an action plan for improvement using a four step process: assessment of the current implementation and identification of high-potential DSM areas; investigation of potential programs using international DSM databases, such as INDEEP, to develop better understanding; development of a prioritized and phased strategy for implementation; and execution of the strategy to achieve measurable results.

Introduction

Electric utilities undertake enormous effort and expense to provide electricity "on demand." But, demand does not have to be treated as entirely outside of the utility's influence and control. Utilities world wide have developed innovative ways to influence both short-term and long-term demand, and to significantly reduce infrastructure costs in the process. Demand Side Management (DSM) is one of the tools in use.

DSM can be looked upon as a tool for energy utilities to find resources on the demand side, instead of on the supply side, or as a more general tool for society to better use and distribute scarce resources. In both cases the objective is to choose the best option to have services, such as light and cooling, that energy can provide at the lowest cost. In this paper, we concentrate on DSM as a utility tool that internalizes the choice for the least cost option in the company but limits the action to its customers. We use international case studies and experiences from the International Energy Agency Agreement on Demand Side Management (IEA-DSM) and other sources to provide an overview of DSM programs, and a framework for assessing how a utility's DSM programs compare to the entire range of proven programs.

Energy efficiency relies on several main actors, and each actor has his own role

If you look at the actors involved in DSM programs you can distinguish actors on the *input* side (government, utilities and non governmental organizations), actors on the *output* side (end/energy users), and actors that affect *throughput* (organizations influencing the setting like designers, equipment providers, energy saving companies) (see table 1).

Table 1: DSM ACTORS

Input		Throughput			Output
Government and NGO's	Utilities	Designers	Equipment providers	Energy saving companies	Energy users
• Equipment efficiency standards • Energy labelling requirements • Building codes • End-user regulations • Utility regulation • Support for DSM and Energy Efficiency Programs	• Electricity infrastructure development • Tariff structures • Customer realtionship management • DSM program development and adminisatration	• Beuilding design • Equipment selection • Energy management • Design decisions for commercial and industrial users	• Equipment development • Equipment design • Equipment promotion	• Install & maintenance equipment • Operate energy management system	• Equipment buying decisions • Building improvement decisions • Equipment use • Energy Efficiency awareness

The overall objective of DSM programs from the utility perspective is to maximize the return on utilization of existing and new electricity supply assets and to defer the construction of new electricity supply infrastructure, by flattening the demand curve and constraining demand growth. From the government perspective, DSM objectives can be to avoid energy shortages, infrastructure limitations, economic cost, foreign exchange requirements or environmental issues. Non-Governmental Organizations (NGO's) are energy agencies, international organizations, and (inter)national and local environmental action groups and their objectives are either to improve the economic or the environmental situation, and usually a good combination of both as part of a sustainable society ideal. The utility customer, the energy (end) user, is likely to include cost reduction and environmental improvements as objectives. The possibilities for improving energy efficiency at the end users are influenced by the characteristics of the buildings, the equipment and production processes as well as behavioral and management interest for this item. From this perspective, designers, equipment providers and energy service companies (ESCO's) are important actors in the field of energy saving.

In the European countries, the USA, Japan, and other countries, more and more utilities combine their primary perspective with a second one, more related to environmental improvements. For example, since 1991 environmental policy has been one of the Dutch energy distribution companies' priorities, visualized in a voluntary initiative, the "General Environmental Action Plan," with clear targets for emissions reductions to be reached by utilities actions by the year 2000 [1]. It is not clear whether the environmental perspective will become more or less important for the utilities and incorporated in the company policy, given the changing structures in the energy production and distribution sector. This changing situation is one of the items studied by the International Energy Agency (IEA) in the DSM Agreement.

IEA DSM Agreement, a cooperative action to improve and promote cost efficient DSM programs

The IEA Demand Side Management Agreement is an international collaboration with fifteen IEA Member countries, working to clarify and promote opportunities for DSM, defined to include load management, strategic conservation and related activities. In 1997 this Agreement had six Tasks [2]. The first task is charged with collecting, analyzing, and disseminating information on DSM programs. In order to facilitate this process and reduce the costs, the International Database on Energy Efficiency Programs (INDEEP) was developed. In this paper results from this database will be presented. The second task is assessing options for applying communications technologies to DSM programs and the focus of the third task is how to speed up the process of marketplace penetration. The (finalized) fourth task developed methodologies for integrating DSM options in utility planning, while the fifth task focused on improved utility and government strategies for implementing DSM technologies in the marketplace. Early in 1997 a sixth task started to develop a range of practical mechanisms whereby economically justifiable DSM programs can be incorporated into changing electricity business environments, such as restructured electricity industries and competitive electricity markets. More

information on the Agreement and these six Tasks is available on the Internet (address: http://dsm.iea.org/). We will now turn to the DSM programs as documented in the INDEEP database.

DSM programs aimed at end-users make use of information, subsidies, contracts, and tariffs to influence demand-side decision making.

Information: Informational DSM programs use advertising, energy audits, or technical research to provide end-users with reasons to take action on their own to save energy. For example, simply showing a brief television advertisement can encourage both residential and commercial users to switch from incandescent to compact fluorescent lighting fixtures, an action which pays for itself in most environments. Energy audits of industrial facilities often turn up opportunities for cost-effective energy savings that the company management was not aware of.

Subsidies: Subsidies for installing energy efficient equipment can greatly accelerate acceptance of energy saving technologies, and these programs take over where information, by itself, has not been enough to change behaviors. These programs typically take the form of low-interest loans, direct payments, or tariff concessions tied to installation of energy efficient equipment. A typical program would involve financing installation of energy efficient lighting and other technologies in a commercial environment.

Contracts: Contracts for energy savings focuses on the result, rather than the method of energy savings. In a contract DSM program, the utility normally pays for specific energy savings on the part of an industrial or commercial end-user. Frequently, contract programs involve a third party (often called an Energy Service Company; ESCO), which installs energy efficient equipment and gets paid based on specific load reduction criteria. Contract programs are relatively rare, probably because they tend to be more complex to administer than either subsidies or tariff based programs, while having a similar impact.

Tariffs: Tariff based programs fall into two basic categories: load shifting, or cost based. Load shifting tariffs are similar to subsidies in that the utility offers tariff concessions if the customer installs specific technologies, such as thermal storage water heaters, that enable load shifting from peak to off-peak hours. Cost-based tariffs use methods such as time-of-use pricing to better match tariff prices to utility, for example by charging two or three times the night rate for electricity usage during peak periods.

DSM programs increase overall energy efficiency primarily by improving utilization of the fixed infrastructure, and by introducing high-efficiency electric equipment.

Although we can find hundreds of innovative DSM programs, all of these programs achieve their real economic benefit either by improving utilization of the fixed infrastructure by reducing the peak load in relation to total usage (flattening the load curve), or by improving energy efficiency.

Infrastructure Utilization: Improvements in the use of the fixed infrastructure give important benefits because the costs of providing electric service is 60-90 percent fixed costs based on building and maintaining the fixed infrastructure of generation, transmission and distribution facilities, and providing periodic billing and related services to all customers, with relatively little cost determined by the amount of electricity delivered (the main variable costs are related to fuel usage and some usage related maintenance costs). For example, at the Tokyo Electric Power Company fuel costs represent only 12 percent of overall costs. Since the fixed infrastructure investment is determined by peak load requirements, DSM programs that reduce the peak load in relation to total usage enable more electricity to be delivered with the same infrastructure investment, reducing the cost per kilowatt hour (kWh) of providing electricity.

Energy Efficiency: Benefits related to energy efficiency rely on the simple argument that end-users want light, spinning motors, and cool buildings, rather than electricity itself. So, more efficient lighting and motors, improved insulation, and other actions can reduce energy usage while providing the same end-use benefit, reducing the economic cost of light, spinning motors, and cool buildings, rather than the cost of the electricity itself.

DSM programs to introduce high-efficiency electric equipment usually are designed differently for residential, commercial, and industrial users.

We now have discussed the four methods of DSM (information, subsidies, contracts, and tariffs), and the two benefits of improved infrastructure utilization, and improved energy efficiency. To complete our introduction, we should discuss three basic categories of energy end-users: Residential, Commercial, and Industrial. Normally, DSM programs are designed for one of these three target populations, due to four significant differences: number of end-users, energy usage per user, types of energy usage, and sophistication of energy management. So, for example, a DSM program that includes an energy audit by a manufacturing engineer

combined with a customized energy savings proposal and financing program makes sense in an industrial environment, while it would not be cost effective in a residential environment. Similarly, a subsidy program that offered a fifty percent discount on up to three compact fluorescent lights could have a significant impact in residential usage, while making no observable impact for commercial and industrial users. In Table 2 some of the key differences between the three market sectors are summarized.

Table 2: Key Differences Between the Three Market Sectors

Key Differences	Residential	Commercial	Industrial
No. of locations	millions of locations	thousands of locations	hundreds of locations
Usage per user	each end-user very small	each end-user significant	each end-user very large
Energy use types	a few common uses	lighting and HVAC primarily	industrial process driven
Energy awareness	usually little energy awareness	usually some energy awareness	professional energy mgmt.

The thousands of DSM programs that have been implemented worldwide can be categorized by Objective, Method, and Market application into sixty DSM applications, creating the Global DSM Map.

Table 3: The Global DSM Map, with INDEEP program counts shown

Objective	Method (by example)	Number of programs in INDEEP	R Res	C Com	I Ind
Infrastructure Util.		26			
Peak reduction	Tariff differentiation		xxx	xx	xxx
	Contract for load reduction initiated by the utility		xxx	xxx	xxx
Valley filling	Low tariff for thermal storage		xxx	xxx	xxx
Energy Efficiency					
General		88			
	Information campaign		x	x	x
	Contract for Energy Management		x	x	xx
	Subsidy for audit or managerial measures		xx	xx	xx
Building Envelopes		43			
	Information for isolation (insulation) measures		x		
	Subsidy for building techniques and isolation measures		xxx		
Appliances		51			
	Information on energy-efficient appliances		xx	x	
	Contract for leasing or renting energy-efficient appliances		xxx		
	Subsidy for purchase of energy efficient appliances		xxx		
	Support of technical development; e.g., demonstration projects		x	x	x
Lighting		53			
	Information on energy-efficient lighting systems and bulbs		x	x	x
	Subsidy on retrofit or installation of energy efficient lighting		xxx	xxx	xxx
	Support of technical development; e.g., demonstration projects		x	x	x
HVAC		12			
	Information for energy-efficient heating, ventilating, air-		x	x	x
	Contract for leasing or renting energy-efficient equipment		xx		
	Subsidy for purchase of energy-efficient equipment		xx		
	Support of technical development; e.g., demonstration projects		x	x	x

Proven value: xxx = high; xx = moderate; x = low or unknown; blank = minimal or no program experience

The large number of DSM programs implemented worldwide can be assigned to one of seven basic DSM objectives, and categorized into twenty basic program types through application of up to four utility DSM methods (information, subsidies, contracts and tariffs). Combining these twenty program types with the three markets (Residential, Commercial, and Industrial) gives a total of sixty potential DSM programs, of which forty-four are well documented internationally, and twenty-two have been shown to have high or moderate cost effectiveness. Table 3, above, presents the sixty programs in our Global DSM Map.

In the INDEEP database over 200 DSM programs are stored from all over the world and this number is still growing. At the end of 1997, 162 programs met the quality standard set by the international export group for programs to include in the first analysis report [3]. For these programs, information is collected using a specific

Data Collection Instrument that includes questions for the type of program, target market and marketing methods used, reason for selecting a program and the technologies involved. So it was very easy to test whether the system developed for documenting basic DSM program types, related to electricity use, is a practical one. The system proved effective for the more common DSM methods, but not for all. The reason for this is that in a lot a programs a combination is made out of elements from the basic program types. This also is presented in Table 3 as the total number is higher than 162. To illustrate, the elements most often combined are marketing methods (direct mail, advertising, personal contact etc.): 77% of the INDEEP programs used two or more marketing methods and about 15% even an combination of four or more.

To understand DSM programs in better detail, we will look at two examples:

- Peak Reduction by Direct Load Control of Residential Air Conditioning and Water Heaters (Table 4)
- Energy Savings by Subsidies for General Purpose Commercial Sector Energy Efficiency Investments (Table 5)

Table 4: DSM EXAMPLE: Peak Reduction by Direct Load Control of Residential Air Conditioners and Water Heaters

Examples	Program Characteristics
Baltimore Gas and Electric • Direct control of customer air conditioners. Air conditioners are cycled off for fifteen minutes at a time. • Customers receive a rate reduction • Load control device is activated by a signal from BG&E's own paging network. **Commonwealth Edison** • Control of thermostat settings directly during peak hours during summer months (June to September). • 15,000 homes in Illinois, USA. • Rate reduction of $5 per month. **South Wales Electricity Board** • Remote control of timers in "Economy 7" thermal storage systems. • Communications is by using TV and radio waves provided by the BBC.	**Best Fit** • Large central air conditioning units • Electric water heating **Keys to Success** • Ability to target customers and market effectively • Technology infrastructure to support communications to load control devices • Ability of customer billing system to support tariff adjustments **Strengths** • Extremely effective at peak clipping for short time periods • Result is to reschedule demand, so load factor is improved • Not noticeable to most customers if implemented effectively **Weaknesses** • Requires selling and installing equipment at each customer • Adds to utility infrastructure and complexity • Can be a source of customer dissatisfaction if not implemented well

Table 5: DSM EXAMPLE: Energy Savings by Subsidies for General Purpose Commercial Sector Energy Efficiency Investments

Examples	Program Characteristics

Southern California Edison
• Program name: Energy Management Hardware Rebate Program
• The program provides rebates (incentives) for the installation of energy management systems. The program is marketed primarily to small and medium commercial customers and municipal water districts.
• Results summary:
  • 5,603 participants (1% of eligible)
  • Total cost: 7.3 M ECU
  • Savings: 96,572 MWh/yr
  • Total Resource Cost: .0082 ECU/kWh saved
	Best Fit
	• Use this program type as a flexible framework to implement specific ideas for improvement.
	Keys to Success
	• Effective customer contact / marketing.
	• Implementation companies available.
	Strengths
	• Can be highly cost effective
	• Customer satisfaction
	Weaknesses
	• Hard to reach a high percentage of customers due to the customer contact time required.

Examples	Program Characteristics
Source: INDEEP program summary USA-26.	

So far we have described DSM programs in general, the INDEEP database of DSM programs, the objectives of using DSM, types of DSM programs, and some specific examples of successful DSM programs. We have also introduced the Global DSM Map, which provides a structured framework for categorizing and assessing DSM implementation. We will now discuss how to use the Global DSM Map and DSM case studies, such as those documented in the INDEEP database, to improve the use of DSM.

To take action for improved DSM implementation, we recommend a four step approach: Assessment, Investigation, Strategy, Execution.

We can summarize these four steps as:

- **Step 1: Assessment:** Evaluate the extent to which your organization is already applying the proven DSM programs types.
- **Step 2: Investigation:** For the DSM programs that your organization is not currently using, use International Program Summaries to better understand the proven options, and identify those programs with the best fit to your organizational strategy.
- **Step 3: Strategy:** Develop a phased approach for expanding your use of DSM, recognizing that a step-by-step approach may be needed.
- **Step 4: Execution:** Develop clear objectives and cost-effectiveness measures to ensure that programs deliver the expected or planned value (see the "European ex-post evaluation guidebook for DSM ..." [5] for guidance in this area).

We provide a brief overview of the first three steps below.

Step 1: *Assessment;* Assess Current DSM Implementation

To assess the current DSM implementation, first catalog all of the existing DSM programs that your organization uses. Then, compare the extent of your current DSM program implementations with the Global DSM Map. For each of the programs in the Global DSM Map you will want to assess the current implementation as:

1. No implementation experience
2. Pilot Program
3. Limited Implementation
4. Extensive Implementation

For example, in the Infrastructure Utilization area, in 1997 the assessment for Tokyo Electric Power Company (TEPCO) was summarized as follows:

Table 6: Global DSM Map Assessment; TEPCO 1997 DSM Program Implementation Summary (partial)

Objective	Method (by example)	Number of programs in INDEEP	R Res	C Com	I Ind
Infrastructure Util.		26			
Peak reduction	Tariff differentiation		xxx	xx	xxx
	Contract for load reduction initiated by the utility		xxx	xxx	xxx
Valley filling	Low tariff for thermal storage		xxx	xxx	xxx

Note: Shaded areas indicate that TEPCO has extensive DSM programs already implemented [6].

In simple terms, of the nine Infrastructure Utilization categories with high or moderate proven value, this assessment summary shows that TEPCO has extensive DSM programs implemented in seven of the areas. In addition to looking for improvements in these seven existing program areas, TEPCO would want to research the two areas that TEPCO is not using today (residential implementations of contracted load reductions and special tariffs for the use of thermal storage).

In general, the assessment step ends with a list of program areas where it appears that additional DSM programs could be implemented with good results.

Step 2: *Investigation;* Use international program experience to better understand potentials

After developing a list of potential program areas, in this step you will want to investigate these program areas to better understand their cost effectiveness and design issues. In this step you will also understand the required infrastructure and regulatory environment for program success. Two useful sources of DSM cases studies, the INDEEP and CADDET databases, are described below.

In developing the data collection methods, the INDEEP project incorporates experience from the US Database of Energy Efficiency Programs (DEEP) and the European association for electricity distributing companies (UNIPEDE) project for collecting program information from twelve countries. Based on this experience, the perspective of the data collection is an *evaluative* one: what were the targets and expected costs, which results were realized, how much money it cost, and which managerial lessons could be learned? On the Internet (address: http://dsm.iea.org/) ten summaries are presented. One of the general conclusions in early 1997 from the INDEEP programs analyses was that the simple cost-saving ratio for about one-third of the programs is less than ECU 0.3 per kWh, but that about nine percent of the programs have a ratio greater than 1.0 (note: 1.0 European Currency Unit is equal to about US $ 1.12).

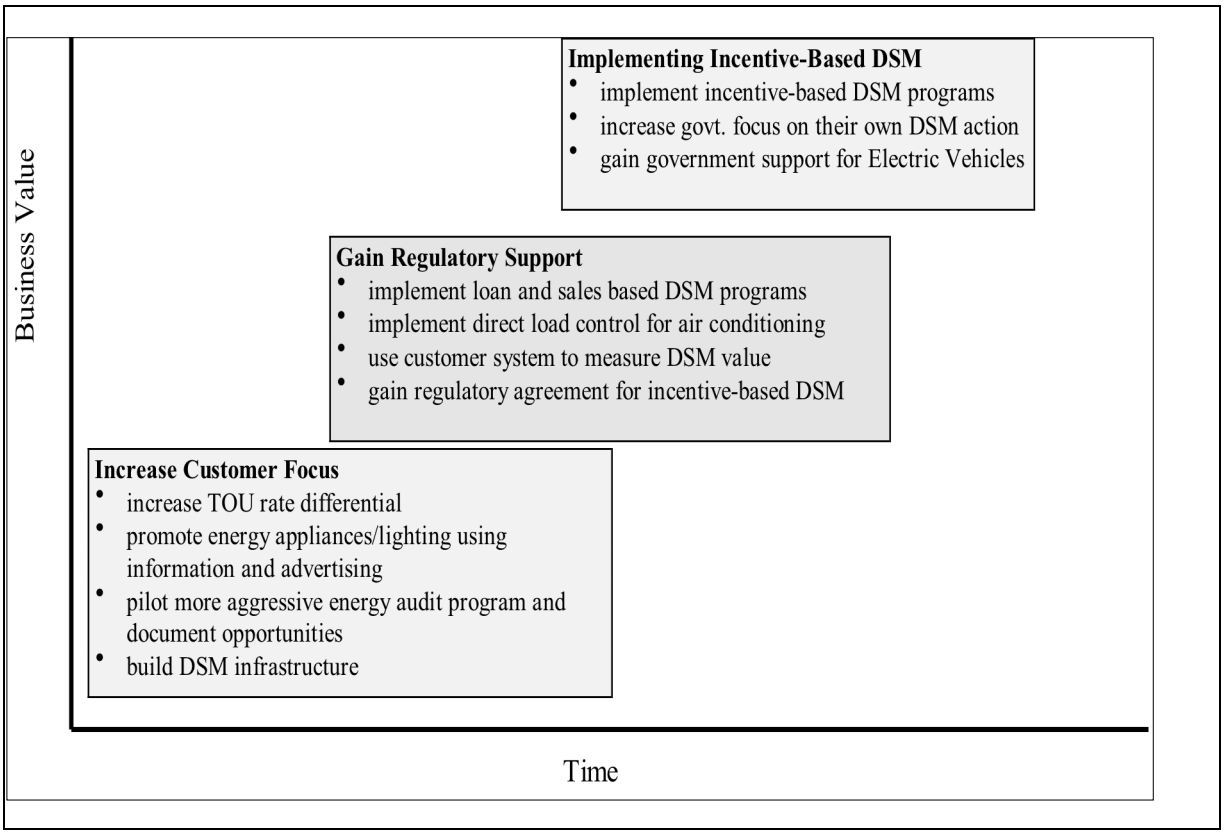
The lessons learned by management are not so easy to summarize, as the basic situation at the start of a program differs between most programs. In general, for all programs, elements for improvement are raised by the program managers, ranging from suggesting a completely redesigned communication campaign to developing a better basis for target setting for new programs.

Another, important international database with a focus on energy efficient demonstration projects is the database maintained by the Center for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET). The Demonstration project database Register is a database of more than 1,900 energy-saving demonstration projects. Simple and versatile search functions allow project selection by keywords, sectors and technologies. Each project record contains a clear description, and energy, economic and environmental data. Access to further information, literature sources and contact details are provided at their Internet site (http://www.caddet-ee.org).

By studying the DSM case studies, you will now have gained a strategy-level view of the potential programs that your organization could implement, and better understand the potential for these programs in your area.

Step 3: *Strategy;* Develop a Strategy for Improving DSM Implementation

Once high-potential DSM programs have been identified, the selection and phasing of programs should be phased based on highest payback potential and organizational readiness. For example, a phasing program might look like the following:



The objective of the strategy step is to ensure that DSM programs are implemented in a logical way, taking into account organizational and regulatory prerequisites.

The fourth step, *execution*, requires in-depth treatment, which we do not have space for in this article. One brief comment to consider: there is significant value to carefully documenting the results of DSM efforts to ensure cost effectiveness, and developing management feedback to ensure that programs stay on track. These and other factors should be considered in the execution step.

In summary:

- DSM has high proven value, and there are still many opportunities to use DSM effectively.
- The Global DSM Map provides a structured framework for evaluating current DSM programs and identifying areas for improvement.
- To use the Global DSM Map to improve energy efficiency, we recommend four steps: Assessment, Investigation, Strategy, and Execution.

References

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(4) Lessons learned by the INDEEP database, a task of the IEA-DSM Agreement, paper presented at DS/DSM Europe 1997 Conference by Harry Vreuls, Novem, Operating Agent for Annex 1 IEA DSM Agreement

(5) European ex-post evaluation guidebook for DSM and EE services Programmes, final phase 1 Report, SRC Internationals APS Denmark, NUTEK Sweden, DEFU Denmark, 1998

(6) The assessment of DSM programs for the Tokyo Electric Power Company (TEPCO) was based on publicly available documentation from TEPCO.