Demand-Side Management

The E7 Experience
DEMAND-SIDE MANAGEMENT
THE E7 EXPERIENCE

AN ELECTRIC UTILITY OVERVIEW OF
POLICIES AND PRACTICES IN DEMAND-SIDE MANAGEMENT

October 2000

THE E7 NETWORK OF EXPERTISE FOR THE GLOBAL ENVIRONMENT
This Manual on Demand-Side Management (DSM) has been prepared by the E7 Network of Expertise for the Global Environment for use by electric utility personnel in Eastern European and developing countries. The Manual’s primary audience includes utility decision-makers and project managers who are new to DSM and who are looking for an overview of DSM at a time when the world electricity supply industry is adjusting to various waves of restructuring and to the demands of international environmental protocols.

Executives and technicians should both benefit from this Manual, based as it is on the lessons learned over more than 20 years of practical and wide-ranging experience by eight of the world’s largest electric utilities operating in rapidly evolving and distinct regulatory and corporate environments. The Manual presents the rationale, principles and process to guide utilities in planning, implementing and assessing portfolios of DSM initiatives that extend or leverage parallel government-driven actions directed toward energy efficiency. It analyses the opportunities for, and constraints to successful DSM, depending on the particular regulatory, energy pricing, technological and industrial environments in each country or region. E7 members believe that a better understanding of these issues can help utilities, together with governments and the private sector, initiate and nurture a long-term market transformation toward the rational use of electricity and other energy sources.

The DSM process described in this Manual provides a framework for E7 DSM seminars. These seminars are aimed at improving the ability of utility managers to get started in DSM and to adopt the right practices related to program implementation while ensuring competitive positioning.

For more information on E7 or on E7’s DSM projects or seminars, please contact the Secretariat of the E7 Network of Expertise for the Global Environment. The address and contact numbers appear on the back cover.

Chair E7 Network
# TABLE OF CONTENTS

Foreword 3
Table of Contents 5
Introduction 7
DSM at a Glance 11

## Part A  DSM: The Environment

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section I</td>
<td>Government and DSM</td>
<td>21</td>
</tr>
<tr>
<td>Section II</td>
<td>Energy Performance Standards and Labels</td>
<td>27</td>
</tr>
<tr>
<td>Section III</td>
<td>Technology and DSM</td>
<td>35</td>
</tr>
<tr>
<td>Section IV</td>
<td>Electricity Rates</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>DSM and the Environment: The Essentials</td>
<td>51</td>
</tr>
</tbody>
</table>

## Part B  The DSM Process

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section V</td>
<td>Overview of the DSM Process</td>
<td>55</td>
</tr>
<tr>
<td>Section VI</td>
<td>Load Analysis and Forecasting</td>
<td>59</td>
</tr>
<tr>
<td>Section VII</td>
<td>DSM Potentials</td>
<td>73</td>
</tr>
<tr>
<td>Section VIII</td>
<td>Overall DSM Plan</td>
<td>83</td>
</tr>
<tr>
<td>Section IX</td>
<td>Program Design</td>
<td>91</td>
</tr>
<tr>
<td>Section X</td>
<td>Program Implementation</td>
<td>103</td>
</tr>
<tr>
<td>Section XI</td>
<td>Program Evaluation</td>
<td>109</td>
</tr>
<tr>
<td></td>
<td>Key Lessons: Improving the Effectiveness of DSM Initiatives</td>
<td>117</td>
</tr>
</tbody>
</table>

List of Figures and Tables 121
Glossary 123
References 127
Acknowledgements 131
INTRODUCTION

In the past, the electricity industry has had to continuously redefine its response to markets, regulations, interest groups, and competition. It has developed numerous, often innovative, mechanisms to adjust to its evolving economic, social, and energy resource environment. Among these adjustments, the adoption in the late 1970s of Demand-Side Management (DSM), has given electric utilities and their economic partners the corporate mindset and tools flexible enough to address with confidence both the planning and corporate positioning challenges that prevailed at the end of the 20th century. Today, at the outset of the 21st century, Demand-Side Management (DSM) remains one of the cornerstones of the future utilities are charting for themselves.

DSM BACKGROUND

North American, European and some Asian countries have promoted end-use energy efficiency since before the first oil shock, recognizing that consumers do not take advantage of all available cost-effective measures. Such public policy measures were driven by a series of forces: the anticipation of deficits in the supply/demand energy balance; the anticipation of severe ruptures or increases in fuel and electricity price profiles; growing concerns and commitments to environmental sustainability; continuous contribution of research and development to the supply of more efficient energy-consuming equipment; and increasing recognition that energy-saving technologies contribute to stronger economies.

In some countries and regions, these driving factors, once combined, translated into the introduction of Integrated Resource Planning policies that considered both demand-side and supply-side “resources” on a par through a process that usually involved public participation. National energy efficiency strategies tended to focus on the impediments—often called market imperfections—that are frequently cited as the cause for weak market uptake of more efficient technology, such as a lack of information or the unavailability of capital.

UTILITIES AND DSM

To varying degrees, electric utilities have played a role in national energy efficiency strategies. Beyond efforts targeted at improving the efficiency of their own assets—e.g., generation, transmission and distribution facilities—utilities have sought to influence consumption patterns through Demand-Side Management. They have developed a wide spectrum of discrete incentive mechanisms that go beyond sending the necessary right price signal and that are designed to overcome national and regional market imperfections, as well as institutional and transactional barriers. The reasons for utility involvement in DSM are varied but they generally relate to optimal resource allocation, cost-competitiveness, customer service considerations, enhanced competitive positioning and/or government dictates.

In the future, changing utility structures and shifting government policies will influence and modulate the objectives, nature, and extent to which these activities will continue. In some cases, changes in utility structures may warrant governments considering alternate means of achieving the same efficiency goals in the long term. Thus, market transformation mechanisms, through improved coordination of market-based and regulatory approaches, are emerging to ensure that efficient goods and services become normal practice on a sustainable basis over time.
OVERVIEW

INTRODUCTION

SECTION I

PERFORMANCE STANDARDS AND LABELS

SECTION II

SECTION III

SECTION IV

SECTION V

SECTION VI

SECTION VII

SECTION VIII

SECTION IX

SECTION X

SECTION XI

OVERVIEW OF THE DSM PROCESS

SECTION V

DSM LIFE CYCLE

DSM: THE ENVIRONMENT

GOVERNMENT REGULATIONS/INCENTIVES

SECTION I

ELECTRICITY RATES

SECTION IV

PERFORMANCE STANDARDS AND LABELS

SECTION II

TECHNOLOGY DEVELOPMENT

SECTION III

OVERALL DSM PLAN

SECTION VIII

PROGRAM DESIGN

SECTION IX

PROGRAM IMPLEMENTATION

SECTION X

PROGRAM EVALUATION

SECTION XI

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

DSM PLANNING

PROGRAM IMPLEMENTATION

SECTION X

OVERVIEW OF THE DSM PROCESS

SECTION V

PROGRAM DESIGN

SECTION IX

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

DSM PLANNING

OVERVIEW OF THE DSM PROCESS

SECTION V

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X

LOAD ANALYSIS

SECTION VI

DSM POTENTIALS

SECTION VII

OVERALL DSM PLAN

SECTION VIII

PROGRAM EVALUATION

SECTION XI

PROGRAM IMPLEMENTATION

SECTION X
The Manual

The Manual provides an introduction to DSM and an overview of lessons learned over more than 20 years of practical DSM experience by eight of the world’s largest electric utilities, i.e., E7 members. The core document is written for an audience of utility executives in developing as well as in restructuring economies that are concerned by the ongoing changes to the electricity industry structure throughout the world. It provides generic principles and issues related to the rationale behind, and the nature of DSM activities by electric utilities.

The core document of the Manual is first introduced by a section designed as a self-contained capsule, in which common definitions and the dynamics in the interplay of key players active in DSM are provided as a background for all readers. This section, entitled “DSM at a Glance” also suggests a framework for analyzing the possible impact on DSM of current industry restructuring.

The core document is then divided into two main streams. As illustrated in Figure 1, the first stream comprises four sections and introduces the environment into utility DSM decision-making (Part A). It proposes a situational analysis of the evolving context that gives utilities various opportunities and threats to address, thus increasing their motivation to use DSM.

Section I – Governments and DSM covers the rationale, role, and mechanisms such as regulation and incentives used by governments and regulatory agencies, key players in the energy efficiency field. Among these mechanisms, energy performance standards and energy performance labels designed and enforced by public authorities, with the collaboration of utilities and industry players, are addressed more specifically in Section II – Energy Performance Standards and Labels. Government and utility technology procurement policies, used as an inducement or as a reinforcement mechanism, are also introduced. Section III – Technology and DSM stresses the need to closely monitor and/or support the continuous development of new end-use technologies, which could give rise to significant opportunities, or potentially adverse threats to utilities’ future positioning. Finally, Section IV – Electricity Rates describes the design of optimal base electric rates as a necessary prerequisite and an essential component to utilities’ involvement in DSM; electric rates are used as the appropriate price signals to be sent to electricity consumers whose usage habits are to be modulated or managed.

The second part (Part B) outlines the steps of a generic process (Section V – Overview of the DSM Process) that can assist utilities when planning (Sections VI – Load Analysis and Forecasting, VII – DSM Potentials and VIII – Overall DSM Plan), designing (Section IX – Program Design), implementing (Section X – Program Implementation), and evaluating (Section XI – Program Evaluation) DSM programs. It provides background information through key questions to ask and key issues to address when responding, through a six-step process (as illustrated in Figure 1). Part B of the Manual is based on the specific experiences and lessons learned by the members of the E7 Network of Expertise for the Global Environment. Together, these utilities have developed, within evolving and very different DSM environments, the complete spectrum of DSM initiatives that can be considered by utilities today in developing and/or restructuring economies. Key messages from E7 utilities are included as a conclusion to the core document.

High-tension power lines, Philippines
**WHAT IS ENERGY EFFICIENCY?**

Energy efficiency is usually measured by a quantity of output per unit of energy input. It refers to the physical performance of specific end-uses or energy services such as lighting, heating, cooling, and driving force. It also applies to the performance of traditional utility functions such as electricity generation, transmission and distribution. The Manual focuses on the energy efficiency of end-uses of electricity.

Energy efficiency programs can apply to all sources of energy and are aimed at saving or reducing the energy required to fulfill consumer needs. Energy efficiency programs comprise the incentives designed and delivered by governments, as well as the DSM initiatives put forward by electric utilities. The DSM initiatives led by utilities are complementary to energy efficiency strategies initiated by government agencies; these are usually embedded in energy policies designed to enhance national or regional energy productivity and security as well as overall economic efficiency. DSM is not a ready-made solution for achieving energy efficiency in all countries and all situations. It is a dynamic process with principles that can be applied to various and different energy conditions to produce benefits both in the power sector and in society in general.

**WHAT IS DSM?**

Demand-Side Management (DSM) refers to organized utility activities or programs intended to affect the timing or amount of electricity used by customers. At the core of a utility DSM program is a series of measures intended to encourage specific groups of customers or market segments to modify their energy usage patterns in a manner consistent with the utility’s DSM objectives, while maintaining or enhancing customer satisfaction. Utility DSM programs usually fall into two broad categories: energy-saving or conservation programs and load management programs.

**ENERGY-SAVING OR CONSERVATION PROGRAMS**

Energy-saving measures are activities designed to encourage replacing less energy-efficient equipment to produce the same level of energy services with less electricity and to change consumer behavior to reduce energy use.

![Installation of an energy-efficient water heater](image)
**Load Management Programs and Load Shape Objectives**

Load management programs are designed by utilities to reduce demand during peak periods or to make more economic use of existing utility resources through demand displacement over time. Load management programs are particularly important to electric utilities that face the particular and unique constraints associated with the real-time synchronization of production or supply with demand.

Figure 2 illustrates the main load shape objectives E7 members have set individually or in combination when planning and designing various DSM initiatives:

- peak clipping (to reduce customer demand at times of heaviest use);
- load shifting (to change the timing of end-use consumption from high-use, high-cost periods to low-use, low-cost periods);
- strategic conservation (to reduce energy consumption seasonally);
- strategic load growth (to selectively increase consumption seasonally, year-round or during off-peak periods).

Power systems characterized by a need for peaking resources benefit most from peak-clipping and load-shifting DSM measures. At the opposite end, systems that need additional base load resources can benefit from strategic conservation measures.

All utility DSM programs (for both energy-saving and load management purposes) can be further combined into:

- programs affecting the way energy-using equipment or systems are operated and maintained; and
- programs that focus on the installation of improved equipment or systems.

Utility DSM initiatives, along with government-driven energy efficiency strategies, are planned, designed and adjusted over time:

- to overcome market and institutional barriers to the rational use of electricity (and other energy sources);
- to leverage or benefit from the opportunities arising from technological development and from end-use equipment or service industry initiatives.

**Players in the DSM Field**

DSM planning, implementation and evaluation is a multifaceted endeavor that requires the active involvement of both the public and the private sectors.

**Public Sector**

Within the public sector, government and regulatory agencies responsible for national or regional energy and electric power planning and energy efficiency programs work in synergy with agencies responsible for industry and trade, the building sector, equipment standards, and research related to energy efficiency. In addition, supranational standards and development agencies, as well as international financing institutions (IFI), play an increasingly important role in persuading countries to put sustainable development at the top of their agendas through funding mechanisms that are conditional on their taking energy efficiency and DSM into account in their energy planning processes.
Some of the international financing institutions that have considered guidelines to ensure that proposed projects are designed and implemented in an environmentally and economically sound fashion are the African Development Bank, Asian Development Bank, Canadian International Development Agency, Inter-American Development Bank, and the World Bank.

For example, the World Bank has designed a “New Environmental Strategy for the Energy Sector” aimed at capturing win-win opportunities that provide environmental benefits through economically attractive solutions at no additional cost. Some of the most important opportunities are described below.

- Energy sector reform and restructuring through the introduction of competition, commercial principles – such as market prices as the right signals to producers and consumers alike – and private investment.
- Energy efficiency initiatives that promote economically sound and financially attractive measures (not always believed to be captured in the reform process). These include: rehabilitation of energy systems, operation and maintenance improvements, energy conservation investments, and improvements in energy-consuming processes that yield savings. The World Bank is considering aggressively seeking out these opportunities by encouraging public and private partners to explore profitable investments and by enabling policies in this field.

**Private Sector**

In the private sector, the cooperation of equipment manufacturers, trade and professional associations, financial institutions and, most significantly, consumers, is an essential ingredient if DSM is to achieve social, economic and commercial objectives. In developing countries, the contribution of the emerging energy service companies (ESCOs) is expected to play an important role in the delivery and implementation of DSM programs. ESCOs are firms that specialize in providing DSM services directly to the end-user. Typically, these firms enter into contractual agreements with the cost savings being shared with the client, i.e., the energy end-user. Very often, ESCOs, in addition to offering expertise and services, provide the up-front financing of the DSM costs incurred by their client.

Several non-governmental organizations (NGOs) (e.g., national technical institutes, university research and analysis centers, industry associations, consumer groups, environmental organizations) can offer ideas, research and demonstration assistance to a utility at both the DSM planning and program-design stages of the DSM process.

Figure 3 illustrates the interaction between electric utilities and players from the institutional and private sectors in the planning and delivery of DSM initiatives. Each player has a specific role:

- on input (governments, utilities, other energy producers/distributors and NGOs);
- on output (final energy users or customers);
- on the throughput of the DSM process (i.e., equipment suppliers, manufacturers and distributors, trade and professional associations, building contractors' associations, ESCOs, consulting engineers, architects and designers).

Motivation for Utility Involvement in DSM

The respective role of each player differs, depending on the situation, the policy objectives, and the type of action being considered. Public and non-governmental institutions are more likely to use public money allocated for energy efficiency to advance societal rather than commercial interests such as funding customer retention or increasing market share.

The involvement of electric utilities in DSM can be categorized according to three principal motivating factors: policy, regulation, and business. For example, utilities in E7 countries are either owned or regulated by government. As such, they are a convenient vehicle for implementing government policies, including those on energy efficiency. Utilities are generally well-positioned to understand how customers use their products. All have developed and maintain a field marketing force. They have engineering and customer service staffs that can be deployed for program design and implementation. They are trusted by most of their customers and are trade allies when it comes to energy matters; finally, they have access to capital that customers may lack.

Utilities are thus considered optimal mechanisms to implement DSM programs, i.e., to provide customers with information, recruit program participants, and reduce transaction costs and DSM barriers.

Most E7 governments grant electric utilities an exclusive franchise or concession to provide service within a given region, and all have introduced some form of regulation as a substitute for competition. Regulatory measures attempt to remove or offset the biases that encourage utilities to increase investments and sales. The regulations specify that resource acquisition decisions are to be based on least-cost criteria through a systematic evaluation to ensure they support cost-effective end-use efficiency. In some E7 countries, utilities operate under constraints and are required not to raise rates. Such business pressures can also arise in competitive markets. Moreover, additions to supply may be rendered close to impossible because of constraints, or be considered too risky due to long lead times and uncertain future energy consumption. Some utilities may also use DSM as a way of gaining or retaining market share relative to competing fuels.

Although not all utility DSM efforts are justified using these categories of motives, they are an important basis for classification, since changing utility structures and shifting government policies will influence the nature and extent to which these activities will continue. Until the problem of paucity of data is resolved, the evaluation of the impact and effectiveness of different utility structures on end-use efficiency must rest on an examination of individual motivations, procedures and activities.
Regulated utilities and government-owned utilities have always been asked to achieve a balance between profit motives and public obligations. In return for their monopoly franchise, utilities were obliged to provide services on a non-discriminatory basis at least cost. For regulated electric or gas utilities, programs to assist social policies were important elements of their public obligations. Among those public purpose programs were DSM, low-income assistance, the development of renewable energy and, in some regions, research and development. Reliance on utilities as instruments for enacting these policies reflected a perception that the benefits of such programs would not flow from the “natural” operation of the market.

A New Balance between Utility Objectives and Incentives

The on-going electricity industry restructuring threatens this balance: the long-standing relationship between a single monopoly provider or a protected franchise and customers has been replaced by a new set of relationships between retail electricity suppliers and customers who are now free to choose providers. In the various countries where restructuring is being considered (or under way), the traditional ways of providing public purpose programs are being re-examined. In the early phases of restructuring, utilities have proceeded to unbundle their traditional functions (generation, transmission and retail distribution). Some have engaged in aggressive cost-cutting efforts to enhance retail price competitiveness. In some regions, dramatic declines in utility spending on public purpose programs, including DSM, were observed as a consequence.

In many countries where restructuring is under way, there are debates as to whether or not there remains a continuing need for ratepayers to fund public benefit programs. In countries where there has been agreement that DSM programs should continue after restructuring, a public benefit charge has emerged as an important option for legislators and regulators to maintain ratepayer funding through collecting a predefined charge per kWh from customers. In parallel, Performance-based regulation (PBR) is being considered as a public policy tool to provide more financial incentives to enhance energy efficiency in utility functions that are still managed as natural monopolies, such as the transmission and distribution of electricity. In these countries, various reasons (see Table 1) have been used as a rationale to continue ratepayer funding for DSM programs.

| TABLE I |

<table>
<thead>
<tr>
<th>RATIONALE FOR RATEPAYER-FUNDED ENERGY EFFICIENCY PROGRAMS IN A RESTRUCTURED ELECTRICITY INDUSTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Facilitating the transition to more competitive markets</td>
</tr>
<tr>
<td>❑ The remaining potential for cost-effective energy efficiency investment is large</td>
</tr>
<tr>
<td>❑ Programs to capture energy efficiency opportunities have been cost-effective</td>
</tr>
<tr>
<td>❑ Restructuring alone is unlikely to significantly reduce market barriers to energy efficiency</td>
</tr>
<tr>
<td>❑ Private-sector energy efficiency activities (e.g., ESCOs) are growing but remain underdeveloped</td>
</tr>
<tr>
<td>❑ Ratepayer funding for energy efficiency programs remains appropriate</td>
</tr>
<tr>
<td>❑ Industrialized countries where restructuring is under way have found it necessary to promote energy efficiency</td>
</tr>
</tbody>
</table>


Basic Principles for Planning and Implementing DSM

E7 members believe that, in countries where industry restructuring is being considered or is under way, the basic principles and methods used to plan and implement DSM remain the same. However, the structural incentives to utilities, the financing of DSM initiatives, as well as the objectives (and their evaluation) pursued by utilities when carrying out DSM initiatives will tend to differ. These will evolve according to the role that the private sector, such as ESCOs, and government agencies will progressively redefine for themselves in the energy efficiency field. Electric utilities are thus likely to develop mechanisms to closely monitor the dynamics of the interplay of the various players in the field.
A NEW ENERGY POLICY OBJECTIVE: “MARKET TRANSFORMATION”

Utility DSM program portfolios have always reflected a balance between different energy efficiency policy objectives such as maximizing cost-effectiveness, environmental benefits, and equity across customer classes. While the first two objectives might not be affected during or after restructuring, it is expected that publicly funded programs will be targeted more to customer classes not well served by the competitive private market.

As has been seen in countries where restructuring is under way, a new objective is being added: transforming energy markets so public funding is not needed to support energy efficiency.

Focusing on market transformation as a strategic framework for DSM program design could lead to improvements over earlier programs primarily designed for resource acquisition purposes. From that perspective, energy was to be quickly saved or displaced over time, in cost-effective ways that could easily be verified. Focusing on changing markets in order to improve energy efficiency naturally, or with sustainable effects leads to:

- program design and evaluation that focus more consciously on market barriers that impede investments in energy-efficient products and services;
- a better coordination of initiatives developed and delivered by a broader range of players.

BARRIERS TO DSM

Most economies have great technical potential for DSM. Yet there are a number of market-based and institutional barriers that must be overcome before much of this potential can be realized. E7 members have noticed that the efficacy of utility DSM initiatives and, in general, of DSM strategies, is directly related to their ability to overcome the major barriers in their service territories. Market barriers to energy efficiency are usually defined as characteristics of the market for an energy-related product, service or practice that help explain the gap between the actual level of investment in, or practice of energy efficiency and the increased level that would appear to be cost-beneficial for the consumer.

These barriers stem from the environment surrounding the decisions and actions taken by end-users, market intermediaries, electric utilities and institutional organizations. Experience shows that the marketplace alone will achieve only a negligible part of the available economic DSM potential.

MARKET-BASED BARRIERS

Market-based barriers (see Table 2) are usually associated with the specific perceptions and behaviors of final customers, intermediaries such as manufacturers and distributors of energy-efficient equipment and energy efficiency service providers (engineering consultants, architects, etc.), and those of electric utilities themselves. E7 members usually group these barriers into the following clusters:

- lack of awareness and general misinformation about the benefits (range of options and associated life-cycle savings and costs) of DSM programs and technologies;
- lack of technical information and expertise characterized by information gaps in the sector-specific and industry-specific breakdowns of energy-use patterns, insufficient technology-specific engineering data, and a scarcity of information about the availability of energy-efficient equipment;
- lack of capital or access to financing where investment selection criteria for new equipment and the structure of financing mechanisms give priority to supply-side solutions to energy shortfalls over demand-side options;
- inertia in established patterns of behavior and/or slow acceptance of new technologies or managerial cultures;
- product or service unavailability, which may be the result of collusive or anti-competitive practices to hold some products (or producers) from the market in favor of others with higher profit margins or other advantages such as market shares;
- misplaced or split incentives, where the incentives of an agent charged with purchasing energy efficiency are not aligned with the motivation of those who could benefit from the purchase.
Institutional barriers refer to conditions created by the nature and scope of interventions by government and regulatory agencies to influence the marketplace according to public policy objectives and budgets. Institutional barriers are usually combined with market-based barriers and lead, for example, to:

- a lack of effort on a national level to coordinate energy efficiency actions initiated by different players (i.e., sector-specific end-use data collection, dissemination of information on energy efficiency, structuring of appropriate vendor infrastructure, establishment of a national energy policy that incorporates both demand- and supply-side options, development of government incentive programs for demand-side options, etc.);
- inappropriate pricing policies where distortions are observed in electricity prices that do not reflect marginal costs, do not provide adequate treatment of externalities, and compete with other energy sources priced according to different regulatory requirements;
- a lack of fiscal incentives for DSM investments;
- a lack of high energy performance standards and deficiencies in their enforcement;
- a lack of continuity in institutional energy efficiency incentive programs;
- the imposition of taxes and tariffs on imported manufactured goods, including energy-efficient equipment.

### Opportunities for Overcoming Barriers to DSM

Experience has shown E7 members that the barriers described above can be circumvented or overcome through a mixture of demand-side approaches or other programs that can be grouped into pricing and non-pricing mechanisms.

### Table 2

**Market-Based Barriers to DSM**

<table>
<thead>
<tr>
<th>Origin of Barriers</th>
<th>Barriers</th>
</tr>
</thead>
</table>
| **Customers**     | ☐ Ignorance or disbelief regarding DSM benefits  
|                   | ☐ Fear of loss of comfort, quality or productivity  
|                   | ☐ Lack of knowledge about efficient equipment  
|                   | ☐ Perceived risk of adopting a new technology  
|                   | ☐ Lack of financial resources  
|                   | ☐ Misperception of financial risks and return on investment  
|                   | ☐ High up-front costs  
|                   | ☐ Unavailability of DSM technologies/services in regions  
|                   | ☐ Consumerism and associated status |
| **Intermediaries**| ☐ Apprehension of market and profit losses  
|                   | ☐ Lack of information/training/know-how about DSM applications  
|                   | ☐ Perception of financial risk  
|                   | ☐ Lack of capital availability to carry out/introduce new efficient products  
|                   | ☐ Third-party decisions made outside by foreign headquarters  
|                   | ☐ Limited influence on decision-making process by end-user |
| **Electric Utilities** | ☐ Apprehension of negative rate impacts  
|                   | ☐ Lack of available resources to allocate to DSM  
|                   | ☐ Prevailing accounting rules  
|                   | ☐ Lack of appropriate DSM culture and know-how |
Pricing Mechanisms

Among pricing mechanisms, pricing and taxation policies that reflect the real cost of energy (i.e., that value energy at its true marginal cost) and that provide financing mechanisms for DSM-related activities are the most prevalent. Through their base rates and a rate structure that reflects demand, energy, and customer-related costs, utilities can send a price signal that guarantees long-term energy efficiency. Rate options such as time-of-use rates or interruptible rates can also be used to better address the specific needs and opportunities of different market segments. According to E7 members’ experience, state-of-the-art rate structures and pricing mechanisms that properly reflect costs and ensure equality across customer classes should be viewed as the single most important prerequisite to any other DSM intervention.

Non-pricing mechanisms

Non-pricing mechanisms comprise:

- approaches that facilitate interplay between institutional players in energy efficiency, e.g., utility participation in the development of a complementary legislative and institutional framework (e.g., energy performance standards), the integration of least-cost planning principles to energy planning and lending activities, development of an energy knowledge base; and
- strategies/programs that directly address market-based barriers:
  - promotional/educational programs, such as labeling programs and energy audits, that are useful vehicles for the dissemination of DSM-related information to customers, efficient equipment/service providers and lending agencies;
  - financial incentives (including rebates) that lower barriers related to customers’ lack (or perceived lack) of up-front capital;
  - support of research into the sector-specific electricity consumption data necessary to focus DSM efforts and support efficient technologies/equipment that could be produced and sold domestically;
  - technical assistance and training programs targeting individuals/firms involved in energy efficiency at all levels to assist in establishing and implementing DSM programs;
  - technology procurement practices (DSM bidding, standard offer programs and other institutional purchase practices).

E7 members believe that these pricing and non-pricing strategies, when combined and tailored to the specific DSM environment of individual countries, could be the backbone of a utility’s contribution to national market-transformation initiatives, in both industrialized and developing countries.
PART A

DSM: THE ENVIRONMENT
E7 member-country governments have promoted end-use energy efficiency since well before the first oil crisis because they recognize that consumers do not make use of all available cost-effective measures.

Generally speaking, the rationale behind the selection and design of the individual initiatives included in the energy efficiency portfolios of E7 governments has been similar in terms of objectives and principles. However, the configuration of their programs has varied significantly, depending on the dynamics of key national factors.

Rationale for Government Initiatives in Energy Efficiency

In E7 countries, the role of government and initiatives in DSM-related activities has usually been justified by policy and designed to achieve a broad range of public objectives.

Some examples are: minimizing the environmental impact of electricity production and transmission to support government commitments to international treaties on environmental sustainability; providing assistance to low-income consumers; creating jobs and stimulating local economic development. These policy objectives have usually been subordinated to larger objectives such as energy security and fuel diversity.

A denominator common to all E7 countries is that the government initiatives in energy efficiency portfolios have been selected for their ability to guarantee the optimum allocation of the energy resources of individual nations or regions over the long term. More recently, as the early impacts of the electricity industry’s restructuring are assessed, governments are adding a further goal of transforming energy markets over the long term to arrive at a point where public funding would no longer be needed to support energy efficiency.

The various policy measures initiated by governments tend to focus on either correcting market imperfections or offsetting the biases introduced by traditional regulatory systems.

Sources of National Differences in Government Energy Efficiency Portfolios

Differences in national energy efficiency strategies stem from the diagnoses national policy planners have formulated as to the particular sources of economic inefficiencies and/or opportunities observed in the profile of their respective energy balances, energy efficiency equipment and service industry, and their regulatory environment. The diversity observed in government energy efficiency portfolios is also related to the variety of responses agencies have made to correct particular inefficiencies or to tap into nation-specific opportunities. Table 3 lists some of these differentiating factors.

Table 3

<table>
<thead>
<tr>
<th>Differentiating Factors Leading to Different Government Energy Efficiency Portfolios</th>
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</thead>
<tbody>
<tr>
<td>- National energy supply-demand balance and inventory of energy resources</td>
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<tr>
<td>- National energy consumption and economic profile of end-use sectors</td>
</tr>
<tr>
<td>- National energy efficiency industry, including energy-efficient product and service providers</td>
</tr>
<tr>
<td>- Potential complementarity of and synergy with initiatives by other players on the national DSM playing field</td>
</tr>
<tr>
<td>- Particular market imperfections that impede the full deployment of energy-efficient investments and behavior, as well as local energy-efficient product and service providers</td>
</tr>
<tr>
<td>- Structure, ownership and degree of competition in the national electricity supply industry (ESI) and the regulatory regime and social contract that form the framework for ESI investments, operations, and interface with end-users and the environment</td>
</tr>
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</tr>
</tbody>
</table>
TYPES OF GOVERNMENT INCENTIVES AND REGULATORY MEASURES TO CORRECT MARKET IMPERFECTIONS

In all E7 countries, public energy efficiency strategies have been designed to reduce or correct market imperfections or impediments, such as lack of information or of capital, that are often cited as the cause for weak industry and market uptake or use of more efficient technology. Government agencies have used incentives as well as regulatory measures for this particular purpose.

GOVERNMENT INCENTIVE PROGRAMS

As shown in Table 4, government incentives to enhance energy efficiency can be classified into five groups: information/education; technical assistance; financial assistance to end-users, ESCOs and energy-efficient product/service providers; taxes; and R&D and technology procurement.

<table>
<thead>
<tr>
<th>GOVERNMENT INCENTIVES TO ENHANCE ENERGY EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Information/education on the energy-use characteristics of appliances, building materials/structures and industrial processes, through energy performance labels or other promotional and training vehicles</td>
</tr>
<tr>
<td>❑ Technical audits of homes, offices and factories to evaluate efficiency opportunities</td>
</tr>
<tr>
<td>❑ Rebate toward the first-cost premium associated with the manufacture, purchase and installation of more efficient equipment or the purchase of consulting, ESCO or financial services</td>
</tr>
<tr>
<td>❑ Tax incentives associated with the manufacture, purchase, import and installation of more efficient equipment and, conversely, imposing additional tax levies on less efficient equipment</td>
</tr>
<tr>
<td>❑ Initiation of or support for public-interest R&amp;D and technology procurement efforts, as well as industry/government voluntary agreements to stimulate the introduction of new high-efficiency measures</td>
</tr>
</tbody>
</table>

Along with these incentives to end-users and third-party product and service providers, governments also set minimum efficiency or energy performance standards for appliances and buildings, as well as establish environmental norms, which constitute economic and readily available compliance mechanisms for investments in energy-efficient equipment.

GOVERNMENT ACTIONS ON THE UTILITY REGULATORY ENVIRONMENT

Throughout the late 80s and 90s, governments in E7 countries also worked at removing inefficiencies introduced by the national or regional regulatory systems put in place to guide the investments and operations of public utilities within the energy supply industry. Such inefficiencies or distortions were perceived as disincentives to DSM and had to be offset by changing some regulatory prescriptions or by introducing regulatory “incentives.”

TYPES OF REGULATIONS AND ASSOCIATED DISTORTIONS

In the past, E7 governments granted utilities (both government-owned or private investor-owned), particularly electric utilities, an exclusive franchise or concession to provide service within a given region. In the electricity supply industry, functions that require more-or-less permanent connections with customer premises, such as transmission and distribution, are recognized as natural monopoly activities.

The absence of competition in monopoly markets has led governments to intervene in order to ensure that monopolies do not abuse their power at the expense of their customers. Most have introduced some form of economic regulation as a substitute for competition. Traditional utility activities that require government approval include: capital investment, borrowing, site and environmental approvals, choice of fuels and generation technologies, import/export and rate-setting.

In the electricity industry, governments have designed regulations that go beyond the mere protection of customers, imposing safety, environmental or other standards, as well as the promotion of specific policy objectives, fuel technologies, etc.
The three types of regulations described below have typically been observed in E7 countries.

- **Social contracts**, such as those seen in France, where the utility and the government sign a contract wherein the utility undertakes to achieve a certain level of performance, both technically and financially; in this situation, governments allow the utilities to operate as quasi-independent autonomous entities.

- **Performance-based regulations**, where strict financial and other objectives are fixed for the utility. The two main types of performance-based regulations are rate of return (ROR) regulations and incentive regulations, the best-known being "price caps."

- **Conduct regulations**, mostly found in the form of Integrated Resource Planning (IRP). IRP is a planning process that explicitly puts supply- and demand-side resources on a par, using a consistent evaluation method and a series of financial criteria. The process also allows the external costs and benefits associated with power supply to be taken into account. It is usually accompanied by a change in utility incentives away from a focus on investments in supply and increases in sales. For example, in some E7 countries, regulators have encouraged suppliers to promote energy efficiency by rewarding them with a comparable level of earnings for energy efficiency investments and/or by decoupling overall earnings from sales.

Various types of regulations that reflect the specific culture of different regions have been applied by governments to oversee utilities in key industrial sectors. Over time, new types of regulations have been introduced to correct the distortions created by the more traditional types (see Table 5 for a review of regulations and their impacts on DSM). For example, price cap regulations, based on a ceiling for annual rate increases, were introduced to move utilities away from ROR regulations and to balance their interests between supply-side and demand-side investments. Similarly, IRP was introduced as an alternative to performance regulations; it includes consideration of the external costs and benefits associated with power supply and it is usually accompanied by a change in utility incentives away from a focus on investments in supply and increases in sales. Wherever applied, these progressive changes in the regulations governing electric utilities have contributed to developing a working environment favorable to DSM.

### Table 5: Types of Regulations and their Impacts on DSM

<table>
<thead>
<tr>
<th>Types of Regulations</th>
<th>Description and Objectives</th>
<th>Period of Introduction</th>
<th>Regions</th>
<th>Impacts on DSM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rate of Return (ROR) or Cost-based</strong></td>
<td>Electric rates set to allow earning a prescribed level of profits, Cost of service regulation + fair return</td>
<td>For a long time the traditional form</td>
<td>North America</td>
<td>Rewards utilities for increasing their rate base and selling more power</td>
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<td></td>
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<td></td>
<td>Neglects opportunities to seek lowest-cost resources, including DSM</td>
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<td></td>
<td></td>
<td></td>
<td>Does not internalize costs of environmentally beneficial DSM</td>
</tr>
<tr>
<td><strong>Incentive (Price or Revenue Caps)</strong></td>
<td>Ceiling on annual increases to electricity rates or utility revenues</td>
<td>Late 80s – 90s</td>
<td>North America</td>
<td>Gives utilities a new set of incentives that may affect or increase their interests in demand-side investments</td>
</tr>
<tr>
<td><strong>Conduct (Integrated Resources Planning – IRP)</strong></td>
<td>Supply- and demand-side options assessed using a consistent evaluation method and a series of financial criteria</td>
<td>Mid-80s – Early 90s</td>
<td>North America, European Community (through EC Save program)</td>
<td>Allows the external costs associated with power supply to be taken into account</td>
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<td></td>
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<td></td>
<td></td>
<td>Encourages utilities to consider options other than supply investments</td>
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</table>
In recent years, a number of E7 countries have increasingly shifted toward deregulation or re-regulation of the electricity supply industry driven by:

- the realization that the industry’s traditional approach to planning new equipment and existing regulatory processes failed to send signals that led regulated utilities to become more efficient and cost-effective;
- the realization that competitive forces can be allowed to operate in the generation and supply of electricity and that they are not natural monopolies.

The political willingness of some E7 countries to open markets and reduce government regulatory intervention has led to a re-evaluation of the role of regulations, governments and utilities in various activities, including DSM. New roles are being defined, and are already being played in some regions.

The implications of changes to the electricity supply industry to achieve end-use efficiency can be analyzed in terms of:

- DSM opportunities in transition periods;
- redirected IRP initiatives aimed at avoiding investments in additional capacity for transmission and distribution systems in natural monopoly environments;
- new public benefit charges or taxes on each kWh sold to finance DSM;
- increased interaction of DSM players, including utilities, under enhanced government-utility cooperation toward market transformation.

### DSM Opportunities in Transition Periods

With industry restructuring, competitive procurement is becoming more prevalent, essentially changing the role of the vertically integrated utility with a “virtual monopoly” in all aspects of the business to one of carrier and supplier of services. However, competition for generation is happening at the margin in most jurisdictions in E7 countries. During the transition period, specific rules are introduced to ensure that longer-term goals are not compromised or disregarded in the interim. For instance, where competition is allowed within particular segments such as generation and supply, larger customers will generally be allowed to participate in the competitive market before smaller customers. During the interim period, circumstances may be such that a utility-organized DSM can capture what might otherwise be lost opportunities:

- some customer groups are being served traditionally;
- the pricing regime associated with a competitive market may be less than fully developed.

### IRP for Transmission and Distribution Investments

Since IRP seems to work well under situations where an open review and planning process focuses on the entire plant-to-customer chain (typically in a vertically integrated structure), an unbundled electricity industry may limit the capacity to coordinate end-use efficiency efforts initiated by utilities. However, IRP can be done for individual segments of the electric industry, and examples have shown that avoidance of investments in additional capacity for transmission and distribution systems have driven DSM activities. In the U.S. for instance, some utilities have started to pay attention to the advantages of selectively targeting DSM to areas short of transmission and distribution capacity.

### Public Benefit Charges

New mechanisms are emerging or being considered in some E7 countries, such as the creation and collection of public benefit or “wire” charges (or a volume surcharge or tax collected from every customer), as a means of generating funds for public benefit programs such as low-income assistance programs, energy-related R&D, renewable energy, as well as general energy efficiency measures. The authority selected to administer public benefit charges comprises either utilities, governmental agencies, or a combination of both.
Enhanced Government-Utility Cooperation Toward Market Transformation

In E7 countries, governments are considering taking steps to compensate for any reduction in utility-organized energy efficiency efforts that might follow a reorganization of the electricity industry. Among the most significant is the coordination, on a national basis, of all energy efficiency initiatives to bring about a long-term market transformation through strategies to encourage the adoption of energy-efficient products and services to the point where their use becomes normal practice and intervention is no longer needed. Table 6 shows examples of the typical distribution of roles in an orchestrated market transformation initiative.

For example, the California Public Utility Commission in 1997 announced these new objectives for its ratepayer-funded energy efficiency activities:

“Our focus for energy efficiency programs has changed from trying to influence utility decision-makers, as monopoly providers of generation services, to trying to transform the market so that individual customers and suppliers in the future competitive generation market will be making rational energy choices. The mission of market transformation is to ultimately privatize the provision of cost-effective energy efficiency services so that customers seek and obtain these services in the private competitive market.” (CPUC 1997)

Finally, enhanced efforts toward market transformation will also mean an increased reliance on conventional mechanisms

<table>
<thead>
<tr>
<th>TABLE 6</th>
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<tbody>
<tr>
<td><strong>Typical Roles in Market Transformation Initiatives</strong></td>
</tr>
<tr>
<td><strong>Type of Organization</strong></td>
</tr>
<tr>
<td>Local organization or utility</td>
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<tr>
<td></td>
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<tr>
<td>Regional government or regional-level organization</td>
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<td>National government or national organization</td>
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<td></td>
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<tr>
<td>International organizations</td>
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traditionally coordinated by governmental agencies with the full cooperation of utilities:

- energy performance standards and product labeling;
- information campaigns and financial incentives to customer segments not addressed by the private sector;
- assistance to help develop a robust, independent and private energy services industry. This assistance would be channeled through:
  - standardized contracts to reduce transaction costs associated with third-party financing;
  - risk guarantees for portfolios of energy efficiency projects;
  - a certification system for ESCOs.

---

**Key Observations from E7 Experience**

- It is important to view utility DSM efforts within the context of energy policies in general, energy efficiency policies in particular, and end-use characteristics of the consuming sectors.
- No one mode of regulation is universally applicable. The form and extent of regulation are functions of the desired level of competition and government control, as well as of the structure and ownership of the national industry. DSM efforts will adjust to different regulatory environments. This, in turn, will influence the nature and importance of DSM outcomes and success.
- Continuously evolving government initiatives, as well as the adoption of an open partnership attitude, appear to be two key ingredients in the success and the productivity of utilities’ own DSM initiatives in progressively transforming markets.
- With altered roles and scope of actions, electric utilities will remain key players, with governmental agencies and DSM industry players, in shaping the success and charting the future of market transformation in various energy, economic, social and regulatory environments.
ENERGY PERFORMANCE STANDARDS AND LABELS:

A JOINT GOVERNMENT-INDUSTRY AND UTILITY EFFORT

ROLE AND IMPORTANCE OF STANDARDS AND LABELS

When implementing their energy efficiency strategies, governments of all E7 member countries, in collaboration with utilities active in DSM, have worked together to develop an environment conducive to:

- the end-use equipment industry manufacturing and marketing increasingly efficient products (lighting and electric appliances) and withdrawing less efficient products from their product lines;
- the building industry adopting techniques and product-assembly practices to more thermally efficient buildings;
- end-users selecting end-use equipment, products and buildings that are clearly differentiated by their higher energy performance.

To achieve these goals, government agencies have designed and worked at enforcing: increasingly stringent energy performance standards for energy consuming equipment, thermal efficiency standards in building codes and energy performance labels for end-use equipment such as electric appliances – refrigerators, freezers, washing machines, heating and cooling equipment, lighting appliances, electric motors, etc.

Energy performance standards and labels are cornerstones of the market transformation initiatives implemented by government agencies and most electric utilities in E7 member countries.

ENERGY PERFORMANCE STANDARDS

CONCEPT AND DEFINITION

According to the most recent definition given by the International ISO Work Group, a standard is “a technical specification, a practice code or any other document applicable for a repetitive use, endorsed by a standardization organization and put at the public’s disposal.”

Most governments have included minimum energy performance levels or standards in their respective energy efficiency strategy, especially for energy-consuming products where:

- energy efficiency is not considered a prime purchase criterion; or
- an exceptionally high consumption level dictates an early withdrawal from the market.

Product compliance to energy performance standards is generally controlled through a certification process that is standard-specific and that usually includes testing procedures for product prototypes.

The certification/accreditation of a product generally results in a national brand or logo being affixed on this product after a prior inspection of the manufacturer and after the testing and control accreditation has been done by a third party. Such accreditation is usually subject to periodic controls.
RATIONALE FOR ENERGY PERFORMANCE STANDARDS

The comparative advantages of performance standards as an intervention mechanism for the majority of “incentive-based” DSM measures and R&D activities are significant:

- the outcomes of standards can be known with a relative level of certainty over a given time horizon;
- the costs of performance standards that can be attributed directly to government authorities are relatively small, as they include only the preparatory studies, coordination of players, and establishment of regulations;
- when revised and increased periodically, performance standards imprint major structural changes on the technical characteristics of equipment stock and prompt manufacturers to develop new generations of equipment, thus triggering “innovation” in the national industry.

CONSUMER AND INDUSTRY PERSPECTIVE ON ENERGY PERFORMANCE STANDARDS

The process of setting performance levels is generally based on a principle of neutrality. For the consumer, the extra cost of equipment built in conformity with standards is balanced by the savings in operating costs that result from higher performance. The optimum level of standardization takes into account the overall costs incurred for all economic players affected by the standards, as well as the spectrum of technological options available from manufacturers and the cost of such options at any given time. The success of any standardization process therefore depends on the structure of the equipment or building supply industry, the adaptation costs it will have to incur to comply with more stringent standards, and, finally, its interest and its ability to adapt manufacturing processes in a timely manner.

The equipment industry has traditionally been reticent to accept energy performance standardization. These difficulties have been by-passed in some E7 countries, such as the U.S., by negotiating the phased implementation of increasingly stringent standards at a rate that is agreed upon at the outset. U.S. experience shows that, contrary to the objections ordinarily raised against performance standardization, the impact of standards implemented in this way may go well beyond the mere elimination of the most inefficient equipment and prompt industries to develop new generations of equipment. Governments in other countries have helped prepare the market and tempered the consequences of a sudden introduction of performance standards by reaching voluntary agreements with the equipment industry on the objectives to be achieved.

DETERMINANTS OF A SUCCESSFUL STANDARDIZATION PROCESS

The success and therefore the impact of energy efficiency standards are heavily dependent on the specific industrial context and market for which they are designed. According to E7 members, a few generic lessons can be learned.

<table>
<thead>
<tr>
<th>TABLE 7</th>
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</thead>
<tbody>
<tr>
<td>DETERMINANTS OF A SUCCESSFUL STANDARDIZATION PROCESS</td>
</tr>
<tr>
<td>❑ Effective and sufficient standards enforcement</td>
</tr>
<tr>
<td>❑ Periodic updates</td>
</tr>
<tr>
<td>❑ Simple and clear formulation of standards and codes</td>
</tr>
<tr>
<td>❑ Carefully thought-out international coordination prior to initiating harmonization of standards</td>
</tr>
<tr>
<td>❑ Standards matched with carefully designed approaches to encourage and enhance industry readiness and collaboration</td>
</tr>
</tbody>
</table>

First, effective enforcement appears a necessary condition and a prerequisite if efficiency standards are to be successful. Energy efficiency policies are labor- and management-intensive because they necessarily affect so many consumers and companies, and because they are based on rapidly evolving technology. Efficiency standards can be enforced by simple periodic testing of selected samples of products. Building codes are more difficult to enforce than standards; they typically involve many more variables because buildings vary in size and location and require greater enforcement resources.
Second, periodic updates of standards are needed in order to achieve the full benefits of efficiency standards. Obsolete standards fail to provide further energy savings and the resultant benefits. Technology can change rapidly and standards have to be changed to take advantage of these advances. Regular updates are important to keep manufacturers on the move toward increased efficiency levels.

As an example, the mandatory U.S. minimum efficiency standards can be seen as a success story. The standards have been effectively set and enforced and are periodically updated to take advantage of advances in technology. Such standards have resulted in large energy savings and consumer benefits. It has been estimated that, for every dollar increase in the price of a compliant product, consumers, on average, recuperate, via energy savings, more than three times their investment over the product’s life cycle.

Third, regionally harmonized standards offer economies of scale, even though they add an extra layer of political and administrative obstacles to the enforcement process. Neighboring countries that are convinced of the benefits of adopting similar standards can leverage their efforts in convincing and stimulating interest on the part of appliance and equipment manufacturers. However, experience in Europe has shown that the extra burden of international cooperation may lessen and considerably delay the ultimate impact of harmonization initiatives. One of the major difficulties stems from the wide disparities in the objectives pursued and in the profile of the equipment stock among the various European markets. For instance, the standard planned for European countries in 1992, if applied, would have contributed to the withdrawal of 17% of the deep freezers in Germany, compared with 36% in France, and 54% in Italy.

Effective building codes and efficiency standards therefore require the careful consideration of technical, marketing, administrative, as well as political factors. Experience has shown that the failure of many initiatives can be traced to one or more of these four factors.

**Limitations of Standards**

Energy efficiency standards affect and reorganize the market, essentially on the basis of existing technologies and products. Their impact varies with the level of enforcement. One of the main limitations to energy performance regulation lies in the lack of incentives for the equipment and building industries to go beyond set performance levels and design new, increasingly efficient equipment.

**Approaches to Encourage and Enhance Industry Readiness for Energy Performance Standards**

Governments in E7 member countries have benefited from the collaboration of electric utilities in matching energy performance standards with incentives to stimulate industry interest in an increased R&D effort toward more efficient products. Such incentives have been aimed at displacing market shares to the most efficient products, through:

- designing technology-procurement programs to organize and raise latent demand to the minimum threshold required by manufacturers to invest in new production lines (see Section III – Technology and DSM). Typical procurement programs in E7 member countries include buyer groups and competitive bidding;
- sponsoring and/or carrying out government and utility-driven R&D (see Section III – Technology and DSM);
- offering utility discount rates for more efficient products;
- developing and promoting energy performance labels as key information vehicles to help customers differentiate between the more efficient, i.e., efficiency standard compliant products, and the less efficient ones.
ENERGY PERFORMANCE LABELS

CONCEPT AND DEFINITION

Labeling programs provide consumers with energy efficiency or product performance information. There are two types of labeling programs: comparison and endorsement. **Comparison programs** provide consumers with information so they can compare all the products within a given category. **Endorsement programs** identify and endorse a limited number of products that meet specified high-performance standards. Both types of programs may be mandatory or voluntary.

RATIONALE FOR ENERGY PERFORMANCE LABELS

The consumer’s lack of information concerning the amount of electricity consumed by his stock of end-use equipment, processes and buildings is usually mentioned as one of the main reasons for the apparent lack of interest in efficient technologies. Several countries have attempted to provide an answer to this market deficiency by instituting energy consumption labels for appliances in all end-use sectors. Among E7 member countries are Canada and the United States, which have preferred a regulatory framework, and Germany, which has instituted a voluntary framework. Energy labeling was introduced in Europe in 1994 through a European Union guideline.

LABELING PROCESS

Labeling is usually initiated in cooperation with appliance manufacturers, who submit their products to a set of performance tests to evaluate the energy efficiency level of their appliances. The labels are usually awarded by an independent organization (government agency, laboratory, energy company, electric utility or environmental NGO) whose role is to inform consumers about the estimated annual energy consumption that can be expected from specific appliances. Some labels include a scale ranking the appliance against others on the market, so the consumer can include energy performance as an additional criterion in the decision-making process at the time of purchase.

DETERMINANTS OF SUCCESSFUL LABELING INITIATIVES

E7 members’ experience shows that the success of labeling programs is strongly linked to seven key factors, listed in Table 8.

<p>| TABLE 8 |</p>
<table>
<thead>
<tr>
<th>DETERMINANTS OF A SUCCESSFUL LABELING PROGRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Easy-to-understand labels</td>
</tr>
<tr>
<td>❑ Strong marketing of labels</td>
</tr>
<tr>
<td>❑ Making labels the focus of product differentiation</td>
</tr>
<tr>
<td>❑ The degree of competitiveness in target industry</td>
</tr>
<tr>
<td>❑ Promoting labels in partnership with distributors, who use labels as a key tool to enhance corporate image and positioning</td>
</tr>
<tr>
<td>❑ Getting equipment manufactures to give consumers access to user-friendly databases</td>
</tr>
<tr>
<td>❑ Central leadership to harmonize labels across numerous countries</td>
</tr>
</tbody>
</table>
The energy performance standards and labels programs currently implemented in E7 member countries, as shown in Table 9 above, are used to:

- contribute to national energy efficiency objectives;
- demonstrate national compliance with international multilateral agreements on the environment.

### TABLE 9

<table>
<thead>
<tr>
<th>Country</th>
<th>Examples of Successful Standards and Labels</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>U.S. Energy Star labeling program (Office equipment, compact fluorescent lamps and fixtures, washing machines, residential air conditioning and heat pumps, TVs, VCRs, windows)</td>
</tr>
<tr>
<td></td>
<td>U.S. Golden Carrot program (labels)</td>
</tr>
<tr>
<td>Europe</td>
<td>1994 Energy Label devised by the European Union (15 member states)</td>
</tr>
<tr>
<td>Canada</td>
<td>EnerGuide Label and Power Smart Label</td>
</tr>
<tr>
<td></td>
<td>National Model Energy Code for houses - 1997 (standards)</td>
</tr>
<tr>
<td></td>
<td>R-2000 program (labels)</td>
</tr>
<tr>
<td></td>
<td>&quot;Nouveau Confort&quot; and &quot;Cascade&quot; labeling programs promoted by Hydro-Québec</td>
</tr>
<tr>
<td>Japan</td>
<td>MITI – Legislation respecting the rational use of energy (standards)</td>
</tr>
<tr>
<td></td>
<td>Standards for thermal efficiency of buildings</td>
</tr>
</tbody>
</table>

### Types and Examples of Standards and Labels in E7 Member Countries

The energy performance standards and labels programs currently implemented in E7 member countries, as shown in Table 9 above, are used to:

- contribute to national energy efficiency objectives;
- demonstrate national compliance with international multilateral agreements on the environment.

### Role of Electric Utilities in the Development and Promotion of Standards and Labels

Over the years, most electric utilities in E7 member countries have worked in close collaboration with government agencies as well as “standards and labels” associations in:

- developing and promoting increasingly stringent energy performance standards;
- designing and coordinating voluntary agreements with equipment manufacturers and distributors.

Through specific DSM programs, utilities have helped leverage the necessary market demand to bring about market transformation in some areas.

In Canada, for instance, Hydro-Québec has been involved in several committees mandated by organizations such as the Canadian Standards Association to set up standards for some electrical appliances. Hydro-Québec’s knowledge of customers and technologies has contributed to creating standards that are more readily acceptable to markets and trade allies, while at the same time respecting the constraints of the electric system. Hydro-Québec has also launched labeling programs, such as “Cascade” and “Nouveau confort” with the specific objective of reducing consumption of water and home heating respectively.

In Europe, Electricité de France (EDF) is promoting efficient household appliances under an agreement with ADEME, the government agency responsible for energy and environment management. EDF is involved with several committees on building regulations and thermal efficiency; it has also set up a center for standardization that drives the activity of several international, European and French electrical standards and labels.
STANDARDS, CODES, LABELS AND MARKET TRANSFORMATION

As the electricity industry restructuring unfolds, key players on the DSM scene, including government agencies and utilities, will move progressively toward implementing market transformation initiatives tailored to the specific characteristics of national energy efficiency markets and industries. Energy performance labels, standards, and building codes that address efficient construction practices and products have been and will be increasingly used as key tools to help energy-efficient products/equipment evolve along their respective market diffusion curves.

Market diffusion or "S" curves are often used to illustrate the market transformation process (see Figure 4). The market diffusion curve shows an idealized version of the process by which a new technology or practice evolves from market introduction to wide-scale adoption or mass-market status. Market transformation initiatives typically include activities designed to accelerate the market’s adoption of a particular energy-efficient measure so that it becomes common practice much sooner.

As a consequence, market transformation initiatives usually include activities designed to:

- stimulate the development and market introduction of new, energy-efficient models. R&D and technology procurement efforts may be used at this stage;
- strategically build the market share of these new products until they achieve a niche position in the market. Typical tools used at this stage are product rebates or programs to support bulk purchases by large customers;
- change consumer purchasing practices to further expand the market’s adoption of these measures so they reach mass-market status and eventually become common practice.

FIGURE 4
STANDARDS AND LABELS IN THE MARKET ADOPTION PROCESS

Source: Nadel and Latham
Consumer education, loans/rebates and other promotional activities such as energy performance labels may be used at this stage.

Codes and minimum efficiency standards are used to complete the transformation process by removing obviously inefficient products and practices from the market. They are very effective at fully transforming a market because the measures become mandatory following their adoption. However, codes and standards are not appropriate for all measures or for all applications and, in some cases, adopting new codes and standards is controversial or politically impracticable. In many instances, success in building a significant market share for a measure will be needed before a code or standard becomes feasible. Thus, the code or standard is used to complete the transformation process by forcing the laggards to follow the way shown by market leaders. Once new codes or standards are adopted, countries can use subsequent phases of market transformation strategies to target even higher levels of efficiency.

**Key Observations from E7 Experience**

Energy performance standards and labels constitute market transformation initiatives that evolve over time; their success is closely linked to the coordinated effort of many DSM players, under the leadership of government agencies. It is therefore important to make the changes as smoothly as possible. Manufacturers and other trade allies require significant notice of future changes to be able to adjust their business decisions accordingly.

E7 members’ experience points to the need to:

- secure, at the outset, the full cooperation of manufacturers and distributors in developing commonly understood timelines for future changes;
- develop tools to continuously monitor technological changes that may drive performance standards upward;
- coordinate efforts of all DSM players. For example, electric utilities can encourage manufacturers, trade allies and other suppliers to enter new, more efficient markets and start new innovation cycles by working directly or indirectly to produce substantial increases in consumer demand for DSM products or equipment.
TECHNOLOGY AND DSM:

ROLE AND IMPORTANCE OF NEW TECHNOLOGIES FOR DSM

Throughout the world, energy consumers are presented with a continuous flow of new end-use technologies (equipment, products or systems), some more energy efficient than others, which emerge from transnational or national equipment manufacturers’ plants. This continuous technological evolution is fed by various sources:

- Research, Development, Demonstration and Experimentation (RDD&E) initiatives of public and private laboratories that ultimately result in new products and equipment;
- new applications of existing products;
- new markets.

These new end-use products and equipment, along with technological development in the telecommunications and metering fields, bring with them both opportunities and threats to the competitive positioning of electric utilities and to the DSM planning environment.

According to E7 members, such threats may come, for example, from changes in the system load curve, in the anticipated demand for electricity, from the increasingly efficient and affordable supply options – cogeneration, combined-cycle gas turbines – that can enable large customers to become self-generators.

At the other end of the spectrum, the evolution of technology may enable utilities to transform threats into opportunities; for example, the integration of specific algorithms into electronic programmable thermostats, activated by random patterns, can help utilities mitigate the impact of night set-back on potential system recovery. In addition, such algorithms may help them recover progressively from system breakdowns by using less system capacity all at once.

It is therefore important for utilities to act on these opportunities and threats using both reactive and proactive approaches by:

- closely monitoring the evolving technological environment created by external sources (manufacturers, R&D centers, demonstration centers, other utilities);
- supporting, early in the process, the full development and distribution cycle (research, development, demonstration, experimentation (RDD&E) and commercialization) of additional equipment or technologies whose characteristics are designed to meet very specific DSM objectives or adapted to the national end-use stock profile.

All utility DSM programs, whether aimed at generating energy savings or at facilitating load management, can be grouped into programs that affect the way energy-using equipment or systems are operated and maintained, or programs that focus on the purchase and installation of improved technologies or equipment.

The success of the latter is closely linked to the availability and accessibility of higher energy-efficient equipment and systems resulting from:

- the development of new end-use and load control technologies whose design specifications are tailored to specific DSM objectives; or
- new applications of existing technologies assembled to be more energy efficient.

E7 members’ experience also shows that such new technologies or new applications or combinations of existing technology will have to be:

- designed with strict reliability and cost/performance specifications;
- promoted to both consumers, manufacturers, as well as to properly trained technology/equipment advisers, installers and service operators;
- financially supported (if required) at both the purchasing and the manufacturing/installation ends of the cycle, in order to generate the outcomes expected from the DSM programs, where they are a core element.
**Typical DSM Technology**

Electric utilities use two types of DSM-related equipment and technology.

- **End-use technologies** – installed at consumer facilities – residential, commercial, institutional or industrial. Typical end-use technologies installed in E7 member countries are shown in **Table 10**. They mainly comprise thermal storage systems used for peak shifting and peak shaving, high-efficiency heat pumps and power-saving electrical appliances for energy savings.

- **Load management equipment** – enables energy suppliers to directly or indirectly control the distribution over time of loads consumed/delivered to consumers:
  - **Indirect load control** consists of systems in which information on usage status and rates is provided to customers to help them voluntarily adjust power loads. The technology required to provide customers with data includes display units and communications technology (radio, power line transmission, etc.);
  - **Direct load control** refers to systems that enable electric utilities to directly adjust customers loads. This requires communications technology (radio, power line transmission, etc.) and automatic control systems (may or may not include sensors).

**Table 10**

**Typical DSM End-Use Technology/Equipment Used in E7 Member Countries**

<table>
<thead>
<tr>
<th>Market</th>
<th>DSM Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residential</strong></td>
<td>☐ Electric thermal storage (room and central) for space heating</td>
</tr>
<tr>
<td></td>
<td>☐ High-efficiency air conditioners</td>
</tr>
<tr>
<td></td>
<td>☐ High-efficiency lighting units</td>
</tr>
<tr>
<td></td>
<td>☐ High-efficiency electrical household appliances</td>
</tr>
<tr>
<td></td>
<td>☐ High-efficiency heat pumps</td>
</tr>
<tr>
<td></td>
<td>☐ Housing: thermal shell insulation materials (and installation techniques)</td>
</tr>
<tr>
<td></td>
<td>☐ Electric water heaters using time-of-use (TOU) rates</td>
</tr>
<tr>
<td></td>
<td>☐ Multi-function heat pumps (for air conditioning and hot water supply)</td>
</tr>
<tr>
<td></td>
<td>☐ Cold storage for air conditioning</td>
</tr>
<tr>
<td></td>
<td>☐ Floor heating using a TOU rate</td>
</tr>
<tr>
<td></td>
<td>☐ Thermostat set-backs</td>
</tr>
<tr>
<td></td>
<td>☐ Control of air exchangers</td>
</tr>
<tr>
<td><strong>Commercial, Institutional (Tertiary)</strong></td>
<td>☐ High-efficiency compressors, motors, pumps and fans</td>
</tr>
<tr>
<td></td>
<td>☐ Electric thermal storage for space heating</td>
</tr>
<tr>
<td></td>
<td>☐ Thermostat set-backs</td>
</tr>
<tr>
<td></td>
<td>☐ Control of air exchangers</td>
</tr>
<tr>
<td></td>
<td>☐ Renewable energy and distributed generation</td>
</tr>
<tr>
<td></td>
<td>☐ Electric water heaters using TOU electricity rates</td>
</tr>
<tr>
<td></td>
<td>☐ Cold storage for air conditioning</td>
</tr>
<tr>
<td></td>
<td>☐ High-efficiency heat pumps</td>
</tr>
<tr>
<td></td>
<td>☐ High-efficiency office equipment</td>
</tr>
<tr>
<td></td>
<td>☐ Heat pumps that use waste heat</td>
</tr>
<tr>
<td></td>
<td>☐ High-efficiency lighting units</td>
</tr>
<tr>
<td></td>
<td>☐ Peak-shaving vending machines</td>
</tr>
<tr>
<td></td>
<td>☐ Heat-exchange extractor fans</td>
</tr>
<tr>
<td><strong>Industrial</strong></td>
<td>☐ High-efficiency compressors, motors, pumps and fans</td>
</tr>
<tr>
<td></td>
<td>☐ Waste-heat recovery heat pumps</td>
</tr>
<tr>
<td></td>
<td>☐ Storage of heat for space heating</td>
</tr>
<tr>
<td></td>
<td>☐ Storage of cold for air conditioning</td>
</tr>
<tr>
<td></td>
<td>☐ Control of air exchangers</td>
</tr>
<tr>
<td></td>
<td>☐ Renewable energy and distributed generation</td>
</tr>
<tr>
<td></td>
<td>☐ Use of heat storage systems in production processes</td>
</tr>
<tr>
<td></td>
<td>☐ More efficient design of manufacturing processes and use of electrotechnologies</td>
</tr>
</tbody>
</table>
Some E7 member utilities use direct and indirect load control technologies; for example, in Germany, RWE has implemented direct load control with a focus on residential use. In Canada, Hydro-Québec’s Dual Energy program uses outside thermal sensors to switch from electric to fossil-fuel heating systems when the weather is extremely cold. In France, EDF’s TEMPO rates scheme, in which information on rates is displayed in real time with digital meters is an example of indirect load control.

**Principles for DSM Technology Selection**

According to E7 members’ experience, once identified through the utility’s technology monitoring and intelligence mechanisms, DSM technologies/equipment are selected using a series of criteria related to their:

- relevance to specific DSM objectives;
- relevance to end-use stock (buildings, energy systems, manufacturing processes), its profile (age, preservation, design, spatial distribution, construction materials/techniques) in a given region, as well as to the profile (training, tools) of operators in end-use facilities;
- availability and widespread commercial use;
- potential impact on the physical environment;
- potential impact on the social and economic environment (including potential job creation and enhancement of the quality of life).

Electric utilities use specific DSM technologies for specific DSM objectives. Utilities that need to provide service in areas where air-conditioning demand is high in the summer, with sharp peaks during daylight hours, require DSM programs and technologies that enable shifting peak air-conditioning demand. Similarly, if overall energy savings are required to reduce environmental effects, then DSM programs will select energy-efficient electrical equipment.

**Various Approaches to DSM Technology Procurement**

**Existing Technology**

The preferred route for utilities to secure the required technology for their DSM programs is first and foremost to use existing or already commercially available equipment (i.e., support the promotion, manufacturing, installation and servicing) that:

- complies with utility-set minimum thresholds of energy, technical and economic performance, reliability, and national or regional accessibility;
- can be combined with other technologies or software into attractive packages for consumers.

E7 utilities have therefore traditionally focused on the Demonstration and Experimentation phases of the RDD&E cycle and this is probably the path utilities will follow in developing countries with fewer research and development resources and facilities. In many instances, however, the required technology has to be developed, using particular design and operating specifications closely linked to utility needs.

**Technology Development**

Electric utilities select an area of technology development by determining:

- the kind of DSM programs considered;
- the existence or lack of technologies suited to DSM program objectives;
- the status of technological development capacities of manufacturers in related fields;
- development difficulties and benefits.
**Organizational Models for DSM Technology R&D**

There are several possible development options for electric utilities that take an active role in technological development. For example:

- conducting research and development in an in-house R&D department. This approach is most suitable, for example, for utility-side technology where:
  - this technology is in a completely new area;
  - no relevant external research exists;
  - the basic technology is not expected to immediately be commercially available.
- out-sourcing research and development work to external organizations (i.e., private or public research centers) on topics and targets established by utilities;
- conducting joint research and development with external organizations, where common topics and targets are established and research is performed cooperatively by both electrical utilities and external organizations. This approach is particularly appropriate, and attractive to external organizations, including equipment manufacturers, when the prospects for commercializing the technology are good;
- supporting independent technology development activities done by external organizations (including manufacturers) that meet DSM objectives, and taking advantage of promotions like technology contests or other bulk procurement practices as incentives to encourage such indirect R&D.

Table 11 shows the advantages and disadvantages of each option, as well as some examples from E7 members’ experience. Utilities select the option or combination of options that best suits their own research and development capabilities, DSM program objectives, and the technology to be developed.

### Table 11

**Organizational Models for Utility-Driven Development of DSM Technology**

<table>
<thead>
<tr>
<th>Organizational Models</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Examples from E7</th>
</tr>
</thead>
</table>
| **Utility in-house R&D** | ❑ Utility can develop technology tailored to its own objectives  
❑ Utility can monopolize results | ❑ Need to provide research staff  
❑ Limited scope of research fields due to staff limitations | ❑ Development within ENEL research facilities of power-storage batteries using electrochemical storage for use in peak-shaving and peak-shifting programs |
| **Out-sourcing R&D to external organizations** | ❑ Easy control of research details and outcomes with budget controlled by utility  
❑ Wide range of external contractors available  
❑ Generally lower costs compared with in-house R&D | ❑ Potential for leakage of proprietary developmental information | ❑ Development of electronic thermostats by manufacturers contracted by Hydro-Québec |
| **Joint R&D with external organizations** | ❑ Lower costs compared with independent R&D since costs are shared  
❑ Easier commercialization of developed technologies by manufacturers involved in R&D | ❑ Less suitable for development of basic technologies for which there is little prospect of short-term commercialization  
❑ Possibility that diffusion and distribution of results may be restricted to protect the profits of the joint developers | ❑ Development of TEPCO’s peak-shifting beverage vending machine “Eco Vendor” with an outside vendor |
| **Support of independent technological development in external organizations** | ❑ Technical development can occur without utility’s resources  
❑ Easier diffusion and distribution of developed technology  
❑ Increased appeal of objectives of DSM projects to external groups | ❑ Anticipated results may not be achieved | ❑ Technological innovation contest held by RWE as part of KeeS Industrie activities |
To be successful in planning and delivering a competitive and balanced DSM program portfolio, utilities are expected to act directly (or indirectly) on the supply of more efficient technology and on the demand for more efficient technology (information/education, labeling campaigns, rebates, or demonstration projects).

On the technology supply front, according to E7 members’ experience, utilities are most successful in insuring the widespread availability of a desired technology (either a new technology or innovative combinations of existing technologies) when they match a series of complementary initiatives to their DSM technology development initiatives. These include:

- incentives to manufacturers to bring newly developed technology up to industrial scale, to commercialize the outcomes at competitive pricing, and to set up the required after-sales servicing. These incentives comprise both financial incentives and innovative technology procurement practices that include design specification for a new technology or guarantees of bulk purchase orders for newly developed batches of products or equipment;
- assistance to the development of higher energy performance standards.

On the demand front, utilities are expected to develop information and education campaigns for end-use consumers that raise their awareness of, and interest in the newly developed technologies, which may also be tagged with energy performance labels. Such information/education initiatives will likely be combined with financial incentives or rebates to customers. Finally, technology advisers (engineering consultants and architects) and installers, key players in the technology commercialization cycle, may be invited to training and/or technology demonstration sessions prior to new technology-based DSM program launches. Many E7 members are deeply involved in such promotional activities; some, such as RWE, Enel, and Tepco, run exhibition centers and organizations dedicated to technology-related promotional activities.

As the electricity industry restructuring unfolds, resulting in more competitive environments for both utilities and end-use technology providers, it is expected that greater collaboration and cost-sharing will develop among key DSM technology providers: local utilities, external research organizations, businesses, universities, and foreign electric utilities. With the enhancement of their commercial vocation, utilities are likely to focus increasingly on demonstration and experimentation with technology that has a shorter time-to-market window, leaving the phases located upstream in the R&D&E cycle to public research centers. Utility initiatives are likely to be financed from resources collected through public benefit charges.

Individual technology developers will be more concerned with securing their intellectual property ownership (and associated economic return) while sharing more and more R&D and commercialization projects with research and trade partners. Finally, in the DSM technology-provider community, the most successful will likely develop strong “competitive technology intelligence” approaches and mechanisms (either in-house, out-sourced or shared monitoring systems) to keep abreast or, even better, come first in bringing to market new DSM technologies that will strengthen their competitive advantage with a more volatile client base.
ELECTRICITY RATES:
AN ESSENTIAL LINK TO DSM

IMPORTANCE OF ELECTRIC RATES AS PRIMARY SIGNALS TO THE RATIONAL USE OF RESOURCES

In E7 members’ experience, electricity pricing mechanisms that properly reflect costs and address equality of treatment of customer classes are the single most important prerequisite to any other kind of DSM initiative. When they are based on economic efficiency principles, electricity prices give the primary signals to the rationale use of the resource and the long-term improvement in energy efficiency. These signals are carried both in the base rates, which set the general level of electricity prices, and in pricing options designed as DSM incentives to particular consumer segments.

Electricity rates, like prices for goods and services in general, perform many functions. Prices charged to consumers, together with systematic revenue collection, generate revenues that enable suppliers (producers, distributors) to cover their costs and earn a return. Prices can also be considered as a flow of information between producers and consumers, giving signals as to the relative availability or scarcity of products in some regions and/or at a given point in time. A pricing mechanism for electricity that gives appropriate signals to investment, production and consumption has proven to be very important for the health of an economy.

Over the years, however, rate makers in the electricity industry have had to face significant difficulties in ensuring rates were designed according to strict economic efficiency principles. Among these difficulties are:

- the additional role played by electricity pricing as a tool to achieve policy objectives, such as the promotion of renewable energy, job creation, fuel choices, or energy efficiency.

Since there are no two similar economic regulatory and energy policy environments, nor one right way of allocating joint costs to different customer categories, different E7 countries or regions have adopted different approaches to fixing the general level and structure of electricity rates. They have, however, used similar generic principles in selecting and applying those approaches.

ARCHITECTURAL LIGHTING
GENERAL PRINCIPLES OF RATE DESIGN

In E7 countries, utility rate designers are asked to achieve economic efficiency while balancing sometimes divergent customer expectations with utility needs. Generally, rates must generate sufficient revenue to maintain the financial health of the utility and ensure the best possible borrowing conditions while covering the costs of supplying electricity to each customer category.

Rate policies act as a series of guiding principles to help balance the opposing interests of consumers and suppliers. Table 12 gives examples of elements included in rate policies in various E7 countries; rate design principles that convey economic efficiency are viewed as the most important.

<table>
<thead>
<tr>
<th>TABLE 12</th>
<th>ELEMENTS OF RATE POLICIES IN E7 COUNTRIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Reflect, as much as possible, the supply costs associated with servicing each customer category in the rate structure</td>
<td></td>
</tr>
<tr>
<td>✓ Include a fair return for the utility in the costs to be recovered</td>
<td></td>
</tr>
<tr>
<td>✓ Maintain territorial price uniformity</td>
<td></td>
</tr>
<tr>
<td>✓ Take customers’ operating methods into consideration by offering many pricing options</td>
<td></td>
</tr>
<tr>
<td>✓ Take into account the competitive context and ensure rates remain attractive</td>
<td></td>
</tr>
</tbody>
</table>

Economic Efficiency

To achieve economic efficiency, base rate structures are founded on two principles.

- **Equality of treatment** – where all customers with the same usage characteristics are offered the same rates. The application of this principle does not, however, exclude substantial differences, depending on the amount and nature of electricity supplied.
- **Rates reflecting costs** – where the right price signal is sent to each customer i.e., the supply costs incurred by the utility to serve each customer have to be passed on to that customer. Each customer is thus encouraged to adopt a consumption pattern whose value is greater that its cost. In doing so, the price signal contributes to economic efficiency.

Through these pricing principles, a utility gives an incentive for energy efficiency and it is said to be economically neutral with regard to its customers’ decisions: if a customer invests in an energy-saving operation, then the customer’s bill will be reduced, but only to the extent of the savings achieved by the power system. If the customer does not invest in the energy-saving operation, the utility system’s capacity will have to be enlarged to meet increased demand, but the customer’s bill will be sufficient to finance those investments. This is the key premise of a utility’s rate policy: it is customers who, through their participation in dsm activities, determine the level of energy efficiency in the economy.

BROAD APPROACHES TO SETTING ELECTRICITY PRICING LEVELS

Three broad approaches to electricity pricing are currently applied or being considered in E7 member countries. Their respective uses, advantages and limitations are shown in Table 13.

- Historical cost or accounting cost recovery approach
- Marginal cost pricing approach, mostly encountered in large integrated state-owned utilities
- Market pricing approach

HISTORICAL COST OR ACCOUNTING COST RECOVERY APPROACH

This approach – also called cost of service or rate of return – focuses on the first function of prices i.e., to allow the producer to cover his costs with a fair rate of return but no excess profit. This approach is mostly found where electricity is provided by private companies operating without competition within regulatory environments that vary from very detailed, such as in the U.S., where the traditional Rate-of-Return (ror) regulations have been prevalent for many years, to looser regulations, such as those found in Germany.
In this approach, operating costs, including financial costs and depreciation, can be recovered in prices, while capital costs invested in existing facilities needed to generate, transmit and distribute electricity are reflected in an approved asset base – called rate base – on which a regulated rate of return can be earned. Interest coverage, capitalization ratio, self-financing ratio, or a level of return on equity no less than the average cost of debt are examples of factors to be taken into account to maintain the utility's financial integrity.

**Marginal Cost Pricing Approach**

This approach enables utilities, especially state-owned utilities, to send economically correct signals to guide consumption and investment decisions, while ensuring the optimal allocation of national or regional resources. **Long-term marginal costs** correspond to the costs of the future investments needed to meet increased demand at both normal and peak periods. In this approach, the price of electricity represents the economic cost of producing and delivering one additional kilowatthour using the next plant to be built.

The main principle underlying the marginal cost approach implies that sunk costs of production – or other utility functions – which may or may not have been optimal and which may or may not reflect current costs of production, do not provide an accurate signal to consumers as to the cost implied by their current decisions to consume or not consume an extra unit of electricity. This accurate signal is particularly important where consumers are being offered various DSM options.

**Short-Term versus Long-Term Marginal Cost**

**Short-term marginal costs** correspond to the variation in operating and maintenance costs associated with the generation (or purchase) and delivery of electricity resulting from a temporary shift in demand. These costs fluctuate considerably, depending on the type of facility used (e.g., hydroelectric generating station or gas turbine) and the system's supply-demand situation.

The differences between the two marginal cost measures stems from differences in the definition of load change and the consequent treatment of capital costs. Short-term marginal costs depend on the cost effect of a temporary change – a single hour or a single day. Such a temporary change only affects operating costs during the period in which the load change occurs, so it has no impact on capital costs. On the other hand, long-term marginal costs depend on the cost effect of a permanent load change lasting many years. Such a permanent change has an impact on capital expenditures. When capacity levels are optimal, short-term and long-term marginal cost measures are identical.

However, capacity levels are never optimal, since the supply-demand balance is a moving target. That is why there has been considerable debate on whether electricity prices should reflect short-term or long-term marginal costs. In a traditional model, long-term marginal costs were used in order to send customers a price that tells them about the long-term value of electricity, for instance, in the design of base rates or rate options meant to improve demand management.

Conversely, short-term marginal costs have been used to develop rates for the sale of temporary surpluses or real-time pricing options. Such sales make it possible to achieve a better balance between supply and demand in the short term. Since the outset of the industry deregulation process, some have said that short-term marginal costs would be more appropriate for market-oriented rates.

**Market Pricing Approach**

This approach relies on the interplay of buyers and sellers, i.e., market forces, to set prices. This third approach relies on markets rather than on any cost-plus approach to achieve optimal pricing. Market pricing is relatively new for electric utilities, emerging in regions where the generation and supply of electricity is being liberalized or where pooling or exchange arrangements allow some power to be bought and sold at market-determined prices.

As markets evolve, pricing innovations will be key for competitive suppliers to differentiate themselves in the marketplace. Pricing will evolve rapidly as suppliers learn about the time differentiation of their costs and about imbalance risk. In an increasingly competitive environment, utilities or power providers are likely to:
use optional rates more often to offer customers new service packages with different billing determinants;

- introduce new premium services such as load profiling tools that allow suppliers to trade off cost and accuracy, or enhanced pricing algorithms that allow end-users to evaluate and select among competitive offerings;

- use derivative instruments and offer price-risk-management services to large customers to hedge the price risks associated with increased price volatility.

As industry restructuring progresses, the variety of rates available will probably expand significantly once regulatory constraints are removed. Customers will have access to a broader array of pricing options, each with a commensurate risk premium that will let them choose the pricing structure that best matches their risk tolerance.

### The Base Rate Structure

Once general price levels are fixed, rate designers determine the utility base rate structure, i.e., the number and nature of rate categories to be considered. In principle, rate categories have to reflect what it costs to supply each category of customers, grouped according to:

- consumption patterns (i.e., level of voltage, distribution of power needs over time, synchronicity of power needs with the utility system peak, intermediate and base demand periods);

- economic or social characteristics (e.g., in the case of protecting agricultural customers).

In E7 members’ pricing policies, similar consumption patterns with similar costs of supply have similar rates.

### Table 13

<table>
<thead>
<tr>
<th>Description</th>
<th>Uses</th>
<th>Advantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Historical or accounting costs</strong></td>
<td>For a given year, costs associated with all facilities, from the oldest to the most recent, needed to generate, transmit, and distribute electricity, including customer-related costs.</td>
<td>Used to estimate revenue requirements.</td>
<td>Essential in making sure the utility maintains a sound financial position.</td>
</tr>
<tr>
<td></td>
<td>Reflect the cost of using existing plants/facilities.</td>
<td>Useful for determining the general level of rates.</td>
<td></td>
</tr>
<tr>
<td><strong>Long-term marginal costs</strong></td>
<td>Cost of supplying a unit of demand at the margin over the long term, taking into account the capital investment required.</td>
<td>Used to determine the rate structure or the relative importance of different charges.</td>
<td>With a price signal corresponding to the cost of satisfying new demand, customers are encouraged to use only those kilowatthours whose value is equal to or greater than the cost of generating (or delivering) the incremental kilowatthours.</td>
</tr>
<tr>
<td></td>
<td>Reflect the cost of using the next plant to be built.</td>
<td>Useful for setting prices for rate options offered to particular customer segments.</td>
<td>More stable reference and better guideline for long-term consumer choices than short-term marginal costs.</td>
</tr>
<tr>
<td></td>
<td>Reflect the cost effect of a permanent load change lasting many years. Such a change has an impact on capital expenditures.</td>
<td>Use of long-term marginal costs traditionally preferred by regulatory agencies.</td>
<td></td>
</tr>
<tr>
<td><strong>Short-term marginal costs</strong></td>
<td>Variation in O&amp;M costs associated with the generation and delivery of electricity resulting from a temporary shift in consumption level. Such a change affects operating costs only and not capital expenditures.</td>
<td>In the traditional model, used to develop rates for the sale of temporary surpluses or real-time pricing options.</td>
<td>In a deregulated industry, could be more appropriate than long-term costs for a market-oriented rate.</td>
</tr>
</tbody>
</table>
Costs by Utility Function

To provide electricity to a customer, a utility must perform different functions (see Table 14): generation, transmission, distribution, and general customer service.

### TABLE 14

**Electricity Supply Functions**

- **Generation**
  - Generating electricity
  - Purchasing power from another system
  - Delivering power to bulk transmission systems
- **Transmission**
  - Transferring power from generation sources to load centers within service areas, or to other utilities
- **Distribution**
  - Transferring power from the transmission system to consumers
- **Customer services**
  - Services not related directly to any other function (e.g., sales promotion, administration, metering, billing)

In vertically integrated utilities, the costs associated with these functions are consolidated so customers pay for the entire production-transmission-distribution chain. In utilities where such functions have been unbundled, the costs are usually broken down and customers can see what they pay for each element in the supply chain.

### DEMAND, ENERGY AND CUSTOMER SERVICE CHARGES

The dynamics of the electricity supply chain in any region prevent utilities from billing consumers solely on the basis of the amount of product consumed (i.e., kilowatthours) as is the case for any other commodity. If strictly applied to electricity transactions, such a practice would neither be fair to customers nor send good price signals. As Figure 5 (overleaf) shows, the distribution over time of kilowatthour consumption has a significant impact on the cost of supplying consumers with different usage patterns.

To address these potential distortions, E7 members have opted to further divide electricity supply costs into three distinct categories – demand, energy, and customer service charges – which are shown separately on bills to consumers.

### DEMAND-RELATED COSTS

Demand-related costs are the fixed costs of meeting customer demand, i.e., the costs of the generation, transmission and distribution facilities utilities must make available to meet customer demand. These costs vary depending on maximum peak demand (kW) over the course of a year. Utilities bill a demand charge based on kW to cover these costs and use the concept of contract power as an essential element in demand billing.

### ENERGY-RELATED COSTS

Energy-related costs are the variable costs associated with the operation of generation facilities to meet customer energy needs. They are thus proportional to the amount of electricity supplied (kWh). Utilities bill an energy charge based on kWh using approaches known as flat rates, inverted rates, and declining block rates. The selection of the approach depends on the utility’s marketing strategy and cost structure.

### CUSTOMER-RELATED COSTS

Customer-related costs include costs associated with the provision of customer services. Customer-related costs and the associated charges that are billed as customer charges vary according to the number of customers serviced by a utility. They include some of the distribution system costs, part of the costs of distribution poles, lines and transformers, sectioning devices and other accessories required to supply the smallest possible load – meter equipment, meter reading and billing operations. Unlike demand and energy costs, these costs are unrelated to consumption and are therefore covered by a fixed charge.

Figure 6 (overleaf) shows the relationship between utility costs by supply functions and utility costs by type of charges.
All E7 members have chosen a binomial pricing structure to date, i.e., a base rate structure with separate demand and energy charges. All have grouped customers with similar consumption patterns into homogenous categories in order to:

- have a billing system that charges the same rate to customers incurring similar costs to the utility;
- ensure the fair treatment of all customers, where customers whose supply costs are low do not pay for customers in the same rate category whose supply costs are higher.

For most E7 members, demand and energy charges are fixed and constant over a one-year period. EDF, on the other hand, has designed a rate structure that allows medium to large-power customer categories to benefit from energy charges that vary according to the time of day or to different periods of the year.

E7 utilities welcome the recent advent of new metering and communications technology that will enable utilities to design...
real-time pricing structures, i.e., to design rates per kWh that vary hourly or over shorter periods. Real-time pricing is considered the optimal base rate structure. It makes it possible to capture the costs of installed capacity and to instantly reflect the costs of production (and transmission) as these costs vary according to the type of plant (base, intermediate, peak) used to supply electricity during a given period of time.

**Pricing Options**

**Rationale for Rate Options**

Demand for electricity takes many different forms. Electricity consumption patterns vary from one customer to the next and reflect different consumer characteristics such as load factor, consumption periods, ability to shift consumption periods, the needs of particular end-use technologies, etc.

A single base rate cannot cover all these situations, nor all possible segmentations of a utility’s client base. It is therefore simpler to offer specific customer groups options that take particular supply characteristics and related costs into account. E7 members have thus moved progressively toward adopting option-based pricing systems.

By using rate options, utilities can customize their pricing system to the specific consumption habits of detailed segments of their customer base. This segmentation is facilitated by using conditional participation in rate option schemes.

Options may be offered for specific customer characteristics such as low-load factor or for special applications. In E7 utilities, rate options have been used as key DSM-pricing mechanisms, particularly for load management purposes (i.e., to transfer consumption from peak to off-peak periods), thus introducing time-of-use pricing options.

**Time-of-Use Pricing Options**

Time-of-Use (TOU) pricing options set a price for energy or power that varies over time. Since they better reflect supply costs and promote better demand management, these pricing options give customers a greater incentive to reduce their electricity bills by shifting certain loads or by modifying their consumption habits. TOU options can be divided into three distinct types, as described below.

- The simplest type of TOU pricing is to bill the energy consumed during peak hours at a rate higher than that for energy consumed during off-peak hours. Residential rates with a high energy price during the day and a lower price during the evening and night are good examples of such options.
- A second type of TOU pricing has rates that vary according to the outside temperature or the supply conditions encountered by the utility. Prices are set in advance, but neither periods when the prices apply nor their duration are known to either the utility or its customers, since they are weather/temperature sensitive.
- Real-time pricing is the more complex of the three options because prices are not fixed in advance and they change continuously in line with the short-term marginal cost of energy generation. Hourly prices can fluctuate significantly depending on the type of power plant used (base, intermediate, peak). Real-time pricing is generally offered to large-power customers and, less often, to medium-power customers.

<table>
<thead>
<tr>
<th>Table 15</th>
<th>Types of Time-of-Use Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type A</strong></td>
<td>Rates with prices and periods of application defined in advance</td>
</tr>
<tr>
<td></td>
<td>Prices reflect long-term marginal costs</td>
</tr>
<tr>
<td><strong>Type B</strong></td>
<td>Rates with prices fixed in advance, but with periods of application defined in real time</td>
</tr>
<tr>
<td></td>
<td>Prices reflect long-term marginal costs</td>
</tr>
<tr>
<td><strong>Type C</strong></td>
<td>Rates with prices and periods of application defined in real time: real-time pricing option</td>
</tr>
<tr>
<td></td>
<td>Prices reflect short-term marginal costs</td>
</tr>
</tbody>
</table>
TOU pricing is truly efficient (for the customer and the utility) if the customer can shift consumption from peak to off-peak periods. In other words, TOU pricing is generally offered as an optional scheme to accommodate customers who are able to modify their consumption pattern (through changing equipment or operation and maintenance schedule). It should not penalize customers with an inflexible consumption pattern. As a general principle, an effective pricing system reflects customer diversity and takes into account differences in the customer’s ability to respond to a price signal.

**E7 Experience with Time-of-Use Options**

All E7 utilities have developed and offer optional rates, particularly TOU options, on top of their base rates. Most of the programs are Type A options, i.e., predetermined prices and periods fixed in advance, and they are offered to most of the customers in all sectors (residential to large-power customers). In fewer cases, Type B and Type C rate options, where the periods of application or prices are determined in real-time, are available: for example, interruptible power options for large-power customers.

The number of participants in TOU optional rate programs varies greatly from one E7 member to the other. Marketing reasons and supply and demand conditions may explain why some rely more on these pricing measures than others. However, all E7 members believe that the introduction of TOU options improves the overall efficiency of the supply-demand balance and therefore brings benefits to both customers and utilities.

Some other types of options are also offered, particularly to medium- to large-power customers. Load retention rate, self-producer purchase tariffs, or special rates in energy surplus periods are examples of rate options that take advantage of market flexibility to assist utilities facing particular energy balance conditions. These options are based either on the short- or long-term marginal costs of supply.

In conclusion, most E7 members are moving toward a pricing system where customers will increasingly be called upon to select the options that best match their consumption habits or needs. The pricing systems include progressively more flexible pricing formulas designed to encourage customers to alter or reorganize their electricity consumption, thus giving customers better control over their electricity bills.
IMPACT OF INDUSTRY RESTRUCTURING ON ELECTRICITY PRICING

The recent pressures for open access to power grids and a restructuring of electricity markets, in conjunction with the development of new technologies in telecommunications and electricity generation, have been acting as strong forces for change. Economic, market, regulatory and legislative changes now under way will dramatically affect the way utilities develop, market and price their product and services.

REGULATORY CHANGES

The goal of restructuring is to open the marketplace to competition in some traditional utility functions – power generation and customer sales and services – thus allowing more customers to choose their electricity provider. The ultimate degree of openness will vary from one country to the next.

In a restructured environment, the distributor and transmission provider will usually have to provide nondiscriminatory access to the grid for all parties who want to sell power in the market and to ensure that all customers who are eligible have the opportunity to choose among the offerings. Some degree of liberalization in the electricity market will allow some customer categories, such as independent municipal distributors or large-power customers, a deregulated price for generation that could eventually be based on the interplay of suppliers and consumers, directly or indirectly, either through marketers or power exchanges. In the latter case, it is hoped that the competitive bidding process will lead to an overall decrease in generation prices. The transmission and distribution of electricity and their respective pricing will continue as natural monopolies, to be regulated by appropriate agencies.

PRICING

Restructuring will have an important impact on rates in many ways. In most cases, rates will have to be unbundled. Unbundling means that rates are broken down into components that reflect the different costs of service. Already, traditional rate structures have been unbundled into demand, energy, and service charges. In more competitive environments, the costs of service will have to be separated into three or more components in order to separately show the costs of generation, transmission and distribution, and even other services.

With respect to DSM or other public purpose program funding, the current thinking among policymakers is to impose a mandatory non-bypassable levy on all retail customers. The levy, based on volume or on a per-customer basis, will be collected in addition to other charges included in the rate structure.

For now, the directions taken by the different utilities and their regulators are not clear and the impact on rate-making mechanisms is not conclusive. The final configuration is likely to include more and more innovative pricing schemes and to differ significantly across service territories. No unique model will emerge, unlike the traditional utility rate-making model.
Demand-Side Management (DSM) dates back more than 20 years in E7 countries. DSM refers to organized utility activities or programs intended to affect the timing or amount of electricity used by customers.

The reasons behind E7 utilities’ undertaking DSM are varied, but they generally relate to optimal resource allocation, cost-competitiveness, customer service considerations, enhanced competitive positioning and/or government dictates.

Furthermore, utilities are not the only players on the DSM playing field. Not only is DSM planning, implementation and evaluation a multi-faceted endeavor that requires the active involvement of both the public and the private sectors, but DSM initiatives led by utilities are very often complementary to energy efficiency strategies initiated by government agencies.

In practice, DSM takes place in an evolving environment where rates and electric regulations, government initiatives – incentive programs, standards, labels, and codes – and new technologies are constantly changing. These changes represent both opportunities and threats to a utility. A utility therefore needs to monitor and understand the evolution of these changes and to set up marketing and technology intelligence mechanisms. These mechanisms will allow the utility to get the most out of its DSM initiatives.

Here are some important contextual aspects a utility should consider when planning and implementing DSM.

**Government and Regulations**

- It is important to view utility DSM efforts within the context of energy policies in general, energy efficiency policies in particular, and the regulatory environment. Every change in the regulatory framework or electricity market affects the degree and type of utility involvement in DSM. Efforts tend to adjust to different regulatory environments, which, in turn, will influence the nature and importance of DSM outcomes and the level of success.

- In the current restructuring, electric utilities are expected to remain key players, along with government agencies and DSM industry players, in shaping the success and charting the future of market transformation in various energy, economic, social and regulatory environments.

- However, the financing and objectives of the DSM initiatives pursued by utilities will tend to differ from those that prevailed in the past. These will evolve according to the role that the private sector, e.g., ESCOs and government agencies, will progressively redefine for themselves in the energy efficiency field.
STANDARDS AND LABELS

- When implementing their energy efficiency strategies, governments and utilities of all E7 member countries have worked together to develop an environment conducive to improving the energy efficiency of appliances, equipment, accessories, and buildings; increasingly stringent energy performance standards for energy-consuming equipment, thermal efficiency standards in building codes and energy performance labels for end-use equipment have been designed and enforced.

- E7 experience shows that energy performance labels, standards, and building codes that address efficient construction practices and products are key tools in helping energy-efficient products/equipment evolve along their respective market diffusion curves.

- The success of energy performance standards and labels is closely linked to the coordinated efforts of many DSM players, under the leadership of government agencies. Experience points to the need to secure, at the outset, the full cooperation of manufacturers and distributors in developing commonly understood timelines for future changes; to develop tools to continuously monitor technological changes that may drive performance standards upward; and to coordinate the efforts of all DSM players. Manufacturers and other trade allies require significant notice of future changes to be able to adjust their business decisions and operations as smoothly as possible.

TECHNOLOGY AND DSM

- Energy consumers are presented with a continuous flow of new end-use technologies; this is one of the most significant sources of opportunities and threats to the competitive positioning of electric utilities and to the DSM planning environment.

- It is therefore important for utilities to take both reactive and proactive approaches to act on these opportunities and threats, by closely monitoring the evolving technological environment created by external sources (manufacturers, R&D centers, demonstration centers, other utilities).

- Experience has also shown that to be more successful in planning and delivering a competitive and balanced DSM program portfolio, utilities are expected to act directly (or indirectly) on both supply and demand for more efficient technology (information/education, labeling campaigns, rebates, or demonstration projects).

ELECTRICITY RATES

- E7 members consider electricity prices to be the single most important prerequisite to any other kind of DSM initiative. They give the primary signal for the rational use of the resource and the long-term improvement in energy efficiency.

- Price signals are sent in both base rates, which set the general level of electricity prices, and in pricing options designed as DSM incentives for particular consumer segments.

- Different E7 countries have adopted different approaches to fixing the general level and structure of electricity rates. However, they have used similar generic principles in selecting and applying these approaches. For example, E7 members have all adopted a binomial pricing structure, i.e., a base rate structure with separate demand and energy charges.

- E7 members have moved progressively toward adopting option-based pricing systems by using rate options, particularly time-of-use options, on top of their base rates. The introduction of time-of-use options has improved the overall efficiency of the supply-demand balance and has thereby brought benefits to both customers and utilities.

- By continuously adjusting base rates to new economic realities and by adding new options in response to the evolution of the energy context, E7 utilities have used rate-making as a key tool that allows them to adapt to the energy and economic context.
PART B
THE DSM PROCESS
OVERVIEW OF THE DSM PROCESS

As an introduction to the second part of this Manual, this section gives an overview of the DSM process that has assisted E7 utilities in acquiring optimal mixes of resources (supply and demand options) as well as in positioning in increasingly competitive markets. The DSM process incorporates planning, program design, implementation and evaluation activities tailored to utilities’ specific objectives and planning environment.

A CONSTANTLY EVOLVING PROCESS

The ultimate configuration of the DSM process, whose sequence is illustrated in Figure 7, varies from utility to utility, depending on numerous factors: the prevailing regulatory environment, the utility’s experience with DSM analysis and implementation, the availability of personnel and financial resources and the timetable for the analysis. Each step of the process corresponds to a key stage in the analysis. However, the DSM process is not a linear mechanistic system but rather a constantly evolving process, with numerous feedback loops.

At the outset of the process, utilities usually undertake numerous “market intelligence” activities such as data/information gathering and very detailed and segmented analyses focused on consumers’ current and future energy needs, consumption behaviors and load profiles. Such analyses help prepare the detailed “reference” demand forecasts against which the impact of various DSM programs will be assessed. Load analysis also provides the key information needed to establish DSM potentials, which will serve as the basis of the Overall Plan.

The first three steps of this process are usually referred to as “planning stages”: their respective outcomes are also used as key inputs in the definition of overall corporate objectives and specific DSM objectives. The last three steps of the process are clustered into what E7 members call the “implementation phase” of the process.

Throughout the DSM process, opportunities to overcome barriers are progressively turned into DSM concepts and then into DSM programs that are screened and evaluated prior (ex-ante), during and after implementation (ex-post) for their economic attractiveness and performance. Various economic criteria and tests are applied, using progressively more documented inputs as DSM initiatives progress through the process.
**Description of Each Step**

**Step 1: Load Analysis and Forecasting**

Electric utilities have always done some kind of load analysis and demand forecasting to support their investment and operational decisions. The introduction of DSM initiatives has induced utilities to adopt new approaches to demand forecasting: these more detailed and “analytical” approaches enable utilities to set adequate “baseline forecasts” against which the impact on the marketplace of the action taken can be assessed.

As a first step in the DSM process, the utility thus defines a baseline forecast using thorough load analyses. The aim is to produce forecasts of electric energy consumption and peak demand in the absence of new DSM programs, i.e., to determine what would likely prevail if no additional DSM actions were implemented by the utility beyond what the other DSM players are expected to introduce during the forecast period. This baseline forecast also becomes a reference for defining corporate load shape objectives. One of the key goals in developing the DSM baseline forecast is to avoid double-counting the effects of efficiency improvements due to the normal workings of the marketplace, government standards and the utility’s earlier DSM programs.

**Step 2: DSM Potentials**

The second step in the DSM process is very important and critical since it provides the background for a preliminary assessment of the overall costs that could be associated with the portfolio of DSM initiatives a utility may decide to implement over time.

This step helps utilities identify applicable DSM measures and estimate the potential impact of those measures on customer electric usage, as represented in the baseline forecast. Unit and aggregate DSM “ex-ante” impacts and costs are estimated as a background to fixing realistic objectives and targets over successive time periods in the Overall DSM Plan.

The key goals pursued in identifying DSM potentials are:

- to identify and describe the various groups of DSM measures applicable to the utility’s situation in terms of their technical feasibility, economic and commercial attractiveness when realistic customer participation rates are taken into account;
- to determine realistic targets for the energy and demand savings a utility can hope to achieve through DSM.

**Step 3: Overall DSM Plan**

As a third step in the DSM process, an Overall DSM Plan is prepared. This plan serves four major purposes:

- to translate estimates of aggregate potential impacts into clearly defined targets, strategies and guiding principles that will serve as a framework for program designers in the next step of the DSM process;
- to provide the utility’s corporate management with overall budgets and global estimates of the total resources associated with the DSM portfolio;
- to serve as justification for securing overall DSM scope/objectives and budget approval from utility corporate management and related regulatory authorities (where applicable);
- to delineate internally consistent marketing approaches.

The contents of an Overall DSM Plan vary from utility to utility, as do the regulatory environments and the relative...
importance of DSM in corporate strategies. DSM plans are built using a common framework and usually include a diagnostic section that introduces the key factors in the utility’s outside environment on which the rationale for DSM is built. Two important elements are then added as the core of the DSM plan: short-term DSM objectives (over a 2–3-year period) and the prioritization of key DSM initiatives in key target markets. These sections may then be completed with a description of the marketing approaches and a presentation of the process to be adopted and the resources needed.

**STEP 4: PROGRAM DESIGN**

At the fourth step, utilities develop program design concepts. The objective of program design is to group cost-effective DSM measures into a program targeting specific market segments and focusing on specific end-uses.

Detailed program designs are intended to optimize customer participation and interest. To be effective, a program must provide a well-organized combination of service packages and financial incentives, if necessary, supported by adequate delivery and promotional activities that address the identified needs and market barriers of specific market segments.

In E7 utilities, program design is usually an iterative process that selects and tests different parameters until an optimal design is reached. Six major tasks are usually involved in designing a DSM program:

1. setting goals and objectives;
2. selecting target markets and technologies;
3. designing the program features (service package, financial incentives, delivery mechanisms, promotion and so on);
4. translating the timetable for implementation into a list of concrete actions;
5. refining program impacts and cost-effectiveness;
6. defining the program evaluation plan.

**STEP 5: PROGRAM IMPLEMENTATION**

Program implementation is the fifth step in the DSM process. At this step, the theoretically designed programs are put to the test of customer acceptance. DSM implementation managers are asked to organize and support the internal and external resources and infrastructure required for program promotion and delivery. They also have to set up and administer a monitoring function and administrative systems that will provide the necessary information for periodic adjustments.

Program managers must fine-tune programs based on feedback provided by key participants involved in pilot or full-scale programs and by the monitoring systems put in place. By reviewing actual program results against expected results on a regular basis, program managers can make adjustments to current and future programs to correct observed discrepancies or to address unexpected market behavior.

Key lessons learned from the implementation stage have helped many E7 utilities refine their approaches at the planning and design stages of the DSM process and improve their overall DSM performance over the years.
STEP 6: PROGRAM EVALUATION

In the sixth and final step, utilities conduct detailed program evaluation activities. These activities are performed to measure a large array of parameters, such as expenses, actual costs of individual DSM measures, actual efficiency of DSM measures, improvements in delivery and promotional activities for new programs, comparison of results with estimates for DSM potentials, and impacts on sustainable market transformation.

Evaluation provides valuable feedback on how effective DSM programs are in achieving stated objectives and impacts. Results from evaluation may in turn be used for various justification activities within utilities or for regulatory authorities.

THREE STREAMS OF INDICATORS

As highlighted in this overview of the DSM process, utilities proceed through a series of steps related to planning and implementing DSM activities. Their configuration, relevance and adequacy are tested or evaluated using three major streams of strategic indicators:

- IMPACT indicators
- MARKET indicators
- PROCESS indicators

Impact indicators examine the nature and magnitude of DSM activities both in terms of economic and energy/demand impacts for each target market. They also include documentation on actual program participation rates, on distortions observed in customer participation, as well as on adoption patterns and the performance of DSM measures and technology.

Market indicators usually comprise non-financial benefits such as changes in customer acceptance and satisfaction, improved utility visibility and image, customer growth, market transformation over the long term, environmental benefits, risk reduction, and other indicators (social, employment), as well as parameters related to the relative success of the program’s communication vehicles. Market indicators permit measuring the relative success of the DSM activities in addressing key market barriers and opportunities.

Process indicators generally review the effectiveness of the management (including distribution of responsibilities) and delivery procedures (i.e., critical path, deadlines, milestones adopted for DSM activities, effectiveness of trade ally involvement, etc.).

As shown in Figure 8, all three major streams of strategic indicators are usually assessed after (ex-post) program implementation. However, some indicators are also used before program implementation. Impact evaluations are typically performed ex-ante and ex-post, whereas process and market evaluations are typically done during program implementation and afterward.
LOAD ANALYSIS AND FORECASTING

A FIRST STEP IN THE DSM PROCESS

Load analysis comprises measuring and analyzing the characteristics of a utility’s loads in order to understand how customers use electricity. Load forecasting comprises projecting energy and demand requirements in the short and long term. In order to get the data and information needed for these activities, utilities usually set up a load research program to conduct both reliable studies and complementary tasks. Load research may also be useful in collecting and analyzing data for other functions within electric utilities.

Load research, as well as load analysis and load forecasting, are introduced in this section as one of the first steps – if not an essential prerequisite – in the DSM process. The ultimate objective of this step as it relates to the DSM process is to forecast the electric energy consumption and peak demand that would prevail in the absence of new DSM initiatives or programs. Such forecasts are used as a background or reference framework to quantify the impact of DSM initiatives. The DSM “baseline” or “reference” forecast allows DSM planners to determine appropriate programs and initiatives targeted at the right end-uses and market segments. The baseline forecast must therefore be based on a detailed understanding of market and customer profiles/behaviors and often requires further breakdown of the utility’s traditional load forecast. The details required for the DSM baseline forecast are thus addressed by the load research program.

This section introduces the load research process and the rationale behind the common applications of load research data; it also provides insights into key approaches and perspectives used in data collection and analysis. A sub-section is devoted to load forecasting, where the models commonly used are presented and evaluated. Finally, this section describes the experience of E7 utilities in planning and developing their respective load analysis and forecasting practices for DSM purposes.

LOAD RESEARCH: COMMON APPLICATIONS

Cost Allocation and Rate Design

Traditionally, load research has served as input for two major utility functions: cost allocation and rate design. Demand-related costs of generation, transmission and distribution facilities can be allocated to various service classes based on their respective contribution to total peak demand. An efficient load research program should provide a reliable estimate, for major rate categories, of the demand profiles at system peak.

Such information is not available through billing records and, since it is essential in developing equitable rates and in estimating the impact both on revenues and on customers’ bills, it must therefore be collected through a load research program.
The increasing complexity of rate design, such as that entailed in time-of-use pricing options, has contributed to justifying an expansion of load research data collection. Knowing the energy and peak demands during the on- and off-peak periods of various potential groups of customers has become an essential ingredient in making sound cost-benefit analyses of new rate options, notably load management rates, from the utility’s as well as from the customer’s perspective.

Throughout the years, as load data has become more readily available, the traditional role and functions of load research have expanded to serve different user groups within utilities, as well as numerous applications. Load data has become a valuable source of information for, among other things, load forecasting, demand-side management and system planning.

**Load Forecasting**

Load forecasting consists of projecting energy consumption or peak demand requirements for the entire system or groups of customers over both the short term (a few hours up to 1 or 2 years) and the long term (3 years and more). Short-term forecasts are used for planning, running and monitoring business operations. The main objective of long-term forecasts is to evaluate future demand growth at the various levels of the electric system – generation, transmission and distribution – in order to assess the needs for new capacity, along with DSM options.

Since the early ’80s, DSM has entailed segmenting load forecasts into finer detail – i.e., by end-uses and/or market segments – than is usually required for traditional utility load forecasts. This is essential since DSM requires a better understanding of the system’s load breakdown by major components. Indeed, end-use load forecasting enables utility planners and DSM managers to develop the appropriate baseline forecasts or reference framework against which the potential (or actual) effects of alternate DSM programs can be assessed. Such an approach fosters better decisions regarding the selection and implementation of the most desirable supply- and demand-side programs.

**Demand-Side Management**

Planning, designing and evaluating DSM initiatives all require detailed load profile data that describes the usage characteristics of, on the one hand, specific appliances, equipment, building shells or industrial processes and, on the other hand, of specific customers or groups of customers. Load research information is used both in planning and evaluating functions: first to identify and quantify ex-ante the potential customers to be targeted for DSM initiatives, then to evaluate ex-post (during or after program delivery) the actual success of programs. Load research provides knowledge on key variables underlying energy and load growth, which can be specifically targeted by a DSM strategy.

Load research allows utilities to match customers’ electricity consumption profiles as closely as possible with the current or projected capacities of the electric system. In so doing, they can evaluate the cost savings expected from DSM-initiated changes on the system load shape.

Load research provides valuable information used at each step of the DSM process, ranging from electricity consumption patterns, i.e., time, magnitude and frequency of usage of electrical service, to behavioral, socioeconomic and demographic information.

**System Planning**

Load research data can be very useful at every level of system planning: generation, transmission and distribution. Information such as coincidence factors, load factors, load profiles and load duration curves for specific market segments or geographical areas can be used by system planners in their design and evaluation functions.

The decision-making process regarding the size of lines, transformers and substations can also be supplemented by a better understanding of usage characteristics during peak hours. For instance, the coincidence factor of electric heating or cooling load during peak hours or after a power interruption can help distribution engineers better calibrate the distribution network and optimize its development.
The Load Research Process

As illustrated in Figure 9, the load research process, a common denominator in E7 load research practices, is structured into three major phases:

- **Planning** – Where the objectives, resources, budgets, schedules and organization of the load research program, including individual studies, are set according to a utility’s corporate objectives and operating environment. At this stage, load research planners must identify the data requirements of various utility groups, develop an action plan that will serve as a common framework and then deliver this action plan while optimizing the resources allocated to its implementation. Once proven efficient, this common framework drives the completion of specific studies that are complementary to what has already been done.

- **Data collection** – Data collection is either impractical or unaffordable if done for every customer in a target population. Utilities therefore do limited data gathering on selected samples of customers. This phase usually encompasses selecting sampling procedures, designing and implementing samples, as well as collecting data from various sources. As described later, four major sources of data are commonly used: billing data, customer surveys, energy audits, and data from monitoring and direct metering. Once collected, load data must be adapted for computer processing and submitted to quality control and data editing prior to any further analysis.

- **Data analysis** – Load data analysis consists in verifying the accuracy of the data and in closely studying and substantiating all or some characteristics of the load profiles of targeted groups of customers. Load data gathered on samples of customers is then expanded to represent the total customer population in the utility’s service area. The main purpose of this exercise is to get an accurate representation of customer demand by rate class and end-use. Data is analyzed according to numerous areas of interest, such as energy use by time segment or occurrence of peak demand, coincidence factor, etc. At this point, analysts try to uncover the relationships between the primary variables of interest and a selection of secondary variables; such an approach gives them a better understanding of the factors underlying load shape and demand/energy growth.

### TABLE 16

#### Common Applications of Load Research: Summary

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate design</td>
<td>Provides data needed for cost allocation, such as occurrence of coincident peak and non-coincident peak, for rate design purposes</td>
</tr>
<tr>
<td>Load forecasting</td>
<td>Provides more detailed information regarding the determinants of demand growth and load shape</td>
</tr>
<tr>
<td>DSM</td>
<td>Describes the usage characteristics of specific appliances, equipment, building shells and industrial processes, as well as of specific customers or groups of customers</td>
</tr>
<tr>
<td>System planning</td>
<td>Provides information on the load characteristics of individual customers and local area groupings of customers to help planners optimize the development of the electric grid</td>
</tr>
</tbody>
</table>

### FIGURE 9

**Load Research Process**

- Planning
- Data collection
- Data analysis
- Cost allocation and rate design
- DSM
- Electric system planning
- Demand forecast
- Rate design
- Load forecasting
- DSM
- Electric system planning
- Demand forecast
E7 practice is to establish load analysis and baseline forecasts for all major customer classes. Load analysis allows a utility to better understand the present situation and the main factors that have an impact on load shape and on demand and energy growth. While forecasting the future is subject to many uncertainties, an unbiased forecast that understands and addresses key unknowns is an important foundation to DSM planning.

The baseline forecast of electric load – i.e., the level of energy service required in the future by a given customer class – depends on two major types of unknowns:

- The expected economic activity of the consumer class considered, including expected patterns of energy usage and, in some cases, the penetration levels of energy services within that consumer class. In the industrial sector, economic activity is usually revealed through growth figures for industrial output per industrial branch. In the residential sector, activity parameters usually include changes in residential stock size and profile (new vs. old, single family vs. multifamily, urban vs. rural) due to demographic changes and market ownership/penetration of electrically powered residential systems and appliances. In the service or tertiary sector (commercial and institutional), activity parameters usually refer to changes expected in the building stock (expressed in floor space) per type of service function (health, education-research, hotels-restaurants, office-government departments, trade-wholesale-retail, sports-culture-community facilities, etc.).

- The expected level of technical efficiency (expressed in terms of intensity of energy use per unit of economic output) to deliver one unit of energy service being considered for that consumer class. Changes in energy intensity are a reflection of technical progress (energy reduction via automation, for example) that do not affect the level of energy services provided, of gains in market share secured by competing energy sources, and of the ability to develop new uses for energy. Changes in usage patterns that result in a reduction in the level of energy services are usually not accounted for as net energy savings.

The level of detail that load analysis and baseline forecasts need to incorporate will depend on the availability of data and the long-term commitment of the utility to dedicate resources to load research. Higher levels of detail usually lead to an increased ability to set appropriate DSM targets and to monitor the impact of DSM initiatives.

Figure 10 illustrates the various levels of detail that may be considered when implementing load research and baseline forecasting, starting with information gathered at the system level.
level and progressing in more detail to sector, segment, end-use, technology, and equipment levels.

An ideal situation prevails when the breakdown of consumption reaches the level of end-uses, and then technology and type of equipment. In order to work at such levels, a vast amount of data must be collected and made available for all or most of the important equipment and end-uses: detailed equipment inventories, estimates of saturation rates, annual energy consumption, coincident and non-coincident demand, and so on. This approach is usually referred to as the “bottom-up” approach. The data required to develop such a baseline forecast is quite detailed and costly, to the point where few E7 utilities have so far adopted it.

Conversely, the “top-down” approach starts with the utility’s official forecast, which is then allocated down to the various hierarchical levels using secondary information from billing data and statistical agencies. As load research data becomes progressively available for a service area, it is appropriate to develop a more complete approach integrating elements of the bottom-up approach into the top-down approach. These so-called hybrid bottom-up/top-down models can use the former approach for some strategic end-uses and the latter for less important uses.

Up to now, E7 utilities have typically used hybrid bottom-up/top-down approaches to forecast load shapes at the sector, segment and/or end-use levels. The criteria used to select the level of detail for each consumer class or sector depend on:

- the importance of each sector, in terms of its electricity consumption;
- the availability of statistics on past and current consumption with the required level of breakdown;
- the likelihood of fundamental changes in any sector during the forecasting period, even if the sector is marginal at the time of forecasting;
- the utility’s knowledge of the specific power demand curve.

**Major Sources of Data**

Utilities usually use four types of data sources to feed the selected forecasting and load analysis approaches with relevant information: billing data, customer surveys, energy audits, and monitoring and direct metering.

**Billing Data**

Billing data is gathered from utility billing files. The availability of data is therefore often limited to the billing determinants used in the rate structure. Billing determinants used in monthly electricity bills typically include:

- monthly customer charges;
- monthly or bi-monthly energy consumption for residential, commercial and industrial customers;
- monthly peak demand for larger commercial and industrial customers and, in some cases;
- time-related monthly energy and peak demands for the largest customers.

Customer billing files may also include demographic information or data on customer sectorial activity that may be used to stratify the population. The main advantages of billing data stem from its ready availability and coverage of a large number of customers. However, the information gathered from the billing files is not comprehensive enough to feed load analysis studies.

Three sources of information may provide data on customer equipment and usage habits that is useful for load analysis purposes: customer surveys, energy audits and direct metering. Information for these tools must be obtained from target groups of customers; thus, accurate sample selection methods must be used to guarantee representativeness.
Customer Surveys

Customer surveys help predict current or likely future customer behavior as it pertains to general lifestyle or economic behavior. All kinds of data is gathered. Energy usage patterns may be determined by collecting data on end-use/technology/appliance ownership, penetration rates of various equipment and appliances, alternate fuel penetration, and building stock. Other types of information refer directly to DSM initiatives: likely participation rates in various marketing and DSM programs, level of awareness, level of satisfaction relative to past or current DSM initiatives, persistence of savings, etc.

Such surveys are usually designed for specific segments of target populations. For cost-effectiveness, customer surveys may be used to simultaneously serve the information needs of numerous load research users and applications. Results from surveys have to be processed and expanded to total population estimates. Careful sampling and validation must be done, since the results can be subject to potential biases in sampling and interviewing and in the information-gathering tools.

Energy Audits

Energy audits usually refer to on-site inventories of building and end-use systems (stock size, equipment profile, age and usage patterns) to which are added more or less sophisticated computations of energy consumption at the most detailed level. The inputs to these computations are either engineering estimates and/or results from direct monitoring of end-use energy consumption. The computations may be done using either rule-of-thumb engineering simulations or sophisticated weather-adjusted software designed to take due account of cross-impact biases when numerous energy systems are working simultaneously.

Energy audits also refer to visits by technical professionals to assist building owners or industrial decision-makers in identifying technical and behavioral opportunities for DSM in terms of energy savings, load reduction or load displacement. Audits are therefore conducted as DSM initiatives, which often bring results in terms of kW and kWh savings in addition to gathering much needed information on the way customers use energy.

In others words, the information gathered through energy audits serves:

- As a reference background to help identify zones of potential efficiency improvements that are fed back to customers to build awareness and to encourage positive decisions toward DSM and investments in energy efficiency.
- As a source of detailed information on how and when prototypical buildings/plants in specific customer class categories consume energy, thus facilitating load forecasting using the prototype approach and the creation of benchmarking databases.

With relatively high unit costs, the relevance of energy audit programs and associated data collection opportunities are usually assessed using cost-benefit analyses and applied only to strategic customer classes.
MONITORING AND DIRECT METERING

The energy and load consumption patterns at specific sites can also be measured on-site through various monitoring techniques and increasingly more sophisticated metering technologies.

Utilities can install various monitoring devices resulting in:

- **spot metering** of electricity use (short-term monitoring of electricity use before and after participation, and measuring other relevant factors such as equipment operating hours, heating/cooling degrees, and so on);
- **end-use load research metering** (metering specific circuits affected by new DSM systems to record kW demand before and after participation).

More expensive and time consuming, direct metering is used to provide large amounts of valuable data for very specific targeted applications and customer classes whose energy profile has to be documented – usually the most important and largest clients in a utility’s service territory. In this regard, utilities are expected to increasingly use the more sophisticated electronic meters now on the market, which enable direct metering and hourly billing.

Two types of data collection are considered:

- **On-site data collection** – utility personnel read the meters once a month. In case of end-use measurement, data collection must be performed more often due to the limited memory of multiple-channel metering devices.
- **Automatic remote data transfer by modem** – the load data is collected by an automated retrieval system. Such a system eliminates on-site data retrieval and allows a more frequent collection schedule. The main drawbacks are higher costs and potential data loss due to equipment or telephone communication failures. Figure 11 illustrates the typical automatic flow of data between the metered customer and the utility’s computer network.

<table>
<thead>
<tr>
<th>TABLE 18</th>
<th>SOURCES FOR DATA COLLECTION: SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DATA SOURCE</strong></td>
<td><strong>DESCRIPTION</strong></td>
</tr>
<tr>
<td>BILLING DATA</td>
<td>Data taken from utility billing files: easily accessible but often incomplete for load analysis purposes</td>
</tr>
<tr>
<td>CUSTOMER SURVEYS</td>
<td>Surveys conducted for targeted market segments to provide data on customer behavior and equipment inventory, as well as on likely participation rates in various DSM initiatives</td>
</tr>
<tr>
<td>ENERGY AUDITS</td>
<td>Detailed on-site inventory of building and end-use systems to which are added sophisticated computations of energy consumption</td>
</tr>
<tr>
<td>MONITORING AND DIRECT METERING</td>
<td>Energy and load consumption patterns measured on-site using various metering techniques for a short period (spot metering) or a long-term end-use load research program</td>
</tr>
</tbody>
</table>
DATA ANALYSIS

DIRECT METERING, ENGINEERING SIMULATION AND STATISTICAL ANALYSIS

Data analysis – load curve analysis or profiling – is at the core of the load research activity. It helps reveal customer consumption patterns and habits or profiles found in the load data. The profile of the load curve reflects the hourly changes in consumption patterns throughout the year and shows the concentration of demand at particular times, days or periods.

Development of end-use and profile data can follow three general approaches:

- Direct metering
- Engineering simulation
- Statistical analysis and estimation

Of the three approaches, metering is the most precise since actual energy consumption is directly measured. Metering is also the only method that can provide load profiles over a short time period, e.g., one hour. All other approaches are designed to derive monthly or annual end-use consumption. Metering is generally too expensive to justify coverage of a significant sample with a broad range of end-uses. It is therefore best used for monitoring total demand along with selected end-uses. It is usually applied to a limited number of the largest customers (typically large industrial customers) that account for most of the demand in a utility’s service territory.

In practice, direct metering can be complemented by engineering simulations and statistical estimates for end-uses, appliances or other electric equipment. According to E7 experience, a combination of the three approaches is the most advantageous and cost-effective.

Engineering simulations are related to technical data about equipment types (standards, size, insulation, efficiency, type of system, etc.) and other variables that can influence consumption, such as weather conditions. Without taking into account consumer behavior, engineering simulation models provide good end-use estimates, if sufficient data is collected.

Finally, statistical analysis and estimation can supplement metering and engineering tools in establishing end-uses and customer profiles. Compared with metering, the statistical approach has many advantages: it is less expensive, it allows coverage of a larger sample with a broader range of end-uses; it also complements engineering tools by taking consumer behavior into account.

Conditional demand analysis (CDA) is an example of the statistical analysis regression method often used for end-use estimation. It links energy consumption with variables that can be correlated to end-uses. CDA was initially designed to infer monthly or annual residential end-use consumption from billing records. However, as evidenced by a large number of studies, the approach has been used for other purposes, such as estimating income and price elasticity for end-use consumption, evaluating the impacts of utility incentive programs, and assessing energy consumption trends for forecasting purposes.

Dairy processing
**Results of Load Profile Analysis**

End-use analysis can detect appliances or electrical equipment that make a major contribution to peak demand. Such information reveals usage patterns or habits that can be modified through DSM measures for an improved overall load factor.

Since load research provides input for various applications, results are usually reported in as much detail as the final user needs. Standard load analysis results include many of the following:

- individual customer, sample average, and total class demands for each hour;
- sample average and class total load curves for system peak or other selected periods;
- accuracy of estimates and measures of reliability for each hour and for class results;
- class-coincident peak demand, class non-coincident peak demand, energy use per month, on- and off-peak energy use per stratum or for the entire class;
- load and coincidence factors for peak days;
- system load curve breakdown by customer class and end-uses;
- load duration curves;
- information on sample demographics collected through questionnaires;
- analysis of demand and energy use according to temperature, square footage, income, and other related variables.

Electricity demand varies considerably during the course of a day or a year. As utilities need to know who is consuming electricity during peak periods or at any other time, they analyze the magnitude of total demand each hour, and put it in perspective with the demand by customer class.

**Figure 12** shows typical load profiles by customer class. Load research data enables precise evaluations of hourly customer loads not only for an average day but also for the entire year. Seasonal factors can be as important to system load shape as daytime periods.

The Load Duration Curve (LDC) is another type of result from load analysis. The LDC sorts utility hourly demands by decreasing size, from system peak to the lowest yearly demand, according to the fraction of the year during which

![Figure 12: Load Profile by Customer Class](image-url)
a given level is exceeded. It typically highlights a few hours of very high peak demand and a gradual reduction in load level, as shown in Figure 13.

The LDC is used to determine the avoided costs associated with a DSM program or initiative. This curve is usually divided into three time segments, indicating the different operating modes used to supply the required resources: peak hours, intermediate hours and off-peak hours. These periods are determined using a combined analysis of load profiles, operational constraints and costs of generating plants. Each period is characterized by specific types of generation equipment and their associated cost of installation and operation.

LDCs provide DSM managers with a clear picture of the load profile of specific customer groups over various time segments. DSM managers can thus multiply the load profile of a given rate category by the corresponding category of marginal cost to calculate the marginal cost of supplying this specific rate category. With this methodology, it is also possible to compute the marginal cost of supplying a specific end-use, provided its load profile is known.

**Forecasting Energy and Peak Demand**

Up until the early ’70s, electricity load forecasting was a relatively simple procedure because demand tended to grow at predictable rates. More recently, as demand growth became more erratic and uncertain, utilities have developed more sophisticated methods, which have contributed to providing more information and a greater knowledge of trends, thus improving the accuracy of the forecasts. Utilities currently use three types of models to generate baseline energy and peak demand forecasts: econometric models, end-use models and combined models.

Load forecast models can be developed to assess energy or peak demand requirements. Available models usually address one or the other. Energy consumption forecasting is important as it provides the basic data for financial projections regarding sales, revenues and variable costs associated with energy generation. On the other hand, peak demand forecasting is essential for planning capacity at the generation, transmission and distribution levels.
E7 utility forecasts are generally based on energy requirements. Once the energy forecast is established, the system peak demand forecast can be derived from coincident load factors by customer class. These factors are provided by the load research program.

**Econometric Models**

Econometric models were widely used in energy consumption projections up until the ’70s and they remain important tools for understanding the aggregate nature of energy requirements and its determinants.

Econometric models relate electricity demand to significant economic and demographic factors such as electricity prices, prices of competing energy sources, gross national product, time, manufacturing indices, population, personal income, and data on weather and temperatures. Specific factors are selected for their high degree of statistical correlation with demand.

Econometric models are usually designed to provide a forecast for each of the major customer classes in a given service territory, i.e., residential, commercial, institutional, and industrial sectors. Each of these sectorial models is based on the specific economic and demographic factors correlated with demand in that sector and generates a separate demand forecast for that sector. The projections for all classes are consolidated to produce the total forecast.

Although very accurate in predicting electricity use over the short term (3–5 years), econometric models are now considered inadequate in helping develop baseline forecasts for DSM planning and evaluation purposes for the following reasons:

- they generally lack end-use details;
- they depend on the basic assumption that the relationship between explanatory factors (e.g., income, price, demographics) and demand which prevailed in the past will continue in the future;
- their dependence on historic data hinders a utility’s ability to predict structural changes, such as those associated with technological or behavioral changes.

Thus econometric models cannot deal with demand-side options such as efficiency improvements, since they represent a change in technology and a change in the relationship between demand and the factors selected as predictors. However, econometric methods are still in use wherever sectorial or end-use information is not available.

**End-Use Models**

End-use models separately address each end-use such as heating, cooling, lighting, air conditioning, motive force, and industrial processes. They compute future consumption based on the increasing number of units (or stock) of each type of technology, equipment or appliance, and on the electricity use per unit. The aggregate consumption by each type of equipment is usually developed for each sector and for the most important sub-sectors. Data for these models is derived from customer surveys and equipment usage studies.

The prototype approach is a variation on the bottom-up end-use models. It integrates engineering simulation models used in DSM analyses in order to assess the energy consumption of prototypical buildings in the residential and commercial sectors.

The use of end-use models is often limited to a few homogenous customer classes where data is more easily and cost-effectively available. End-use models are most commonly used by E7 utilities for forecasting demand in both the residential and tertiary (commercial/institutional) sectors. End-use models enable utilities to analyze behavioral responses to changes in technology and policy. They are today considered more adequate for DSM planning and evaluation purposes.

However, the use of end-use models is not problem-free:

- significant investments in time and resources are required to develop the appropriate databases with quality data;
- the effects of economic factors, such as price and income, on equipment usage intensity – i.e., equipment size and number of hours of operation – are difficult to obtain.
COMBINED MODELS

Combined models have been designed to capture the effects of both economic and technological factors. Some add economic parameters such as income or price to an end-use framework. Conversely, end-use equations may be added to existing econometric models. Combined models are the forecasting models most commonly used by E7 electric utilities.

No matter the type of model, utilities have to deal with uncertainty. They usually do so by preparing several forecasts reflecting different probabilities or based on different scenarios of possible future events impacting demand.

LOAD ANALYSIS AND FORECASTING FOR E7 MEMBERS

E7 GENERAL PRACTICES

There is a wide disparity in the level of knowledge of load curves per sector and/or activity developed by E7 members. Most have adopted policies and practices that enable them to measure at least the consumption of industrial and tertiary customers (on a 15-minute basis for the largest customers). Only a few have implemented structured processes to better understand residential load profiles by end-use and by region. This knowledge is still being obtained through surveys, complemented by engineering simulations and statistical estimates.

Load forecasting also varies among E7 members, who use different software to forecast energy and peak demand per customer class, geographical sectors and so on.

All E7 utilities do simulations of the potential impact of DSM initiatives before the implementation step. Some monitor load curves for the actual changes observed in consumption in order to evaluate the economic value of the technology implemented. Others assess the results of DSM programs by using specific “ex-ante” evaluation methods tailored according to their needs and knowledge of customer class and system load curves.

LESSONS FROM E7 EXPERIENCE

E7 experience reveals that a good load research program is an essential prerequisite to an adequate understanding of the key global factors underlying system load and customer consumption patterns. This understanding gives the utility a better knowledge of the dynamics prevailing in markets and facilitates designing DSM initiatives with maximum impact. Here are a few lessons that can be shared regarding load analysis and demand forecasting:

- A substantial commitment is required from the utility if it is to benefit fully from its load research program and adequately meet the data requirements from various utility groups, including DSM managers. Both adequate resources for specific short-term studies and a long-term vision are necessary to develop and operate a stable and permanent department responsible for conducting reliable and cost-effective load studies.
Load research has to be carefully planned and periodically monitored for cost-effectiveness and relevance, as its implementation requires significant investments in time and resources, and to further ensure that both the original objectives and the ever-changing needs of user departments within utilities are being met.

Utility corporate objectives and operating environments provide the foundation for load research program design. For cost-effectiveness, it is essential to know the expectations and needs of all groups involved so as to determine, at the outset, the scope of customer sampling, data collection and analysis required.

When implementing load research plans, utilities have to stay focused and resist measuring more customers on more parameters than required. Once again, it is highly recommended that the information needs of all the groups involved be assessed before launching a full-scale load research program.

The quality of data collection procedures has a great impact on the quality of results as well as on utility-customer relations, since customers are directly involved in the process. The strengths and weaknesses of the different components of the load research program also need to be identified to ensure progressive improvements in efficiency.

Load research must go beyond ad-hoc and out-sourced data collection and analyses done for specific purposes. Load research has to become a permanent utility function, well supplied with adequate in-house resources (expertise and financial) to ensure discipline, rigor, consistency and quality in both data and analyses.

The load research function can be divided into two distinct activities: data collection and data analysis. Data collection can be performed by a department that interacts directly with customers (usually responsible for metering and billing functions). Experience has shown that data analysis is better performed through a central unit whose responsibility extends to integrating data from diverse sources and utility departments.

Data collection gives the utility data and information on customers that may appear personal and, in many cases, confidential. Utility managers must be aware of the inherent risks that may arise as a result of implementing a load research program and be able to handle this sensitive issue; first, with the customer, and, second, with utility personnel and all users. Normally, individual customer information and consumption data is kept strictly confidential. Only entire class profiles should be disclosed.

E7 utilities have progressively gone from using econometric or economic trend models to developing their own approach to end-use models that are subject to continuous refinement. Utilities that are new to planning and implementing load research are expected to jump-start their own practices. They will benefit from the latest metering technologies, sound analysis methods and E7 experience when determining the scope and focus of load research that their available resources will be able to support over the long term.
Rationale for Assessing DSM Potentials

As a second step in the DSM process, utilities conduct DSM potential impact analyses. These analyses lead to a preliminary technical, economic and commercial screening of DSM measures that could be considered for inclusion in the Overall DSM Plan and for further development at the Program Design stage.

Fixing Realistic DSM Targets and Objectives

The assessment of DSM potentials helps utilities identify applicable DSM measures in their respective service territories and estimate the potential impact of those measures on customer electric usage, as represented in the baseline forecast. Unit and aggregate impacts as well as costs associated with these measures are estimated “ex-ante”, i.e., prior to implementation, as a background to fixing specific and realistic objectives and targets in each major market segment over successive time periods. Such inputs are equally critical to both the DSM Plan and the Overall Corporate Plan when it comes to the point of truly relying on DSM.

A Stepwise Approach

The assessment of DSM potential impacts requires an understanding of a number of elements related to the market, the use of energy, the number of clients, technologies used, and costs. E7 member utilities rely on a stepwise approach to collect the appropriate data and complete the necessary market research and analyses.

FIGURE 14

Stepwise Approach to Estimating DSM Potential Impacts

- Market Data
- Technical Potential
- Economic Potential
- Opportunities
- Barriers
- Achievable Potential

LOAD ANALYSIS AND FORECASTING
DSM POTENTIALS
OVERALL DSM PLAN
PROGRAM DESIGN
PROGRAM IMPLEMENTATION
PROGRAM EVALUATION
Once a baseline forecast is set, using the extensive market data gathered (e.g., consumption levels, load profile, number of customers, customer attitude toward DSM and tariff structure by customer class), the DSM technical potential is estimated.

**DSM Technical Potential** is a measure of the energy and peak demand savings that are technically feasible for each market sector, assuming the best and most energy-efficient, commercially available equipment is installed in the stock of buildings and industrial processes located in the utility service territory. Technical potential sets an upper boundary for DSM savings. This also applies to peak displacement over time.

**DSM Economic Potential** is then evaluated. Economic potential is a subset of technical potential estimated only for DSM measures that are economically attractive, i.e., the least expensive demand options compared to supply options to meet future electricity demand.

Finally, **DSM Achievable Potential** is estimated. It corresponds to the aggregate impacts of economically attractive measures, combined with corresponding customer participation rates. Realistic customer participation rates are based upon the opportunities and barriers that exist in the market. Achievable potential serves as a basis for setting realistic targets for the DSM savings (or peak displacement over time) a utility can hope to achieve through DSM programs.

DSM potential concepts can be applied to either an individual DSM measure, a program based on a combination of measures, or a portfolio of DSM programs.

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**DSM Technical Potential**

Technical potential is derived from the following sequence of operations:

- preparing a comprehensive list of DSM measures and technologies accessible and applicable to the utility service territory;
- qualitative screening of individual DSM measures;
- gathering detailed information on relevant characteristics of DSM measures and estimating unit impacts and costs associated with each measure;
- calculating potential aggregate impacts.

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**ENERGY OR DEMAND SAVINGS**

DSM potentials can be estimated both in terms of energy and demand savings. Available models usually address one or the other. The impact on system demand takes into account the coincidence of the specific DSM measure to system peak demand. “Coincident load factors” are specific to individual end-uses, customer categories and DSM measures.
**Comprehensive List of DSM Measures and Technologies**

As a first step, a comprehensive list is drawn up of DSM measures and technologies that are of potential benefit to electricity customers. This list primarily includes DSM technologies that are applicable to major end-uses in each electricity market segment in the service territory. Usually, these measures are designed so as not to affect the customers’ comfort and safety nor the quality of service provided.

DSM measures can be applied to:

- an appliance or an accessory (e.g., high-efficiency refrigerator or low-flow shower head);
- equipment (e.g., variable speed furnace or ground water/heat pump);
- a system (e.g., thermal energy storage);
- a process (e.g., automated industrial production);
- the shell of a building (e.g., ceiling and wall insulation or caulking and weather stripping);
- customer behavior when using or operating the above (technical practices and operations).

This list of potential measures can be developed from information on other utilities’ DSM experience as well as from DSM-related publications. Conservation and load management technologies are changing rapidly. Emerging technologies and measures should be monitored closely by reviewing R&D and pilot programs. Once a list of potential DSM measures has been prepared, several screening analyses are typically performed to identify the measures that are applicable to the utility’s service territory and that are the most effective from a technical and economic perspective.

**Qualitative Screening of DSM Measures**

Qualitative criteria are defined to assess the applicability of DSM measures to conditions unique to the utility’s service territory. The purpose of the qualitative screening is to produce a list of measures that merit detailed analysis with a reasonable expenditure of analytical effort. These qualitative criteria require a “Yes” or “No” answer as opposed to a quantitative answer. Table 19 introduces some of the qualitative criteria used by E7 utilities to screen potential measures.

**Table 19**

<table>
<thead>
<tr>
<th>Screening Criteria</th>
<th>Key Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological immaturity and reliability</td>
<td>Is the option based on unproven technology or does it lack adequate technological development? Is it available on the market or easily accessible with a minimum investment? Is it reliable?</td>
</tr>
<tr>
<td>Poor match with utility load objectives</td>
<td>Are the likely impacts of the option incompatible with the utility’s load objectives?</td>
</tr>
<tr>
<td>Poor market match</td>
<td>Is the technology incompatible with the climate, building stock or equipment that is typical of the utility’s territory?</td>
</tr>
<tr>
<td>Limited infrastructure and market size</td>
<td>Is there a limited industry infrastructure to support effective DSM programs? Or is there a limited market size to support administrative and other program delivery costs?</td>
</tr>
<tr>
<td>Better measure available</td>
<td>Is another DSM measure clearly equivalent in function and more cost-effective?</td>
</tr>
<tr>
<td>Non-quantifiable savings</td>
<td>Are the costs and impacts of the DSM measure non-quantifiable or quantifiable with very low reliability so that economic evaluation is not possible or reasonable?</td>
</tr>
<tr>
<td>Poor customer acceptance</td>
<td>Does the measure reduce the quality of the energy service provided to the point where customers in important markets are unwilling to install it? Does it correspond to consumers’ cultural values?</td>
</tr>
<tr>
<td>Environmental and health concerns</td>
<td>Does the measure present any potential environmental and health concerns?</td>
</tr>
</tbody>
</table>
After the initial qualitative screening, information needs to be compiled on the key characteristics of each measure that passes the screening. These can be grouped into five clusters of characteristics and various information sources and analytical methods can be used to document the clusters, as shown in Table 20:

<table>
<thead>
<tr>
<th>Clusters of Key Characteristics</th>
<th>Parameters</th>
<th>Information Sources/Analytical Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>Data from utility’s own programs or from other utilities’ databases, Consultants, Scientific institutions</td>
</tr>
<tr>
<td>Operating history</td>
<td>Measure’s track record in the field</td>
<td>Data from utility’s own programs or from other utilities’ databases, Customer surveys</td>
</tr>
<tr>
<td>Annual energy consumption, demand and load impacts</td>
<td>On energy consumption, On peak demand, On load shape</td>
<td>Measures insensitive to weather variations, Simple engineering estimates, but with care taken not to over-evaluate DSM potentials, Measures sensitive to weather variations, Engineering and statistical methods, Computerized simulation models that simulate energy consumption behaviors of prototype buildings with and without DSM and that assess interactive effects between end-uses in buildings as well as various building occupation interactions</td>
</tr>
<tr>
<td>Cost of DSM measure</td>
<td>New &amp; replacement equipment, Incremental costs (purchase, installation and maintenance) between high-efficiency and standard equipment, Add-on equipment, Purchase and installation cost of equipment + maintenance costs</td>
<td>Several sources of information on costs, General cost information for residential, commercial and industrial sector DSM measures (adjusted to specific utility service territory conditions), Cost data handbooks, Surveys of vendors and distributors of energy-efficient equipment in the utility service territory</td>
</tr>
<tr>
<td>Environmental impacts</td>
<td>Indoor air quality reduced, Reduction of solid waste, Use or capture of chlorofluorocarbons</td>
<td>Data from utility’s own programs, Consulting firms, Scientific institutions</td>
</tr>
</tbody>
</table>
Potential Biases and Mitigation Procedures when Calculating Unit Impacts

Technical potentials are often overestimated. According to E7 experience, care has to be taken so as not to overestimate impacts associated with stacking multiple measures (cumulative effects) or potential impacts generated by measures aimed at specific end-use, such as lighting, on the energy used in weather-sensitive end-uses (interactive effects). Another important bias is over-evaluating the contribution of a specific technology to building consumption.

Typical biases leading to over-evaluating potentials can be dealt with by using computerized simulation models that simulate the energy consumption behavior of prototype dwellings or building types with and without DSM measures. Using the prototype approach facilitates the assessment of many interactive phenomena encountered in buildings, as well as a variety of building occupation interactions.

More generally, typical biases are decreased and potential estimates improved when accurate data, including information about the principal technologies used in buildings and their operating modes, is collected at the participant or site-specific level.

Dynamic Dimension of Potential Evaluation

Finally, the dynamic dimension of DSM implementation, such as the natural replacement of equipment in the marketplace, has to be taken into account in order to avoid the real limitations that arise during the implementation of DSM measures. It is not usually cost-effective to change equipment or an accessory before the end of its useful life. That is why customers wait until the equipment has to be replaced.

To take such dynamics into account, DSM measures are further classified as having either permanent or temporary technical potential:

- **Permanent Potential** includes measures that can be implemented at any point in time. These measures are associated with retrofitting existing buildings, such as attic insulation, or add-on equipment or accessories such as water-heater jackets.

- **Temporary Potential** comprises measures that have to be implemented at a specific point in time, or the economic opportunities vanish. Measures included under temporary potential should be considered opportunities that arise each year and build up over time. Examples are: wall insulation during new housing construction or major renovations, upgrading a water heater, or an air-conditioning system a customer is about to purchase, etc.

Most of the controversy about DSM potential estimates comes from misunderstanding these two types of potential. If total, immediate and continuous conversion to the most efficient technologies in all market segments is assumed, regardless of cost, the estimate obtained may appear very impressive. In fact, this concept is best referred to as the Instantaneous Technical Potential (see Hagler & Bailey 1996). The concept, though much in use, ignores the dynamic dimension associated with implementing DSM programs, such as the natural replacement rate of equipment and the rate of new building construction. This concept can therefore only be used to set the base for long-term targets, 15 to 20 years in the future.

Phase-In Technical Potential corrects this weakness and estimates the energy and demand savings taking into account the rate at which equipment and systems are replaced and new buildings constructed over time. It is then assumed that the best commercially available equipment will be chosen over equipment that would normally have been purchased.
(temporary potential). Add-on technologies such as attic insulation or water-heater jackets are added instantaneously (permanent potential).

It can therefore be concluded that the “real” technical potential over a short time period (e.g., 1, 5 or 10 years) can only be phase-in technical potential. It is usually only after a 15-year period or more, as building and equipment stock is being replaced, that phase-in technical potential estimates converge with instantaneous technical potential estimates. As an immediate corollary, it follows that if a temporary potential is not captured in a 5-year period, then the potential over a 15–20-year period is diminished accordingly (see illustration Figure 15). Since DSM is a resource to be built up year after year, a consistent and permanent approach, such as market transformation strategies, has to be adopted in order to achieve the full potential of DSM.

**SCREENING DSM MEASURES FOR THEIR COST-EFFECTIVENESS**

DSM measures that have survived the qualitative screening are then filtered for their economic cost-effectiveness. At this stage of the DSM process, the remaining DSM measures are usually screened using a concept known as the Total Resource Cost (TRC) test. This test compares the lifetime benefits of each DSM measure with its lifetime costs: lifetime benefits are expressed in terms of avoided marginal costs of energy and demand and avoided operation and maintenance (O&M) costs, while lifetime costs include capital and installation costs as well as the O&M costs of the measure itself.

For this type of preliminary economic analysis, the effects of participation rates as well as program administration and delivery costs are ignored. As the DSM measures go through further steps in the DSM process, additional tests using other perspectives – utility, ratepayer, society, program participant and program non-participant – are used to assess the cost-effectiveness of DSM programs in more detail.

**RANKING COST-EFFECTIVE DSM MEASURES: THE “SUPPLY CURVE” OF DEMAND OPTIONS**

In order to compare the cost of DSM measures to the cost of electricity supply options, technical measures must be sorted according to their cost, ranging from the most to the

**DSM ECONOMIC POTENTIAL**

Economic potential is a measure of the energy and peak demand savings that are economically feasible in each market segment studied. Economic potential is a subset of technical potential, composed only of DSM measures that are economically attractive, i.e., the least expensive electricity demand options (compared to supply options) to meet future electricity demand. In other words, it is all the DSM measures that are less expensive than building new facilities.
least economical DSM measure. The cost of these individual measures is then compared to system avoided costs.

The economic potential of energy savings can be charted as a supply curve of demand options, as illustrated in Figure 16. This curve represents the cumulative potential of energy savings available, according to various levels of avoided costs. Each block is associated with a measure or group of measures, usually clustered by end-use or market segment. Each block is also characterized by a distinct average unit cost and a savings potential: the higher the avoided costs, the more numerous the blocks of DSM measures stacked as economically attractive options. This shows how influential system avoided costs are in the DSM planning process and in the ultimate combination of DSM programs that could be incorporated into an Overall DSM Plan (see boxed text below).

According to E7 members’ experience, since economic potential estimates vary over time, they should not be considered a fixed concept. The costs of individual DSM measures change over time as does the promotion, development, and thus the market price for specific technologies. Similarly, avoided costs, discount rates, or the cost for new capacity will also change over time. The dynamics in these parameters must therefore be closely monitored by DSM planners.

**AVOIDED COSTS: A FEW CONSIDERATIONS**

Most of the cost-effectiveness tests used in DSM start with developing a set of avoided cost estimates from the most recent utility plan; these estimates are used as a baseline for comparing alternative supply and demand options. Avoided costs can be defined as the money saved if the last kWh of energy and/or kW of power is not needed. In other words, avoided costs measure the expected change in a utility’s total costs resulting from a reduction in energy demand brought about by a DSM initiative.

Avoided costs are divided into demand-related costs, energy-related costs and customer-related costs and are calculated for all functions of electricity service: generation, transmission and distribution.

However, not all cost components are relevant in evaluating avoided costs associated with a particular DSM option. Each potential DSM program must be reviewed carefully in order to determine what is really avoided in the whole chain of electricity service over the period of time considered in the analysis. For example, a program may have a weak impact on energy but a strong impact on power savings. In this case, it might also have a strong impact on the generation and transmission equipment planned and a different impact on the distribution network. This impact could be immediate and bring results over a very long period of time, thus delaying the need for constructing peak equipment. Other DSM initiatives may have a short-term impact as they only contribute to accelerating a trend already seen in the market, in which case, avoided costs would be limited to energy savings in the short-term.

Avoided cost estimates are usually developed for each year, season and time period, such as peak and off-peak periods during the day. With this approach, resources that primarily displace peak power during the summer (or winter, depending on the region) and those that displace baseload power throughout the year can be compared to the appropriate avoided costs.

Avoided costs can be calculated as generic or customized and resource-specific. In the case of customized avoided costs, since their calculation is usually time-consuming, they are usually done for long-term planning over a 10-year horizon, as is the case for the Overall DSM Plan, where the targets in terms of energy or demand are relatively high. For specific options or programs involving smaller potential savings, shortcuts have been developed so analysts can calculate avoided costs without re-optimizing the resource mix each time. Generic approaches, such as the Peaker method, the Next Plant approach or the Proxy Unit approach, must be used with care, with a full knowledge of their built-in biases and limitations.
Achievable potential helps determine realistic targets for the DSM savings a utility can hope to achieve through DSM programs in each market segment over successive time periods. It corresponds to the aggregate impacts of economically attractive measures, with their corresponding customer participation rates factored in. Utilities can estimate realistic customer participation rates by taking into account:

- The opportunities and barriers that exist in the market. As indicated in the first part of this Manual, the most common barriers to DSM are often related to market imperfections: energy prices set below market level or below the marginal cost of electricity generation/transmission/distribution, the lack of competitiveness or deficiencies observed in the DSM industry supplying energy-efficient equipment and services, and the lack of technical information, knowledge and incentives that would allow customers to make decisions favorable to DSM.

- The likely effect of the marketing strategy (or the optimal combination of marketing tools) and financial incentives the utility adopts to promote its DSM programs.

**Preliminary Estimates of Customer Participation Rates**

Preliminary customer participation rates can be estimated using primary and secondary data sources. Primary sources include results obtained from the utility’s pilot programs, or full-scale programs already implemented, and results from analyses of the attitudinal and behavioral characteristics of the utility’s customers (focus groups and surveys). Secondary data can be found in the results obtained by utilities with similar programs that incorporate the measures under consideration.
**Pre-Selecting Clusters of Achievable DSM Measures for Consideration in the Overall DSM Plan**

The DSM impacts aggregated under achievable potential can be used to identify clusters of DSM measures that may be worth packaging into DSM programs. These measures are initially grouped into DSM program concepts. These concepts are then integrated into the Overall DSM Plan developed at the next step in the DSM process.

**Lessons from E7 Experience**

As shown in Figure 17, when all the technical, economic and marketing constraints are taken into account, a forecast of achievable potential is built, which corresponds to the maximum that can be achieved by the utility using DSM.

Some immediate conclusions can be drawn from this bar chart:

- At first sight, achievable potential may look small compared to total demand (baseline forecast). However, when compared to the demand increase over the same time horizon, achievable potential appears much more substantial.
- DSM potential impact estimates are critical in setting realistic DSM targets for individual end-use and market segments in credible Overall DSM Plans. In particular, due consideration of the dynamics associated with DSM implementation in the marketplace will greatly improve the credibility of the projected impact of possible programs.
- Technical potential is built up year after year. It results from the cumulative sum of temporary potentials that arise each year and the permanent potential in existing building stock.
- Achievable potential is a subset of technical and economic potential. Once economic constraints and marketing considerations are taken into account, the achievable potential presents a more realistic target for a utility to pursue.
- It is always easier to implement new projects than to correct the impact of previous, less energy-efficient initiatives in existing building stock; lost opportunities are too expensive and should be dealt with at the outset.
- In E7 countries, DSM potentials are very significant. In situations of an imbalance in the supply-demand equilibrium, avoided costs may lead to quite substantial estimates of DSM potentials.
- Working with incomplete data is better than not estimating potentials at all.
- Estimates of potential impacts can change over time. Periodic revisions are required through continuous monitoring of key market dynamics and industry supply factors.
OVERALL DSM PLAN

INTRODUCTION

As a third step in the DSM process, utilities prepare a multi-purpose wrap-up document called the Overall DSM Plan. In simple terms, the Overall DSM Plan states, for various audiences:

- **WHY** the utility will carry out DSM activities over a predetermined planning period
- **WHAT** types of DSM activities will be implemented
- **WHICH OBJECTIVES** in specific markets are to be achieved
- **WHAT** the ENVIRONMENT’s characteristics are (energy supply-demand balance, market receptiveness, presence of allies, barriers or opportunities)
- **HOW** these activities will be introduced or marketed and, finally,
- **WHAT RESOURCES** (financial and human resources, internal or external to the utility) are required.

This section introduces the rationale for, and the content of the Overall DSM Plan, as well as the criteria and tests used by E7 utilities to select and prioritize the DSM measures and their respective marketing in target markets included in the Overall DSM Plan. The section concludes with the type of financial and human resources that need to be considered and secured through various sources to implement the Overall DSM Plan.

RATIONALE FOR PREPARING OVERALL DSM PLANS

The planning phase of the DSM process is completed when utilities produce a multi-year Overall DSM Plan. According to E7 DSM experience, the plan is used:

- as a decision-making tool that provides the utility’s corporate management and the regulatory authorities with a justification (i.e., the rationale and key issues) for undertaking DSM, and thus for securing overall DSM budget approval from both internal and external funding sources over successive periods;
- as a communication tool that provides all parties involved in the DSM effort with a coherent vision of the entire development process, showing how the many individual tasks fit together;
- as a framework that provides individual DSM program designers with corporate guidelines as to customer equity principles and market interventions (e.g., nature of incentives, program implementation and delivery mechanisms), and approaches or marketing mix to be prioritized in targeted market segments;
- as a road map for the research, design and implementation activities needed to support viable DSM programs.
The content of an Overall DSM Plan may vary greatly from utility to utility, as do the regulatory frameworks and the relative importance of DSM in corporate strategy. Here are some elements commonly addressed in an Overall DSM Plan at this stage of the DSM planning and implementation process.

1. **Introduction**: an introductory section providing a summary statement of overall corporate objectives and DSM long-term objectives over the plan horizon.

2. **Situational analysis**: a diagnostic section that introduces the key factors in the utility’s outside environment on which the rationale for the DSM plan (or its revision) is built. The relevant information is gathered and analyzed in the first two steps of the DSM process, i.e., Load Analysis and Forecasting and DSM Potentials. This section usually comprises:
   - the baseline forecast and issues that, according to results stemming from utility load research, deserve specific attention (see Section VI – Load Analysis and Forecasting);
   - a review of prevailing market barriers and opportunities;
   - a description of both exogenous and endogenous factors that might affect the utility’s decisions over the plan horizon (see Table 21);
   - a description of the technical, economic and achievable potentials for DSM initiatives (see Section VII – DSM Potentials).

3. **Short-term DSM objectives**: where long-term DSM objectives are distributed over short-term DSM targets for each sector and sub-sector over successive 2-3-year periods (see Page 85 and Table 22).

4. **Prioritization of key DSM initiatives in key target markets**: this section introduces the priorities selected for DSM initiatives and the criteria/tests or principles that have guided the selection process (see Tables 23 and 24), as well as those that should be used in the design, monitoring and evaluation of DSM programs/initiatives.

5. **Marketing approaches**: marketing mix selected to promote DSM in target markets and the guiding principles used to segment and approach target markets (see Page 87).

6. **Process and resources**: human resources/competencies and financial/budgetary resources required to implement the overall plan. This section usually includes:
   - a critical path of the tasks to be performed both at the load and market research, program design-implementation-evaluation stages;
   - the level and organization of human and financial resources required by major tasks, major market segments and categories of DSM initiative;
   - the cost control mechanisms;
   - potential sources for financing and staffing the delivery of the Overall DSM Plan, including both internal or external/out-sourced resources and the rationale behind the resources selected (see Page 88).
SETTING SHORT-TERM DSM OBJECTIVES IN SPECIFIC MARKET SEGMENTS

Usually, an Overall DSM Plan uses and integrates the utility’s corporate objectives and DSM strategy as basic inputs. It then takes into account the DSM measures that have been screened for their aggregate potential impacts and translates these inputs into realistic short-term DSM objectives for specific segments. The result is a list of DSM initiatives and/or programs for major markets such as residential, industrial and tertiary markets (commercial and institutional sectors), whose likely receptiveness to DSM and contribution to load shape objectives have been carefully analyzed through market and load research and analysis.

Short-term DSM targets are set over successive 2-3-year time periods. The Overall DSM Plan usually outlines the types, time schedules and budgets for the DSM initiatives or programs and for all other complementary activities that may be planned, such as load research and R&D activities. Traditionally, utilities establish key criteria for setting appropriate short-term targets for their DSM initiatives. These criteria are clearly spelled out in the plan.

### TABLE 22

<table>
<thead>
<tr>
<th>CRITERIA FOR SETTING SHORT-TERM TARGETS FOR DSM INITIATIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Specific positioning of utility-generated DSM initiatives relative to government agency and free market involvement in DSM delivery and financing</td>
</tr>
<tr>
<td>❑ Utility’s rationale behind its selection of the specific economic tests used to screen and assess the detailed cost-effectiveness of DSM programs</td>
</tr>
<tr>
<td>❑ Utility’s decisions to ensure equity across customer classes and to determine customer eligibility</td>
</tr>
<tr>
<td>❑ Utility’s expected return on investment</td>
</tr>
<tr>
<td>❑ Utility’s perspective on environmental issues</td>
</tr>
<tr>
<td>❑ Utility’s secondary objectives such as market transformation, regional economic development and job creation</td>
</tr>
</tbody>
</table>
The economic impact or cost-effectiveness of DSM initiatives or programs is progressively assessed throughout the DSM process using increasingly detailed tools that represent different perspectives. Since DSM activities tend to affect different segments of society differently, the assessment of their relative cost-effectiveness has led to some controversy. Cost-effectiveness analyses provide both an indication of whether an initiative or program is “worthwhile” and for whom. Five tests are usually considered in DSM cost-effectiveness analysis “standard practice”: Participant test, Total Resource Cost test (TRC), Ratepayer Impact Measure (RIM) test, Utility Cost test and the Societal test.

Table 23 summarizes the perspective considered for each test and the implicit objectives pursued. In Table 24, the type of benefits and costs considered are listed for each test. The Overall DSM Plan usually includes a list of the tests used and the rationale behind their selection. It is important to remember that programs that are not cost-effective may be included in a portfolio of DSM programs on occasion. These are for reasons of equity (e.g., low-income programs), to create a more attractive portfolio (by responding to specific customer needs or requests), or to ensure the competitive positioning of the utility in open markets.

### TABLE 23

<table>
<thead>
<tr>
<th>COST-EFFECTIVENESS TEST</th>
<th>PERSPECTIVE CONSIDERED</th>
<th>CONCERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARTICIPANT TEST</td>
<td>Typical customers participating in specific programs or initiatives</td>
<td>Is the program worthwhile for the average participant?</td>
</tr>
<tr>
<td>TOTAL RESOURCE COST TEST</td>
<td>Customers</td>
<td>How does the program impact the cost of electricity?</td>
</tr>
<tr>
<td>RATE IMPACT MEASURE TEST</td>
<td>Non-participating customers</td>
<td>Will the program affect average rate levels?</td>
</tr>
<tr>
<td>UTILITY COST TEST</td>
<td>Electric utility revenues</td>
<td>Does the program impact the utility’s revenues?</td>
</tr>
<tr>
<td>SOCIETAL TEST</td>
<td>Citizens</td>
<td>All things being equal, does the program represent a societal gain or loss</td>
</tr>
</tbody>
</table>

**Prioritizing DSM Initiatives and Programs: Tests and Perspectives**

The economic impact or cost-effectiveness of DSM initiatives or programs is progressively assessed throughout the DSM process using increasingly detailed tools that represent different perspectives. Since DSM activities tend to affect different segments of society differently, the assessment of their relative cost-effectiveness has led to some controversy. Cost-effectiveness analyses provide both an indication of whether an initiative or program is “worthwhile” and for whom. Five tests are usually considered in DSM cost-effectiveness analysis “standard practice”: Participant test, Total Resource Cost test (TRC), Ratepayer Impact Measure (RIM) test, Utility Cost test and the Societal test.

### SELECTING THE RIGHT TEST TO PRIORITIZE DSM MEASURES

It is important to determine at the outset of the DSM process what rules will be followed in selecting the economic criteria and tests used by the utility to screen, plan, design and then evaluate the various DSM initiatives that will ultimately be integrated into a diversified portfolio of DSM programs. According to E7 experience, there is no right or wrong, nor is there a unique way of going about this selection. Each test represents a different point of view and brings into play different efficiency and equity considerations that cannot be ignored.

As a rule of thumb, E7 members tend to use neither the Total Resource Cost test nor the Rate Impact Measure test...
in isolation. The selection of DSM programs or initiatives requires using both tests since DSM programs always need to address the dual goals of efficiency and equity.

The following procedure for selecting DSM programs could be considered:

1. eliminate all programs that do not pass the TRC test;
2. implement all programs that pass the RIM test;
3. redesign the remaining programs that pass the TRC test but fail the RIM test to minimize their impact on non-participants;
4. deal with the remaining programs in two ways: as a program redesign or as a regulatory policy issue.

This procedure basically proposes that all programs which do not pass the TRC test should be eliminated, since they have been shown to be more expensive than the supply-side alternative. All programs that pass the RIM test should be implemented, since they have shown themselves to be cheaper than the supply-side alternative and benefit all customers, whether they participate in the program or not, through rate reductions.

### Selecting the Appropriate Marketing Mix for Major Markets

The appropriate marketing mix for each major target market is the optimal number and combination of DSM activities, in

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**TABLE 24**

**Benefits and Costs Considered in Individual Cost-Effectiveness Tests**

<table>
<thead>
<tr>
<th>Cost-Effectiveness Test</th>
<th>Benefits</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Participant Test</strong></td>
<td>❑ Bill reductions&lt;br&gt;❑ Avoided appliance costs (relevant to fuel-switching programs)&lt;br&gt;❑ Customer incentives&lt;br&gt;❑ Tax credits</td>
<td>❑ Bill increases&lt;br&gt;❑ Program costs paid by participants&lt;br&gt;❑ Participation charges</td>
</tr>
<tr>
<td><strong>Total Resource Cost Test</strong></td>
<td>❑ Avoided energy and capacity costs&lt;br&gt;❑ Avoided appliance costs (relevant to fuel-switching programs)&lt;br&gt;❑ Tax credits</td>
<td>❑ Energy and capacity costs&lt;br&gt;❑ Program costs paid by the utility and participants</td>
</tr>
<tr>
<td><strong>Rate Impact Measure Test</strong></td>
<td>❑ Avoided energy and capacity costs&lt;br&gt;❑ Revenue gains&lt;br&gt;❑ Participation charges</td>
<td>❑ Energy and capacity costs&lt;br&gt;❑ Revenue losses&lt;br&gt;❑ Customer incentives&lt;br&gt;❑ Program costs paid by the utility</td>
</tr>
<tr>
<td><strong>Utility Cost Test</strong></td>
<td>❑ Avoided energy and capacity costs&lt;br&gt;❑ Participation charges</td>
<td>❑ Energy and capacity costs&lt;br&gt;❑ Customer incentives&lt;br&gt;❑ Program costs paid by the utility</td>
</tr>
<tr>
<td><strong>Societal Test</strong></td>
<td>❑ Avoided energy and capacity costs&lt;br&gt;❑ Avoided appliance costs (relevant for fuel-switching programs)&lt;br&gt;❑ External benefits (environmental, employment, etc.)</td>
<td>❑ Energy and capacity costs&lt;br&gt;❑ Program costs paid by the utility and participants&lt;br&gt;❑ External costs</td>
</tr>
</tbody>
</table>

addition to initiatives and programs, to be implemented in each major market or market segment:

- publicity, promotion, information to increase DSM awareness;
- support mechanisms, including training and R&D assistance to induce and motivate DSM-oriented business practices within the community of DSM intermediaries;
- rate-scheduling mechanisms to send appropriate cost messages and support innovative and more flexible or adaptable rate structures; and
- other financial incentives (rebates, etc.).

According to E7 experience, such marketing mixes will be specific to each consumption sector (residential, industrial, or tertiary) and each country. In countries where energy demand is growing rapidly and construction flourishing, major opportunities will stem from improved codes and standards and direct incentives aimed at new construction. In countries where economic growth has stabilized or is stabilizing, DSM potentials in the existing building stock will be tapped through well-designed awareness-raising mechanisms. In all cases, the prevalent apathy of major players, such as architects or engineers, will need to be addressed through support mechanisms and through setting up competitive pressures around DSM performance.

The Overall DSM Plan usually includes the rationale and principles to be used in selecting the specific marketing mix that will be the focus when specific interventions are further refined at the design and implementation stages of the DSM process. Factors that usually contribute to selecting marketing mixes are related to the service territory supply-demand context: short-term energy surplus or deficit, financial status of DSM promoters, the relative capacity of DSM supply and the flexibility desired. It is therefore expected that the marketing mixes selected will evolve over a predetermined sequence of stages and that their effects will be incremental and complementary over the plan period.

As a group, E7 members have learned that an optimum marketing mix is best achieved when:

- all categories of market interventions are used strategically;
- the marketing mix is continuously adjusted to evolving situations;
- the marketing mix is closely related to customer needs, where customer decision making is fully understood by utilities through close and continuous interaction with decision-makers;
- success stories and experience from abroad are drawn upon extensively;
- economic methods prevail in the selection process.

### Financial and Human Resources Required for Overall DSM

The Overall DSM Plan generally includes the global budgets (costs) associated with the overall DSM portfolio in target markets, as well as the global impacts. It highlights the utility's overall needs for financial and human resources (utility staffing and/or out-sourcing of expertise). Financial resources may be needed for a diagnosis of the above-mentioned exogenous and endogenous factors:

- for upstream market research and load analysis;
- for developing trade allies;
- for assessing the availability of DSM measures;
- for performance and/or cost data collection;
- for program design activities;
- for the selection, implementation and evaluation of pilot DSM programs;
- for full-scale program implementation; and
- for measuring and evaluating the energy, market, and process impacts.

### Potential Sources for Financing Overall DSM Plans

The Overall DSM Plan describes the options for financing the above-mentioned activities, the sources selected and the rationale behind that selection. Among the primary sources of financing are:

- internal financing from the utility’s rate base;
system benefit charges or surcharges (per kWh, per customer, or as a percentage of the total customer bill) that could be recommended by regulatory authorities;

- national or international financing institutions whose economic mission and financing criteria include the development of structured energy efficiency programs and market transformation strategies.

### Need for Periodic Revisions to the Overall DSM Plan

To keep the plan responsive to the needs of the present, a dynamic process is usually put in place to regularly update the plan (e.g., every 3–5 years). The monitoring practices developed by utilities to track dsm impacts play an important part in this dynamic process and provide the information needed for plan revisions and updates. Plan revisions are usually done:

- at the end of the current Overall DSM Plan’s time horizon;
- when changes occur in corporate and/or dsm objectives, e.g., changes in electricity supply-demand patterns and balance, associated changes with marginal costs, changes in corporate competitive positioning in specific markets, changes in the regulatory framework and demands on the utility, etc.;
- when over- or under-performance of specific dsm programs or combinations of programs is observed in terms of their impact (energy, economic), their process efficacy, or their influence on markets;
- when changes occur in market barriers or opportunities that the plan takes into account, e.g., changes in the interplay, capacities or actions of trade allies or other dsm promoters, technological breakthroughs that may change the relative attractiveness of new dsm measures, and advances in market transformation.

It is therefore expected that those responsible for preparing the first or revised versions of an Overall DSM Plan will develop and maintain various mechanisms for gathering information and analyzing competitive technology, market and regulatory intelligence, in order to keep abreast of evolution in the environment that may have an impact on the plan.

### Lessons from E7 Experience

The Overall DSM Plan is fundamental to the global dsm process.

- The Overall Plan is the focal point or basic reference for corporate decision-makers, regulatory authorities, the utility’s trade allies, and program designers when considering the legitimacy and orientations the utility wishes to imprint upon dsm.
- It helps prioritize targets, determine the marketing mix and orientations of initiatives or programs in each major target market, helps quantify energy savings and global costs, serves as the basis for corporate commitment and dsm vision and so forms part of the overall corporate business plan and, finally, it serves as a short-term action plan.
- The nature of the Overall DSM Plan is bound to change over time as many endogenous and exogenous factors evolve.
- Utilities have to periodically review the principles and objectives selected in previous plans.
- The scope and comprehensiveness of dsm initiatives included in the Overall DSM Plan at any given moment are intimately linked to the breadth of understanding the utility has developed of the dynamics of the markets that it wants to transform or align to the social and corporate objectives being pursued.
- In regions where such understanding is just starting to be developed, the Overall DSM Plan will be limited in scope - a pilot project for instance - and will mostly be composed of the market and load research activities needed to support more refined and extended editions of the plan in the future.

E7 Meeting
INTRODUCTION

Program design is the fourth step in the DSM process. Its objective is to group cost-effective DSM measures developed in the DSM planning process into programs focused on specific target markets, generally at the end-use level. Individual DSM programs can be defined as follows: well-organized combinations of service packages and financial incentives supported by well-thought-out delivery and promotional activities that address the identified needs and market barriers of specific market segments.

Effective program design is based on a solid understanding of both customers and markets. By addressing customer needs and market barriers, well-designed programs help utilities generate desired load shape and energy impacts (strategic conservation or load management), ensure program cost-effectiveness (sustain high participation rates while minimizing administrative costs or free ridership) and reinforce customer relations.

This section describes the six major components of a typical program designer’s mandate:

- designing the program features: the service package; financial incentives; program delivery and promotion or marketing; as well as approaches to forging strategic partnerships among consumers, utilities, the government and trade allies that are necessary for the long-term success of potential DSM programs and the desired market transformation;
- translating the timetable for implementation into a list of concrete actions;
- refining the estimates of program impacts and cost-effectiveness;
- defining the program evaluation plan, i.e., objectives, parameters to be measured, resources, data tracking systems, and schedule to be followed to monitor program impacts, transactions and administrative performance.

This sequence of steps should not be seen as linear, but rather as a constantly evolving process that is revisited whenever new and relevant information is made available to the utility through the feedback loops. According to E7 experience, the time and resources spent at the program design stage can make a real difference between a successful program that is rewarding for both customers and the utility and a disappointing performance in the field. Other lessons learned from E7 experience are presented at the end of the section.
At the outset of the program design phase, program designers are asked to develop a clear and detailed understanding of the goals and objectives established by corporate and DSM planners and to refine these in accordance with a much more detailed understanding of customers and trade allies.

Much of the Overall DSM Plan revolves around providing individual program designers with an appropriate understanding of corporate and DSM goals and objectives:

- issues regarding institutional constraints and obligations, as well as corporate competitive positioning in key target markets; and,
- explaining the consistent and general approach the utility’s corporate planners want program designers to consider when designing, marketing, delivering and assessing the cost-effectiveness of individual DSM programs.

In the absence of any structured Overall DSM Plan, program designers have to make sure that clearly identified goals and objectives are set in order to establish targets against which the detailed program results will be assessed later on in the process.

Table 25 shows examples of issues or questions that have to be addressed prior to or at the outset of the program design.

### Table 25

**Examples of Issues Addressed at the Outset of Program Design**

<table>
<thead>
<tr>
<th>Issues Pertaining to</th>
<th>Barriers</th>
</tr>
</thead>
</table>
| **Program objectives** | Are they related to learning more about market response to DSM programs rather than reaching precise targets in terms of kWh or kW?  
Are there specific regulatory guidelines from utility commissions or other bodies to be followed? |
| **Market segmentation** | What group or sub-group of customers will be targeted?  
Should the utility, for reasons of fairness, consider all market segments? |
| **Program service package and associated delivery mechanisms** | Is there a priority list of targeted technologies?  
Will financial assistance be offered?  
What form and level of financial assistance should be considered?  
What specific trade allies or other community groups must be brought in? |
| **Program managerial and administrative systems** | Will the program be implemented in full or rolled out in stages?  
Who will market the program to the customer? (Internal resources versus outsourcing) |
| **Program resources and schedule** | How many resources will be allocated to the individual programs?  
What is the time frame in implementing the program? |
| **Program evaluation** | What results and process will be measured, and how? |

According to E7 experience, successful DSM programs are those that closely match their marketing approach as well as the end-uses and technologies selected for their greatest load impact potential on the needs of specific customer groups. A match is usually obtained when program designers perform detailed market research and carry out the following four tasks:
- **Select technologies** – technology selection is refined in order to balance DSM marketing efforts and logistical constraints.

- **Understand the customers** – barriers to customer acceptance and customer buying are identified for each market segment.

- **Devise market segmentation** – bases and criteria for identifying market segments are determined and profiles of the various segments developed.

- **Match targeted technologies with market segments** – the appropriate mix (including clear messages to potential users) is developed for each selected target segment.

### SELECT SPECIFIC TECHNOLOGIES

At this stage, the program designer usually knows the type of technologies proposed for the program. However, it is important to refine the technology selection in order to take into consideration market constraints and program objectives. When selecting technologies (and associated equipment) with the greatest load impact potential, a designer must balance various technology- and market-related eligibility criteria that might work in opposite directions.

For instance, a designer may wish to select a small number of the most efficient products instead of offering a broad menu of products with broader customer choice: the increased participation usually associated with a broader choice is counter-balanced by increased free ridership, decreased per-customer impact and eroded cost-effectiveness.

Table 26 illustrates the type of questions program designers have to answer at this stage.

<table>
<thead>
<tr>
<th>DSM Technology Eligibility Criteria</th>
<th>Related Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nature of Criteria</strong></td>
<td><strong>Specific Criteria</strong></td>
</tr>
<tr>
<td><strong>Technology-related characteristics</strong></td>
<td>☐ Energy performance or energy efficiency</td>
</tr>
<tr>
<td></td>
<td>☐ Reliability of the technology/associated equipment</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Technology supply characteristics</strong></td>
<td>☐ Availability of the specific technology</td>
</tr>
<tr>
<td></td>
<td>☐ Cost of products</td>
</tr>
<tr>
<td></td>
<td>☐ Market awareness and usage</td>
</tr>
<tr>
<td></td>
<td>☐ Free ridership potential</td>
</tr>
<tr>
<td></td>
<td>☐ Incentives needed</td>
</tr>
<tr>
<td></td>
<td>☐ Are customers and trade allies sufficiently familiar with the eligible products?</td>
</tr>
<tr>
<td></td>
<td>☐ What are the current saturation estimates for a particular class of equipment?</td>
</tr>
<tr>
<td></td>
<td>☐ What are the penetration estimates for eligible models?</td>
</tr>
<tr>
<td></td>
<td>☐ Are eligible products low-cost products that have significant pre-program penetration?</td>
</tr>
<tr>
<td></td>
<td>☐ What is the potential level of incentive needed to sell the eligible products?</td>
</tr>
</tbody>
</table>
**Understand the Customer**

According to E7 experience, the success or failure of a program is directly related to the understanding a utility has developed of how customers think and behave with respect to DSM technologies. To obtain this information, program designers extensively use market research and surveys on customer needs that, when combined to serve multiple purposes, can be designed to be cost-effective and to minimize bothering customers.

**Barriers to Customer Acceptance**

First and foremost, the specific barriers to customer acceptance of the DSM options have to be clearly identified for the targeted market segments. Typical barriers can be clustered into information deficiencies and misperceptions; stringent investment criteria; aversion to different types of risks; and lack of customer choice.

If any of these barriers qualify as factors keeping customers from adopting a product or a technology, utilities can design the program to overcome the barriers. Examples of typical barriers and possible program design solutions selected from E7 experience are listed in Table 27.

**Customer Buying Process, Preferences and Behavior**

Preferences and behavior relative to energy purchases stem from customers’ experience and values regarding time, resources, environment, convenience, comfort, safety, etc. Factors such as preferences and behavior may be just as important as income and other demographic characteristics in predicting DSM program participation. Market research is needed to

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### Table 27

**Examples of Barriers to Customer Acceptance and Possible Solutions**

<table>
<thead>
<tr>
<th>Category of Barriers</th>
<th>Example of Barriers</th>
<th>Possible Design Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information-related</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Lack of knowledge about a product or a technology</td>
<td>□ Printed materials informing customers and trade allies about the benefits and features of the products (mostly for residential customers)</td>
</tr>
<tr>
<td></td>
<td>□ Little interest in learning about the product</td>
<td>□ Special promotion or advertising to direct customers’ attention to the product</td>
</tr>
<tr>
<td></td>
<td>□ Lack of knowledge about the benefits of a particular technology</td>
<td>□ For large preferred customers, meetings with customer service representatives to discuss the utility’s offerings</td>
</tr>
<tr>
<td></td>
<td>□ Lack of a proven track record</td>
<td>□ Laboratory tests and validations</td>
</tr>
<tr>
<td><strong>Aversion to Risk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Perceived risk in adopting a technology</td>
<td>□ Free trial demonstration</td>
</tr>
<tr>
<td></td>
<td>□ Perceived risk of decreased comfort or convenience</td>
<td>□ Case study materials on successful applications elsewhere</td>
</tr>
<tr>
<td></td>
<td>□ Perceived risk of reduced productivity</td>
<td>□ Training and education sessions for customers and trade allies</td>
</tr>
<tr>
<td><strong>Stringent Investment Criteria</strong></td>
<td></td>
<td>□ Case study materials on successful applications elsewhere</td>
</tr>
<tr>
<td></td>
<td>□ High up-front cost or reluctance to pay a premium for efficient products</td>
<td>□ Direct incentives structured to provide an effective payback or internal rate of return that meets customer criteria</td>
</tr>
<tr>
<td></td>
<td>□ Customer requirements of payback period or internal rate of return that eligible products cannot meet mostly commercial and industrial customers</td>
<td></td>
</tr>
<tr>
<td><strong>Lack of Customer Choice</strong></td>
<td></td>
<td>□ Program designed to include customized equipment options and incentives</td>
</tr>
<tr>
<td></td>
<td>□ Customers’ brand preferences, specialized equipment needs, buying practices</td>
<td>□ Product qualifying criteria rather than a specific list used to determine product eligibility</td>
</tr>
</tbody>
</table>
DEMAND-SIDE MANAGEMENT
THE E7 EXPERIENCE

Table 28 illustrates the type of marketing mechanisms used by utilities to address both customer preferences, behavior and decision stages.

**Devise Market Segmentation**

Market segmentation refers to the division of a market or rate categories into smaller groups with similar characteristics. These characteristics are established in such a way as to foster DSM penetration and ease program implementation. The benefits of market segmentation for utility DSM program designers are threefold: better achievement of load shape and conservation objectives, greater cost-effectiveness, and better market intelligence. Market segmentation for DSM purposes is a far more extensive activity and requires far more resources and time than the traditional market segmentation done by utilities for their marketing efforts.

**TABLE 28**

**Matching Marketing Mechanisms to Customer Preferences and Decision Stages**

<table>
<thead>
<tr>
<th>Decision Stages</th>
<th>Examples of Program Marketing Mechanisms Considered at DSM Program Design Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness and Problem Recognition</td>
<td>❑ To create basic awareness through introductory information channeled via bill inserts, customer newsletters, brochures, radio and TV advertising, public exhibits and cooperative advertising with trade allies</td>
</tr>
<tr>
<td>Understanding the Applications</td>
<td>❑ Visual media (illustrated literature), hands-on demonstrations, personal sales presentations and TV or video messages are known to be effective mechanisms in helping customers learn about how they might put the technology or program to work for their own use</td>
</tr>
<tr>
<td>Evaluating Alternatives and Their Relative Merits</td>
<td>❑ Personalized services are typically used to assist customers in weighing the benefits and costs, e.g., facility surveys or calls from account representatives</td>
</tr>
<tr>
<td></td>
<td>❑ For many programs, designers may think of offering direct incentives and alternative rate structures to reduce risk perceptions that are often linked to the amount of money at stake</td>
</tr>
<tr>
<td>Motivation</td>
<td>❑ Customers who do not participate as soon as they hear about a DSM program may be convinced to respond later through personal sales presentations, peer influence, or detailed descriptions of the benefits of the program’s financial incentives</td>
</tr>
<tr>
<td>Purchase Decision or Adoption</td>
<td>❑ Convenient methods for assisting participant enrollment include phone contact via telemarketing, postage-paid return cards with check-off boxes, point-of-purchase rebate forms and bill envelope tear-offs</td>
</tr>
<tr>
<td></td>
<td>❑ Easy access and clear labeling of high-efficiency products on shelves at retail outlets</td>
</tr>
<tr>
<td>Post-purchase Behavior</td>
<td>❑ As customers accept a utility’s program and the utility increases its market share, word of mouth becomes an increasingly important way of raising customer awareness and interest</td>
</tr>
</tbody>
</table>

determine the dominant preferences and behavior, together with buyer readiness in targeted market segments. Program designers use market research to select or adjust the DSM program’s marketing mechanisms to fit the situation, such as direct customer contact, advertising and promotion, trade ally cooperation or customer education.

Electronic thermostat
Customers are numerous, widely scattered across the service territory, and very different in their buying habits and program participation requirements. Moreover, they own and operate a variety of equipment and buildings with characteristics that have specific impacts on load profile and energy consumption and therefore on DSM potential. More refined methods of segmentation based on customer needs and characteristics are thus required to customize DSM program features. Fine segmentation allows program designers to target equipment types, incentives and delivery approaches to specific audiences, and so limit program uncertainty and costs.

**Approaches to Market Segmentation for DSM Program Design**

Segmentation variables or criteria used for designing DSM programs relate closely to:

- the energy use and load shape characteristics of the end-use and building types found in the market, including penetration of specific equipment, building age, size and construction type (e.g., multiplex versus single-family); this type of data is useful in understanding the physical impact of DSM options on customers;

- customer demographics or corporate economic profiles as they relate to residential customers – age, family size, income and ownership status, or to corporate customers – building usage or functions (office, school, retail) and ownership characteristics; this type of data is particularly useful in addressing, for example, the likely problems with split-incentives when buildings are not owner-occupied;

- customers’ attitudinal and organizational characteristics such as:
  - customers’ attitude toward the utility, risk, value, comfort, convenience, choice, and reliability;
  - specific investment criteria and other variables pertaining to customers’ decision-making style (benefits sought, user status, etc.);
  - perception of information source’s credibility.

According to E7 experience, the hierarchy and the combination of segmentation parameters are specific to each utility’s market structure and dynamics. They are usually based on results from market research, including analyses of statistics, surveys and focus groups with customer samples. From such experience, DSM program designers have learned the benefits of doing more systematic market segmentation and program targeting earlier on in the design process, using sound market research.

**Match Targeted Technologies to Market Segments**

The specific technologies selected as having the greatest load impact need to be matched to specific customer groups or market segments. Market and load research and other relevant data enable the program designer to identify which categories of customer groups have the characteristics (such as contribution to peak system demand or types of equipment) that are most suitable for the technology options the program is to promote. In other words, at this stage, program designers determine which type of buildings and customers offer the greatest opportunities for the program.

In so doing, designers have to take into consideration both building types and customer characteristics. Some building characteristics may offer greater opportunities, but when the type of customers occupying the buildings is factored in, these characteristics may not translate into high participation levels.

For instance, in one E7 utility, the promotion of electronic thermostats for electric baseboard heating systems was limited in buildings that were not owner-occupied. Since the owners are not the ones who benefit from the savings – renters often pay the heating bill – they do not want to invest in installing new equipment and accessories. Wherever split benefits exist, program designers should differentiate approaches adopted for owner-occupied versus other building segments.

As is clear from that example, matching technologies to market segments leads directly to designing a service package that overcomes barriers to customer participation. In buildings where DSM potentials are important but barriers to participation potentially high, program designers should still try to design a package to exploit that DSM opportunity. Their creativity will be put to work in designing incentives and marketing techniques that will succeed in lowering those barriers.
Design the Program Features

A DSM program usually comprises four key components: the service package offered to customers in specific market segments, associated financial incentives, program delivery mechanisms, and promotion of the program to targeted customers and trade allies. Program designers are asked to assemble the appropriate combinations of these components to achieve program objectives. It is at this stage that designers decide whether or not to introduce pilot programs rather than immediately implement large-scale programs. It is also at this stage, if not already decided when the Overall DSM Plan was determined, that the role and level of integration of trade allies in program delivery has to be resolved.

Design the Service Package

The service package is the core of a DSM program. It is customized to overcome barriers to customer participation in very specific market segments. Simple programs may offer only a single service, such as energy audits combined with a financial incentive, whereas complex programs offer more sophisticated menus of services. Typical examples of program services are:

- Facility energy surveys or energy audits that provide baseline information on customers’ building equipment, usage, load shapes and DSM potential, as well as opportunities for the utility to improve customer relations.
- Education and training that introduce customers and trade allies to a new technology or the program through one-day workshops, or extended courses for training and certification. This type of service not only stimulates market awareness but assists in bringing about long-term market transformation.
- Design assistance, such as direct technical services to building owners and design firms, or economic analysis services that highlight DSM technology benefits.
- Installation assistance such as a list of certified vendors or installation contractors.
- Turn-key direct installation services where utility personnel (or utility contractors) handle the entire transaction for the customer.
- Financing assistance, such as arrangements for traditional customer loans, below-market interest rates, or flexible repayment terms.
- Special rate schemes.
- Comprehensive services from first inquiry through installation, provision of performance guarantees and financing by the utility.
- Performance contracting where an energy service company, designated as an ESCO, typically performs the full array of services from energy audit, analysis, technology selection, installation, financing and maintenance and is paid back through share-saving arrangements over medium- to long-term periods. With this type of service, customers do not bear the up-front costs; using various formulas, downstream payments are covered by utility bill savings. In some E7 countries, some utilities have decided to create their own ESCOs as separate subsidiaries.

Design the Financial Incentives

Direct incentives are used by utilities to either encourage or increase customer participation. These incentives reduce the cash outlay required from customers for equipment purchases. In the late ’80s, the determination of DSM financial incentives was considered the most important aspect of program design. However, according to E7 experience, this should not always be the case. As utility deregulation unfolds, other means should be proposed, in conjunction with, or in
replacement of financial incentives to bring about market transformation.

There are two basic steps in properly designing financial incentives: determining the incentive level within a utility’s acceptable range and defining the incentive structure.

- **Determine the Incentive Level.** The incentive level must be optimized so as to be high enough to motivate customers in targeted market segments (i.e., to meet their financial performance thresholds as indicated by market research) and low enough to stay within the utility’s economic constraints (i.e., within the boundary set by the utility’s avoided costs or the utility’s resource value for the incentive).

- **Define the Incentive Structure.** Categories of direct incentives include:
  - **Cash grants** – usually a one-time payment to customers who adopt a specific DSM option. The amounts are sometimes tied to the expected energy or demand savings. They are offered to encourage the purchase of energy-efficient equipment or devices, or to hire qualified consultants who will then advise customers on further implementation.
  - **Rebates** – usually single payments by utilities to customers for purchasing and installing a specific DSM equipment, either as an original or as a replacement for a less efficient device. Similar to cash grants, rebate amounts are usually set according to utility benefits.
  - **Billing credits** – applied to customers’ bills in exchange for the purchase and installation of a particular option.
  - **Low-or no-interest financing** – used by utilities to promote the installation of DSM options with a high up-front cost.

**DESIGN PROGRAM DELIVERY MECHANISMS**

Program designers must then decide which distribution channels to use to deliver the program to targeted customers – delivery mechanisms can be seen as the “how” of the program, whereas services refer to the “what” of the program. According to E7 experience, program delivery mechanisms are dictated by program features such as eligible technologies, eligible customers and incentive structure.

Delivery mechanisms typically relate to:

- **Ensuring equipment availability** – manufacturers and local vendors must be able to supply sufficient eligible products in a time frame that meets program requirements.
- **Developing services to support program delivery** – program designers have to decide upon the timing, location and staffing for training, design assistance, energy auditing and other services. Support materials have to be developed and the delivery of service packages coordinated, especially the most complex ones offered in the commercial and industrial sectors.
- **Maximizing cooperation with trade allies** – for example, engineering consultants, contractors, wholesalers, retailers, home builders, local chapters of professional societies, trade groups and associations may play key roles in marketing, installation and quality control. According to E7 experience, trade allies contribute significantly to the success of DSM programs; they have strong influence on the customers’ choice of fuel, type of equipment and device efficiency, thus contributing to significant reductions in a utility’s marketing costs. Trade allies are particularly valuable partners in commercial and industrial programs aimed at the replacement market. Where required, appropriate incentives to trade allies may prove valuable in mobilizing key levers to DSM program participation, which is the cornerstone of long-term market transformation to DSM.
DESIGN PROGRAM PROMOTION

Program designers may choose from a wide range of methods to influence customer adoption of the utility’s DSM programs and initiatives. The most common promotional methods are advertising, customer education, and direct customer contact.

PROGRAM ADVERTISING

Advertising media appropriate for promoting DSM programs and their benefits include magazines and newspapers; radio and television; outdoor displays; direct mail; catalogs, directories, and circulars. Mass media are particularly useful in enabling large and instant access to many potential clients at once.

Advertising is particularly useful in problem recognition and in the search-for-more-information stage of buyer readiness. Advertising programs can make customers aware of the programs, mitigate negative emotions and provide information to enhance knowledge.

The direct mail approach screens customers according to factors that identify candidates likely to participate in the program. Direct mail, followed by newspaper ads, is the most common advertising strategy used by utilities, whereas newspaper advertising is viewed as the least costly form of media advertising.

CUSTOMER EDUCATION (INFORMATION)

In order to increase customer awareness of the utility’s programs, most utilities need some form of customer education such as brochures, information packages, educational seminars, radio advertisements, and billing inserts.

Some of the most effective methods of providing energy advice along with promoting DSM programs are:

- **Energy audits** – particularly useful in identifying areas for reducing energy consumption. They also provide an opportunity to interact with customers and sell DSM options.
- **Energy advice** – utilities help customers analyze and choose their energy options. Such services may be offered solely through representatives or by contractors, consultants and trade allies.
- **Storefront displays** – can provide energy information on efficient appliances and devices. Some E7 members have used this method successfully and created numerous advisory centers across their service territory.
- **Workshops/seminars** – may be used to give advice on a variety of topics, including home energy conservation, energy-efficient appliances, commercial energy management, financing, use of ESCOs and DSM technologies.

DIRECT CUSTOMER CONTACT

Direct customer contact refers to face-to-face communications between the customer and a utility representative. These representatives perform one or more of the following tasks for the utility:

- **Prospecting** – representatives find and cultivate new customers who have not been enrolled in previous DSM programs.
- **Communicating** – representatives communicate information about the utility’s products and services and DSM programs.
- **Closing deals** – representatives approach, present, answer objections and close deals by signing up customers for DSM programs.
- **Information gathering** – representatives carry out market research and intelligence work and fill in call reports.
- **Servicing** – representatives provide various services to customers - consulting on their problems, providing technical assistance and advice on equipment selection, arranging financing and expediting delivery.
**Decide on Timing**

Once technologies have been specified, market segments selected and marketing methods chosen, program designers have to foresee the program implementation phase and consider the pace of implementation. Will the program be launched as a full-scale initiative or will it start with a small pilot phase and, depending on the results, gradually be transformed into a wider-scale program? Will a smaller sub-segment of the market be targeted first? What will the implementation strategy be for some geographical segments or types of customer? The risks and rewards associated with each approach need to be carefully calculated.

Program designers are then ready to integrate the items discussed above into a list of concrete actions. Program budgets and schedules should incorporate timing, staff and resource requirements from all the utility departments that will be providing program services. The full collaboration and participation of these departments is critical to the success of DSM programs.

**Assessing Program Cost-effectiveness**

Assessing the cost-effectiveness of a DSM program is the ultimate step in program design. This assessment activity should pervade the entire DSM process so that the planners and designers can progressively evaluate the impact of their decisions on the final results. However, it is at the design stage, when all important decisions have been taken, that the program designers refine their estimates of program impacts and costs, including all the parameters that may have an impact on the cost-effectiveness.

Specific program features such as budget, incentive level, eligible equipment, size of eligible customer population, participation rate, program duration and marketing resources, are examples of parameters that affect program cost-effectiveness. Once these parameters are documented, a basic economic analysis is conducted using key economic tests. However, these parameters may fluctuate when reality enters the picture. Sensitivity analyses must be conducted to assess the uncertainty of key variables.

There are several types or groups of uncertainties that need to be recognized:

- **Technical uncertainty** – arises from the lack of accurate and detailed information on the targeted applications, variability in the operational factors that characterize these applications, and the performance of proposed DSM measures.
- **Economic uncertainty** – associated with parameters such as marginal costs, rates and program costs.
- **Market uncertainty** – results from the range of potential consumer responses to DSM programs. Program participation rates (proportion of eligible customers who participate in the program) and market penetration (proportion of physical units actually replaced or sold from the entire stock or annual market sales) are key indicators to examine.
- **Persistence of DSM measures** – over time, some measures no longer produce the same reduction in savings or in the load displacement level expected. This uncertainty is very important as it could change future system planning.

**Program Evaluation Plan**

Careful planning is critical to ensure that program evaluation – the last step in the DSM process – serves the program and organization well. According to E7 experience, it is important that evaluation plans be developed as early on in the program design stage as possible, so that the resources and data needed for their implementation can be provided. Evaluation plans usually cover the following areas:

- **Objectives of the evaluation** – flow naturally from the program objectives and encompass measurements of achievements on three fronts: load and energy impacts, market impact, process effectiveness.
- **Evaluation approach** – the methods for conducting evaluation are spelled out (e.g., engineering versus statistical versus metering techniques to estimate energy savings).
- **Data collection requirements and schedule** – data and sources of data needed for analyses are specified and usually include sample sizes for direct measurements and surveys, variables to be monitored and the time periods over which
they will be measured; schedules are prepared for data collection, analysis and reporting.

- **Evaluation resources and work assignments** – a program evaluation budget is prepared and included in the overall program costs; budget estimates should take into account the expected value of the information relative to its cost. Experience reveals that the cost for evaluating full-scale DSM programs should not exceed 10% of the implementation budget.

### Lessons Learned from E7 Experience

The design of DSM programs dates back more than 20 years in E7 countries. Numerous case studies of successes and failures can be studied. Valuable knowledge and information can be drawn from this experience. While adaptation to individual environments is necessary, here are some of the lessons worth sharing with other countries.

- Even if DSM is a resource to be developed, utilities have to keep customers at the center of their interest, present a global and simple approach to address their needs, and remember that clients buy services, not electricity. Thus, DSM technologies that generate positive impacts on service quality have a better chance of being adopted. Conversely, technologies perceived as potentially detrimental to service quality will be rejected by customers.

- Utilities should seriously consider adopting a progressive approach to DSM initiatives, progressing from simple technologies and markets where the decision-making process appears less intricate to more complex technologies and decision-making structures. No matter what the approach selected, DSM marketing materials should be kept as simple as possible and designed to facilitate customer acceptance of, and participation in the program.

- The notion of equity between customer groups and even between suppliers and consultant groups is a very sensitive issue that has to be addressed carefully.

- DSM programs have to address the concerns of multiple stakeholders. Advisory bodies external to utilities – trade allies, non-governmental organizations, individual customers, outside experts and customer advisory groups – have proven to be very valuable in helping determine DSM marketing approaches as well as in preventing mistakes.

- There are benefits to adopting a holistic perspective in designing and implementing DSM. This means seeing customers as more than a collection of end-users, or targeting interventions to whole buildings, as opposed to selecting disparate individual measures. Also, the utility’s DSM should coordinate efforts with those of the multiple players involved in the delivery of energy efficiency promotion and improvement. Finally, coordination with the utility’s own departments, such as rates and marketing, is needed, for example, to develop rates that are consistent with the new products and programs.

- Pilot projects should be prioritized first before a large-scale implementation is launched. Pilot projects help understand customer reactions and behavior, and avoid problems ahead of time.

- DSM programs should be designed to take advantage of specific situations that otherwise would be considered lost opportunities for energy efficiency improvement. For instance, it is easier to reach customers at the time of decisions to purchase new appliances (in shopping malls, for example) or when new houses, commercial buildings or industrial plants are being built. This is particularly relevant for rapidly growing countries. For example, standards, labels or DSM programs should be considered for all new construction projects.

- Lastly, particular attention should be given to designing DSM programs that contribute to the progressive and long-term market transformation toward self-motivated and permanent energy-efficient behavior in the marketplace.
Program implementation is the fifth step in the DSM process. In this step, the theoretically designed programs are put to the test of customer acceptance. At the outset of the implementation phase, DSM implementation managers know from the program design phase, the objective and the plan, how the program delivery will be launched. They are asked to:

- organize the infrastructure required for program promotion and delivery as well as organize and support internal and external resources;
- set up and administer a monitoring function and administrative systems that will provide the necessary information to:
  - fine tune program implementation activities on a real-time basis;
  - gather data for evaluating the program;
- fine tune programs according to feedback provided by key participants involved in pilot programs or the launch of full-scale programs and by the monitoring systems put in place;
- review actual program results regularly against expected results;
- make adjustments to current and future programs to correct observed discrepancies or address unexpected market behavior.

These tasks are first defined and included in an action plan that assigns specific responsibilities to various groups of resources, clearly defining individual program goals within the Overall DSM Plan, together with specific implementation objectives. The plan is then implemented and the process and results monitored for follow-up action and feedback into the DSM process.

This chapter introduces in sequence the organization of the various resources required to implement and monitor DSM programs, the approach adopted to staffing and training, the logistics used in ensuring the effectiveness of the underlying delivery infrastructure, and the various management and administrative systems put in place to track and monitor DSM program delivery.

### Organization of DSM Resources

According to E7 experience, DSM programs are labor-intensive initiatives whose implementation requires a diverse set of skills, good communication and the effective management of utility staff, contractors and trade ally relationships. DSM planning and the implementation of either pilot or full-scale programs bring utilities into the retail energy service marketing business. Many utilities involved with DSM around the globe have been obliged to make adjustments to their internal functions in order to accomplish their DSM mission.
The expertise and skills used in DSM implementation and monitoring can be clustered into technical, administrative and marketing support related to the three streams of strategic indicators used in DSM evaluation: energy and load shape impacts, market impacts and process effectiveness. It is usually the responsibility of program designers and implementers to either develop and teach these skill sets within the utility or to outsource them, i.e., acquire them through the services of outside consultants and contractors.

As shown in Figure 18, the organization of DSM resources draws directly on many functions in a utility. Other functions such as public relations, metering, general services (facilities, printing and transportation), engineering and system operations (especially for load management programs) also contribute indirectly to DSM program planning, design, implementation and evaluation.

**Figure 18**

*Organization of DSM Resources*

- **DSM Program Manager**
  - **Technical Support**
    - Utility Field Representatives
    - ESCOs, Trade Allies, Contractors Coordination
    - Technical Professionals
      - Engineering analyses
      - Technical feasibility studies
      - Technology performance
      - DSM measurement & screening
      - Field training
    - Program Planners and Designers
    - Program Evaluators
  - **Marketing Support**
    - Market and Load Research
    - Marketing and Promotion
      - Raising awareness of DSM programs
    - Customer Services
      - Billing
      - Complaints
      - Program participants support
  - **Administrative Support**
    - Finance and Accounting
      - Project cost
      - Accounting incentive levels & payment methods
      - Financial expenditures
    - Procurement Technology Equipment
    - Legal Contracts with Trade Allies or Customers
    - Management and Customer Information Systems
      - Program administration
      - Customer services

Source: Adapted from Hagler & Bailey, 1996

**The DSM Organization: Staffing and Training**

**Selecting the Right Skills**

Many of the skills involved in DSM implementation are not traditionally found among utility staff. When the time comes to staff the selected DSM organization, the utility may elect to either train existing staff to develop a broad set of new skills, hire new types of staff to complement those already in place, or contract out implementation services to outside groups such as consultants or contractors. When it comes to choosing among these alternatives, utilities have to take into account a variety of considerations:
the availability of internal staff and the availability and competition for the appropriate skills in the job market;

the respective knowledge and skill sets of both internal and external resources;

the program budget, schedule and duration;

the relative time needed to perform the required training of internal or external resources;

the utility’s appreciation of the relative ability of internal and external resources to provide the expected results in a timely fashion;

the potential benefits of developing internal resources that will be used for other functions in the future;

the confidentiality required for some tasks and projects.

Utilities in E7 countries have taken both paths, either using internal staff – training existing staff or hiring new staff – or contracting out services.

OUTSOURCING

Utilities that elected to contract out portions of their DSM service delivery did it to take advantage of the flexibility it offers, to avoid the relatively long delays usually required to train internal staff, and to benefit from the higher participation rates and program penetration rates that can be expected when external resources are involved. As a consequence, many contract service companies and ESCOs have emerged to service utilities and they have become pivotal to the transformation of emerging markets in countries where they have extensively contributed their experience and expertise.

Outside labor is most effectively used when:

- a detailed analysis is done and specifications drawn up as to the types of services and capabilities external groups must possess;
- a definition of the role and results expected from outside organizations (ESCOs, trade allies, equipment suppliers and contractors) is clearly spelled out prior to their being hired for a particular DSM program;
- the selection of the best-qualified contractors is made through a bidding process.

TRAINING

Utilities that have chosen to train existing staff have typically made up skill deficiencies by providing training in the following functional areas: marketing, sales, business management, contract negotiation, industrial engineering, and account management. They designed training programs, prepared or assembled training materials, and followed strict training schedules.

The need for training differs according to the functions to be handled by various professionals in designing or delivering DSM programs. Generally, all internal and external resources contributing to a utility’s program are informed of the rationale behind the program design, the program’s attributes and objectives, as well as the relations between the various DSM programs included in the Overall DSM Plan. Customers and potential participants in DSM programs frequently address questions about utility DSM programs to anyone involved in such programs. All professionals working on any of the programs therefore need some basic training and knowledge of who to pass along the various questions to for an appropriate and timely response.

SUPPORT RESOURCES TO OPERATIONS

The success of many DSM programs hinges on the procurement of energy-efficient or load management equipment. The implementation of DSM programs is also supported by a variety of operational resources whose availability and delivery logistics have to be planned and duly coordinated. Among these support resources are:

- equipment and hardware components that need to be specified, stored, tracked for inventory control or, in some cases, installed at customers’ premises;
- facilities (office space, warehousing of equipment inventories, vehicles to transport marketing and field staff and to deliver equipment and materials);
- procedure manuals that document DSM program procedures, qualifications and other key information to serve as a reference for utility and external resources implementing DSM programs.
SECTION X
PROGRAM IMPLEMENTATION

The program implantation plan must thus ensure that the necessary market infrastructure is developed and available in an orderly and timely manner. Table 29 gives examples of key questions utilities have to answer at this stage of DSM program implementation.

<table>
<thead>
<tr>
<th>Type of Operational Support Resources</th>
<th>Questions Asked at Implementation Planning Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring and metering equipment</td>
<td>□ What type of equipment?</td>
</tr>
<tr>
<td></td>
<td>□ What specifications?</td>
</tr>
<tr>
<td></td>
<td>□ Which equipment suppliers?</td>
</tr>
<tr>
<td></td>
<td>□ How to track equipment in the field? Whose responsibility?</td>
</tr>
<tr>
<td></td>
<td>□ Who will install the equipment?</td>
</tr>
<tr>
<td></td>
<td>□ Is training required for installation?</td>
</tr>
<tr>
<td></td>
<td>□ Are there any legal liabilities as a result of installation?</td>
</tr>
<tr>
<td>Energy-saving or load management devices or components</td>
<td>□ Who will store and control inventory for devices or components? Utility or suppliers?</td>
</tr>
<tr>
<td></td>
<td>□ Who will provide quality control?</td>
</tr>
<tr>
<td></td>
<td>□ Who will install the devices? Is training required for installation?</td>
</tr>
<tr>
<td></td>
<td>□ Are there any legal liabilities as a result of installation?</td>
</tr>
</tbody>
</table>

The manual has often emphasized the importance of monitoring and feedback in the success and cost-effectiveness of DSM programs. Monitoring and tracking systems assist DSM program managers in:

□ learning how well programs are working both in terms of their physical (actual energy and market impacts) and financial (process cost-effectiveness) performance;

□ understanding patterns of participation (e.g., most responsive market segments, most popular measures being installed, characteristics of participants and non-participants) versus planning and design expectations;

□ identifying problems that warrant immediate or long-term attention;

□ determining what potential markets remain to be tapped.

E7 utilities have typically used two types of systems for monitoring and tracking DSM programs on top of the various approaches (market surveys, end-use metering, etc.) adopted to monitor program participants’ and non-participants’ behavior beyond electric meters: management systems and administrative systems.

![Steel foundry](image-url)

Steel foundry
Management Systems

E7 experience has shown that well-thought-out tracking systems allow DSM program managers to closely follow the progress of particular programs. With such systems, project managers can determine whether or not programs are on track with expected performance and adjust or improve the program to maximize benefits on a real-time basis. These systems can also be used to generate reports to senior management, program evaluators and planners, and for quality control.

Management systems are used at every step of DSM program implementation, to track key variables such as: project costs, installation costs, equipment costs, types of installation, technologies used, customer types, participant demographics, commissioning date, amount of incentives paid, amount of revenue collected, and electricity usage. Variables related to energy and load impact, such as energy savings, load reduction and displacement, or other fuel savings may also be tracked. However, the assumptions on which these savings are assessed will need to be validated during the evaluation process.

A variety of reports can thus be generated from this database showing, for example, participation rate, energy and demand savings based on different segmentations, results based on market segment or geographical breakdown, and program cost-effectiveness.

For outsourced programs, a management system that oversees the services provided by external resources is also needed. This helps utilities determine whether the external contractors or consultants have fulfilled their contractual obligations. This is particularly important in regions where the contractors and consultants are viewed as representatives of the contracting utilities.

Administrative Systems

An administrative system needs to be set up to process program applications, to ensure the smooth functioning of the whole process and the consistent treatment of client files. Experience has shown that quickly processing program applications and responding to applicants is an important ingredient in the recipe for success.

Applicants need to know whether the application has been accepted or rejected by the utility. The administrative staff therefore need to follow program eligibility rules that are clearly stated and easily understood for rapid acceptance or rejection of the application. This also applies to processing the financial incentives and rebates that may be associated with the program’s service package, or the supporting documents required with the application forms.

Typical questions asked at this stage of program monitoring are:

- If an energy-saving report is needed with the incentive application, what kind of report is suitable?
- Should the report be signed by a professional engineer, utility personnel, or only by the customer?
- Alternately, should the report be verified by an independent third party not involved in the project?

Finally, good administrative systems enable program managers to track the paper flow from the time a program application is filed up to the mailing out of the final payment of the associated financial incentive. With clear information on the time required to process each step, a manager can determine whether or not corrective action is merited to improve the speed and processing of applications. The design of a utility’s administrative system should therefore facilitate DSM program managers in their monitoring (data collection and analysis) and adjustment tasks.
LESSONS LEARNED FROM E7 EXPERIENCE

Here are some of the many lessons that can be learned from E7 members’ experience with DSM program implementation and monitoring.

MARKET APPROACH AND INTERVENTION

- It is very difficult to foresee everything right from the start. Utilities should therefore be prepared to correct the course of action and to adjust their programs to the “brutal” reality of market acceptance. DSM program managers should factor in flexibility: act, listen, analyze, adjust or modify, monitor, and adjust again.
- A utility’s understanding of customers should never be overestimated. A cautious attitude is therefore required in communicating and negotiating with customers whose actual needs and perceptions may be different from what was originally forecast.
- Utilities can benefit significantly from being absolutely firm about the careful monitoring and evaluation of the program’s delivery process and results. Program monitoring and tracking systems and the process by which feedback is sent to corporate and DSM planners, program managers and program evaluators, are important mechanisms in gathering and communicating the information critical for real-time and ex-post improvements to DSM initiatives.

ENERGY AND ECONOMIC IMPACT

- DSM programs could turn out to be more expensive than planned. In order to avoid this problem, they should be considered the same as programs on the supply side. They therefore deserve the appropriate and needed resources, especially at the implementation and monitoring phases, where attention to small details makes a difference with customers and trade allies.
- The potential for DSM may be very significant. However, programs that focus only on a few very cost-effective DSM measures may simply “skim the cream” off that potential. By targeting whole buildings as opposed to selecting disparate individual measures, the energy impact and thus the cost-effectiveness of programs can be increased.
- Rewarding demand management investments with financial incentives may create biases: too many grants and too much optimism about results. To bring DSM costs down, alternatives to direct financing should always be explored, together with cost-control mechanisms and an audit process that must be put in place in order to avoid free ridership or misplaced investments.

PROGRAM MANAGEMENT

- The process is likely to be more productive (i.e., lead to more significant results while addressing potential managerial issues) if clearly defined objectives and roles for every player involved in utility DSM are established right from the start and used to improve accountability and relationships between in-house and external DSM resources.
- While the utility’s image is generally an asset when it comes to dealing with customers, the advantages of outsourcing DSM program management should not be underestimated:
  - outsourcing takes advantage of a more decentralized decision-making process and smaller teams;
  - the utility, through its audit and accreditation process, may act more as an independent body that focuses on quality control and results;
  - suppliers and contractors in search of increased business are likely to put additional effort into marketing DSM programs and into promoting program participation.
In the sixth and final step of the DSM process, utilities conduct a detailed program evaluation. This evaluation provides valuable feedback on how effective DSM programs are in achieving stated goals and impacts. It is used as an important and objective mechanism for demonstrating the value of DSM activities to the various players in the DSM process: utility corporate management, regulatory agencies, trade allies in the DSM market place, program participants who invested in DSM measures, and utility DSM practitioners involved at each stage of the DSM process. Based on E7 experience, the importance of evaluation should never be underestimated and the resources required should be allocated accordingly.

**Definitions and Objectives**

As outlined in the previous sections, utilities proceed through a series of steps related to planning and implementing DSM activities. Their configuration, relevance, and effectiveness are tested or evaluated progressively, using increasingly detailed measurements of three major streams of strategic indicators:

- **Impact Evaluation** – the assessment of the nature and magnitude of the impacts of DSM activities, both in terms of economic and energy/load shape impacts, including documentation of program participation/load shape impacts and any distortions observed, as well as patterns of adoption and performance of the DSM measure and technology.

- **Process Evaluation** – the assessment of the efficiency of the administrative and operational processes and strategies adopted by utilities to plan, design, deliver, promote and assess DSM activities. Process evaluation provides utilities with a systematic way of learning from their DSM experiences, both within a particular program over time and across programs being tested in the field simultaneously, or programs being considered for the future and being coordinated with other utility functions.

- **Market Evaluation** – the assessment of the DSM measures’ impact on market receptiveness and transformation to DSM, including customer satisfaction with program services and issues dealing with market acceptance and the utility’s corporate image.

These three types of evaluation are useful at every stage of the program planning and delivery process as they can assist utilities in making on-going changes to delivery strategy and administrative procedures as well as revisions to the overall DSM process, when needed.

Impact evaluations are typically performed before (ex-ante) and after (ex-post) program implementation: ex-ante evaluations
enable program planners to determine the potential magnitude of impacts to be expected from a DSM program or measure and hence decide whether or not to include it in the Overall DSM Plan. Ex-post evaluations are typically conducted during the second year of program implementation to measure the actual effects of a program beyond its introductory and transitory phases. Process and market evaluations are typically done during program implementation and after (ex-post).

The objectives of a DSM evaluation may vary considerably. Table 30 shows the wide spectrum of potential objectives a utility may prioritize in its evaluation process. These range from justifying a DSM program within the company to assessing the duration of the effect of a specific measure introduced by a program.

TABLE 30

EXAMPLES OF EVALUATION OBJECTIVES

- Determining program efficiency
- Determining program costs
- Improving the efficiency of future programs
- Comparing actual results with estimated potential impacts/costs
- Estimating how long the effects of DSM measures last
- Justifying the program within the company
- Justifying the program with authorities
- Determining the practical costs of energy conservation for the utility
- Systematic weighting supply-side measures against demand-side measures

NEED FOR CAREFUL PLANNING AND COORDINATION

The careful planning of program evaluation is usually done by program designers preparing individual Program Evaluation Plans just before the formative stages of DSM program implementation. Such plans, whose frameworks have been introduced earlier (see Section X – Program Design), typically comprise: evaluation objectives, both qualitative and quantitative; criteria and data sources to be used; methods to analyze and compile evaluation results; schedule, budget and resources to be allocated.

Evaluation plans are used:

- by program managers as a background to prepare and apply program monitoring mechanisms to gather appropriate inputs to ongoing and ex-post program evaluations;
- by professionals in other utility departments to organize the gathering and transmission of data and information needed as inputs to the various analyses performed for each type of evaluation.

The next sections introduce the issues associated with the evaluation of DSM programs, as well as the scope and methods typically used in E7 countries to conduct impact, process and market evaluations.

IMPACT EVALUATION

CRITICAL PARAMETERS AND DATA SOURCES

Impact evaluations are conducted to quantify the energy/load shape and economic effects of DSM programs. Numerous parameters have to be assessed and monitored in order to determine the impact of a program, a series of initiatives or even a global strategy. These parameters can be clustered into four groups that deserve particular attention:

- Energy and demand impacts – evaluated in terms of annual and seasonal effects on energy consumption and load shape. These also include consideration of the persistence (and conversely decline) of effects over time. They must also take into consideration the distortion effects that arise within buildings, for instance, where cumulative effects of adopting more than one measure at a time or interactive effects between end-uses can occur.
Program costs and benefits – management expenses of all kinds and financial incentives offered to participants. Benefits derive from avoided costs of generation, transmission and distribution associated with energy and capacity savings or with load management. From a customer perspective, benefits derive from lower energy bills or increased energy efficiency.

Customer participation – gross and net program participation: the latter is the most valuable indicator as it subtracts the participation of free riders, i.e., customers who participate in a program in order to get the financial incentives (when offered), even though they were already planning to undertake the incremental action or make the investment specifically aimed at by the program. Free ridership is the most important distortion to examine since it may account for more than 45% of program participation (and unnecessary costs), according to E7 experience.

Distortions to customer participation – on top of free ridership, there is a series of secondary positive (free drivers, equipment supply effect, spin-off) and negative (snap-back, attrition) effects that have to be monitored and assessed in consumer and supplier behavior to get a complete picture of the program’s impact in the short and the long term.

Parameters included in the four groups are defined more precisely in Table 31, on the following page, along with data sources and techniques used. The approaches to evaluating DSM program impacts refer to various information sources and analytical techniques that are complementary and used simultaneously to achieve greater accuracy. Data sources range from data generated through program monitoring and measurements, technical estimates, customer and supplier surveys using interviews or mailed questionnaires, the analysis of secondary data from customer bills, sales data from the industry, and earlier market surveys.

There are methods for each of the four groups of parameters that allow the evaluation team to assess the impact with more or less accuracy, depending on the nature of the tools used or the type of information available. Also, some issues deserve more attention than others.
### TABLE 31

**Impact Evaluation: Key Parameters and Data Sources**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>DEFINITION</th>
<th>DATA SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENERGY AND DEMAND IMPACTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ANNUAL AND SEASONAL EFFECTS ON ELECTRICAL ENERGY</strong></td>
<td>Change in energy use on an annual or seasonal basis associated with participation in a program or installation of a DSM measure</td>
<td>Load curves and end-use metering, engineering calculations, statistical analyses: comparisons between participants and non-participants</td>
</tr>
<tr>
<td><strong>LOAD SHAPE EFFECTS</strong></td>
<td>Changes in energy use and peak demand at specific times during the year</td>
<td>Load curves and end-use metering, engineering calculations</td>
</tr>
<tr>
<td><strong>EROSION EFFECT</strong> (Opposite is persistence)</td>
<td>Decline over time of DSM savings due to maintenance deficiencies or early replacement of DSM measures before end of life-cycle</td>
<td>Market surveys</td>
</tr>
<tr>
<td><strong>CUMULATIVE EFFECTS</strong></td>
<td>When customers purchase a combination of measures and therefore affect savings from each measure. Particular attention must be paid to this effect in order to avoid overestimation.</td>
<td>Market surveys, engineering models, building simulation</td>
</tr>
<tr>
<td><strong>INTERACTIVE EFFECTS</strong></td>
<td>Impact of a measure in a specific end-use on another end-use load. Can be positive or negative. For example, savings in lighting that diminish the need for space conditioning.</td>
<td>Engineering models, building simulation</td>
</tr>
<tr>
<td><strong>PROGRAM COSTS AND FINANCIAL BENEFITS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PROGRAM COSTS</strong></td>
<td>All costs associated with program planning, implementation and evaluation, including financial incentives</td>
<td>Accounting</td>
</tr>
<tr>
<td><strong>PROGRAM BENEFITS</strong></td>
<td>Benefits to utility and society</td>
<td>Avoided costs associated with energy/capacity savings, load curve and energy data analyses</td>
</tr>
<tr>
<td><strong>CUSTOMER PARTICIPATION AND MARKET PENETRATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GROSS PARTICIPATION</strong></td>
<td>Number of customers who participated in a program or percentage of eligible customer population</td>
<td>Participation statistics</td>
</tr>
<tr>
<td><strong>NET IMPACT</strong></td>
<td>Number of customers who should be included in the calculation of the energy/load impact considering all positive or negative distortion effects related to participation, i.e., net impact = gross participation – free riders + free drivers</td>
<td>Participation statistics and use of control groups of customers who do not participate in the program</td>
</tr>
<tr>
<td><strong>MARKET PENETRATION</strong></td>
<td>Equipment affected by the program or % of eligible equipment</td>
<td>Market and supplier surveys</td>
</tr>
<tr>
<td><strong>NEGATIVE OR POSITIVE DISTORTIONS OF CUSTOMER PARTICIPATION</strong></td>
<td>Customers who participate in a program even though they were planning to implement the measure</td>
<td>Surveys including program participants and non-participants</td>
</tr>
<tr>
<td><strong>ATTRITION OR DROP-OUT EFFECT</strong></td>
<td>Any pattern of customers dropping out of ongoing programs</td>
<td>Market surveys</td>
</tr>
<tr>
<td><strong>SNAP-BACK EFFECT</strong> (Revenue effect, rebound or take-back)</td>
<td>Customers who purchase additional or larger appliances or who more heavily use existing appliances as a result of higher disposable income associated with incentives</td>
<td>Surveys including program participants and non-participants</td>
</tr>
<tr>
<td><strong>FREE DRIVERS</strong></td>
<td>Customers who install program measures as a result of increased awareness without participating in the program (not asking for financial aid)</td>
<td>Market surveys</td>
</tr>
<tr>
<td><strong>SPIN-OFF EFFECT</strong> (Spill-over effect)</td>
<td>Customers adopting measures outside a program as a result of the promotion and incentives such as items not included in the program or items exceeding the number eligible for financial aid</td>
<td>Supplier surveys</td>
</tr>
<tr>
<td><strong>EQUIPMENT-SUPPLY EFFECTS</strong></td>
<td>Direct and indirect effects that the level of program funding has on participation patterns through its impact on suppliers</td>
<td>Market and supplier surveys</td>
</tr>
</tbody>
</table>
Energy and Load Shape Impact Assessment Methods

Methods used for energy and load shape impact assessment comprise technical estimations or engineering calculations, end-use metering, statistical analysis of billing and load research data, econometric models, as well as combinations of the above.

Based on E7 experience, greater accuracy is warranted when several techniques are used concurrently. Table 32 provides a summary of these techniques and comments on their particularities.

Impact Evaluation: Some Issues Worth Noting

Certain technical phenomena must be taken into consideration in order to correctly assess the energy and load impact. According to E7 experience, particular attention has to be paid to two aspects:

- **Cumulative effects** – when stacking multiple measures affects the savings from each measure. This phenomenon is important as it often leads to a decrease in the energy savings from what was anticipated since distortions could not be properly taken into consideration in the planning phase.

### Table 32

<table>
<thead>
<tr>
<th>Five Techniques to Assess Program Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical estimations or engineering methods</strong></td>
</tr>
<tr>
<td>Technical estimations determine average savings obtained by certain energy-efficient technologies. Calculations of expected changes in energy consumption, peak demand and load shape are based on vendor-stated technical performance of DSM measures and assumptions about operating patterns and conditions. Engineering methods include a family of approaches ranging from simple definitional relations to complex simulations of physical processes. With these approaches, the impacts are extrapolated to all program participants and calculated in the absence of very important behavioral effects and empirical validation.</td>
</tr>
<tr>
<td><strong>End-use metering</strong></td>
</tr>
<tr>
<td>When applied to program impact evaluation, end-use metering requires measurements of equipment that has been affected by the DSM program. Although this method is the most expensive, it is appealing since the resulting impacts are based on direct measurements. Measured loads and energy consumption are compared before and after program treatment and comparisons must account for differences in operating conditions and other factors that influence equipment utilization.</td>
</tr>
<tr>
<td><strong>Comparison of billing data</strong></td>
</tr>
<tr>
<td>Billing data comparisons are usually straightforward and lead to statistical analyses of total customer energy or load data to infer changes in usage associated with the adoption of DSM measures. Based on recorded total usage data, they are suitable for examining variations by customer attributes, but difficult to use when the impact of individual measures is being estimated. Billing comparisons typically include performing three types of comparisons: before/after comparisons for program participants; before/after comparisons for program participants and non-participants; before/after comparisons for program participants and control groups. Differences in consumption between the various pairs are assumed to be exclusively attributable to DSM programs; external influences are not taken into consideration, thus sometimes yielding ambiguous results.</td>
</tr>
<tr>
<td><strong>Sample surveys</strong></td>
</tr>
<tr>
<td>Measurements obtained through random sampling of participants and control groups serve the purpose of adapting technical estimations; the results of sampling surveys facilitate the more accurate calculation of energy savings and their distribution over time; with periodic monitoring, sampling surveys facilitate the calculation of savings associated with changes recorded in customer-usage patterns. Sample checks thus serve the purpose of successively transforming the ex-ante estimates, through accounting for the various distortions in customer participation, into closer estimates of actual net impacts. The sampling frequency and size of sample population are clear cost determinants of such a method. Particular attention is therefore given to limiting sampling surveys to very strategic market segments.</td>
</tr>
<tr>
<td><strong>Econometric models</strong></td>
</tr>
<tr>
<td>Along with billing comparisons, regression analysis is the other common statistical technique used to estimate program impacts. This method is typically used as a complement to other methods and it establishes causal relationships between data from technical estimations and measurements used as independent variables to determine average estimates of savings. Econometric models can control for other effects such as weather, can identify impacts from individual measures and interactions among measures and behavioral effects; hence, they offer several advantages over simple billing comparisons.</td>
</tr>
</tbody>
</table>
Interactive effects – when a modification of usage in electric appliances and equipment has an impact on energy use for building heating and air conditioning. The magnitude of the interactive effects depends on the sector, the prevalence of electric space heating and air conditioning, and the relative importance of space heating and cooling loads.

Program cost and benefit assessment depends extensively on the analysis of utility accounting, load research and billing data. That information is amalgamated through analyses of avoided costs associated with energy and capacity savings. Secondary data is typically preferred over primary data from field investigation.

Estimating avoided costs is the most strategic aspect of the benefit assessment. Indeed, each DSM program must be reviewed carefully in order to determine what was really avoided in the whole chain of electricity service over the period of time considered in the analysis. Was there really an impact on the distribution peak? Will that impact be felt over the long term or only in the short term? And, of course, the assessment of the economic value associated with kW or kWh saved depends directly on the energy balance situation at every step of the electricity service chain.

Customer participation and the effects of related negative and positive distortions are usually evaluated through participation statistics and market surveys, using samples of program participants whose behavior is compared with that of control groups and/or samples of non-participants.

Among the various distortions that may occur in market behavior when DSM programs are implemented, free ridership is the most important for utilities to assess, since net impacts need to be computed. Based on E7 experience, free ridership may be particularly important in DSM programs with financial incentives (e.g., rebates), since many program participants would have made the specific energy-efficient investment promoted in the program regardless of the associated incentives. The share of free riders must be estimated both ex-ante (during program planning to avoid providing funds for unnecessary rebates) and ex-post, especially at the early stages of program delivery and afterward.

Information on free riders is typically gathered through customer surveys using either:

- more versatile in-person interviews with small samples of participants; or
- less costly but less investigative written questionnaires mailed to larger groups of customers.

In both cases, particular attention is needed to ensure the data's accuracy or validity, reliability and representativeness, by applying pre-test and rigorous sampling methods.

### PROCESS EVALUATION

Process evaluations are conducted to identify problems with, and recommend actions regarding different aspects of a DSM program, such as the program concept, program delivery, internal administration, incentive levels, program implementation costs, burdens on field staff or contractors, selection of technologies, and data tracking. The key parameters are summarized in Table 33, and potential information sources are suggested for each aspect of the process evaluation. Process evaluations assist in assuring interested players that DSM programs are being designed, delivered, implemented and administered effectively, and modified as deemed necessary.

<table>
<thead>
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<th>TABLE 33</th>
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<tbody>
<tr>
<td><strong>PROCESS EVALUATION: KEY PARAMETERS AND INFORMATION SOURCES</strong></td>
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<tr>
<td><strong>Parameter</strong></td>
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<tr>
<td>Program concept</td>
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<tr>
<td>Problems in program administration</td>
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<td>Program implementation costs</td>
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<tr>
<td>Obstacles to participation</td>
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<td>Burdens on market partners</td>
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<td>Burdens on field staff</td>
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<td>Selection of technologies</td>
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As highlighted in Table 33, process evaluations rely extensively on interview and survey techniques, including personal interviews and focus groups, site visits and document reviews. These methods for evaluating DSM program performance offer different cost levels, breadth of coverage and potential biases. They also bring both on-stream procedural changes to on-going pilot or full-scale programs and an improved procedural framework for future or other programs delivered concurrently. Process evaluations are typically performed during the pilot phase of program implementation and at successive periods during full-scale delivery.

**MARKET EVALUATION**

Market evaluations address customer satisfaction with program services and issues dealing with market acceptance and the utility’s corporate image. Market evaluations serve to improve customer satisfaction and identify market threats and opportunities since they promote utility awareness of customer perceptions and needs. They also contribute to increasing industry-wide knowledge and intelligence about DSM programs, hence facilitating market transformation to energy efficiency. Table 34 provides a summary of key parameters and some potential information sources for each aspect of the market evaluation.

In market evaluations, the focus shifts to questions such as: How is the program perceived by utility customers (participants and non-participants) and by trade allies? How effective are promotional strategies and incentive levels as market saturation approaches? What changes in market response, quality of service or other indicators can be observed in the marketplace as a result of the program? Will energy-efficient equipment suppliers continue to sell the equipment once the program ends? Are energy conservation measures leading to changes in behavior?

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<tbody>
<tr>
<td><strong>MARKET EVALUATION: KEY PARAMETERS AND INFORMATION SOURCES</strong></td>
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<tr>
<td><strong>ASPECT</strong></td>
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</table>
| **PROGRAM MARKET AND ECONOMIC IMPACTS** | □ Improving customer acceptance  
□ Improving utility image  
□ Increasing number of customers  
□ Creating jobs  
□ Reducing emissions | □ Interviews and surveys with customers  
□ Secondary statistics |
| **PROGRAM DESIGN** | □ Clearly understood program  
□ Clearly stated program objectives  
□ Program accessibility | □ Interviews and surveys with customers and market partners |
| **COMMUNICATION STRATEGY** | □ Program easy to remember  
□ Interest in the program  
□ Evaluation of information flow  
□ Frequency of use of information channels selected | □ Interviews and surveys with customers and market partners |
| **CHANGES IN THE MARKETPLACE** | □ Increased market share of energy-efficient equipment  
□ Reaction and collaboration with equipment manufacturers/ market partners  
□ Changes in customer and partner behavior that could be used as indicators for increasing market transformation | □ Market surveys, interviews with retailers, manufacturers and market partners |
Evaluation reports are prepared to highlight DSM program results and impacts as well as to provide explanations of the differences between program targets and actual performance. These reports are generally used as a vehicle to:

- activate the necessary feedback loops required to inform corporate management as well as other stakeholders about utility DSM initiatives and their energy, market and process impacts;
- document and sustain the necessary decision-making process regarding the utility’s further involvement in DSM;
- supplement the utility’s corporate short- and long-term memory of its DSM initiatives since they are closely linked to its competitive positioning in energy services marketing and delivery.

Key Lessons Learned from E7

DSM program implementation dates back more than 20 years in E7 countries. It is through the evaluation process that utilities have been able to improve and change the course of their programs. Here are some of the lessons worth mentioning from E7 experience with program evaluation:

- The importance of program evaluation and its accurate communication to utility corporate and regulatory authorities should never be underestimated.
- The process underlying program evaluation is complex and requires expertise and know-how: costs are only partially known and many distortions can occur. The approaches to evaluation are typically tailored to utility budgetary constraints.
- DSM initiatives have definite economic impacts: impacts such as potential rate increases and competitive positioning in the short term deserve special attention.
- Distortion effects on customer participation or the physical phenomena occurring in buildings considered systems should be examined closely. Special attention should be paid to free ridership, especially for programs with financial incentives. In buildings, cumulative or interactive effects may modify, in one way or another, the energy savings associated with DSM measures and so must be closely monitored.
- Throughout the program evaluation, it is important to bear in mind that the ultimate goal of DSM is to help markets make the best choices – right rates, right behavior within the manufacturer-wholesaler-contractor-retailer-consumer structure, right standards and labels – all pivotal to progressive market transformation.
KEY LESSONS

IMPROVING THE EFFECTIVENESS OF DSM INITIATIVES

As highlighted in this Manual, E7 utilities go through a series of steps in planning and implementing DSM initiatives. Below is a summary of the essentials of Part B.

LOAD ANALYSIS AND FORECASTING

- E7 experience reveals that a good load research program is an essential prerequisite to gaining an adequate understanding of the key global factors underlying system load and customer consumption patterns. This understanding gives the utility a better knowledge of the dynamics prevailing in markets and facilitates designing DSM initiatives with maximum impact.

- A substantial commitment is required from the utility if it is to benefit fully from its load research program and adequately meet the data requirements from various utility groups, including DSM managers. Both adequate resources for specific short-term studies and a long-term vision are necessary to develop and operate a stable and permanent department responsible for conducting reliable and cost-effective load studies.

- Utility corporate objectives and operating environments provide the foundation for load research program design. For cost-effectiveness, it is essential to know the expectations and needs of all groups involved so as to determine, at the outset, the scope of customer sampling, data collection and analysis required. When implementing load research plans, utilities have to stay focused and resist measuring more customers on more parameters than required.

DSM POTENTIALS

- DSM potential impact estimates are critical in setting realistic DSM targets for individual end-use and market segments in credible Overall DSM Plans. Working with incomplete data is better than not estimating potentials at all. In particular, due consideration of the dynamics associated with DSM implementation in the marketplace will greatly improve the credibility of the projected impact of possible programs. And, once economic constraints and marketing considerations are taken into account, the achievable potential presents a more realistic target for a utility to pursue.

- Technical potential is built up year after year. It results from the cumulative sum of temporary potentials that arise each year and the permanent potential in existing building stock. A consistent and permanent approach therefore has to be adopted in order to achieve the full potential of DSM.

- Estimates of potential impacts can change over time. Periodic revisions are required through continuous monitoring of key market dynamics and industry supply factors.

OVERALL DSM PLAN

- The Overall Plan is the focal point or basic reference for corporate decision-makers, regulatory authorities, the utility’s trade allies, and program designers when considering the legitimacy and orientations the utility wishes to imprint on DSM.

- The nature of the Overall DSM Plan is bound to change over time as many internal and external factors evolve. Utilities have to periodically review the principles and objectives selected in previous plans.

- The scope and comprehensiveness of DSM initiatives included in the Overall DSM Plan at any given moment are intimately linked to the breadth of understanding the utility has developed of market dynamics. In regions where such understanding is just starting to be developed, the Overall DSM Plan will be limited in scope – a pilot project, for instance – and will mostly be composed of the market and load research activities needed to support more refined and extended editions of the plan in the future.
Program Design

❑ Even if DSM is a resource to be developed, utilities have to keep customers at the center of their interest, present a global and simple approach to address their needs, and remember that clients buy services not electricity. Thus, DSM technologies that generate positive impacts on service quality have a better chance of being adopted. Conversely, technologies perceived as potentially detrimental to service quality will be rejected by customers. No matter what the approach selected, DSM marketing materials should be kept as simple as possible and designed to facilitate customer acceptance of, and participation in the program.

❑ DSM programs have to address the concerns of multiple stakeholders. Advisory bodies external to utilities – trade allies, non-governmental organizations, individual customers, outside experts and customer advisory groups – have proven to be very valuable in helping determine DSM marketing approaches, as well as in preventing mistakes. The notion of equity between customer groups and even between suppliers and consultant groups is a very sensitive issue that has to be addressed carefully.

❑ Utilities should seriously consider adopting a progressive approach to DSM initiatives, progressing from simple technologies and market segments where the decision-making process appears less intricate to more complex technologies and decision-making structures. Pilot projects should be prioritized before a large-scale implementation is launched. Pilot projects help understand customer reactions and behavior and avoid problems ahead of time.

❑ There are benefits to adopting a holistic perspective in designing and implementing DSM. This means seeing customers as more than a collection of end-users, or targeting interventions to whole buildings as opposed to selecting disparate individual measures. Also, utilities should coordinate their DSM efforts with those of the multiple players involved in the delivery of energy efficiency promotion and improvement. Finally, coordination with the utility’s own departments, such as rates and marketing, is needed, for example, to develop rates that are consistent with the new products and programs.

❑ DSM programs should be designed to take advantage of specific situations that otherwise would be considered lost opportunities for energy efficiency improvement. It is easier to reach customers at the time of decisions to purchase new appliances (e.g., in shopping malls) or when new houses, commercial buildings or industrial plants are being built. This is particularly relevant for rapidly growing countries, where standards, labels or DSM programs should be considered for all new construction projects.
**Program Implementation**

- It is very difficult to foresee everything right from the start. Utilities should therefore be prepared to correct the course of action and to adjust their programs to the “brutal” reality of market acceptance. DSM program managers should factor in flexibility: act, listen, analyze, adjust or modify, monitor, and adjust again.

- A utility’s understanding of customers should never be overestimated. A cautious attitude is therefore required in communicating and negotiating with customers whose actual needs and perceptions may differ from what was originally forecast.

- Utilities can benefit significantly from being absolutely firm about the careful monitoring and evaluation of the program’s delivery process and results. Program monitoring and tracking systems and the process by which feedback is sent to corporate and DSM planners, program managers and program evaluators, are important mechanisms in gathering and communicating the information critical for real-time and ex-post improvements to DSM initiatives.

- While the utility’s image is generally an asset when it comes to dealing with customers, the advantages of outsourcing DSM program management should not be underestimated. Outsourcing takes advantage of a more decentralized decision-making process and smaller teams; the utility, through its audit and accreditation process, may act more as an independent body that focuses on quality control and results; suppliers and contractors in search of increased business are likely to put additional effort into marketing DSM programs and promoting program participation.

**Program Evaluation**

- The importance of program evaluation and its accurate communication to utility corporate and regulatory authorities should never be underestimated. Consequently, the appropriate and required resources for evaluation should be allocated, even though the approaches to evaluation are typically tailored to utility budgetary constraints.

- The process underlying program evaluation is complex and requires expertise and know-how. A good way to facilitate and reduce potential problems is to develop an evaluation plan as early in the design stage as possible so as to specify who is responsible right from the start and thus decrease the overall cost of data collection associated with evaluation.

- Distortion effects on customer participation or the physical phenomena occurring in buildings should be examined closely. Special attention should be paid to free ridership, especially in the case of programs with financial incentives. In buildings, cumulative or interactive effects may modify, in one way or another, the energy savings associated with DSM measures and so must be closely monitored.
LIST OF FIGURES AND TABLES

FIGURES

FIGURE 1 PAGE 8 DSM Life Cycle
FIGURE 2 PAGE 12 Utility Load shape objectives
FIGURE 3 PAGE 13 Players on the DSM Field
FIGURE 4 PAGE 32 Standards and Labels in the Market Adoption Process
FIGURE 5 PAGE 46 Distortions over Time from Similar Rate Treatment Applied to Consumers with Different Consumption Patterns
FIGURE 6 PAGE 46 Relationship between Costs by Function and Types of Charges
FIGURE 7 PAGE 55 DSM Process
FIGURE 8 PAGE 58 Three Streams of Strategic Indicators for the Overall DSM Process
FIGURE 9 PAGE 61 Load Research Process
FIGURE 10 PAGE 62 Level of Details in Baseline Forecast
FIGURE 11 PAGE 65 Data Metering Process
FIGURE 12 PAGE 67 Load Profile by Customer Class
FIGURE 13 PAGE 68 Load Duration Curve
FIGURE 14 PAGE 73 Stepwise Approach to Estimating DSM Potential Impacts
FIGURE 15 PAGE 78 Illustration of Phase-In Technical Potential
FIGURE 16 PAGE 78 Economic Potential: Supply Curve of Cost-Effective Demand Options
FIGURE 17 PAGE 81 Illustration of DSM Potentials
FIGURE 18 PAGE 103 Organization of DSM Resources

TABLES

TABLE 1 PAGE 15 Rationale for Ratepayer-Funded Energy Efficiency Programs in a Restructured Electricity Industry
TABLE 2 PAGE 17 Market-Based Barriers to DSM
TABLE 3 PAGE 21 Differentiating Factors Leading to Different Government Energy Efficiency Portfolios
TABLE 4 PAGE 22 Government Incentives to Enhance Energy Efficiency
TABLE 5 PAGE 23 Types of Regulations and their Impacts on DSM
TABLE 6 PAGE 25 Typical Roles in Market Transformation Initiatives
TABLE 7 PAGE 28 Determinants of a Successful Standardization Process
TABLE 8 PAGE 30 Determinants of a Successful Labeling Program
TABLE 9  PAGE 31
Examples of Standards and Labels in E7 Member Countries

TABLE 10  PAGE 36
Typical DSM End-Use Technology/Equipment used in E7 Member Countries

TABLE 11  PAGE 38
Organizational Models for Utility-Driven Development of DSM Technology

TABLE 12  PAGE 42
Elements of Rate Policies in E7 Countries

TABLE 13  PAGE 44
Uses, Advantages and Limitations of Historical or Accounting Cost versus Marginal Cost Pricing Approaches

TABLE 14  PAGE 45
Electricity Supply Functions

TABLE 15  PAGE 47
Types of Time-of-Use Rates

TABLE 16  PAGE 61
Common Applications of Load Research: Summary

TABLE 17  PAGE 63
Examples of Segmentation Issues

TABLE 18  PAGE 65
Sources for Data Collection: Summary

TABLE 19  PAGE 75
Examples of Qualitative Screening Criteria

TABLE 20  PAGE 76
Characteristics of Individual DSM Measures

TABLE 21  PAGE 85
Situational Analysis: Factors Affecting the Content of Individual Overall DSM Plans

TABLE 22  PAGE 85
Criteria for Setting Short-Term Targets for DSM Initiatives

TABLE 23  PAGE 86
Perspective Considered in Individual Cost-Effectiveness Tests

TABLE 24  PAGE 87
Benefits and Costs Considered in Individual Cost-Effectiveness Tests

TABLE 25  PAGE 92
Examples of Issues Addressed at the Outset of Program Design

TABLE 26  PAGE 93
DSM Technology Eligibility Criteria

TABLE 27  PAGE 94
Examples of Barriers to Customer Acceptance and Possible Solutions

TABLE 28  PAGE 95
Matching Marketing Mechanisms to Customer Preferences and Decision Stages

TABLE 29  PAGE 106
Questions Asked at the Implementation Planning Stage about Operational Support Resources

TABLE 30  PAGE 110
Examples of Evaluation Objectives

TABLE 31  PAGE 112
Impact Evaluation: Key Parameters and Data Sources

TABLE 32  PAGE 113
Five Techniques to Assess Program Savings

TABLE 33  PAGE 114
Process Evaluations: Key Parameters and Information Sources

TABLE 34  PAGE 115
Market Evaluations: Key Parameters and Information Sources

SIDEBARS

Impact of Industry Restructuring on Electricity Pricing  PAGE 49
Avoided Costs: A Few Considerations  PAGE 79

Energy or Demand Savings  PAGE 73
### GLOSSARY

**Avoided costs**
Avoided costs measure the expected change in a utility’s total costs resulting from a reduction in energy demand brought about by a DSM initiative.

**Baseline forecast**
The electric energy consumption and peak demand associated with a market segment or a customer group that would prevail in the absence of new DSM initiatives or programs. In other words, the baseline forecast is the underlying reference situation characterized by certain habits and technologies against which a program’s impact is measured.

**Billing credits**
Discounts applied to customers’ bills as an incentive to purchase and install a particular DSM measure.

**Billing determinants**
Components of the rate structure required to bill a given rate. A typical rate generally is composed of an energy charge based on kWh, which may be complemented by a customer-related charge (fixed amount per period) and/or a demand charge based on kW.

**Cash grant**
One-time payment to customers who adopt a specific DSM measure. The amounts offered are sometimes tied to energy or demand savings.

**Coincident peak demand**
The load, expressed in kW, of a particular customer or group of customers at the time when the utility’s peak demand occurs.

**Coincidence factor**
The ratio of the coincident peak demand of a group of customers or the entire system to the sum of each customer’s individual peak demands. That ratio is usually expressed as a % and can never be greater than 100%.

**Cost allocation**
An activity that consists in distributing the investment and operating costs associated with each electric service — generation, transmission, distribution, and customer service — to the different rate classes by taking into consideration their characteristics: voltage level, coincident peak demand, energy consumption, load factor, and so on. Costs can be determined using either marginal or historical (accounting) cost methods.

**Demand-Side Management (DSM)**
Planning, implementation and evaluation of utility activities to encourage specific groups of customers to modify the amount and timing of their energy usage in a manner consistent with the utility’s objectives.

**DSM activity**
Applying a particular tool or engaging in an action in order to accomplish specific DSM objectives. For example, training sessions aimed at teaching air-conditioner installers correct installation techniques, or offering rebates toward the purchase of products that meet a desired efficiency level.

**DSM measure**
Refers to energy efficiency products, services or practices.

**DSM load shape objectives**
DSM programs are usually designed with the objective of reducing demand during peak periods and/or encouraging demand during off-peak periods. Various load shape objectives can be pursued: load shaving, load shifting, strategic conservation, or strategic load growth.

**DSM program**
A series of measures put into a package and promoted through an initiative launched by an organization, such as a utility, and generally targeting a market or a market segment. For example, a commercial lighting program.

**DSM strategy**
A broader, more strategic effort than a single program intended to effect dramatic changes across all market segments and in the economy in general. A DSM strategy, generally initiated by the government, will include a variety of programs engaged in the delivery of a series of coordinated initiatives and associated activities that will evolve as market penetration or transformation progresses.

**Demand (electricity)**
The rate at which electrical energy is delivered or supplied at a given moment (kW) or averaged over a given period of time (kWh).

**Distortion effects**
Factors that positively or negatively affect the impact of DSM initiatives compared with the effective or nominal situation. For instance, official participation in a program may be 1,000 customers, while some customers may, in fact, have implemented the measure without actually being registered in the program's administrative tracking system (free drivers), or others have participated in the program even though they were going to implement the measure promoted in the program anyway (free riders). Free drivers and riders must therefore be considered in evaluating the program’s net impact.

**Electricity industry restructuring**
Restructuring usually refers to the movement away from the traditional regulated monopoly structure toward a structure that allows consumers to purchase electricity from competing suppliers. It also usually involves the reconfiguration of vertically integrated electric utilities to separate the various utility functions into individually operated entities.

**End-uses**
Energy services provided by various forms of energy at the customer level, such as lighting, heating and cooling.
ENERGY AUDITS
Refers to on-site inventories of building and end-use systems (stock size, equipment profile, age and usage patterns) to which are added more or less sophisticated computations of energy consumption at the most detailed level.

ENERGY EFFICIENCY
The energy productivity of specific end-use applications or energy services. It may be measured in terms of output per unit of energy input and is generally used for all forms of energy.

ENERGY CONSUMPTION
The rate at which energy is transmitted over a given period of time, such as an hour. Electrical energy consumption is usually measured in kilowatthours.

ENERGY PERFORMANCE LABELS
Technical specifications tagged on products/equipment or systems that give the consumer energy efficiency performance information so comparisons can be made between specific products/equipment or systems.

ENERGY PERFORMANCE STANDARDS
Technical specifications that define the minimum acceptable level of efficiency for a piece of equipment, a product or a system.

ENERGY SERVICE COMPANIES (ESCOs)
Firms that specialize in providing DSM services directly to the end-user. Typically, these firms enter into contractual agreements where the cost savings are shared with the client. Very often these firms, in addition to offering expertise and service, finance the cost of the DSM initiative at the customer level.

EXTERNALITIES
Costs or benefits considered external to a conventional economic analysis, i.e., costs or benefits experienced by a third party as a consequence of a transaction between two other parties. For example, the environmental impacts associated with supplying electricity.

FOCUS GROUP
A market research technique that helps get a better understanding of a target population by organizing a structured and facilitated discussion involving a small group of customers.

HISTORICAL (ACCOUNTING) COSTS
Include all expenditures incurred by the utility to generate, transmit and distribute electricity to meet current demand with existing facilities.

GRID (POWER)
Interconnected power lines that make up a region’s transmission/distribution network.

IMPACT EVALUATION
Calculation of energy savings and/or load demand displacement potential ex-ante (before), and calculation of actual energy savings/displacements associated with DSM programs ex-post (after).

INTEGRATED RESOURCE PLANNING (IRP)
Planning process and decision-making framework that facilitates selecting a combination of supply- and demand-side resources to minimize the total cost of meeting future electricity demand.

INTERNATIONAL FINANCIAL INSTITUTIONS (IFI)
Formal lending agencies that operate across national boundaries, such as the World Bank.

LOAD ANALYSIS
An activity that consists in measuring and analyzing the characteristics of a utility’s loads in order to understand how customers use electricity.

LOAD CHARACTERISTICS
All or part of the features of the electric service associated with a customer, a group of customers, or the entire electric system, such as energy consumption, peak demand, load factor, coincidence factor.

LOAD CURVE OR LOAD PROFILE
Curve showing the power used or supplied during a specified period of time, usually a 24-hour period or a year, against the time of occurrence.

LOAD DURATION CURVE
A curve showing the cumulative frequency distribution of a utility’s load levels. The load duration curve plots the utility’s hourly demand by decreasing size according to the fraction of the year in which a given level is exceeded. Typically, it shows a few hours of very high peak demand, and then a gradual reduction of the load level as the cumulative frequency increases.

LOAD FACTOR (LF)
The load factor is the ratio between the energy used (in kWh) and the maximum energy that can be used during a given period, according to the maximum power demand or peak demand.

LF = consumption for the period (kWh) / maximum power demand (kW) × number of hours in the period

LOAD FORECASTING
An activity that consists in projecting energy and demand requirements in the short and long term.

LOAD RESEARCH PROGRAM
A framework that allows the utility to conduct both reliable studies and complementary tasks in order to obtain the data and information needed for load analysis and load forecasting, as well as for other functions within the utility.

LONG-TERM MARGINAL COST
The generation, transmission and distribution costs associated with future investments needed to meet growing demand during normal and peak periods. Long term corresponds to the time horizon for which capacity is not yet fixed.

MARKET EVALUATION
Assessment ex-post (after) of market changes brought about by DSM programs or initiatives. The market evaluation checks the impact of DSM programs on market participants and the marketplace.

MARKET RESEARCH
An activity that consists in collecting, using various techniques and tools, and analyzing data on the utility’s customers so as to get a better understanding of the way customers might be influenced into taking action or making a decision. Characteristics such as decision-making patterns regarding electrical equipment, environmental awareness, or degree of knowledge of electricity usage are examples of issues raised in market research.
**Market transformation strategy**
A DSM strategy, usually involving more than one organization at the national or regional level, with the aim of making a fundamental change in the market for energy-efficient products, services, and practices in such a way that the change becomes permanent. A market transformation strategy may include initiatives that promote both energy-saving technologies and related installation and maintenance practices.

**Non-Governmental Organization (NGO)**
Organizations or associations not attached to government agencies, such as public organizations and environmental interest groups.

**Off-peak energy (period)**
Energy supplied or used during periods of low system demand, as specified by the utility, where the cost of generation is generally below average.

**On-peak energy (period)**
Energy supplied or used during periods of high system demand, as specified by the utility, where the cost of generation is generally above average.

**Peak demand**
The highest demand of a load that occurs during a specified period of time (day, week, month or year). The demand may be expressed as a total for a customer, a group of customers, or the entire system covering all customer classes (system peak demand).

**Performance-based regulation (PBR)**
Through performance-based regulation, regulators seek to encourage economic efficiency and behavior that furthers competition, enhances the environment, and improves customer service. PBR usually includes incentives for regulated companies to behave in ways that promote the public interest. The goals of PBR are generally derived from, and consistent with a nation’s or a region’s public policy objectives.

**Population (target population)**
All the utility’s customers, or a group of customers (sector, rate class, all owners, etc.) that the researcher wishes to study in order to measure certain load characteristics or other relevant parameters, usually on a survey basis.

**Power load**
The rate at which energy is transferred at a given moment. Electrical power is usually measured in kilowatts, which is also used as a measure of capacity.

**(DSM) Pricing measures**
Rate options that better target the specific needs and opportunities of specific market segments. Their objective is to encourage a change in energy usage consistent with the utility’s needs.

**Process evaluation**
Assessment (ex-post) of the productivity and efficacy of DSM program implementation versus expectations.

**Public benefit programs**
Programs introduced by a utility to meet public policy objectives, whose beneficiaries are primarily customers or the general public. For example, an energy efficiency program targeting low-income customers, or a research and development project.

**Public involvement**
A range of techniques that can be used to inform, consult or interact with stakeholders affected by a proposal.

**Rate design**
An activity that consists in determining a utility’s rate structure using different allocation methods and parameters while simultaneously taking into account revenue requirements and corporate orientations.

**Rate structure**
A standardized set of charges (customer, energy and demand) for utility service applicable to a specific customer or, more generally, to a group of customers (rate class).

**Rebates**
Single payments usually made to customers by utilities to purchase and install a specific DSM appliance/piece of equipment, either an original or a replacement for a less efficient one.

**Sample**
A representative subset of customers that shows the characteristics of the target population from which the sample was drawn.

**Short-term marginal costs**
Variable production costs associated with the lowest cost incremental unit. Short term is the time horizon for which production capacity is fixed.

**Stranded assets (transition costs)**
Costs a utility has an obligation to pay (e.g., long-term contracts or payments on a generation plant) but may not be able to recover from a customer because the customer no longer uses the utility’s service.

**Technology procurement**
Mechanisms initiated by utilities or government agencies to encourage demand for new technologies, equipment or products that would not spontaneously materialize. Government purchase of newly designed energy-efficient products is a good example.

**Time-of-Use (TOU) rates**
Pricing options where the price of energy or power varies over time.

**Trade ally**
Any organization involved in transactions between a utility and its customers; typically, equipment vendors/manufacturers, construction contractors, engineering consulting companies, who come in contact with DSM in the course of their primary business. They assist utilities in their efforts to make DSM measures available in the target markets.

**Unbundling utility functions**
Separating electricity generation, transmission and distribution services in order to increase competition in these segments of the industry.

**Unbundling rates**
Separating the charges for electricity service into components that match the costs of providing those services so consumers can make rational choices when choosing service providers.
REFERENCES

For a complementary perspective on the topics addressed in this manual, the reader is invited to consult three generic references that have substantially contributed to the depth and illustration of the sections in both Part A – DSM: the Environment and Part B – The DSM Process:


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OVERALL DSM PLAN


PROGRAM DESIGN AND PROGRAM IMPLEMENTATION


PROGRAM EVALUATION

Domotechnica-Bericht (Domotechnica Report). Hauptberatungsstelle für Elektrizitätsanwendung. (HEA) (Main Advisory Centre for Electricity Usage), Frankfurt/Main, Germany

Hausgeräte-Analyse-Program von RWE Energie AG, HEW AG, EVS AG. Appliance Analysis Programs by RWE Energie AG. HEW AG, EVS AG), VWEW-Verlag, Frankfurt/Main, Germany

VDEW. Haushaltskundenbefragung (Residential customer survey). Frankfurt/Main, Germany 1991

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