Energy demand management, also known as demand side management (DSM), entails actions that influence the quantity or patterns of use of energy consumed by end users, such as actions targeting reduction of peak demand during periods when energy-supply systems are constrained. Peak demand management does not necessarily decrease total energy consumption but could be expected to reduce the need for investments in networks and/or power plants. Today, demand side management is also known as demand response. Energy demand management activities should bring the demand and supply closer to a perceived optimum.

1. World energy demand and energy efficiency

In economics, supply and demand describes market relations between prospective sellers and buyers of a good. The supply and demand determines price and quantity sold in the market. Governments of many countries mandated performance of various programmes for demand management after the 1973 energy crisis.

Energy-efficiency programs were designed in an IRP framework in which regulators required utilities to consider the benefits and costs of substituting such programs for the acquisition of new generation resources. In a deregulated competitive market, generating capacity will likely be added or retired based upon its marketability. Resource planning will become a competitive business function. This change is leading some commentators to question the continuing role of energy-efficiency programs. The resulting debate focuses on three issues:

- The ability of markets to capture cost-effective energy-efficiency opportunities.
- The costs of energy-efficiency programs in a competitive electric power market and the benefits of the programs to consumers and society.
- The rate impacts of energy-efficiency programs.

In a competitive market, the effects of significant efficiency programs will be to reduce demand and to lower the market price of generation services. These
benefits would accrue to all electricity consumers in relevant market areas. Given that generation revenues in a fully competitive market will be recovered at market prices, instead of on a cost-of-service basis, the interests of utilities in operating such programs will change. In the regulated environment, utilities have an obligation to serve, including the obligation to build or acquire generation resources.

Energy-efficiency programs offer an attractive way to avoid the need for investment in new capacity. In a fully competitive environment, the obligation to serve could become an obligation to provide access to the transmission and distribution grid. In a competitive market for generation services, it is in the vertically integrated utility’s interest, as competitive generation supplier, to sell more generation services at a higher market price.

Efficiency programs will bring this interest into conflict with the utility’s traditional service objective of helping customers reduce their total energy bills. Energy-efficiency programs typically reduce energy consumption and may place downward pressure on the price of generation. This downward pressure on generation prices could reduce utility profits. This shift in the interests of local utilities might help to explain reductions in savings from DSM programs.

World Energy Council (WEC) has been collaborating with ADEME (Agency for Environment and Energy Efficiency, France) on a joint project “Energy Efficiency Policies and Indicators”. APERC (Asia Pacific Energy Research Centre) and OLADE (Latin American Energy Organisation) have also participated in the study, which has been monitoring and evaluating energy efficiency policies and their impacts around the world.

According in World Energy Council (WEC) and Energy Information Administration (EIA) in the absence of new government policies, the world’s energy needs will rise inexorably. World primary energy demand is projected to expand by more than half between now and 2030, an average annual growth rate of 1.6%. By 2030, the world will be consuming 17.1 billion tonnes of oil equivalent – 6 billion toe more than today (table nr.1 and fig.no.1).

The latest report, published in 2006, presents and evaluates energy efficiency policies in 63 countries, with a specific focus on five policy measures, for which in-depth case studies were prepared by selected experts:
- Minimum energy efficiency standards for household electrical appliances;
- Innovative energy efficiency funds;
- Voluntary/negotiated agreements on energy efficiency;
- CO2;
- Local energy information centres;
- Packages of measures.
Table no.1. World Primary Energy Demand (Mtoe\(^1\))

<table>
<thead>
<tr>
<th>Energy resources</th>
<th>History</th>
<th>Previsions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>1.439</td>
<td>2.773</td>
</tr>
<tr>
<td>Oil</td>
<td>2.446</td>
<td>3.940</td>
</tr>
<tr>
<td>Gas</td>
<td>895</td>
<td>2.302</td>
</tr>
<tr>
<td>Nuclear</td>
<td>29</td>
<td>714</td>
</tr>
<tr>
<td>Hydro</td>
<td>104</td>
<td>242</td>
</tr>
<tr>
<td>Biomass and waste</td>
<td>683</td>
<td>1.176</td>
</tr>
<tr>
<td>Other renewables**</td>
<td>4</td>
<td>57</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5.600</td>
<td>11.20</td>
</tr>
</tbody>
</table>

\(^*\) annual average evolution during 2004-2030;
\(^**\) solar, wind and geothermal energy;
\(^1\) toe- tons oil equivalent , 1toe=11.626 kWh = 41.868 Joules calorific net value/kg=39,671·10^6 Btu
(british thermal unit 1Btu= 1055,05585 Joules)

Fig. no.1 World Energy Demand 1971-2030 by Region (IEA Reference Scenario) \((Source: \text{WEO 2006})\)

2. IRP (Integrated Resource Planning) and DSM (Demand-Side Management)
2.1. Integrated resource planning (IRP)

Integrated resource planning (IRP) is a planning process for electric utilities that evaluates many different options for meeting future electricity demands and selects the optimal mix of resources that minimizes the cost of electricity supply while meeting reliability needs and other objectives.

With traditional utility planning, planners take into consideration the demand to be met, the reliability to be achieved, and applicable government policies and regulations. The planner then selects the types of fuels, power plants, distribution systems and patterns, and power purchases that will meet these objectives with minimum revenue requirement (the revenue the utility must collect to finance and operate the power system). Options are selected only from the supply side (options to supply more power) as opposed to the demand side (options to reduce electricity demand) of the electricity system.

IRP attempts to take the traditional planning approach several steps further. It strives to:

1. Evaluate all options, from both the supply and demand sides, in a fair and consistent manner.
2. Minimize costs to all stakeholders (and not just costs to the utility).
3. Create a flexible plan that allows for uncertainty and permits adjustment in response to changed circumstances.

The traditional goals of utility planning are reliable service, economic efficiency, environmental protection, and equity. Reliable service necessitates the balancing of customer and investor interests (balancing the quality of service against cost). Equity necessitates the additional balancing of the interests of the various customer classes as well as the interests of present and future generations.

IRP makes it easier to strike a balance among these traditional goals by considering all supply and demand options as potential contributors and by integrating them into a common framework. The result is an opportunity to achieve lower overall costs than might result from considering only supply-side options. Furthermore, the inclusion of demand-side options presents more possibilities for saving fuel and reducing negative environmental impacts than might be possible if only supply-side options were considered. However, while DSM programs are one important aspect of an IRP, an IRP is much more than DSM programs. An IRP will also usually include many supply-side measures, ranging from traditional power plants to more innovative sources of electricity supply such as power purchases, independent power plants, cogeneration, and renewable energy sources.

**Integrated resource planning** (IRP) usually consists of a number of steps:

1. Identifying the objectives of the plan (e.g. reliable service, meeting peak demand at least cost, etc.) and the appropriate time horizon.
2. Collecting data needed for the planning process.
3. Developing one or more demand forecasts.
4. Identifying resource options including demand-side and supply-side resources.
5. Consistently evaluating all resources including calculating avoided costs, conducting benefit-cost analyses, and considering environmental externalities.
6. Selecting the most promising options to create an integrated, effective, and responsive plan.
7. Conducting uncertainty or scenario analyses for different economic, environmental, and social circumstances.
8. Based on these uncertainty or scenario analyses, developing a plan that best addresses the most likely contingencies while providing flexibility in case one of the less likely scenarios comes to pass.
9. Developing an action plan.
10. Implementing the action plan.
11. Monitoring and evaluating implementation of the plan and revising the plan as necessary.

2.2. Demand-Side Management (DSM)

Demand-side management measures take advantage of opportunities to increase the efficiency of energy service delivery; these opportunities are not being fully taken advantage of in the market. To make use of DSM measures requires special programs that try to mobilize cost-effective savings in electricity and peak demand. These programs help overcome various barriers that prevent many cost-effective DSM measures from being adopted; these barriers exist even in countries with fully developed market economies. Without DSM programs, these energy and peak demand savings would not occur or would materialize only after significant delay, and in any case could not be relied upon, forcing utilities to construct expensive back-up capacity and causing higher rates. Numerous studies in China and other countries have found that cost-effective DSM programs can reduce electricity use and peak demand by approximately 20 to 40 percent.

DSM benefits households, enterprises, utilities, and society including:
1. Reduces customer energy bills.
2. Reduces the need for power plant, transmission, and distribution construction.
3. Stimulates economic development.
4. Creates long-term jobs that benefit the economy.
5. Increases the competitiveness of local enterprises.
6. Can reduce maintenance and equipment replacement costs.
7. Reduces local air pollution.
8. Reduces emissions that contribute to national and international environmental problems such as acid rain and global warming.
9. Enhances national security by easing dependence on foreign energy sources.

10. Can increase the comfort and quality of work spaces, which in turn can increase worker productivity.

11. Can create market transformations with long-term results.

The process to design and implement DSM programs generally consists of the following steps:

1. Identify sectors, end-uses and efficiency measures to target;
2. Understand the market for targeted sectors and measures;
3. Develop program designs;
4. Conduct cost-effectiveness screening;
5. Prepare an implementation plan;
6. Implement programs;
7. Evaluate programs.

3. Benefits and Utility DSM programs

Many program and policy alternatives exist for implementing DSM measures. Among the options are utility-operated DSM programs, government-operated DSM programs, regulations and standards. Each of these approaches has a useful role to play. Equally important, utility and non-utility approaches can work together, and such joint approaches are often the most powerful method for overcoming market barriers. For example, utility programs can make regulatory approaches more effective and palatable by bearing some of the costs of compliance and enforcement, for example, in new buildings. Also, utility programs can increase the market penetration of new technologies to the point where they are used by the majority of customers and mandatory government efficiency standards can take over, a point that might not be reached until years later without utility programs.

Utility DSM programs generally fall into three main categories:

1. Conservation programs: Reduce energy use, e.g., programs to improve the efficiency of equipment (lighting and motors, for example), buildings, and industrial processes.
2. Load management programs: Redistribute energy demand to spread it more evenly throughout the day, e.g., load shifting programs (reducing air conditioning loads during periods of peak demand and shifting these loads to less critical periods), time-of-use rates (charging more for electricity during periods of peak demand), and interruptible rates (providing rate discounts in exchange for the right to reduce customers electricity allocation during the few hours each year with the highest electricity demand).
3. Strategic load growth programs: Increase energy use during some periods, e.g., programs that encourage cost-effective electrical technologies that operate primarily during periods of low electricity demand. Within these categories there are many different program approaches that can be used including:
1. General information programs to inform customers about generic energy efficiency options.
2. Site-specific information programs that provide information about specific DSM measures appropriate for a particular enterprise or home.
3. Financing programs to assist customers with paying for DSM measures, including loan, rebate, and shared-savings programs.
4. Direct installation programs that provide complete services to design, finance, and install a package of efficiency measures.
5. Alternative rate programs including time-of-use rates, interruptible rates, and load shifting rates. These programs generally do not save energy, but they can be effective ways to shift loads to off-peak periods.
6. Bidding programs in which a utility solicits bids from customers and energy service companies to promote energy savings in the utility's service area.
7. Market transformation programs that seek to change the market for a particular technology or service so that the efficient technology is in widespread use without continued utility intervention.

4. DSM Examples

Many successful examples of IRP (Integrated resource planning) and DSM exist throughout the world. IRP and utility DSM programs were developed in the United States during the 1980s and have since been used in Canada and Australia (table no.2). IRP processes and DSM programs are beginning in Latin America, Western and Eastern Europe, and several Asian countries. For example, the Electricity Generating Authority of Thailand is now implementing a five-year DSM master plan, investing $189 million U.S. in order to achieve annual energy savings of 1427 GWh and peak capacity reduction of 238 MW by the end of 1997.

Table no.2. Electric Utility Demand- Side Management Programs 1989-2004

SUA
<table>
<thead>
<tr>
<th>Year</th>
<th>Actual Peakload Reductions</th>
<th>Energy Saving</th>
<th>Costs in DSM programs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Megawatts</td>
<td>Million Kilowatthours</td>
<td>Thousand Nominal Dollars</td>
</tr>
<tr>
<td>1989</td>
<td>n.a.</td>
<td>12.463</td>
<td>14.672</td>
</tr>
<tr>
<td>1990</td>
<td>n.a.</td>
<td>20.458</td>
<td>1.177,457</td>
</tr>
<tr>
<td>1991</td>
<td>n.a.</td>
<td>24.848</td>
<td>1.803,773</td>
</tr>
<tr>
<td>1992</td>
<td>7.890, 9.314</td>
<td>17.204</td>
<td>35.563</td>
</tr>
<tr>
<td>1993</td>
<td>10.368, 12.701</td>
<td>23.069</td>
<td>45.296</td>
</tr>
<tr>
<td>1994</td>
<td>11.662, 13.340</td>
<td>25.001</td>
<td>52.483</td>
</tr>
<tr>
<td>1998</td>
<td>13.591, 13.640</td>
<td>27.231</td>
<td>49.167</td>
</tr>
<tr>
<td>2000</td>
<td>12.873, 10.027</td>
<td>22.901</td>
<td>53.701</td>
</tr>
<tr>
<td>2001</td>
<td>13.072, 11.927</td>
<td>24.955</td>
<td>53.936</td>
</tr>
<tr>
<td>2002</td>
<td>13.420, 9.516</td>
<td>22.936</td>
<td>54.075</td>
</tr>
<tr>
<td>2004</td>
<td>14.272, 9.260</td>
<td>23.532</td>
<td>54.710</td>
</tr>
<tr>
<td>2005</td>
<td>14.720, 9.938</td>
<td>24.658</td>
<td>58.000</td>
</tr>
</tbody>
</table>

The actual reduction in peak load reflects the change in demand for electricity that results from a utility demand-side management (DSM) program that is in effect at the time that the utility experiences its actual peak load as opposed to the potential installed peakload reduction capacity. Differences between actual and potential peak reduction result from changes in weather, economic activity, and other variable conditions.

Energy Efficiency refers to programs that are aimed at reducing the energy used by specific end-use devices and systems, typically without affecting the services provided. These programs reduce overall electricity consumption, often without explicit consideration for the timing of program-induced savings. Such savings are generally achieved by substituting technically more advanced equipment to produce the same level of end-use services (e.g., lighting, heating, motor drive) with less electricity.

Load Management includes programs such as "Direct Load Control," "Interruptible Load Control, and, "Other Types" of DSM programs. "Direct Load Control" refers to program activities that can interrupt consumer load at the time of

37 n.a. - not available
annual peak load by direct control of the utility system operator by interrupting power supply to individual appliances or equipment on consumer premises.

**Acts The International Energy Agency in DSM Programme**

The International Energy Agency (IEA) acts as energy policy advisor for its 26 member countries in their effort to ensure reliable, affordable and clean energy for their citizens.

The Demand-Side Management (DSM) Programme, which was initiated in 1993, deals with a variety of strategies to reduce energy demand. The following 19 member countries and the European Commission have been working to identify and promote opportunities for DSM: Australia, France, New Zealand, Austria, Greece, Norway, Belgium, India, Spain, Canada, Italy, Sweden, Denmark, Japan, United Kingdom, European Commission, Korea, United States, Finland Netherlands.

DSM programme vision is in order to create more reliable and more sustainable energy systems and markets, demand side measures should be the first considered and actively incorporated into energy policies and business strategies.

DSM programme mission is to deliver to our stakeholders useful information and effective guidance for crafting and implementing DSM policies and measures, as well as technologies and applications that facilitate energy system operations or needed market transformations.

The Programme’s work is organised into two clusters:
- the load shape cluster;
- the load level cluster.

The “load shape” cluster includes Tasks that seek to impact the shape of the load curve over very short (minutes-hours-day) to longer (days-week-season) time periods. The “load level” cluster includes Tasks that seek to shift the load curve to lower demand levels or shift loads from one energy system to another.

A total of 18 projects “Tasks” have been initiated since the beginning of the DSM Programme. The overall program is monitored by an Executive Committee consisting of representatives from each contracting party to the Implementing Agreement. The leadership and management of the individual Tasks are the responsibility of Operating Agents.

**CONCLUSIONS**

Demand Side Management, or "DSM" is the process of managing the consumption of energy, generally to optimize available and planned generation resources. Demand side management provides a range of technical, organisational and behavioural solutions to cut or decrease electricity consumption and demand. Demand Side Management (DSM) is the implementation of policies and measures which
serve to control, influence and generally reduce electricity demand. DSM aims to improve final electricity-using systems, reduce consumption, while preserving the same level of service and comfort.

DSM is recognized as a major solution in the fight against climate change since energy consumption and peak demand are reduced, installed capacity and distribution network extension can be avoided (or postponed), and less primary energy is required, reducing greenhouse gas emissions.

In addition to the benefits of DSM action such as reducing the electricity consumption issue or preventing the construction of new power plants and transmission lines, there are other significant benefits which should be mentioned:
- DSM actions are cost-efficient and bring substantial financial savings. DSM is one of the rare type of investments which generates its own economy;
- DSM actions can improve the wellbeing and comfort of end-users;
- DSM actions are win/win solutions with positive impacts for all actors involved: local authorities (reduction of public electricity bill, emphasizing local resources, concrete contribution within the national and European commitments), end-users (reduction of electricity bill, improvement of service and comfort, concrete contribution to the national and European commitments, corporate citizenship), producers and suppliers (reduction of required investments for extension of power and transmission capacity, better public image, customer retention, concrete contribution to the national and European commitments)

Energy-efficiency improvements can slow the growth in energy consumption, save consumers money and reduce capital expenses for energy infrastructure. Additionally, energy efficiency reduces local environmental impacts, such as water and air pollution from power plants, and mitigates greenhouse gas emissions. Energy efficiency standards and labeling programs provide enormous energy savings potential that can direct developing countries towards sustainable growth.

It now focuses well beyond oil crisis management on broader energy issues, including climate change policies, market reform, energy technology collaboration and outreach to the rest of the world.

As the industry considers major restructuring, the scope and character of electric utility DSM are likely to change. Market interventions designed to accelerate the commercialization of new energy-efficient technologies or practices may continue to be justified as a means of reducing market failures. At the same time, restructuring could greatly expand other demand-side activities including the use of real time pricing, time-of-use pricing, automated energy management, energy information services, and other services designed to expand the ability of customers to respond to changing price signals. Providing service packages that include generation, management of the price risks associated with competitive generation.
markets, and demand-side services could help attract and retain customers in a competitive market.

The future of DSM will be determined by the choices that consumers, utilities, other service providers, regulators and legislators make during the transition to competitive electric power markets.

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