Energy Management & Utilization

Chapter 6

Demand-Side Management

Prof. Dr. Uğur Atikol, cea

Director of EMU Energy Research Centre
What is Understood from Demand-Side Management?

“Activities that involve actions on the demand or customer side of electric meter, either directly or indirectly stimulated by the utility.”

Clark Gellings
(Electric Power Institute, USA) 1984
What is Understood from Demand-Side Management?

- The adjustment of consumer demand for electricity by means of financial incentives (such as rebates) or education is termed demand-side management (DSM).
- The main objective of DSM is to:
  - encourage the consumer to use less energy during the peak hours
  - use different sources of energy replacing electricity during peak hours
  - move the time of energy use to off-peak times (such as after mid-night or weekend)
  - reduce the need for investments in the electricity networks
Typical Daily Demand Curves

North Cyprus in 2012

- Hot Summer Day: Ideal Load (279 MW), Peak at 313 MW, 5 hours approx.
- Cold Winter Day: Ideal Load (210 MW), Lower demand.

Demand (MW)

Time of Day (Hours)
Typical Duration Hours for Maximum Peaks

N. Cyprus Load Duration Curve in 2012

- Decrease in required asset
- Decrease in cost of electricity

9% duration
Load Leveling Strategies

- Peak clipping
- Load shifting
- Strategic conservation
- Flexible load shape
- Strategic load growth
- Valley filling
## Examples of DSM Technologies: Residential Sector

<table>
<thead>
<tr>
<th>Residential measures</th>
<th>Impact on demand curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Insulation</td>
<td>Strategic conservation</td>
</tr>
<tr>
<td>Double glazing windows</td>
<td>Strategic conservation</td>
</tr>
<tr>
<td>Energy efficient motors</td>
<td>Strategic conservation</td>
</tr>
<tr>
<td>Efficient appliances</td>
<td>Strategic conservation</td>
</tr>
<tr>
<td>Heat Storage</td>
<td>Valley filling/Load shifting</td>
</tr>
<tr>
<td>Timers</td>
<td>Valley filling/Load shifting</td>
</tr>
<tr>
<td>Instantaneous electric water heaters</td>
<td>Load shifting</td>
</tr>
<tr>
<td>DHW cyclic control</td>
<td>Peak clipping/strategic conservation/flexible load</td>
</tr>
<tr>
<td>Gas heaters</td>
<td>Peak clipping</td>
</tr>
<tr>
<td>Photovoltaic systems</td>
<td>Peak clipping/strategic conservation</td>
</tr>
</tbody>
</table>
## Examples of DSM Technologies: Commercial/Industrial Sectors

<table>
<thead>
<tr>
<th>Commercial and Industrial measures</th>
<th>Impact on demand curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation/double glazing</td>
<td>Strategic conservation</td>
</tr>
<tr>
<td>Efficient appliances</td>
<td>Strategic conservation</td>
</tr>
<tr>
<td>CFL or LED lamps</td>
<td>Strategic conservation</td>
</tr>
<tr>
<td>Energy efficient motors</td>
<td>Strategic conservation</td>
</tr>
<tr>
<td>Heat pump water heaters</td>
<td>Strategic conversation</td>
</tr>
<tr>
<td>Time of use controllers</td>
<td>Load shifting</td>
</tr>
<tr>
<td>Cool storage</td>
<td>Load shifting</td>
</tr>
<tr>
<td>Gas heaters</td>
<td>Peak clipping</td>
</tr>
<tr>
<td>Industrial process heat exchangers</td>
<td>Peak clipping/strategic conservation</td>
</tr>
<tr>
<td>Cogeneration</td>
<td>Peak clipping</td>
</tr>
</tbody>
</table>

- **Energy Efficiency**
  - Strategic conservation
- **Time of Use**
  - Load shifting
- **Disconnect**
  - Peak clipping
  - Flexible load shape
A Simple DSM Planning Cycle

1. Baseline Forecast
2. Program Planning
3. Program Design
4. Program Implementation
5. Program Evaluation

Evaluation:
- Outstanding
- Excellent
- Very Good
- Average
- Below Average
Cost Effectiveness Requirement in DSM – The Traditional Approach

- The costs associated with any DSM program must be less than any «equivalent» supply-side option. (i.e., $NPV = PV_{AS} - PV_{i}$)
Example of a DSM Program for Electric Water Heaters

- Hot water consumption pattern explored
- Two-stage discharging is assumed

The Effect of Standing time on Temperature

According to Turkish Standards, one person needs 50 L of warm water (at 40°C) for taking a shower which is equivalent to 21.4 L of hot water at 80°C mixed with 10°C cold water.

DSM Program Implementation Options

Timer setting strategy that can be employed in N. Cyprus

By controlling the connection times of the EWHs instead of the disconnection times, the utilities can have more control over the hourly load curve

Cost-Effectiveness of the Peak-Shifting DSM Program

- Cost of each timer + installation $42 USD
- 5667 houses selected (5667 x 3kW → 17 MW)
- Rebate $200 → Total cost of program $242
- Total cost of timer installations = $1,371,414
- A 17-MW power plant costs $12,000,000.-
- Avoided cost is $10,628,586 USD
- Cost effectiveness is 12.4 W /$

Importance of DSM for Networks

- The capacity of network needs to be taken into account → Helps regulating the power in the network.
- Even though the installed power is sufficient for meeting the demand if the network capacity is not good, then demand may not be met.
- DSM needs to be applied

Power Generation → Network → Demand
Renewables Complicate the Problem Further

- Renewable energy may be available when there is no demand
- Demand needs to be modified to use the renewable power when it is available — **DSM needs to be applied**!
A Whole-System Management for Lower Prices

- Electric energy is volatile
- Need to use it when it is available

**Diagram:**
- Conventional supply-side generators
- Solar
- Demand
- Peak generators
A Whole-System Management for Lower Prices

DSM with Advanced Control Systems
- Advanced communication
- Smart grid system
- Energy management units
- Smart pricing
- Optimization

Storage Systems
- Pumped water power plants
- Battery systems
- Electric vehicles
- Hydrogen production
- Thermal storage systems

On-Site Generation
- Distributed generation
- Renewable energy
- Cogeneration

Resource integration for reducing costs
Future Directions

- Advanced control systems for the network to exchange communication with the end-users
- Smart grid is helpful
- Smart pricing
- Demand response
- Energy storage strategies
- On-site generation of electricity
Demand Response Based on Advanced Control Theory

Energy Controllers on the Demand-Side

Pre-set rules can be used to avoid peak hours

Information from the generation side is used to avoid the peak hours

Wholesale Electricity Market and Pricing of Electricity

Approaches in Pricing of Electricity

- Average pricing
- Peak load pricing
- Adaptive (real-time) pricing
Common Barriers for DSM in Developing Countries

- Lack of finance
- Inadequate incentives
- Inappropriate institutional structure
- Lack of policy framework
- Habits, traditions and cultural issues
- Poor public awareness
- Lack of technical expertise and know-how