Chapter 3

RESEARCH METHODOLOGY

This research aims to validate the feasibility of the DSM options suggested in the previous chapter.

3.1 Demand Side Management Options

Feasibility has multiple aspects depending on the stakeholder for whom it is being considered. In this research, we discuss feasibility from different perspectives for different stakeholders. Then try to combine these perspectives to develop a broader understanding of feasibility, considering economic, social, and environmental, and policy-related considerations. Feasibility for the consumer depends on the cost-effectiveness of the proposed technology compared to other available technology options. The benefit to the utilities is calculated in terms of utility avoided costs (Reddy, 1996). If DSM options are executed, the utility saves cash on assets for each capacity addition, and fuel costs for power generation are decreased (CEA, 2020). As far as distribution companies (DISCOMS) are concerned, most do not earn cash by supplying electricity to domestic consumers, but rather accumulate losses. Local state governments significantly subsidize retail electricity bills and cross-subsidies from the industrial and business sectors. The advantage to the DISCOMs is discussed in terms of the reduction of these losses. Apart from these, there is a higher cost to the environment and society linked with energy generation and consumption. Large amounts of electricity are generated, exchanged, and consumed every day in the market; still, market prices do not reflect the "true costs" of the energy being sold or consumed. They ignore the external costs to the environment and society. These costs are excluded because they do not affect any stakeholder in the short-term economic sense. But it is high time we understand that the planet belongs to each of us. We should take its responsibility. Environmental and societal advantages are discussed based on studies available on external costs of electricity generation and latest carbon credit prices (Winkler & Van Es, 2007). Electricity generation is a capital and source exhaustive process with prolonged period impacts and site-specificity. Societal and environmental effects are prevalent, and therefore decisions should be made considering the larger costs associated and not just short-term economic advantages. This will guarantee that the results are publicly appropriate, ecologically sustainable, and reasonably feasible (Tatrallyay & Stadelmann, 2013). The common commodity/number across all DSM measures suggested is electricity and the cost associated with it. All assessments are made based on the cost associated with electricity in INR/kWh. Energy and costs are considered as two essential quantities for this analysis, where the time value of money is considered using specific interest rates, but the absolute value of electricity is assumed to not change with time. Technical energy losses have been considered wherever technical processes incur losses. The nomenclature of these costs associated with electricity in INR/kWh may vary based on cases for ease of understanding. This cost is calculated considering the amount of electricity saved and estimates regarding the equivalent incremental costs. We then estimate the cost of saved/generated electricity for each of the DSM options. We then compare it to the cost of supply from numerous viewpoints to provide visions into the cost-effective efficiency improvement levels (Garg et al., 2014).

3.2. Technical Feasibility and Data Collection

To assess the technical feasibility, the key factor taken is to assess whether the technology is simply accessible and adequately available to scale the implementation. Based on said criteria, all the DSM measures suggested are technically feasible, and this is supported by multiple studies mentioned in the introduction and literature review (Martins, 1996).

3.2.1 *Data Collection*

The data collection was carried out by referring to various reports and available data from multiple DISCOMS. The summarized information of the data collection is given below:

A. Data collected from MAHADiscom website and multiple substations (Appendix A):

   Data collected feeder wise, Distribution transformer wise, consumer wise for industrial units Commercial and Municipal units, Residential premises, Load pattern, Peak hours load data, off-peak hours data

B. PM Kusum Scheme (Appendix B):

   Data collected from websites of MNRE and Ministry of power, Central Government. State-wise data, city-wise data, Solar irradiation, PVsyst software output images, graphs etc. farmers' data, Solar pump data.

C. Air-conditioners as energy-efficient technologies (Appendix C)

   Inverter based Air-conditioners, 3star, 4 star, and 5 star rated appliances data from BEE website

D. Utility avoided cost (Appendix D):

   Data collected from 10 states 50 cities for assessing roof top solar power generation 2kW, 3kW and 5kW solar PV system

3.3 Cost Effectiveness for Consumers

Is the cost of implementing the technology competent at market standards? Suppose the incremental cost per unit electricity saving associated with the DSM option suggested is equivalent or less than the consumer tariff being charged by state distribution companies (DISCOMs). In that case, the recommended alternative is cost-efficient for the consumer (Khalid et al., 2019).

3.3.1 *State of Electricity costs and consumer tariffs in India*

The State Electricity Regulatory Commissions determine rates for retail supply and sale of electricity. The price structure is based on the cost of electricity supply depending on voltage of supply, connected load, and energy used. Classifications are made based on different voltage levels and load categories such as 0-2 kW, >2-5 kW, >5-10 kW, >10-25kW, and >25 kW for each voltage level. The consumption slabs are further classified by usage for each load category, such as 0-200 units, 201-400 units, 401-800 units, 801-1200, and >1 200 units with enlightened rates. End-user rates in India are categorized by consumption group, and there is a large variety of tariffs in each state, with cross-subsidy between industrial and domestic users. (Motlagh et al., 2015) Retail prices at the state level show a wide range of price structures and methodologies, leading to a widespread of categories. India's residential retail electricity prices are among the highest in the world, if assessed by purchasing power parity (PPP). In the absolute sense, they are low. Only Brazil and Japan have more costly power prices. These are the consumer average revenues for the year 2015-16. Various reports have described the consumer tariff for the domestic sector in the range of 3 to 10 INR per unit (IEA, 2017), (Khan, 2019) (Xia, 2016).

Table 3.1. Consumer average revenue per unit (INR/kWh), 2015-16

Region	State	Domestic Average	Commercial Average.	Agricultural Average	Industrial Average.
Eastern Region	Bihar	3.32	6.73	3.61	6.86
	Jharkhand	1.38	7.41	0.55	6.10
	Odissa	3.67	6.48	1.58	6.28
	Sedum	2.64	4.94	-	5.96
	West Bengal	5.47	7.43	4.07	3.75
North eastern Region	Arunachal Pradesh	3.78	4.91	-	3.85
	Assam	3.82	7.33	6.31	6.36
	Manipur	3.10	3.53	0.73	2.29
	Meghalaya	3.85	6.92	3.33	6.12
	Mizoram	3.60	6.63	2.00	6.19
	Nagaland	1.93	1.90	-	0.86
Northern Region	Delhi	6.40	11.60	3.82	10.2
	Haryana	5.60	7.69	0.34	7.36
	Himachal Pradesh	4.02	5.71	7.29	5.70
	Jammu & Kashmir	1.77	3.21	1.74	1.43
	Punjab	4.54	6.95	-	6.99
	Rajasthan	4.54	7.00	4.80	6.50
	Uttar Pradesh	3.62	9.22	1.63	8.35
	Uttarakhand	3.24	5.14	2.52	4.97
Southern Region	Andhra Pradesh	3.23	11.42	0.30	6.56
	Kamataka	4.43	8.34	0.98	6.68
	Kerata	3.76	12.73	2.29	6.83
	Puducherry	2.39	5.28	0.26	5.35
	Tamil Nadu	2.82	8.84	-	10.77
	Telangana	2.73	9.23	0.43	7.98
Western Region	Chhattisgarh	3.71	4.89	3.76	7.09
	Goa	2.06	4.82	1.59	4.52
	Gujarat	5.15	5.65	2.67	6.88
	M. .P	5.04	6.59	1.09	7.09
	Maharashatra	5.80	-	2.61	6.66

For evaluation, and analysis of the overall national average tariff on electricity for residential customers is assumed to be INR 5 per unit. In the states in which the consumer tariffs are higher than the average value taken, consumers should expect more significant savings and cost benefits. Similarly, if the consumer tariffs are lower than the average value taken (very few), they should expect consistently lower cost benefits (Esther & Kumar, 2016).

3.4 Gains to Utilities

3.4.1 *Generation Utilities*

If DSM choices are employed, the power generation utility saves cash on investments for each capacity supplement, and fuel costs for power generation are decreased. Factual evaluations between economic impacts of implementing DSM measures and construction of extra generating capacity are made centered on saving potentials of DSM options and utility avoided costs for different sources of power. Utility avoided costs include prolonged-term marginal costs of power generation, transmission, and distribution. Long-run marginal costs consist of capital expenses (Capex) for building new capacity and operational expenditures (Opex) for fuel and routine maintenance (Reddy, 1996).

- *Marginal capacity cost (Capex):* are assets in power generation and T&D facilities to supply extra power. Estimation of marginal capacity costs requires a thorough analysis of the current investment program in the power sector. The weighted average capital cost per kW is calculated based on the share of future installed capacity.
- *Marginal energy costs (Opex):* Fuel and operational costs are needed to provide extra energy. Marginal energy costs include fuel costs and the expenses of transporting the fuel. Running expenses include energy-related and O&M charges.

- *Transmission and distribution costs***:** the price per kW of transmission capacity Sudhakar et al. (Reddy, 2018) calculated the leveled electricity generation cost through various technology options. They have calculated the capital and operational costs at the plant level, and hence the total cost does not include transmission and distribution costs or losses. The results are given in the table below (Reddy, 1996).

According to the Ministry of Power reports, the capital cost of coal-based power plants has increased (2015 data). Also, this data does not include the transmission and distribution infrastructure cost; therefore, it serves the purpose of a conservative estimate for the cost of power generation. The average unit price of electricity generation to the utility company has been taken from this table to calculate the utility avoided cost calculations in different sections.

To compute the actual amount of electricity savings at the source, technical and commercial losses were added to the amount of energy savings at the consumer end. For the estimate for technical and commercial losses, the latest numbers were considered from the CEA executive summary report (CEA, 2020).

Table 3.2 Cost of electricity generation through different sources of energy in India

Description	Solar PV	Solar Thermal	Wind	Biomass	Nuclear	Gas	Hydro	Coal (SC)	Coal (IGCC)
Plant life (in years)	25	25	25	20	40	40	40	30	40
Discount rate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Capital Cost (in Million INR/MW)	62	137.7	61.9	49.21	150	42	72	54	85
O&M Cost (in Million INR/MW)	1.3	1.77	1.06	4.47	15	1.94	2.33	1.2	1
PV	11.8	16.07	9.65	38.06	146.69	18.97	22.79	1 1.31	9.78
Fuel Price (in INR/kg)	0.0	0.0	0.0	1.58	4147	5.71	0.0	3.3	3.3
Fuel Consumption (in kg/kWh)	0.0	0.0	0.0	1.25	0.00025	0.46	0.0	0.75	0.5
Fuel Cost (in INR Mil/MW)	0.0	0.0	0.0	12.11	6.36	6.9	0.0	13.0 1	10.12
Present Value of fuel cost (INR million)	0.0	0.0	0.0	103.1 1	62.17	67.5	0.0	122.63	98.94
Life Cycle Cost (INR Million)	73.8	153.77	71.55	190.37	358.85	128.47	94.79	187.94	193.72
Annualized LCC (INR Million)	8.13	16.94	7.88	22 .36	36.7	13.14	9.69	19.94	19.81
Capacity factor (%)	18	22	25	70	70	30	35	60	70
Annual Generation (kWh/kW)	1577	1927	2190	6132	6132	2628	3066	5256	6132
Genera1ion Cost (INR/kWh)	5.16	8.79	3.6	3.65	5.98	5	3.16	3.79	3.23

3.4.2 *T&D and AT&C Losses (%)*

Taking a careful estimate, Average T&D losses are considered at 21%, and average AT&C losses are considered at 23%. In the states in which the losses are higher than the average value taken, utilities should expect more significant savings and cost benefits. Likewise, where the losses are lower than the average value taken (very few) should expect proportionally lower cost benefits (CEA, 2020).

Table 3.3: T&D and AT&C losses in India

	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
T&D Losses	23.04	22.84	22.77	21.81	21.42	21.04
AT&C Losses	25.48	22.62	25.72	23.98	NA	NA

Provisional Note: As per for utilities selling directly to consumers NA- Not available

3.4.3 *Distribution Companies*

The discrepancy between average cost of supply and average revenue attainment post subsidies has been the significant driver of losses and poor financial health of the Indian power distribution utilities, which are recognized as the lowest link in the overall power sector value chain. India's distribution companies undergo enormous financial losses due to poor transmission efficiency and the non-collection of incomes from consumers. Retail electricity tariffs are subsidized by state governments, as well as via cross-subsidies from industrial and commercial sectors to domestic consumers. Revenues are further challenged by very high technical and commercial losses, with aggregate technical and commercial (AT&C) losses amounting to 20% on average and 40% or greater in some states (IEA, 2017), (CEA, 2019), the same is highlighted in figures below.

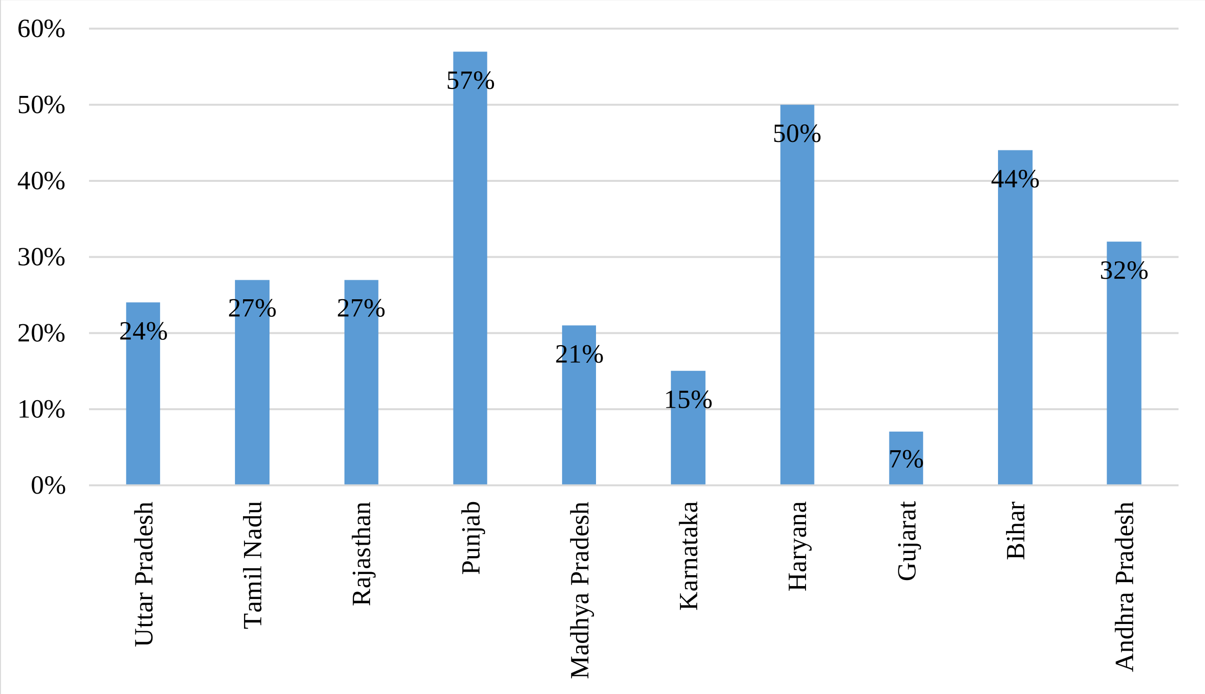


Figure 3.1: State support to the power sector as share of gross fiscal deficit for 2012-13

Most Distribution Companies are not making profits by supplying electricity to domestic customers; rather they are accumulating losses by doing so. A target was set by the UDAY scheme of GOI in 2016 that energy tariffs could only be set within a band of +/- 20% of the average cost of supply – any tariff below this band would have to be paid for by the states to the DISCOMs. In contrast to the domestic sector, commercial and industrial customers are financially desirable for Distribution Companies since they pay elevated tariffs covering the cost of supply and a cross-subsidy to offset part of the losses incurred in the residential sector. The latest figures available from the CEA executive summary report (Authority, 2019) give the difference in the average cost of supply and average revenue attainment by DISCOMs.

3.4.4 *Average cost of power & Average Realization*

Table 3.4 Average cost of power and realization for Distribution Companies (paise/kWh)

Year	Average cost of supply (ACS) (paise/unit)	Average Revenue Realization (paise/unit)			
		Without subsidy	Gap ACS-ARR (without subsidy) paise/unit	Gap ACS-ARR (on subsidy booked basis) paise/unit	Gap ACS-ARR (on subsidy received basis) paise/unit
2013-14	518	400	118	76	77
2014-15	520	412	108	58	60

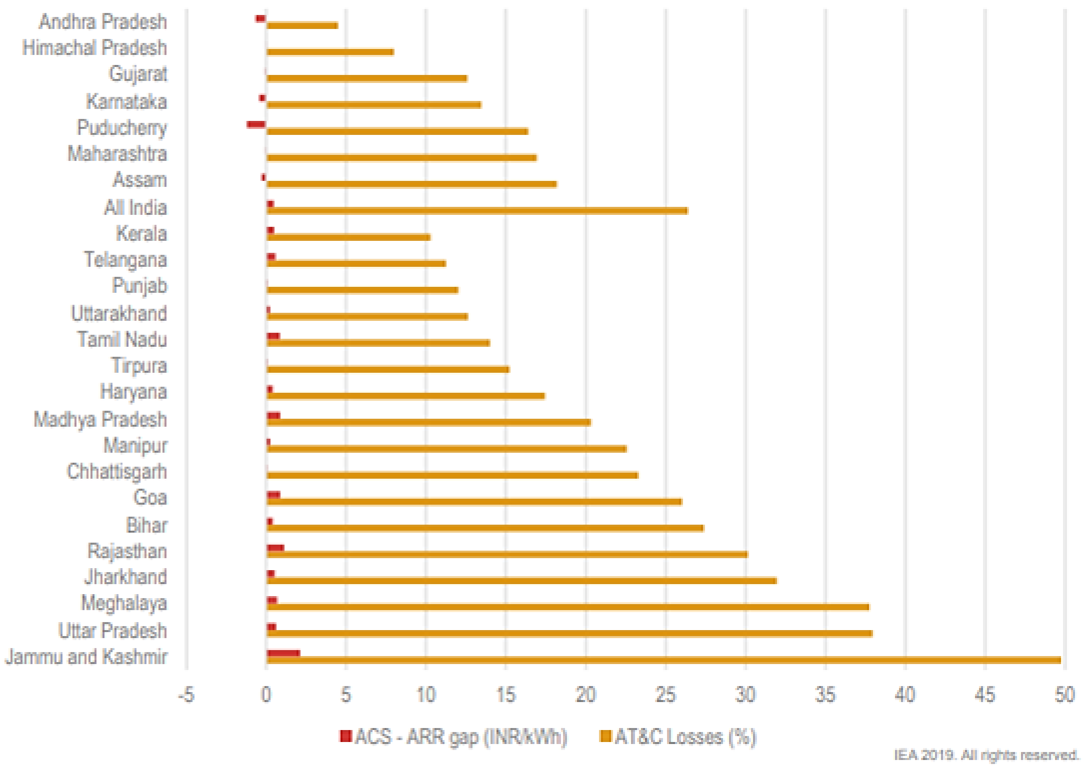
Source PFC Reports on the performance of state power utilities (PFC Ltd., 2016)

Table 3.5 Average cost of supply and average realization over the years

Year	Cost of supply	Realization (paise/unit)	
		Including agriculture	Only Agriculture
2004-05	254	209	75.68
2005-06	260	221	76.36
2006-07	276	227	74.23
2007-08	293	239	77.27
2008-09	340	263	87.13
2009-10	355	268	88.13
2010-11	398	303	88.70
2011-12	455	330	119.75
2012-13	501	376	135.14
2013-14	518	NA	148.67
2014-15	520	NA	175.00

Source: PFC reports on the performance of state power utilities (PFC Ltd., 2016)

State Wise performance of DISCOMs in India is represented by the graph below; except for Andhra Pradesh, Karnataka, and Puducherry, all states have a positive ACS-ARR gap.



Notes: ACS = average cost of supply; ATC = aggregate technical and commercial; ARR = average revenue realised.
Source: UDAY (2019), *Dashboard*, https://www.uday.gov.in/home.php.

Figure 3.2 State Wise performance of DISCOMs in India

Taking a moderate estimate of the ACS-ARR gap, we have assumed that DISCOMs save INR 1 for every unit of electricity they do not sell to the residential customers. For analysis on state wise or utility wise basis, accurate numbers for ACS-ARR gap should be considered. The states in which the gap is higher than the average value taken, utilities should expect greater savings and cost benefits. Equally, where the gaps are lower than the average value taken (very few) should expect proportionally lower cost benefits.

3.5 Environmental and Social Impact Assessment

India still depends on fossil fuels for more than 70% of its actual power requirements, as can be observed from the table below. A Lot of contribution to India's greenhouse gas emissions directly results from burning fossil fuels for power generation. More than 175 countries across the globe, including India, have been signed the United Nations Paris Agreement, which is envisioned as the new global framework that drives collective action towards a low-carbon and climate-resilient future. India thus has a promise to reduce emissions due to power generation (UNIDO, 2007).

The energy we received from the grid comes from multiple sources like coal, natural gas, hydro based, nuclear, solar, etc. Each of these different types of power plants employ various processes to generate power and have widely different effects on the environment. It is necessary to know how much contribution of savings came from each source individually, or rather how much load was reduced on each source because of DSM implementation. To create a precise model for the cumulative effect on the environment, it is required to know if the DSM options suggested are not implemented. In what quantities that electrical energy (which is saved due to DSM) would have come from different sources of energy. Since India has a nationally unified electric grid, for the calculation of cumulative effect on the environment, the formula for total emissions was used. Energy saved was assumed to be distributed into energy from various sources, in proportion to their share in India's total annual power generation (Harding et al., 2019).

$$Total\ CO_2\ Emissions = Energy\ Saved\ by\ DSM\ (kWh) \times \sum [emission\ per\ kWh\ from\ that\ source \times Percentage\ share\ of\ that\ source\ in\ India's\ stotal\ power\ generation]$$

The proportion of various power sources in the total annual energy generation was taken from the generation capacity of India (CEA, 2020).

Table 3.6: Percentage share of different sources in India's total annual generation (CEA, 2020)

POWER GENERATION CATEGORY	**FUEL**	**Total 2019-2020 (MU)**	**% OF TOTAL GENERATION**
THERMAL	COAL	1058970	72.34
	LIGNITE	36000	2.46
	NATURAL GAS	47000	3.21
	DIESEL	150	0.01
NUCLEAR		44720	3.06
HYDRO		136932	9.35
WIND		72528	4.93
SOLAR PV		46398	3.16
BIOMASS		2763	0.19
BAGASSE		7704	0.52
SMALL HYDEL		10258	0.70
OTHERS		368.4	0.03
GRAND TOTAL		1463793.8	100

After the source distribution of energy savings, we must understand what effect generating per kWh of energy from that source will have on our environment, mainly the carbon emissions. To calculate cumulative effective carbon emission saved by implementing the DSM option, from equation 1 above, CO_2 emissions per kWh from different sources are required.

The total CO_2 emissions per kWh from different sources is calculated in two components in this study. One is direct emissions due to generation; the other component is the external cost due to generation due to activities like mining, transportation, health hazards, etc.

3.5.1 ***External Costs of Power Generation***

Electricity pricing in India does not consider any outwardness arising from pollutants such as sulfur oxides (Sox), nitrogen oxides (NOx), total suspended particulate (TSP), and carbon dioxide (CO_2). Numerous studies have confirmed that these pollutants cause tangible damage to human health, buildings, crops, etc. (Mahapatra et al., 2012) determined the monetized value of the floating emissions from the coal fuel cycle in Ahmedabad. Their results have been used here to calculate the external cost of coal-based power production after adjusting for price increases (Mahapatra et al., 2012).

Table 3.7. Pollutants and receptors considered for this study

Receptor	**Pollutant considered**
Building Material	SO_2
Crop	SO_2, Acid rain
Human Health	PM10, CO_2, Fugitive emission, Mines Dust

Air pollution, apart from causing multiple respiratory diseases also causes harm to a wide range of uncovered surfaces such as materials used in buildings, bikes, and prehistoric buildings by corroding and deteriorating these surfaces. Direct exposure to gaseous or particulate air pollutants or indirectly through soil acidification is often the cause of vegetation damages (Mahapatra et al., 2012).

Table 3.8: External cost due to different activities in coal-based power generation

External Costs	**Reported Values 2012 (Paisa/kWh)**	**Inflation adjusted value (Paisa/kWh)**
External Cost from Coal Mining	12	19.24
External Cost from Coal Transport	6.4	10.26
External Cost of Power Generation on Human Health	39.7	63.64
External Cost of Power Generation on Building Material	4.1	6.57
External Cost of Power Generation on Agriculture Crops	3.3	5.29
Total	65.5	105

Direct Emissions

As per direct emissions in the process of generation of power, a report on "CO_2 Baseline Database for the Indian Power Sector User Guide," by the Ministry of Power, Government of India (Bhawan & Puram, 2018), gives the average CO_2 emission factor per MWh of energy for the Indian grid as 0.82 tons of CO_2 /MWh. Applying the data (WNA, 2020) (Bhawan & Puram, 2018) the emission factors for different energy sources are tabulated below, giving the CO_2 emissions in tones per MWh. Multiplying this with the carbon price of 25 dollars per ton of CO_2, we get external costs associated with carbon emissions for each of these power sources. 1 USD is taken to be equal to 74 INR.

Coal-based sources have maximum CO_2 emissions. Photovoltaics (PV) and nuclear are clean energy sources at the use stage, but their life cycle impacts are significant. The emissions due to nuclear and hydel power generation are not direct, but rather indirect, including aspects like material extraction, transportation etc.

Similarly, it is vital to note that energy generated by solar PV panels (rooftop PV systems and solar pumps) also has some indirect CO_2 emissions. It has been calculated in a study done by Norani Muti Mohamed *et al.*, that the CO_2 emissions corresponding to a DSC (Dye-sensitized solar cell) panel fabrication equal to about 0.69 kg/kWh (Mohamed et al., 2016). But these emissions happen only during the production of PV panels and not during their usage. Assuming a solar panel's life with optimal efficiency to be 15 years, this gives us 46 g/kWh per year of equivalent emissions. This value has been taken for calculations here.

Table 3.9: CO_2 emissions and associated cost for different sources

Source of fuel	**grams of CO_2 per kWh**	**tons of CO_2 per MWh**	**Associated Cost (INR/kWh)**	**Total Cost including External Costs (INR/kWh)**
Coal	1040	1.04	1.92	2.97
Natural Gas	545	0.545	1.01	1.01
Nuclear	12	0.012	0.02	0.02
Hydro	24	0.024	0.04	0.04
Diesel	775	0.775	1.43	1.43
Solar	46	0.046	0.09	0.09
Lignite	1280	1.28	2.37	2.37
Naphtha	610	0.61	1.13	1.13

(Source : Ministry of Power, Government of India (Bhawan & Puram, 2018)).

Considering all the above-mentioned costs, techno-economic, and environmental effects of power generation are included. Considering the cost effectiveness, is after including this total environmental cost to the economic cost of supply, the widest, most inclusive definition of cost-effectiveness is achieved. The price-effective efficiency level and corresponding savings ability from a societal perspective are determined to calculate the electricity supply cost to society. From this perspective, even greater efficiency levels could be directed to avoid imposing these costs on society.

3.6 Long term Savings

A detailed engineering-economic evaluation of the efficiency/energy saving ability of DSM measures studied & suggested. We have performed this analysis using data on technologies currently available in the market and assumptions regarding future projections for demand, costs, consumption, and technology enhancements from reports and research articles. To estimate future savings, a "baseline scenario" is assumed for each of the DSM options based on the data on the current scenario in the market, which is publicly available.

For Air Conditioners and Roof Top Solar, we have calculated the system's cost based on current data available from vendors and e-commerce websites. Nevertheless, the cost of implementing the greater efficiency design options is expected to decline through the experience curve effect. In the medium to long term, when economies of scale are realized, the cost of higher efficiency options will go down, even though costs may go up in the short term. Therefore, the savings calculated in this study give only a conservative estimate, and actual savings in the future are expected to be more significant.

The cost of conserved energy is calculated using the established cost, the discount rate, the life cycle of the product, the energy tariff, and the base case model's maintenance cost. The research is ordered such that each subsection in the consequent chapter will demonstrate the feasibility of each DSM Measures in the definition of feasibility. In the next chapter, electricity cost-effectiveness and savings are calculated for each of the DSM options suggested. Based on the cost-effectiveness and saving calculation, the total savings in terms of economic and environmental impact has been discussed in chapter 6.

3.7 DIFFERENT TYPES OF DSM MEASURES

Utilities have adopted various DSM methods or by the energy end-users themselves, usually industrial units and commercial establishments. Utilities try to encourage energy users to alter their consumption behaviors. Such is always achieved through positive tariff incentives that allow customers to schedule demand activities at a time that will decrease their energy costs. This inturn, enables the utilities to change consumer demands away from the peak period. In some cases, financial penalties are charged for the continued operation of inefficient equipment with unnecessarily high loads; this is intended to encourage customers to replace equipment and thereby lower electrical demand.

Industrial units will generally consider a wide range of possible actions to lower all types of energy consumption. A direct reduction in energy consumption will generally reduce costs, and a shift of demand to a different time might reduce costs if an appropriate tariff is available. DSM activities are classified into three classes:

- *Energy reduction programs implementation:*: Decreasing demand through more efficient processes, buildings, or equipment.
- *Load management programs*: changing the load pattern and encouraging less demand at peak times and peak rates**.**
- *Load growth and Energy conservation programs.*

3.7.1 ***Industrial and commercial DSM practices***

Energy management practices

The purpose of energy management is to lower energy costs and bring immediate advantages to an organization or enterprise. Energy management is the designed application of a range of management practices that allows an organization to detect and implement measures for reducing energy consumption and costs. Energy management activities usually cover:

Purchase of Energy, Metering and billing, Performance measurement, Development of Energy policy, Energy surveying and auditing, Awareness-raising, training, and education
Capital investment management (including equipment procurement).

The most critical and precise tasks of an energy management department will depend on the organization's nature and the budget and workforce skills available. Energy management is a process with regular monitoring of energy performance and efficient maintenance and improvement of the use of energy.

Once top officers of the organization have given its approval to undertake energy management in the organization, and suitable resources have been authorized, the next step is an energy manager's appointment. The role of an energy manager will vary from organization to organization, but they will usually be concerned with the following tasks:

- To collect and analyze energy-related data on a day to day basis.

  Do monitoring of energy purchases and equipment procurement.
- Identify energy saving prospects.

  To develop projects of saving energy, including technical and financial appraisals.
- To implement projects and checking post-implementation performance.
- To maintain employee communications and public relations.

The essential part of his job is the collection and analysis of data. Thus, the energy manager must know load profiles and time of use for all forms of energy required to be consumed. Reliable quantitative information on load profiles is needed to analyze the opportunities for load shifting and load leveling. He has to obtain the data, automated measurement and recording equipment is available to record load profiles, and indeed control and manage the use of electricity, gas, liquid fuels, steam, and water. As an example, he has to use the advanced software programs to organize data on energy use (and other key operating parameters) and provide a series of utility cost management applications, such as (C. Martel Chen, 2004):

- Daily load profiling of individual and multiple facilities to ease energy decisions.
- Ensure external and internal benchmarking of energy performance.
- Ensure measurement and verification of energy conservation measures.
- Ensure tenant billing for multiple occupancy buildings.
- Ensure facility management reporting to senior management.
- Do utility bill verification and budget tracking.
- To do Energy accounting, baselining, and savings analysis.
- To do internal cost allocation by cost centers, product lines, etc.

Housekeeping Sector

The procedures to reduce energy consumption and improve energy efficiency in enterprises & other organizations may be divided into three basic categories (for “energy audits”):

- Category 1: There should be no cost and low-cost measures
- Category 2: Some Measures required moderate levels of investment
- Category 3: Some measures required significant investment.

Every organization will have to decide what “moderate” and “significant” mean, as this varies on many factors, such as the size of facilities, levels and cost of energy consumption, and the organization's financial status. The first category is the no and low-cost measures, which cover items usually known as “good housekeeping,” and the organization is expected to“tidy up” its operations. All establishments and organizations should always consider implementing housekeeping measures promptly and diligently because they can reduce energy demand in the short term, usually for exceedingly small capital investments and low installation costs. Some examples of good housekeeping are:

- Replacing / Removing redundant lighting fixtures—many industrial units undergo modifications and reorganization, but lighting systems are often not correspondingly moved, with the result that lights may become redundant.
- Replacing / Removing unnecessary pipework—lighting, process changes or increases in production capacity often results in piping (and sometimes equipment) being redundant. If not properly insulated or removed, the redundant items may lead to unnecessary heat losses and leaks of steam.
- Remove /Making out i.e. off / Switching off of unnecessary loads, such as:
  - Lights—in unoccupied areas and in areas where daylight provides adequate lighting (manually—light switches at strategic points can facilitate manual switching; or by automatic controls—motion detectors, time controls, and photo sensors) should be used.
  - When not in use, computers and monitors switch off reduces the load and reduces heat and, therefore, the demand on space cooling.
- Improving of distribution systems for electricity, steam, and other utilities, e.g., better insulation of hot and cold services, replacing electricity lines to cut line losses.
- Repairing steam leaks—improves the system efficiency and reduces the energy needed to compensate for energy losses in the leaked steam.
- Automation of processes /Maintaining appropriate process control settings, optimizing the processes' efficiency and other energy-dependent activities, thus reducing energy needs.

3.7.2 *Challenges of implementation of DSM Programs*

In developing countries like India, Pakistan, Bangla Desh, there is generally low awareness of energy efficiency programs and DSM programs. Therefore promotion of DSM programs for market operators and the general public are necessary to promote these policies, strategies etc. In the service sector department of a utility company, the sectors, and end-users,customers that can benefit from DSM need to be identified. Customized programs are developed (and their cost-effectiveness evaluated), and then an aggressive plan to market & implement the programs needs to be prepared. Many industrial and commercial establishments have not carried out energy audits to collect reliable information on their day to day operations. While this may be due to management's failure to appreciate the potential advantages of energy efficiency, some companies will lack skilled Energy managers and Energy Auditors to perform audits. For that purpose, consultation from Energy Auditors should be taken, as the cost will usually be well justified. Organizations conducting energy audits or advising on DSM measures need to have a knowledge and understanding of DSM systems and opportunities. (Eskom DSM, 2004). They must demonstrate the competence and comprehensiveness of their assessment. They must consider the accuracy of their assumptions. They have to be aware of the production and safety constraints of involved plants/companies.

A variety of DSM measures may be identified for completing an audit; the load management programs to increase energy efficiency need to consider the following factors (Satish Saini, 2004). The cost incurred to the customer, The disparities in the prices of electricity and other fuels. The value of avoided losses resulting from improved electricity system reliability indices, any potential losses in production when implementing DSM programs.

It is important to carry out a proper financial analysis of the advantages of energy efficiency improvement when considering setting up DSM activities. For example, too much stress may be placed on the initial cost of equipment used by DSM programs rather than on life cycle costs. Also, there is often a perception that electrical energy is a tiny component of overall cost, and therefore, there is little motivation to pay for DSM measures to modify load profiles. Where fuels are involved, proper sensitivity analyses may not be performed to consider potential energy cost variations or inaccuracies in capital investment estimates. All financial investments need to be warranted as part of the process of finding funds for DSM projects. This applies both to funds from company internal cash and to funds from banks or other financial institutes such as international cooperation agencies and the World Bank. A competent evaluation of a project is, therefore, must, otherwise, it will be difficult to get funds authorized and sanctioned, internally or externally. The disaster of getting funds is one of the most critical challenges for implementing DSM projects.