An Analytical Review of Enabling Demand Side Management in Indian Power Market Context

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Abstract

This paper describes, the basics of demand side management (DSM) in perspective of specific area. Understanding of basic relation between demand and supply in DSM is presented. The impact of deliberated interventions of demand and supply on human behavior in electrical power sector is explained. A study of natural and human activities effect on electricity consumptions requirement and accordingly DSM for that, in the rest of world countries of different area and India has been done. A suitable DSM model for India has been developed and studied with respect to natural and human activities in different area.

Keywords: Demand side management, demand and supply, integrated resource planning, distributed generation, distributed energy resources.

1. Introduction

Demand side management (DSM) in electricity power sector is defined as "Demand side management is the planning and implementation of those electric utility activities designed to influence customer uses of electricity in a way that will produce desired changes in the utility's load shape" [3]. Thus, the planning and implementation should be ultimately customer's behavior oriented as their needs, life styles, desires, and satisfactions to obtain the desired goal. The electricity demand and supply depend on the customer's behaviors [2-6] and these vary according to the environmental and human activities and conditions of a specific area [5-11], [82]. Accordingly, the requirements of demand of electricity should be fulfilled by DSM considering proper analysis of demand and supply relationship for that specific area. As the demand and supply are two sides of a market of consumption and production [96].

The study for understanding, the concept of supply and demand with their constraints related to consumers and available resources [4], can play an important role to reap information of consumers' behavioral variations and making suitable demand side management using demand response (DR), integrated resources planning (IRP), distributed energy resources (DERs) and distributed generations (DGs) in electricity sector according to the customer's behavioral information in a specific area [13-15].

The concept is a value added and customer oriented in a range of activities of participants in a practical and more assured way of better managing alternatives [121] along with supply chain [45-50] considering demand of an appropriated strategic position, adequate structural configuration, collaboration, integration and policy in an area [4].

The consumers' behavior is encircled by natural and human activities. The human activities try to be comfort in a specific natural environment in a specific area. The world has different area as cold, hot, developed and in underdevelopment. In this sense, the available resources, requirements, productions, consumptions, markets, policies, investments, technologies used are also different in different area of the world (Fig. 1) [102].

In the fact, there is need of allocation of scare resources of electricity to meet unlimited human wants in optimal case under friendly environment in a specific area. The demand side management in electric power sectors is the perfect concept in this process concerning with conditions.

In literature, several studies have been conducted on demand side management for many issues and objects as methods [1], [13], [16-17]; planning [12], [18-22] alternatives [14]; comparative study [23-24]; development [25-34]; demand response [174, 185], [3]; distribution generation [18], [23], efficiency [39-40]; electric end use technologies [41]; evaluations[42-43]; marketing [114, 128] in various natural and human activities in different area (countries) of the world. There are numerous literatures available on DSM.

The literatures on demand side management have been included the supply and demand curves analysis in many dimensions as follows. Murat Fahrioglu et al. [4] have explained that predicting customers demand management behavior through using existing utility data of supply and demand. The estimated customer cost functions can be calibrated with the help of designing efficient demand management contracts as demand side management [3]. An analysis of market clearing price (MCP) with supply and demand using renewable energy resources (wind energy) can be created competitive market in electric sector [169,136]. H. Zhong et al. [36] modeled coupon incentive-based demand response (CIDR) using price elasticity of supply and demand. Uniform marginal pricing of distributed network with the help of demand curve have been analyzed by P. M. De oliveira De Jesus et al. [47]. Vivekananthan et al. [84] presented demand response as a customer reward (CR) concept with demand and supply curves analysis for home appliances. Mencharella et al. [38] introduced real-time demand response in energy distribution system (EDS) by total costs and energy input analysis using supply and demand curves information. Such analyses have been adopted by many researchers.

Literature on DSM in India has been introduced by Nadel et al. [48] in 1990s with the report on opportunities for improving end-use electricity in India. After this, many literatures have been included for the estimated potential and the cost-effectiveness of energy efficiency and DSM in India [24], [49-54], [32]. In last few years, in India, the issues and challenges are being controlled by demand side management concept in electric power sector [59-56]. In this view, Harish et al. [24] explained action plan, policy and regulation for DSM. Multi-criteria evaluation of DSM for implementation strategies is described by Sanjay at al. Multi-objective DSM evaluation is studied by Nandkishor at al. [55] for utility peak demand deficit. In the process, several approaches have been reported concerning with India.

Nevertheless, in the above literature, regarding to India have not emphasized on a model and discussion on planning, implementation and evaluation considering the issues related to variations of consumers behaviors due to natural and human activities under different conditions in a specific area by DSM with demand and supply study (understanding).

In view of above this paper presents a model for enabling demand side management in India on area based. The model is designed by studying of demand side management in different countries of different natural and human conditions under supply and demand.

The rest of this paper is arranged as follows. Section-II introduces the supply and demand concept for utilizing that information in demand side management in specific condition. Section-III explains the impacts of natural and human activities on energy requirements and demand side managements in different countries (in a specific area). Section-IV develops a suitable model of DSM for Indian scenario and section-V presents conclusions and scopes.

2. Demand and Supply in DSM

2.1 Market law of Demand and Supply

A market is the locus of exchange where simply buyers and sellers coming together for transactions. Through the circular flow, we can better understand the interdependency of a market sector [4] as follows in Fig. 1.

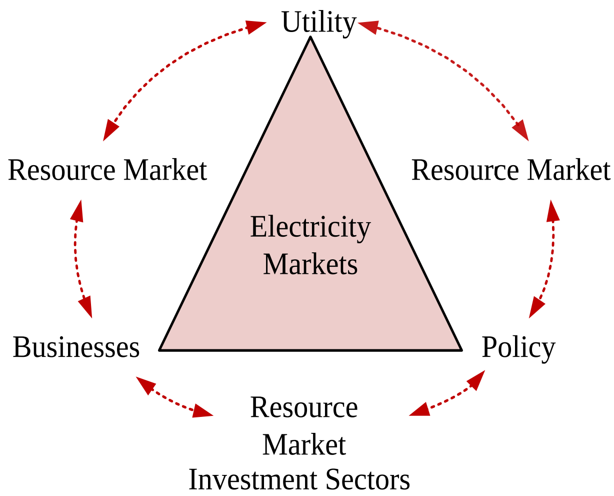

Fig. 1. The circular flow diagram for a market interdependency

The circular flow diagram includes as inside the pyramid is the energy markets where the parties obtain and sell the energy; the factor markets which is shown in the dashed arrows circle are where the utilities parties obtain and supply the energy resources under the regulated policy to gain the suitable profits and the investment sector in base indicates that the same buying and selling of electricity with investment by private, public private or public sectors. The circular flow diagram shows that each of the sectors relies on the others for resources and supplies interdependency [4].

In the market, law of demand states that as price increases consumers will purchase less and vice versa [4]. It has negative slope as in Fig. 2. The slope depends upon utility (use, pleasure, jollies) from the consumption, changes in utility (marginal utility), income effect, substitutive effect and diminishing marginal utility [2], [36], [45]. Diminishing marginal utility is the fact that at some point further consumption adds smaller and smaller increment to the total utility received from the consumptions.

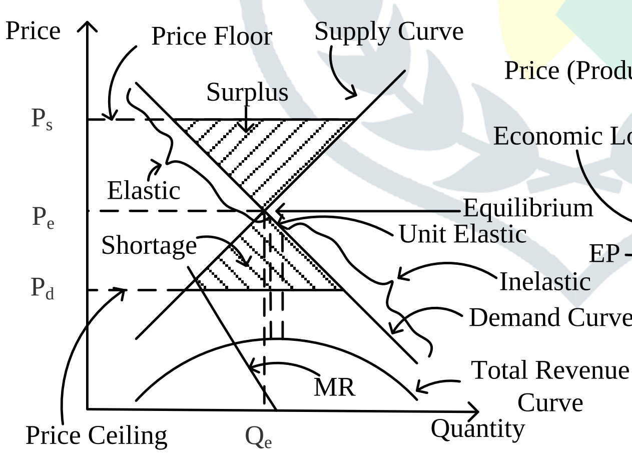

Fig. 2. Demand and Supply Curves

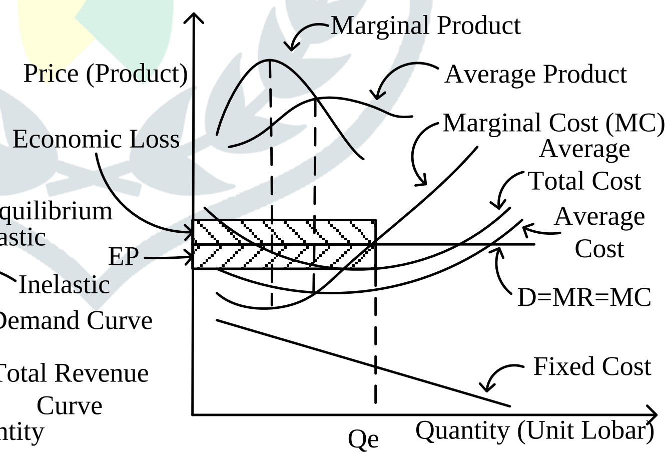

Fig. 3. Costs with Demand Curves

EP=Economic Profit, D=Demand, MR=Marginal Revenue.

The law of supply states that more the supply, the higher the price. Supply schedule at the quantities supplies at each and every price. The supply curve is a positive relation between price and quantity of a supply curve as in Fig. 2. A market supply and demand are simply an aggregate of all individual supply and demand curves [4].

2.2 DSM with Supply and Demand

Demand side management in electrical sector includes demand response, integrated resource planning, distributed energy resources in demand and supply [13]. The demand side management can be implemented on the electrical energy market of demand and supply. The demand and supply in electric sector depend on various factors of natural and human activities in an area [2], [4], [130-136], and [181-184].

The supply of energy in electric market can be managed as follows.

1. The resources prices can be handled by optimization process of demand response, integrated resources, alternatives and distributed generation [3], [14], [36-37];
2. Technology used in electricity production, consumption and supply in the demand side management, integrated resource planning, distributed energy resources, demand response [79-80], [123-125];
3. Taxes and subsidies can be changed by governing policy and demand responses for motivation [11], [21], [28], [58];
4. Making competition among energy providers for reduction energy price using renewable energy resources with demand response and providing suitable policy for preferential/feed-in tariffs(FITs), renewable energy certificates(RECs), renewable portfolio obligations(RPOs)/renewable portfolio standards(RPSs) [44-45], [59-63];
5. Ensuring consumers expectation of future price and supply with proper managing the energy with demand response [37];
6. Increasing distributed energy resources [38].

In the demand side of electric power system, the energy can be managed as follows.

1. Tastes and preferences of consumers by using demand response both in incentive based and time based [190-192];
2. Changing the consumptions by using efficient electric end use devices and electrification (Technologies) [41];
3. Using integrated resource planning [18];
4. Consumer's expectations for future availability and prices by better demand side management [3];
5. Changing the changes of demand versus quantity of usage of electricity [2];
6. Changes in electricity market create new equilibrium position on supply and demand curves [4].

The price of electricity energy can be controlled considering demand and supply with surplus and shortage with respect to analysis of market equilibrium with suitable profit for energy providers and giving options to consumers within suitable policy as in Fig. 2 and Fig. 3. For example, both demand and supply can be expressed as follows [4].

$$Q_d = 8 - P \quad \text{for demand curve}$$
$$Q_s = 2 + P \quad \text{for supply curve}$$

In the equilibrium condition,

$$Q_s = Q_d$$

Therefore,

$$8 - P = 2 + P$$
$$P = 3$$

To find the equilibrium quantity, we plug 3 (for P) in to either supply or the demand curves and we get, 8-3=5 (demand side) and 2+3=5 (Supply side).

Enabling suitable demand side management with understanding the equilibrium conditions of the electricity market with respect to changes in demand and supply; we can get good results in environment impacts, reduction of costs and prices [2], [4], [47], [64].

The effect of price changes on demand can be measured by the price elasticity of demand that is a measure of responsiveness of quantities demanded to changes in prices (Fig. 3). The elasticity coefficient is calculated using mid-point formula as follows [3-4].

$$E_d = \ (Change\ in\ Quantity\ /((Q_1 + Q_2))/2)/(Change\ in\ Price/((P_1 + P_2)/2))$$

Elastic demand means that the quantities demanded respond more than proportionality to changes in prices. The elastic demand coefficient is more than one. The inelasticity of demand means that the quantities demanded respond less than proportionality to changes in prices. The inelasticity of demand coefficient is less than one. Under unit elasticity of demand the quantities demanded respond proportionality to changes in prices. The unit elasticity of demand coefficient is exactly one (Fig. 3) [4].

The price elasticity depends on substitutability, proportion of income, luxuries versus necessities and time which one suitable for demand side management in electric power sector. The price elasticity of supply is determined by the following time frames. The more time, a producer has to adjust output the more elasticity supply. This depends on market period, short run, long run. Cross elasticity of demand measures the responsiveness of the quantity demanded of one producer to changes in the price of another producer. The income elasticity of demand measures the responsiveness of the quantity demanded of to changes in customer price.

The understanding on concept of demand and supply, equilibrium of market under demand and supply, elasticity of demand and supply, inelasticity of demand, cross elasticity, income elasticity and their constraints provides better understanding for total cost (TC)=fixed cost (FC) + variable cost (VC), total revenue= $P \times Q$, marginal revenue (MR), marginal cost (MC), average total cost (ATC), average variable cost (AVC) which are demand and supply in markets of electric sector (Fig. 3) [4]. These understandings provide important information for planning, implementation, monitoring and evaluation in demand side management in for desired changes in electric sector.

3. Natural and Human Activities with DSM

Natural and human activities play an important role in allocation the natural and human resources for generation of electricity according to requirement and their impacts on environment.

3.1 Natural and Human Activities in World Scenarios

World is divided in seven continents with different natural and human activities with different allocation of resources among population. There is more than seven billion population. Population is increasing and the conventional source availability is decreasing. The adverse effect on environment is increasing due to climate changes caused by external forces as human activities. In the world's different parts climate is different due to their location, terrain, altitude, nearby water bodies and their currents. Therefore, there is variation in temperature, weather, humidity, atmospheric pressure, and other meteorological variation in a region over a time (long or short). Because of these variations in the natural activities, there is variation in resources availability and human activities in a particular region (area) of the world. According to the variations in the activities, the electricity requirement, generation, management and impact on environment also different for different regions, countries and areas as in table-I as follow [76-78].

Table-I, shows data in percentage for electricity generations and consumptions of different countries of different areas with different resources of generation and consumptions. The electric power generation is now shifting from fossil fuels as coal, oil, gas to towards the renewable energy resources as hydro (Hyd), wind, photovoltaic (PV), Tidal (TD), geothermal (Geo) and biomass (Bio). The nuclear (NC) energy is also an important resource for electricity generation. There are four major end use sectors: commercial (Com), industrial (Ind), residential [Heating (HT), Cooling (CL), Lighting (LT)], transportation (Tran). The electric power sector (PS) also consumes energy.

Thus, in the same and/or different conditions each and every country has its own technology, policy and capability to use available resources. For example, Japan with many ups and downs of accidental, environmental and economic issues has emerged strongly in photovoltaic energy use due to its suitable policy and innovative technology according to available resources [65].

Table 1 World data of energy consumption

Country	**Electricity Generation Resources** (All in TW)								**Electric Consumption MWh/yr**							**Per Capita**
(Area)	***Fossil Fuel***			***Renewable***					***NC***	***Resi***	***Com***	***Agr***	***Ind***	***Tras***	***Oth***	
	Coal	Oil	Gas	Hyd	Wind	PV	Geo	Bio & Oth.	(All In Percentage)							
World	41%	5.5%	21%	16%	1.1%	.064%	0.3%	1.3%	13%	27.4	23.4	2.5	41	1.6	3.43	313
USA	2133	58	911	282	56	2.48	17	73	838	36.3	35	-	24	0.20	4.59	1402
UK	127	6.1	177	9.3	7.1	0.02	-	11	622	27.4	25.6	0.88	44.7	1.33	-	622
Germany	291	9.2	88	27	41	4.4	0.02	29	148	26.5	22.6	1.66	46.1	3.14	-	861
Japan	288	139	283	83	2.6	2.3	2.8	22	258	29.8	36.4	0.09	31.5	1.95	5.05	774
China	2,733	23	31	585	13	0.2	-	2.4	68	15.5	5.4	3.12	67.8	1.05	7.19	442
India	569	34	82	114	14	0.2	-	2	15	20.7	8	17.92	46.4	1.93	5.05	883.6
Nigiria	-	3.1	12	5.7	-	-	-	-	-	55.3	24.7	-	20	0.07	-	12
Egypt	-	26	90	15	0.9	-	-	-	-	39.2	15.4	4.13	33.4	-	7.84	147
Australia	198	2.8	39	12	3.9	0.2	-	2.2	-	34.5	28.6	1.14	33.2	2.47	-	1114
Iran	0.4	36	173	5	0.2	-	-	-	-	32.3	19.0	12.92	33.2	0.15	2.50	305
Brazil	13	18	29	370	0.6	-	-	20	14	23.2	23.7	4.49	48.1	0.39	-	268

An analysis of energy problems and issues requires a comprehensive presentation of basic supply and demand data for all resources of the market. This gives building blocks for madding suitable planning, implementation, evaluation and overall management to obtain a desired goal concerning with the problems and issues for a specific market and area conditions; and then this provides ways for its implementation increasingly in a large scale (area). For example, in electric market, demand side management started from California of the USA in 1970s with energy issues and at present, it is increasingly spreading over the world [8].

3.2 Current DSM in Wold

Demand side management (DSM) in electric power sector started in 1970 from the USA in California states in response of rising oil price (cost). It has also been issues to improve its image in public hostility for reducing cost issues and environmental issues. In the early 1980s, it started in the context of integrated resources planning for cost reduction and meeting energy demand in the United States. Demand response (DR) and integrated resource planning (IRP) increased the importance of DSM for utilities through changes for incentives set by regulators [14]. By the regulators calculated the allowed rate of return, many utilities in the United States became profitable and less dependent upon the numbers of units sold. Demand side programs had been implemented many states of the USA, Canada, and Australia, numbers of European, African, South American and Asian Countries. As in the review Table 3, the types of DSM policies and programs are currently underway in different parts in the world as follows [8], [31], [69], [78], [137], [153], [57], [178].

At regional or multi-national level, in 1999, the International Energy Agency (IEA) proposed that all countries harmonize energy efficiency policies to reduce standby power to 1 Watt or less per device in all products by 2010. Further the IEA proposed that all countries adopt the same definition and test procedure, but that each country uses measure and policies to its own circumstances. 480 TWh, standby energy each year has been estimated worldwide. It can be reduced to 60 to 80 percent [39].

At country level in globally, many countries are using voluntary endorsement labels. Korea and USA have implemented government procurement procedure. The Japan and California adopted the regulation of IEA. Australia, New Zealand, USA, Canada are considering the regulation and in the Europe the voluntary code of conduct is implemented. In African countries, DSM implementation has introduced due to many factors as education, financial [100]. DSM in electric sector is in growing age. At present, this is in the limited area and being spread worldwide of the globe as in Fig. 5 [106].

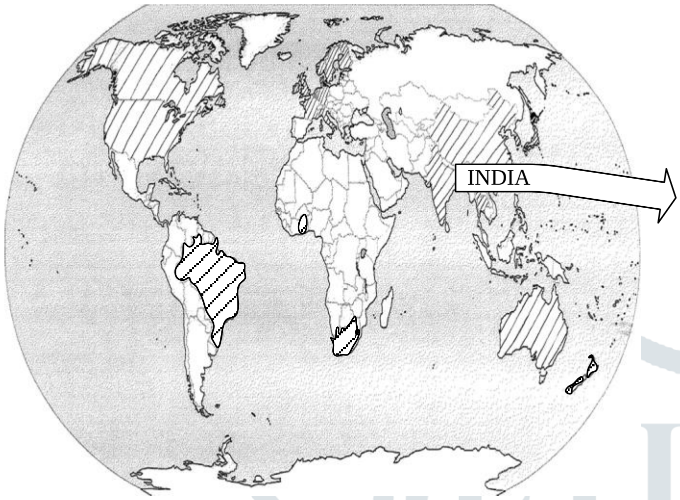

Fig. 5 DSM in the World

Fig. 6 DSM in India

Table 3. World-wide comparative analysis and justification of proposed review article

Ref.	Objective	Algorithm	Manag--ement		Energy Source		Load Model				User Comfort		Pricing Scheme		Resource Scheduling	
			PS	PD	RE	BE	UE	SL	NL	TC	SOC	WL	RTP	TOU	HEM	DEM
[8]	Profile Manag-ement	DSM concept	√	√	×	×	√	√	×	×	×	×	√	√	×	√
[31]	Uncertainty handling	DSM in microgrid	√	√	√	√	√	×	×	×	×	×	×	×	×	√
[39]	Lower emission	DSM survey	√	√	√	√	√	×	×	×	√	×	√	×	×	√
[69]	DSM implementation	DSM concept	×	√	×	×	√	√	√	√	×	×	√	√	×	√
[78]	Reduce greenhouse gas	DSM programs	×	√	×	×	√	√	×	×	×	×	×	√	×	√
[100]	Load aggregation	DSR concept	×	×	√	√	√	√	√	×	×	×	×	√	×	√
[106]	Cyber security	Smartgrid	×	×	√	√	√	×	×	×	√	×	√	√	×	√
[137]	Emission reduction	DSM policy	×	√	√	√	√	×	×	×	√	×	√	√	×	√
[153]	Peak load Saving	DSM concept	×	√	×	√	√	×	×	×	√	×	×	×	×	×
[163]	Resources profitability	ESS concept	√	×	√	√	√	×	×	×	√	×	√	√	×	√
[173]	General comfort	DSM concept	×	√	√	×	√	√	√	√	×	×	√	√	√	×
[176]	PBP benefits	Price-based program	×	√	×	×	√	√	√	×	×	×	√	√	×	√
[178]	Reduce cost	DSM concept	√	√	√	√	√	×	×	√	×	√	√	×	√	√
Proposed article	Demand-supply balance	DSM elasticity concept	√	√	√	√	√	√	√	√	√	√	√	√	√	√

PS-Power supply, PD-Power demand, RE-Renewable energy, BE-Battery energy, UE-Utility energy,TC-Thermal comfort, SL-Shiftable load, NL-Non-shiftable load, WL-Water level, RTP-Real-time price, TOU-Time-of-use, HEM-Home energy management, DEM-Distribution system management

TAble 2 Indian data of energy consumption

Country (Area)	Electricity Generation Resources (All in MW)						Electric Consumption						Per Capita
	Fossil Fuel			*Renewable*			*UT*	*DM*	*CM*	*IR*	*ID*	*OT*	
	Coal	Oil	Gas	Hydro	RES	NC	(CAGR 2003-04 to 11-112 All In %)						
NR	35,283.50	12.99	5,231.26	5,455.12	670.06	1620.00	10.8	11.5	11.2	10.4	10.5	10.2	833.2
WR	54,069.51	17.48	9,738.31	7,447.50	9,925.19	1,840.00	8.4	10.7	10.6	4.6	9.1	8.3	1,201.2
SR	26,582.51	939.32	4962.78	11,398.03	13127.33	1,620.00	8.9	9.9	11.0	7.3	8.6	9.4	938.8
ER	34,583.50	17.20	190.00	4113.12	417.41	0.00	11.4	17.7	5.5	8.1	9.2	6.1	521.2
NER	60.00	142.74	1208.50	1242.00	252.65	0.00	13.9	20.1	12.2	8.1	8.8	7.1	0
Islands	-	70.02	-	-	10.35	-	11.5	12.6	10.3	0	8.7	9.6	0
India	140,723.39	1,199.75	21,381.85	39,893.40	29,462.55	4,780	9.5	11.9	10.5	7.3	9.3	8.9	917.2*
In %	58	9	1	2	18	12	9.5	11.9	10.5	7.3	9.3	8.9	917.2*

*Provisional

3.3 Natural and Human Activities in India

India is situated on the globe north of the equator between 8°4´ and 37°6´ north latitude and 68°7´ and 97°25´ east latitude. It has good solar radiations. It has average temperature range 12.5 °C to 30 °C in the northwest, 17.5 °C to 30 °C in the north and northeast, and 22.5 °C to 30 °C in the south. The total area of India is 3, 287,263 km^2. India is seven largest country and one-third size of United States. India's coastal line is 7,516 km. It has 29 states and 7 territories of different level of developments [67-68]. The Table 3 reviews Indian data.

India has 1.21 billion populations which shares 17% world population. India is second largest country after China in the world population. In India, rural and urban population distribution is 68.84 % and 31.16 % respectively with electric energy consumption and requirement growth rate of 10% and 8% [5]. So, India has good potential in natural as well as human resources.

The costal and sea areas have good wind energy resources. And also, the whole land area of India is very suitable for solar electricity resource. The climate of the India is monsoon. So, most of the land is used for agriculture. As from the table-II, the electricity used is 7.3% in agriculture (IR), 9.3% in industrial (ID), 10.5% in commercial (CM), 11.9% in domestic (DM), 9.5% in utility (UT) and 8.9% in other sector. The table also shows the electricity consumption in different regions (area) as north region (NR), south region (SR), west region (WR), east region (ER), northeast region (NER) and islands of India with indication of the different activities and developments. India's economy very much depends on agriculture and growing towards industrial and technology with strong economic growth driven by real GDP growth of 8.7%in the last 5 years. Hence, India has a great potential of human resources and markets for demand side management in electric power sector which is very much suitable and important.

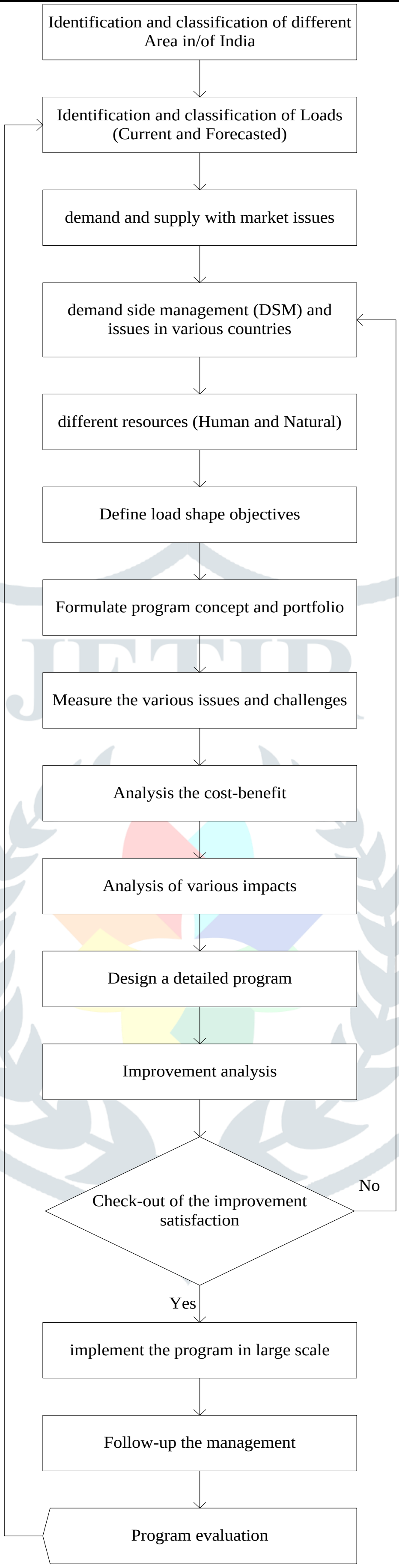

Fig. 7 Flow Chart for DSM for India

Table 3. India-based comparative analysis and justification of proposed review article

Ref	Objective	Algorithm	Management		Energy Source			Load Model		User Comfort			Pricing Scheme		Resource Scheduling	
			PS	PD	RE	BE	UE	SL	NL	TC	SOC	WL	RTP	TOU	HEM	DEM
[5]	Cost- energy conservation	Training transfer concept	×	√	×	×	√	×	×	√	×	×	×	×	√	×
[14]	Reduceenergy consumption	Demand response concept	×	√	×	×	√	×	×	√	×	×	×	×	√	×
[26]	Methodology implementation	DSM concept	×	×	√	×	×	×	×	×	√	×	√	√	×	×
[49]	Cost minimization	DSM concept	√	√	√	×	×	√	√	√	×	×	×	√	×	√
[61]	Demand-supply Balance	DSM concept	√	√	√	√	√	×	×	×	√	×	√	×	×	√
[67]	Load Profile improvement	MonteCarlo simulation	√	√	√	×	×	√	√	√	×	×	×	×	×	√
[79]	Reduceenergy emission	DSM concept	√	√	×	×	√	√	√	×	×	×	√	√	×	√
[160]	sustainable energy	Solar energy	√	√	√	√	√	×	×	×	×	×	√	√	√	√
[170]	Futureaspects	wind energy	√	√	√	×	√	×	×	×	×	×	×	×	×	√
[171]	Impact investigation	Govt.policy	×	√	√	×	×	×	×	×	×	×	√	√	×	√
[172]	Load balancing	V2G-G2V concept	×	√	√	√	√	×	×	×	√	×	√	×	×	√
Proposed article	**Demand-supply balance**	**DSM elasticity concept**	√	√	√	√	√	√	√	√	√	√	√	√	√	√

PS-Power supply, PD-Power demand, RE-Renewable energy, BE-Battery energy, UE-Utility energy, TC-Thermal comfort, SL-Shiftable load, NL-Non-shiftable load, WL-Water level, RTP-Real-time price, TOU-Time-of-use, HEM-Home energy management, DEM-Distribution system management

3.4 Current DSM in India

Demand side management in India introduced by literature Nadel et al. [48] in 1990s with the effect of DSM in the USA and worldwide. The DSM came in planning and implementation in India in 8th five-year plan (1992-1997) to save 5000 MW and 6 million tones petroleum funding with Rs. 1000 crores [49]. During the 11th five-year plan, Bureau of Electricity Efficiency (BEE) and Ministry of Power (MOP) has introduced a number of schemes for promotion of energy efficiency in India [79]. After, almost fulfillment of ‘one nation one grid’ dream in 11th five-year plan (FYP), 12th FYP is conducting governments.

Low carbon growth strategy to ensure the sustainable development of the power sector with DSM schemes. In this way, enactment of the Electricity Act 2003, National Electricity Policy (NEP) 2005, Integrated Poly 2008 and

Energy Conservation Act 2011 with State electricity Regulation Commission (SERC), State Design Agency (SDA), and National Action Plan on Climate Change (NAPCC) [67-74].

The State Designated Agency (SDA) is a nodal agency in many states in India that advises the SERC for suitable enabling the policy of DSM with State Energy Contribution Conservation Fund (SECF). The states like Gujarat, Tamil Nadu, Maharashtra, Himachal Pradesh, Rajasthan, Andhra Pradesh, Mizoram, Chhattisgarh, Haryana, and Karnataka have been adopted regulation under the EA 2003 and NEP 2005 as in Fig. 6 [73].

3.5 DSM Model for India

As per the above studies, we have been modeled a suitable DSM for the India as shown in Fig. 7, [67],[79], [160], [172]. The data of the table-I & table-II, Fig. 5 & Fig. 6 and the study show the different levels of status in a large difference of electricity in different regions of the world and India. And the human activities depend on education, available resources, technologies, income, living style and development in a particular area. So, we first need to identification and classification of different Area of India as Regions, States, Divisions, Districts, Tehsils, Blocks, Panchayats, and Villages for understanding electric demand and supply according to the activities in that area. Then understand the loads and markets issues and correlate these with previous implemented DSM in the same environmental and human conditions with resources for proper allocation as per demand. Define load shape objectives for obtaining with DSM and formulate program concept and portfolios with proper measurements. Now, analyze the cost-benefit with demand and supply concept for the objective and design a detailed program. Do the analysis for the improvement, check-out for the desired goal. Implementation should be with proper follow-up management and evaluation with time.

4. Conclusions and Scope

This paper provides the basic understanding of demand side management with supply-demand and various activities in different area. The situations, issues, activities and conditions are different in various parts of India. This understanding is very important for India to construct the infrastructures in electric power sector as it is developing countries where proper electrification has a need.

5. References

[1] Clark W. Gellings, “The concept of demand–side management for electric utilities,” in *Proc. IEEE Journals & Magn*., vol. 73, no. 10, pp. 1468-1470, Oct. 1985.

[2] Kumar, S., Bhattacharyya, B. & Gupta, V.K. “Present and future energy scenario in India.” *J. Inst. Eng. India Ser. B* 95, 247–254 (2014).

[3] R. Premkumar, R. Shanmugasundaram, K. R. Thilak and A. N. V. S. S. Balaji, "A review on demand side management: definition, scope, challenges and benefits," *2022 8th International Conference on Smart Structures and Systems (ICSSS)*, Chennai, India, 2022, pp. 1-4.

[4] M. Fahrioglu and F. l. Alvarando, “Using utility information to calibrate customer demand management behavior models,” IEEE Trans. Power Systems, vol. 16, no. 2, pp. 317-322, may 2001.

[5] Ali, S.S., Tyagi, R. Free of cost energy conservation through behavioural training: An Indian perspective. *J. Inst. Eng. India Ser. B* 103, 1563–1575 (2022).

[6] Subhasis Panda, Sarthak Mohanty, Pravat Kumar Rout, Binod Kumar Sahu, Mohit Bajaj, Hossam M. Zawbaa, Salah Kamel, ”Residential demand side management model, optimization and future perspective: A review”, Energy Reports, Volume 8, 2022, Pages 3727-3766, ISSN 2352-4847.

[7] W. Yang, R. Yu and M. Nambiar, “Quantifying the benefits to consumers for demand response with a statistical elasticity model,” IET Gener. Transm. Distrib., vol. 8, no. 3, pp. 503-515, Aug. 2014.

[8] S. Baraniya and S. Zahid Nabi Dar, "Consumer demand profile management through demand side load management: A review," *2022 Third International Conference on Intelligent Computing Instrumentation and Control Technologies (ICICICT)*, Kannur, India, 2022, pp. 1742-1747.

[9] Sisodiya, Sukhlal, Ganesh Balu Kumbhar, and M. N. Alam. "A home energy management incorporating energy storage systems with utility under demand response using PSO." *2018 IEEMA Engineer Infinite Conference (eTechNxT)*. IEEE, 2018.

[10] M. S. Behera and S. K. Jain, "A review on different techniques of demand response management and its future scopes," *2021 International Conference on Control, Automation, Power and Signal Processing (CAPS)*, Jabalpur, India, 2021, pp. 1-8.

[11] U. S. Energy Infornation Administration (EIA): International energy outlook 2013. [Online]. Available: http://www.eia.gov/forecasts/ieo/pdf /0484 (2013).pdf

[12] K. Banerjee, S. Sen, S. Chanda and S. Sengupta, "A review on demand response techniques of load management in smart grid," *2021 IEEE International Power and Renewable Energy Conference (IPRECON)*, Kollam, India, 2021, pp. 1-8.

[13] D. C. Sekhar, P. V. V. R. Rao and R. Kiranmayi, "Conceptual review on demand side management, optimization techniques for the improvement of power quality in smart grids," *2022 Second International Conference on Artificial Intelligence and Smart Energy (ICAIS)*, Coimbatore, India, 2022, pp. 1640-1647.

[14] Potdar, A., Potdar, D. "Electrical energy conservation aspects in Indian railways," *J. Inst. Eng. India Ser. B* 101, 177–184 (2020).

[15] Sarkar, S., Chakrabarti, U., Bhattacharyya, S. *et al.* "A comprehensive assessment of the need and availability of smart grid technologies in an electricity distribution grid network," *J. Inst. Eng. India Ser. B* 101, 753–761 (2020).

[16] United nations industrial development organization: Demand-side management, module 14, Aug. 2006. [Online]. Available: http:// www. unido.org/fileadmin/media/documents/pdf/EEU_Training_Package/Module14.pdf

[17] Kumar, S., Sharma, S., Sood, Y.R. *et al.* "A review on different parametric aspects and sizing methodologies of hybrid renewable energy system," *J. Inst. Eng. India Ser. B* 103, 1345–1354 (2022).

[18] S. Chakraborty and A. K. Bohre, "Planning of renewable DG with different load modelling," *2021 IEEE 2nd International Conference On Electrical Power and Energy Systems (ICEPES)*, Bhopal, India, 2021, pp. 1-7.

[19] Sisodiya, Sukhlal, and Ganesh Balu Kumbhar. "Demand-side resources for electric energy management." *2018 4th International Conference on Electrical Energy Systems (ICEES)*. IEEE, 2018.

[20] International Energy Agency (IEA), Nordic energy technology perspectives : At a glance, 2012. [Online]. Available: https://www.iea. org/media/etp/nordic/NETPataglance(web).pdf

[21] Balasubramanian Sambasivam, Yuan Xu,"Reducing solar PV curtailment through demand-side management and economic dispatch in Karnataka, India", Energy Policy, Volume 172, 2023, 113334, ISSN 0301-4215.

[22] Preeti Gupta, Yajvender Pal Verma, "Voltage profile improvement using demand side management in distribution networks under frequency linked pricing regime," Applied Energy, Volume 295, 2021, Pages 117-153, ISSN 0306-2619.

[23] Tarun M. Khanna, "Using agricultural demand for reducing costs of renewable energy integration in India," Energy, Volume 254, Part C, 2022, Pages 124-385, ISSN 0360-5442.

[24] P. Saini and L. Gidwani, "Study on energy storage system applications, allocation and challenges," *2020 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, Jaipur, India, 2020, pp. 1-7.

[25] K. Parvin, M.A. Hannan, Looe Hui Mun, M.S. Hossain Lipu, Maher G.M. Abdolrasol, Pin Jern Ker, Kashem M. Muttaqi, Z.Y. Dong, "The future energy internet for utility energy service and demand-side management in smart grid: Current practices, challenges and future directions," Sustainable Energy Technologies and Assessments, Volume 53, Part C, 2022, Pages 102-648, ISSN 2213-1388.

[26] V.S.K.V. Harish, Arun Kumar, "Demand side management in India: Action plan, policies and regulations," Renewable and Sustainable Energy Reviews, Volume 33, 2014, Pages 613-624, ISSN 1364-0321.

[27] N. S. S. R. Krishna, Elangovan, T. S. Kishore and G. Sowgandhika, "A review on technical-economic aspects of grid connected hybrid renewable energy power system," *2017 International Conference on Intelligent Sustainable Systems (ICISS)*, Palladam, India, 2017, pp. 355-360.

[28] Olufolahan O. Osunmuyiwa, Andrew D. Peacock, Sarah R. Payne, P. Vigneswara Ilavarasan, David P. Jenkins, "Divergent imaginaries? Co-producing practitioner and householder perspective to cooling demand response in India," Energy Policy, Volume 152, 2021, Pages 112-222, ISSN 0301-4215.

[29] P. K. Gurjar, C. P. Barala, P. Mathuria and R. Bhakar, "Electric vehicles navigation planning and operation for smart city: A review," *2022 1st International Conference on Sustainable Technology for Power and Energy Systems (STPES)*, SRINAGAR, India, 2022. pp. 1-6.

[30] Ministry of Power (MOP), Report on 17th electric Power survey of India. India, May, 2007. [Online]. Available: https://www.powermin. nic.in/ generation/pdf/17th%20EPS.pdf

[31] Dharmaraj Kanakadhurga, Natarajan Prabaharan, "Demand side management in microgrid: A critical review of key issues and recent trends," Renewable and Sustainable Energy Reviews, Volume 156, 2022, Pages 111-915, ISSN 1364-0321.

[32] M. Kumar and B. Tyagi, "A state of art review of microgrid control and integration aspects," *2016 7th India International Conference on Power Electronics (IICPE)*, Patiala, India, 2016, pp. 1-6.

[33] Ankit Kumar Sharma, Akash Saxena, D.K. Palwalia, "Oppositional slime mould algorithm: Development and application for designing demand side management controller," Expert Systems with Applications, Volume 214, 2023, Pages 119-002, ISSN 0957-4174.

[34] Sisodiya, Sukhlal, and Ganesh Balu Kumbhar. "A novel algorithm for scheduling of a house loads incorporating pv system with utility using PSO." *2018 International Conference on Power Energy, Environment and Intelligent Control (PEEIC)*. IEEE, 2018.

[35] José Adrián Rama Curiel, Jagruti Thakur, "A novel approach for direct load control of residential air conditioners for demand side management in developing regions," Energy, Volume 258, 2022, Pages 124-763, ISSN 0360-5442.

[36] R. V. Kadam, S. B. Rokade and P. Y. Ganvir, "Review of Maharashtra's regulatory framework in electricity distribution CAPEX regulation," *2015 International Conference on Nascent Technologies in the Engineering Field (ICNTE)*, Navi Mumbai, India, 2015, pp. 1-5.

[37] European Environment Agency (EEA), The European environment state and outlook 2010: Synthesis. Copenhagen, 2010. [Online]. Available: http://www.eea.europa.eu/soer/synthesis/synthesis

[38] Rajesh K. Ahir, Basab Chakraborty, "A novel cluster-specific analysis framework for demand-side management and net metering using smart meter data," Sustainable Energy, Grids and Networks, Volume 31, 2022, Pages 100-771, ISSN 2352-4677.

[39] Sarthak Mohanty, Subhasis Panda, Shubhranshu Mohan Parida, Pravat Kumar Rout, Binod Kumar Sahu, Mohit Bajaj, Hossam M. Zawbaa, Nallapaneni Manoj Kumar, Salah Kamel, "Demand side management of electric vehicles in smart grids: A survey on strategies, challenges, modeling, and optimization," Energy Reports, Volume 8, 2022, Pages 12466-12490, ISSN 2352-4847.

[40] Bishwajit Dey, Fausto Pedro García Márquez, Aniruddha Bhattacharya, "Demand side management as a mandatory inclusion for economic operation of rural and residential microgrid systems," Sustainable Energy Technologies and Assessments, Volume 54, 2022, Pages 102-903, ISSN 2213-1388.

[41] D. Crossley, Asia-Pacific Economic Corporation (APEC): Overview of APEC energy working group projects (Stage3), May 2009. [Online]. Available: http://www.egnret.ewg.apec.org/news/ Overview%20 of%20 EWG% 20 Projects_Stage%203%20_Fnl_080609.pdf

[42] M. Kern, S. Shakya and G. Owusu, "Integrated resource planning for diverse workforces," Proc. IEEE Computer & Industrial Eng., CIE 2009, pp. 1169-1173, paper 10.1109/ICCIFE.2009.5223730.

[43] Clark W. Gellings, The smart grid: Enabling energy efficiency and demand response. The Fairmont Press, CRC Press (Taylor and Francis), 2009.

[44] Reynold and M. Delgodo," Demand-side management alternatives," Proc. IEEE Journals & Magn., vol. 73, no. 10, pp. 1471-1488, Oct. 1985.

[45] Aouadni and A Rebai,"performance of Tunisian Enterprises Integrating quality system, ERP (Enterprise Resource Planning) and SCM (Supply Chain Management)," Proc. IEEE Modeling, Simulation and Applied Optimization, 5th ICMSAO 2013, pp. 1-4.

[46] H. Nilsson, “The many faces of demand-side management,” Special Feature IEEE Power Eng. journal, vol. 8, no. 5, pp. 207-210, Oct. 1994.

[47] A. Mohamed and M. T. Khan, “A review of electrical energy management techniques: Supply and consumer side (Industries),” Journal of Energy in South Africa (JESA), vol. 20, no. 3, pp. 14-21, Aug. 2009.

[48] J. A. Lopes, N. Hatziargyrious, M. Mutale, P. Djapic and N. Jenkins, ”Integrating distributed generation into electric power systems: A review of drivers, challenges and opportunities,” Electrical Power Syst. Resource, vol. 77, no. 9, pp. 1189- 1203, July 2007.

[49] Bhongade, Sandeep, R. S. Dawar, and S. L. Sisodiya. "Demand-side management in an indian village." *Journal of The Institution of Engineers (India): Series B* (2021): 1-9.

[50] H. Zhaoguang, Z. Jinghang, T. Xiandong, W. Quan, X. Minjie and S. Baoguo, ”A low-carbon electricity model: Integrated resource strategic planning and its application,” proc. IEEE Power and Society, General Meeting, 2010, pp, 1-7.

[51] B. F. Hobbs, H. G. Rouse and D. T. Hoog, “Measuring the economic value of demand-side and supply resources in integrated resource planning models,” IEEE Trans. Power Syst., vol. 8. no. 3, pp. 979-987, Aug. 1993.

[52] C. A. Dortolina, N. Bacalao, R. Nadira and P. D. Arizon, “Integrated resource planning in developing countries: A novel practical approach,” Proc. IEEE Power Eng. Society, General Meeting 2004, vol. 2, pp. 1243-1249.

[53] E. Hirst and V. Goldman, “ Key issues in integrated resource planning for electric utilities,” IEEE Trans. Power Syst., vol. 5, no. 4, pp. 1105-1111, Nov. 1990.

[54] R. Banerjee, “Comparison of options for distributed generation in India,” Energy Policy, vol. 34, no. 1, pp. 101-111, Jan. 2006.

[55] V.S.K.V. Harish and A. Kumar, “Demand side management in India: Action plan, policies and regulation,” Renewable and Sustainable Energy Reviews, vol. 33, pp. 435-444, June 2014.

[56] United States Agency for International Development (USAID), India: DSM best practice guide book. Feb. 2005. [Online]. Available: http: //www.juccce.com/documents/Energy%20Landscape/DSMGuidebook_ USAID.pdf

[57] A. Jain, B. Jangid, R. Bhakar, P. Mathuria, C. P. Barala and V. Gupta, "Clustering models for demand response aggregation," *2021 IEEE 2nd International Conference On Electrical Power and Energy Systems (ICEPES)*, Bhopal, India, 2021, pp. 1-7.

[58] R. Verma, "Application of computational techniques in demand response: a review," *2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS)*, Coimbatore, India, 2021, pp. 1242-1246.

[59] Sumit Kumar Jha, Deepak Kumar, M. Lehtonen, "Modified V-I droop based adaptive vector control scheme for demand side management in a stand-alone microgrid,” International Journal of Electrical Power & Energy Systems, Volume 130, 2021, pages 106-950, ISSN 0142-0615.

[60] Karthick T., Charles Raja S., Jeslin Drusila Nesamalar J., Chandrasekaran K.,” Design of IoT based smart compact energy meter for monitoring and controlling the usage of energy and power quality issues with demand side management for a commercial building,” Sustainable Energy, Grids and Networks, Volume 26, 2021, pages 100-454, ISSN 2352-4677.

[61] Devandvc, India-Power Sector: Emerging development and critical issues. Jan. 2013. [Online]. Available: http://www.studymode.com/essay s/India-Power-Sector-1343197.html

[62] Harsh Wardhan Pandey, Ramesh Kumar, Rajib Kumar Mandal, “Transformation of Indian Distribution Sector: Opportunity and challenges for unlocking the demand response potential,” Renewable Energy Focus, Volume 42, 2022, Pages 221-235, ISSN 1755-0084.

[63] Kai Zhang, Jihua Yu, Yan Ren, “Demand side management of energy consumption in a photovoltaic integrated greenhouse,” International Journal of Electrical Power & Energy Systems, Volume 134, 2022, pages 107-433, ISSN 0142-0615.

[64] C. P. Barala, P. Mathuria and R. Bhakar, "Virtual energy storage systems: challenges and opportunities," *2021 9th IEEE International Conference on Power Systems (ICPS)*, Kharagpur, India, 2021, pp. 1-6.

[65] S. M. Jayasurya and S. Varun Kumar, "Smart grid infrastructure for efficient power consumption using real time pricing algorithm and distributed algorithm," *2018 International Conference on Recent Trends in Electrical, Control and Communication (RTECC)*, Malaysia, Malaysia, 2018, pp. 173-175.

[66] S. Pradhan, D. Mishra and M. K. Maharana, "Energy management system for micro grid pertaining to renewable energy sources: A review," *2017 International Conference on Innovative Mechanisms for Industry Applications (ICIMIA)*, Bengaluru, India, 2017, pp. 18-23.

[67] C. Moyo, F. Mafuratidz and J. C. Mbudzi, "Demand-side management as a strategy to alleviate power shortages," ACEEE Summer Study on Energy Efficiency in buildings, vol. 5 pp. 302-312, 2012. [Online]. Available:http://www.aceee.org/files/proceedings/2012/data/papers/0193-000142.pdf

[68] S. Balasubramanian, P. Balachandra, "Characterising electricity demand through load curve clustering: A case of Karnataka electricity system in India," Computers & Chemical Engineering, Volume 150, 2021, pages 107-316, ISSN 0098-1354.

[69] J. Plunkett, F. Weston snd D. Crossley, Government Oversight of grid company demand-side management activities in China: Recommendations from international experience. Sept. 2012. [Online]. Available: http://www.efa.com.au/Library/David/Published%20Reports/2012/RAPWestonCrossleyGovtOversightofGridCompanyDSMinChina .pdf

[70] D. Sharma and P. Singh, "Optimal planning of distribute energy resources sizing and location problem—A review," *2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA)*, Coimbatore, India, 2020, pp. 500-504.

[71] T. R. K. R. Ballireddy and P. K. Modi, "Generation expansion planning considering reliability of the system: A review on various optimization techniques," *2017 International conference of Electronics, Communication and Aerospace Technology (ICECA)*, Coimbatore, India, 2017, pp. 137-142.

[72] Bishwajit Dey, Srikant Misra, Fausto Pedro Garcia Marquez, "Microgrid system energy management with demand response program for clean and economical operation," Applied Energy, Volume 334, 2023, Pages 120-717, ISSN 0306-2619.

[73] R. K. Pachouri and Pooja Mehrotra, "Vision 2020: Sustainability of India's material resources," TERI, New Delhi. [Online]. Available: http://planningcommission.gov.in/reports/genrep/bkpap2020/13_bg2020.pdf

[74] Department of the environment, transport and the regions," Climate Change: The UK Programme," Scottish Executive, the national assembly for Wales department of the environment (North Ireland), 2000.

[75] Jagruti Thakur, Basab Chakraborty, "Demand side management in developing nations: A mitigating tool for energy imbalance and peak load management," Energy, Volume 114, 2016, Pages 895-912, ISSN 0360-5442.

[76] S. S. Mohapatra, M. K. Maharana and S. B. Pati, "Comprehensive review to analyze the islanding in distributed generation system," *2021 1st International Conference on Power Electronics and Energy (ICPEE)*, Bhubaneswar, India, 2021, pp. 1-7.

[77] A. K. Prasad and M. K. Singh, "Design and analysis of different types of solar collector for solar air dryer: A review," *2022 1st IEEE International Conference on Industrial Electronics: Developments & Applications (ICIDeA)*, Bhubaneswar, India, 2022, pp. 169-174.

[78] N. Rivers and M. Jaccard, "Electric utility demand- side management in Canada," IAEE, the Energy Journal, vol. 32, no. 4, pp. 93-116, Nov. 2011.[Online].Available:http://bwl.univie.ac.at/fileadmin/userupload/lehrsuhlindenuw/lehre/ws1112/SEInt.EnergyMgmt1/DSMCanada.pdf

[79] A. Sinha, S. Neogi, R. N. Lahiri and S. Choudhary, "Role of demand side management for power utility in India," Proc. IEEE Power Eng. Society, General Meeting, pp. 1-8, 2011.

[80] I. Dube, M. Beta and S. Dihwa, “Opportunities for demand side management in integrated energy resource planning and development in power sector: The case of Zimbabwe,” Proc. IEEE Power Eng. Society Integral Conference and Exposition, Africa, 2005, pp. 234-240.

[81] G. Zhang and W. Long, “Important Stage of community energy planning: Assessment of resource potential,” Proc. IEEE Management and Service Science, MASS 2009, pp. 1-3.

[82] M. Goldberg, ”Measure twice, cut once,” I EEE Trans. Power and Eng. Magn., vol. 8, no. 3, pp. 46- 54, May/June 2010.

[83] H. Zhang, L. Xie and Q. Xia, “Coupon incentive-based demand response: Theory and case study,” IEEE Trans. Power Syst., vol. 28, no. 2, pp. 1266-1276, May 2013.

[84] C. Vivekananthan, Y. Mishra, G. Ledwich and L. Fanging, “Demand response for residential appliances via customer reward scheme,” IEEE Trans. Smart Grid, vol. 5, no. 2, pp. 809-820, March 2014.

[85] P. Mancarella and G. Chicco, “Real-time demand response from energy shifting in distributed multi-generation.” IEEE Trans. Smart Grid, vol.4, no. 4, pp. 1928-1938, Dec. 2013.

[86] Centre for climate and energy solution (C2ES), Residential building end-use efficiency: The climate techbook, pp. 1-12, Dec. 2009. [Online]. Available:http://www.c2es.org/docUploads/Residential%20End-Use% 20Efficiency%20final0.pdf

[87] T. R. Olorunfemi and N. Nwulu, "A review of demand response techniques and operational limitations," *2018 International Conference on Computational Techniques, Electronics and Mechanical Systems (CTEMS)*, Belgaum, India, 2018, pp. 442-445.

[88] S. Paul, S. Choudhary and N. P. Padhy, "A review on residential area demand response analysis in smart grid era," *2018 IEEE 8th Power India International Conference (PIICON)*, Kurukshetra, India, 2018, pp. 1-6.

[89] M. Dansinh Solanki and S. K. Joshi, "Recapitulation of electric spring: A smart grid device for real time demand side management and mitigating power quality issues," *2016 National Power Systems Conference (NPSC)*, Bhubaneswar, India, 2016, pp. 1-6.

[90] T. S. Kumar and T. Venkatesan, "A survey on demand response in smart power distribution systems," *2020 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS)*, Chennai, India, 2020, pp. 1-12.

[91] M. D. Solanki and S. K. Joshi, "Review of electric spring: A new smart grid device for efficient demand dispatch and active and reactive power control," *2016 Clemson University Power Systems Conference (PSC)*, Clemson, SC, USA, 2016, pp. 1-8.

[92] J. D. Z. Word, Energy efficiency through demand side management: An examination to residential sector. Thesis, Duke University, North Carolina, 2010. [Online]. Available: https://econ.duke.edu/ uploads /assets/dje/2010/Final%202010%20PDFS/Zahniser-ord_DJE.pdf

[93] Priyadarshan Patil, Khashayar Kazemzadeh, Prateek Bansal, “Integration of charging behavior into infrastructure planning and management of electric vehicles: A systematic review and framework,” Sustainable Cities and Society, Volume 88, 2023, Pages 104-265, ISSN 2210-6707.

[94] Md. Tanvir Ahammed, Imran Khan, “Ensuring power quality and demand-side management through IoT-based smart meters in a developing country,” Energy, Volume 250, 2022, Pages 123-747, ISSN 0360-5442.

[95] R. S. Prabu and S. Prabhakar Karthikeyan, "Scheduling and energy management of smart homes using customer choice based algorithm," *2018 International Conference and Utility Exhibition on Green Energy for Sustainable Development (ICUE)*, Phuket, Thailand, 2018, pp. 1-8.

[96] N. Padmanabhan and H. Alharbi, "Demand response and energy storage system participation in north american electricity markets," *2020 International Conference on Power, Instrumentation, Control and Computing (PICC)*, Thrissur, India, 2020, pp. 1-6.

[97] World Energy Council, Energy end-use technologies for the 21st century. Report, July 2004. [Online]. Available: http://www.worldenergy. org/ documents/et2104.pdf

[98] J. E Runnels and M. D. Whyte, “Evaluation of demand-side management,” Proc. IEEE Journals and Magn., vol. 73, no. 10, pp. 1489-1495, Oct. 1985.

[99] J. Flory, J. Peters., L. Vogt, K. Keating and B. Hopkins, “Evaluating demand side management: Can an engineer count on it? A short note paper summarizing a panel session at the July 1992 summer meeting,” IEEE Trans. Power Syst., vol. 9, no. 4, pp. 1752-1758, Nov. 1994.

[100] Bosong Li, Jingshuang Shen, Xu Wang, Chuanwen Jiang, “From controllable loads to generalized demand-side resources: A review on developments of demand-side resources,” Renewable and Sustainable Energy Reviews, Volume 53, 2016, Pages 936-944, ISSN 1364-0321.

[101] K. Karunanithi, S. Saravanan, B.R. Prabakar, S. Kannan, C. Thangaraj, “Integration of demand and supply side management strategies in generation expansion planning,” renewable and sustainable energy reviews, Volume 73, 2017, Pages 966-982, ISSN 1364-0321.

[102] M. Mallahassani-Pour, A. Abdullahi and M. Rashidnejad, “Investigation of market-based demand response impacts on security-constrained preventive maintenance scheduling,” IEEE Trans. Syst. Journal, Early Access, 2014.

[103]] S. Nadel, S. Gopinath and V. Kothari, Opportunities for improving end-use electricity efficiency in India. Report no. 17, Nov. 1991.

[104] L. Suganthi, Anand A. Samuel, “Energy models for demand forecasting—A review,” Renewable and Sustainable Energy Reviews, Volume 16, Issue 2, 2012, Pages 1223-1240, ISSN 1364-0321.

[105] S. Balasubramanian, P. Balachandra, “Effectiveness of demand response in achieving supply-demand matching in a renewables dominated electricity system: A modelling approach,” Renewable and Sustainable Energy Reviews, Volume 147, 2021, Pages 111-245, ISSN 1364-0321.

[106] A. I. Kawoosa and D. Prashar, "A review of cyber securities in smart grid technology," *2021 2nd International Conference on Computation, Automation and Knowledge Management (ICCAKM)*, Dubai, United Arab Emirates, 2021, pp. 151-156.

[107] D. Suri, J. Shekhar, A. Mukherjee and A. Singh Bajaj, "Designing microgrids for rural communities: a practitioner focused mini-Review," *2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)*, Madrid, Spain, 2020, pp. 1-6.

[108] J. K. Parikh, B. S. Reddy, R. Banerjee and S. Koundinya, “Demand side management survey in India: Awareness, barriers and implement ability,” Energy, vol. 21, no. 10, pp. 955-966, Oct. 1996. [Online]. Available: http://www.ipeindia.org/main/uploads/IPE/JEPR/JEPR7_1_1 .pdf

[109] T. Kanetkar and R. Banerjee, Power sector planning in India, 2008.

[110] D. Chattopadhyay, R. Banerjee and J. Parikh, “Integrated demand side options in electric utility planning: A multi-objective approach,” IEEE Trans. Power System, vol. 10, no. 2, pp. 657-663, May 1995.

[111] R. Banerjee, “Load management in the power sector using US experience,” Energy, vol. 23, no. 11, pp. 961-972, Nov. 1998.

[112] N. Kinhekar, N. P. Padhy and H. O. Gupta, “Multiobjective demand side management solution for utilities with peak demand deficit,” International Journal of Electrical Power and Energy Systems, vol. 55, pp. 612-619, Feb. 2014.

[113] Y. Alagh, Transmission and distribution of electricity in India: Regulation investment and efficiency. [Online]. Available: http://www.oecd.org/dev/partnerships-networks/46235043.pdf

[114] B. Shen, G.Ghatikar, Z. Lei, J. Li. G. Wikler and P. Martin, “The role of regulatory reforms, market changes and technology development to make demand response available resource in meeting energy changes,” Applied Energy, in press, Jan. 2014.

[115] L. He, Y. Liu and J. Zhang, "An occupancy-informed customized price design for consumers: a stackelberg game approach," in *IEEE Transactions on Smart Grid*, vol. 13, no. 3, pp. 1988-1999, May 2022.

[116] Z. Li, L. Wu, Y. Xu and X. Zheng, "Stochastic-weighted robust optimization based bilayer operation of a multi-energy building microgrid considering practical thermal loads and battery degradation," in *IEEE Transactions on Sustainable Energy*, vol. 13, no. 2, pp. 668-682, April 2022.

[117] N. Tucker, G. Cezar and M. Alizadeh, "Real-time electric vehicle smart charging at workplaces: a real-world case study," *2022 IEEE Power & Energy Society General Meeting (PESGM)*, Denver, CO, USA, 2022, pp. 1-5.

[118] Lin Li; MengChu Zhou, "Electricity demand response for manufacturing systems," in *sustainable manufacturing systems: An energy perspective*, IEEE, 2023, pp.205-256.

[119] S. Jaiswal and M. S. Ballal, "Optimal load management of plug-in electric vehicles with demand side management in vehicle to grid application," *2017 IEEE Transportation Electrification Conference (ITEC-India)*, Pune, India, 2017, pp. 1-5.

[120] R. K. Yadav, P. N. Hrishikesha and V. S. Bhadoria, "A nature inspired strategy for demand side management in residential sector with smart grid environment," *2020 9th International Conference System Modeling and Advancement in Research Trends (SMART)*, Moradabad, India, 2020, pp. 235-239.

[121] S. Panda, P. K. Rout and B. K. Sahu, "Residential sector demand side management: A review," *2021 1st Odisha International Conference on Electrical Power Engineering, Communication and Computing Technology(ODICON)*, Bhubaneswar, India, 2021, pp. 1-6.

[122] S. Baraniya and S. Zahid Nabi Dar, "Consumer demand profile management through Demand side load management: a review," *2022 Third International Conference on Intelligent Computing Instrumentation and Control Technologies (ICICICT)*, Kannur, India, 2022, pp. 1742-1747.

[123] V. A. Vatul, N. A. Aravinth and K. Narayanan, "Demand Side management: A different pricing model," *2019 IEEE 1st International Conference on Energy, Systems and Information Processing (ICESIP)*, Chennai, India, 2019, pp. 1-4.

[124] C. Yokita, S. Nithin and A. S. Pillai, "Development of a battery monitoring and control unit aiding utilities in demand side management," *2018 International Conference on Inventive Research in Computing Applications (ICIRCA)*, Coimbatore, India, 2018, pp. 1325-1329.

[125] M. Yadav, N. Pandey and M. Jamil, "Impact of plug-in electric vehicle on residential demand side management," *2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC)*, Mathura, India, 2020, pp. 365-369.

[126] S. Patil and S. R. Deshmukh, "Development of control strategy to demonstrate load priority system for demand response program," *2019 IEEE International WIE Conference on Electrical and Computer Engineering (WIECON-ECE)*, Bangalore, India, 2019, pp. 1-6.

[127] K. H. S. V. S. Nunna and S. Doolla, "Responsive end-user-based demand side management in multimicrogrid environment," in *IEEE Transactions on Industrial Informatics*, vol. 10, no. 2, pp. 1262-1272, May 2014.

[128] J. B. Jones and M. Vagliasindi, Revising policy options on the market structure in the power sector, June 2011. [Online]. Available: http:// www.esmap.org/sites/esmap.org/files/study%20on%20energy%20sector.pdf

[129] N. Loganathan and K. Lakshmi, "Demand side energy management system using ANN based linear programming approach," *2014 IEEE International Conference on Computational Intelligence and Computing Research*, Coimbatore, India, 2014, pp. 1-5.

[130] Neeraj, P. Malik, S. Garg and K. Singhal, "Demand side management using GUI," *2019 3rd International Conference on Recent Developments in Control, Automation & Power Engineering (RDCAPE)*, Noida, India, 2019, pp. 100-105.

[131] S. Parashar, A. Swarnkar, K. R. Niazi and N. Gupta, "Operational management of grid connected microgrid with responsive loads," *2019 8th International Conference on Power Systems (ICPS)*, Jaipur, India, 2019, pp. 1-5.

[132] A. Vijayan, V. Kurupath and J. Das, "Residential demand side management using artificial intelligence," *2021 8th International Conference on Smart Computing and Communications (ICSCC)*, Kochi, Kerala, India, 2021, pp. 323-327.

[133] N. Arya, The Indian power sector: Investments, growth and Prospects. Jan. 2013. [Online]. Available: http://friendsofforgottenchildren.com/ doc/pdf/download/www__ibef__org--download--Power-Sector-040213 .pdf

[134] S. Kumar, "Demand side management road map in India," *2009 IEEE Power & Energy Society General Meeting*, Calgary, AB, Canada, 2009, pp. 1-8.

[135] A. M. Tayade, V. P. Dhote and A. G. Thosar, "Demand side management and voltage regulation in microgrid using electric spring," *2018 International Conference on Emerging Trends and Innovations In Engineering And Technological Research (ICETIETR)*, Ernakulam, India, 2018, pp. 1-4.

[136] S. E. Fleten and E. Pettersen, "Constructing bidding curves for a price-taking retailer in the Norwegian electricity market," IEEE Trans., vol. 20, no 2, pp. 701-708, May 2005.

[137] W. Petter, "A review of demand-side management policy in the UK," Renewable and sustainable energy review, vol. 29, pp. 941-951, 2014.

[138] K. H. S. V. S. Nunna and S. Doolla, "Responsive end-user-based demand side management in multimicrogrid environment," in *IEEE Transactions on Industrial Informatics*, vol. 10, no. 2, pp. 1262-1272, May 2014.

[139] M. K. Mishra and S. K. Parida, "A game theoretic horizon decomposition approach for real-time demand-side management," in *IEEE Transactions on Smart Grid*, vol. 13, no. 5, pp. 3532-3545, Sept. 2022.

[140] Library of Congress- Federal Research Division, Country Profile: India, Dec. 2004. [Online]. Available: http://lcweb2.loc.gov/frd/cs/profiles/ India.pdf

[141] Stefane Dias Rodrigues, Vinicius Jacques Garcia, "Transactive energy in microgrid communities: A systematic review," Renewable and Sustainable Energy Reviews, Volume 171, 2023, Pages 112999, ISSN 1364-0321.

[142] Nihar R. Sahoo, Pratap K.J. Mohapatra, Biswajit Mahanty, "Examining the process of normalising the energy-efficiency targets for coal-based thermal power sector in India," Renewable and Sustainable Energy Reviews, Volume 81, Part 1, 2018, Pages 342-352, ISSN 1364-0321.

[143] Jay Prakash Bijarniya, K. Sudhakar, Prashant Baredar, "Concentrated solar power technology in India: A review," Renewable and Sustainable Energy Reviews, Volume 63, 2016, Pages 593-603, ISSN 1364-0321.

[144] Yanfeng Liu, Sisi Yu, Ying Zhu, Dengjia Wang, Jiaping Liu, "Modeling, planning, application and management of energy systems for isolated areas: A review," Renewable and Sustainable Energy Reviews, Volume 82, Part 1, 2018, Pages 460-470, ISSN 1364-0321.

[145] Wikipedia, Geography of India. [Online]. Available: http://en.wikipedia.org/wiki/Geography_of_India

[146] Census of India (2011), Rural-urban distribution of population (Provisional population totals). [Online]. Available: http://www .censusindia.gov.in/2011-prov-results/prov_results_paper1 india.html

[147] Sisodiya, Sukhlal, Kunal Shejul, and Ganesh Balu Kumbhar. "Scheduling of demand-side resources for a building energy management system." *International Transactions on Electrical Energy Systems* 27.9 (2017): e2369.

[148] Report on 17th Power survey of India [Online]. Available: http://www.powermin.nic.in/generation/pdf/17th%20EPS.pdf

[149] Mohit Bansal, R.P. Saini, D.K. Khatod, "Development of cooking sector in rural areas in India—A review," Renewable and Sustainable Energy Reviews, Volume 17, 2013, Pages 44-53, ISSN 1364-0321.

[150] Bikash Kumar Sahu, "Solar energy developments, policies and future prospectus in the state of Odisha, India," Renewable and Sustainable Energy Reviews, Volume 61, 2016, Pages 526-536, ISSN 1364-0321.

[151] Central Electricity Authority (CEA), Executive summary, Power sector, Govt. of India, Ministry of Power (MOP) 2014. [Online]. Available: http://www.cea.nic.in/reports/monthly/executive_rep/feb14.pdf

[152] Jiangyun Zhang, Dan Shao, Liqin Jiang, Guoqing Zhang, Hongwei Wu, Rodney Day, Wenzhao Jiang, "Advanced thermal management system driven by phase change materials for power lithium-ion batteries: A review," Renewable and Sustainable Energy Reviews, Volume 159, 2022, Pages 112-207, ISSN 1364-0321.

[153] Moslem Uddin, Mohd Fakhizan Romlie, Mohd Faris Abdullah, Syahirah Abd Halim, Ab Halim Abu Bakar, Tan Chia Kwang, "A review on peak load shaving strategies," Renewable and Sustainable Energy Reviews, Volume 82, Part 3, 2018, Pages 3323-3332, ISSN 1364-0321.

[154] Vima Mali, Rajat Saxena, Kundan Kumar, Abul Kalam, Brijesh Tripathi, "Review on battery thermal management systems for energy-efficient electric vehicles," Renewable and Sustainable Energy Reviews, Volume 151, 2021, Pages 111-611, ISSN 1364-0321.

[155] Paritosh Nandi, Sujay Basu, "A review of energy conservation initiatives by the Government of India," Renewable and Sustainable Energy Reviews,Volume 12, Issue 2, 2008, Pages 518-530, ISSN 1364-0321.

[156] Report of the working group on power for twelfth plan (2012-2017), Govt. of India, Ministry of Power (MOP), Jan. 2012. [Online]. Available: http://planningcommission.nic.in/aboutus/committee/wrkgrp12/wg_power1904.pdf

[157] Sunil Luthra, Sachin Kumar Mangla, Ravinder K. Kharb, "Sustainable assessment in energy planning and management in Indian perspective," Renewable and Sustainable Energy Reviews, Volume 47, 2015, Pages 58-73, ISSN 1364-0321.

[158] R.M. Sebastian, J. Louis, "Understanding waste management at airports: A study on current practices and challenges based on literature review," Renewable and Sustainable Energy Reviews, Volume 147, 2021, Pages 111-229, ISSN 1364-0321.

[159] S.S. Chandel, Rajnish Shrivastva, Vikrant Sharma, P. Ramasamy, "Overview of the initiatives in renewable energy sector under the national action plan on climate change in India," Renewable and Sustainable Energy Reviews,Volume 54, 2016, Pages 866-873, ISSN 1364-0321.

[160] S. Manju, Netramani Sagar, "Progressing towards the development of sustainable energy: A critical review on the current status, applications, developmental barriers and prospects of solar photovoltaic systems in India," Renewable and Sustainable Energy Reviews, Volume 70, 2017, Pages 298-313, ISSN 1364-0321.

[161] Utility CEO forum on demand side management , Model state policy on utility driven demand side management , Sep. 2013. [Online]. Available: http://www.shaktifoundation.in/cms/uploadedImages/model_dsm_policy%20-%20post%20second%20meeting%20final.pdf

[162] Ghulam Rasool, Farrukh Ehsan, Muhammad Shahbaz, "A systematic literature review on electricity management systems," Renewable and Sustainable Energy Reviews, Volume 49, 2015, Pages 975-989, ISSN 1364-0321.

[163] Mostafa Rezaeimozafar, Rory F.D. Monaghan, Enda Barrett, Maeve Duffy, "A review of behind-the-meter energy storage systems in smart grids," Renewable and Sustainable Energy Reviews, Volume 164, 2022, Pages 112-573, ISSN 1364-0321.

[164] P. K. Ray and C. J. Jena, "Security-constrained unit commitment for demand response provider - A stochastic approach," *2020 IEEE International Conference on Power Electronics, Smart Grid and Renewable Energy (PESGRE2020)*, Cochin, India, 2020, pp. 1-5.

[165] B. K. Ghosh, S. Sen and S. Chanda, "Intelligent energy management systems for optimal techno-commercial benefit in dc micro-grids: A review," *2020 IEEE VLSI DEVICE CIRCUIT AND SYSTEM (VLSI DCS)*, Kolkata, India, 2020, pp. 1-6.

[166] G. Shamim and M. Rihan, "A technical review on smart grids in India," *2017 4th IEEE Uttar Pradesh Section International Conference on Electrical, Computer and Electronics (UPCON)*, Mathura, India, 2017, pp. 642-648.

[167] IEEE Power Engineering Review, "Status of demand side management in the USA", IEEE Trans. Power Eng. Review, vol. PER-7, no. 8, pp. 3-8, Aug. 1987.

[168] B. Rajasekhar *et al*., "A survey of computational intelligence techniques for air-conditioners energy management," in *IEEE Transactions on Emerging Topics in Computational Intelligence*, vol. 4, no. 4, pp. 555-570, Aug. 2020.

[169] S. P. S. Mathur, A. Arya and M. Dubey, "A review on bidding strategies and market power in a competitive energy market," *2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS)*, Chennai, India, 2017, pp. 1370-1375.

[170] Atul Sharma, Jaya Srivastava, Sanjay Kumar Kar, Anil Kumar, "Wind energy status in India: A short review," Renewable and Sustainable Energy Reviews, Volume 16, Issue 2, 2012, Pages 1157-1164, ISSN 1364-0321.

[171] Enayat A. Moallemi, Lu Aye, John M. Webb, Fjalar J. de Haan, Biju A. George, "India's on-grid solar power development: Historical transitions, present status and future driving forces," Renewable and Sustainable Energy Reviews, Volume 69, 2017, Pages 239-247, ISSN 1364-0321.

[172] M. Kumar, S. Vyas and A. Datta, "A review on integration of electric vehicles into a smart power grid and vehicle-to-grid impacts," *2019 8th International Conference on Power Systems (ICPS)*, Jaipur, India, 2019, pp. 1-5.

[173] D. Muralidar, Meikandasivam and Vijayakumar, "A review about energy management techniques in industrial buildings," *2017 Innovations in Power and Advanced Computing Technologies (i-PACT)*, Vellore, India, 2017, pp. 1-9.

[174] V. J. Tambe and R. Roy, "A critical review on demand response scenario," *2012 11th International Conference on Environment and Electrical Engineering*, Venice, Italy, 2012, pp. 758-763.

[175] Subhojit Dawn, Prashant Kumar Tiwari, Arup Kumar Goswami, Manash Kumar Mishra, "Recent developments of solar energy in India: Perspectives, strategies and future goals," Renewable and Sustainable Energy Reviews, Volume 62, 2016, Pages 215-235, ISSN 1364-0321.

[176] Mohamad Fani Sulaima, Nofri Yenita Dahlan, Zuhaila Mat Yasin, Marlinda Mohd Rosli, Zulkiflee Omar, Mohammad Yusri Hassan, "A review of electricity pricing in peninsular Malaysia: Empirical investigation about the appropriateness of Enhanced Time of Use (ETOU) electricity tariff," Renewable and Sustainable Energy Reviews, Volume 110, 2019, Pages 348-367, ISSN 1364-0321.

[177] B. Priya Esther, K. Sathish Kumar, "A survey on residential Demand Side Management architecture, approaches, optimization models and methods," Renewable and Sustainable Energy Reviews, Volume 59, 2016, Pages 342-351, ISSN 1364-0321.

[178] Dharmaraj Kanakadhurga, Natarajan Prabaharan, "Demand side management in microgrid: A critical review of key issues and recent trends," Renewable and Sustainable Energy Reviews, Volume 156, 2022, Pages 111-915, ISSN 1364-0321.

[179] Banik and A. Sengupta, "Scope, challenges, opportunities and future goal assessment of floating solar park," *2021 Innovations in Energy Management and Renewable Resources(52042)*, Kolkata, India, 2021, pp. 1-5.

[180] S. K. Bala, B. C. Babu and S. Bala, "A review on development of smart grid technology in india and its future perspectives," *2012 Students Conference on Engineering and Systems*, Allahabad, India, 2012, pp. 1-6.

[181] V.S.K.V. Harish, Arun Kumar, "Demand side management in India: Action plan, policies and regulations," Renewable and Sustainable Energy Reviews, Volume 33, 2014, Pages 613-624, ISSN 1364-0321.

[182] Rajeev Alasseri, Ashish Tripathi, T. Joji Rao, K.J. Sreekanth, "A review on implementation strategies for demand side management (DSM) in Kuwait through incentive-based demand response programs," Renewable and Sustainable Energy Reviews, Volume 77, 2017, Pages 617-635, ISSN 1364-0321.

[183] S. Chakraborty, S. Kar and D. Kumar, "Review of demand side management with thermostatically controllable loads," *2021 IEEE 2nd International Conference On Electrical Power and Energy Systems (ICEPES)*, Bhopal, India, 2021, pp. 1-5.

[184] P. Kumar, G. S. Brar and L. Singh, "Energy efficiency evaluation in commercial and residential buildings with demand side management: A review," *2019 8th International Conference on Power Systems (ICPS)*, Jaipur, India, 2019, pp. 1-6.

[185] A. M. Saklani, H. S. V. S. Kumar Nunna and S. Doolla, "Intelligent demand response approach in smart distribution systems: A review," *2012 Annual IEEE India Conference (INDICON)*, Kochi, India, 2012, pp. 1057-1062.

[186] Saurabh Gupta, Tanushree Bhattacharya, "DSM Power Plant in India," Renewable and Sustainable Energy Reviews, Volume 21, 2013, Pages 537-547, ISSN 1364-0321.

[187] Jamshid Aghaei, Mohammad-Iman Alizadeh, "Demand response in smart electricity grids equipped with renewable energy sources: A review," Renewable and Sustainable Energy Reviews, Volume 18, 2013, Pages 64-72, ISSN 1364-0321.

[188] Jagruti Thakur, Basab Chakraborty, "Intelli-grid: Moving towards automation of electric grid in India," Renewable and Sustainable Energy Reviews, Volume 42, 2015, Pages 16-25, ISSN 1364-0321.

[189] S.S. Chandel, Aniket Sharma, Bhanu M. Marwaha, “Review of energy efficiency initiatives and regulations for residential buildings in India, Renewable and Sustainable Energy Reviews,” Volume 54, 2016, Pages 1443-1458, ISSN 1364-0321.

[190] S. Gupta, A. Maulik, D. Das, A. Singh, “Coordinated stochastic optimal energy management of grid-connected microgrids considering demand response, plug-in hybrid electric vehicles, and smart transformers,” Renewable and Sustainable Energy Reviews, Volume 155, 2022, Pages 111-861, ISSN 1364-0321.

[191] X. Chen, Y. Li, J. Shimada and N. Li, "Online learning and distributed control for residential demand response," in *IEEE Transactions on Smart Grid*, vol. 12, no. 6, pp. 4843-4853, Nov. 2021.

[192] A. S. Kahnamouei and S. Lotfifard, "Enhancing resilience of distribution networks by coordinating microgrids and demand response programs in service restoration," in *IEEE Systems Journal*, vol. 16, no. 2, pp. 3048-3059, June 2022.

[193] Yael Parag, “Which factors influence large households’ decision to join a time-of-use program? The interplay between demand flexibility, personal benefits and national benefits,” Renewable and Sustainable Energy Reviews, Volume 139, 2021, Pages 110-594, ISSN 1364-0321.

[194] Z.Y.I. Abba, N. Balta-Ozkan, P. Hart, “A holistic risk management framework for renewable energy investments,” Renewable and Sustainable Energy Reviews, Volume 160, 2022, Pages 112-305, ISSN 1364-0321.

[195] X. Kou *et al*., "A comprehensive scheduling framework using sp-admm for residential demand response with weather and consumer uncertainties," in *IEEE Transactions on Power Systems*, vol. 36, no. 4, pp. 3004-3016, July 2021.

[196] S. Chen, L. Jiao, F. Liu and L. Wang, "EdgeDR: An online mechanism design for demand response in edge clouds," in *IEEE Transactions on Parallel and Distributed Systems*, vol. 33, no. 2, pp. 343-358, 1 Feb. 2022.