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Strategies of Demand Side Management and Various Impacts on Grid

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Abstract – This paper includes the study and analysis of demand side management and various use of techniques for the consumer demand side management. As the generation transmission and distribution consider as a whole power system and the steps taken for the energy efficiency makes a remarkable change in the utility and supply side, on the other hand the demand from the consumer side increasing rapidly and for fulfilling the demand of all the consumers more generation as well as transmission has to be done results in higher generation and transmission losses. So the most important step is to be taken at the consumer end for the demand reduction that will be totally interlinked with the generation and transmission. In this work we will try to find out various strategies to reduce the demand of power from the consumer side. Various sector like residential, industrial and agricultural consumers involved in the consumer side. Depending upon the consumer's category DSM measures has to be taken to reduce the demand growth.

***Key Words*:** DSM Demand side management, HEMS Home energy management system, MNRE Ministry of New and Renewable Energy, Solar Roof Top, DISCOM Distribution Company, Capex Capital Expenditure, Resco Renewable energy service companies

1. INTRODUCTION

Global energy demand has been increasing steadily at an average annual rate of since 2011. The growth of demand is mainly occurring in developing countries. Most of it is being met by fossil fuels. Several international efforts have been undertaken to tackle climate change. Paris climate agreement that aims at reducing greenhouse gas emissions entered into effect in November, 2016. At the United Nations Climate Change Conference, leaders of nations pledged to work against attaining inexhaustible energy. In 2015, inexhaustible energy assumed to be around the global final energy consumption. Cost devaluations of efficient sustainable technologies like solar PV and wind power and reliable forecasting; enable promoting countries to enhance their renewable scope. The global renewable power capacity increased by gigawatts (GW) in 2016; which is an increase compared to 2015.In India, An aggregate of around 73.35 GW of sustainable power source limit has been introduced in the nation as on October, 2018 from all sustainable power sources which incorporates about 34.98 GW utilizing Wind, 24.33 GW utilizing sun based, 4.5 GW utilizing Small Hydro Power and 9.54 GW utilizing Bio-power. Tasks of 30 GW sun powered and 10 GW wind power age will be finished in the year 2018-19 and 2019-20. Government has reported that the force age of 60 GW utilizing solar based and 20 GW utilizing wind vitality will be done till 31-3-2020. [1]

2. **DEMAND SIDE MANAGEMENT**

Demand Side Management is any activity undertaken with an objective to lower the overall cost of electricity to the consumers of the Distribution Licensee as well as the Distribution Licensee, by economical and efficient use of resources, which shall include the measures/principles to:

- Control reduce and influence electricity demand.
- Encourage consumers to amend their electricity consumption pattern both with respect to timing and level of electricity demand for efficient use of energy.
- Complement supply side strategies to help the utilities to avoid or reduce or postpone
    - ✓ Costly capacity (generation, transmission & distribution network) additions
    - ✓ Costly power purchases
- ✓ • Reduce the environmental damage by reducing the emission of greenhouse gases.
- ✓ • Supplement national level efforts for implementation of various DSM programmes set out by the Bureau.
- ✓ • Make strategic efforts to induce lasting structural or behavioural changes in the market that shall result in increased adoption of energy-efficient technologies, services, and practices.
- ✓ • Protect the interest of the consumers and shall result in overall reduction in tariff for all the consumers.

Implementing DSM algorithm substantially relies on two-way communication among the utility and end user. The end user willingness to reduce/shift their power consumption. Power generation can be averted through shifting power usage from peak hours to off-peak hours so that cost of production gets reduced. [2-3]

There are six types of DSM technique methods for different users for load shaping and they are load shifting, valley filling, strategic conversation, peak clipping, strategic load growth and flexible load shape. Load shifting is nothing but the load shift from on peak to off peak hours and the advantage of load shifting is to lower the cost and peak demand. [4]

Electricity charge relates at the power consumption of the users. In electricity market, The DSM has the essential role. As demands increases the cost of electricity also increase. The increase in electricity cost will change the whole users in power system. By lowering the peak to average ratio, DSM regulates the power cost in electricity market. [5]

A DSM approach for domestic level users based on totally on load shifting approach is proposed here. The idea of behind this method is primarily based on users load precedence and comfort preferences. DSM allows in managing and controlling power consumption on the basis of electricity supply. [6]

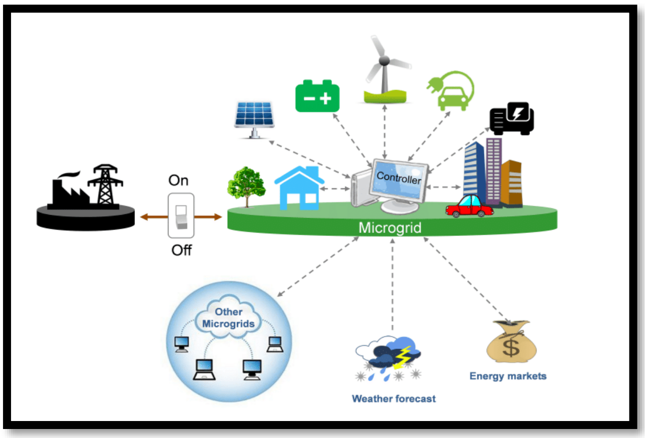

Fig. 1 Demand side management in microgrid system

In today's era the major concern is about the increase in demand of electricity to fulfill the requirements in the various sectors like Agriculture, Industrial, Commercial as well as Residential Buildings. In 2018-19 buildings in residential sectors consumed about 24% of India's Electrical Energy, primarily for HVAC, lighting and ceiling fan. India's developmental challenge becomes further convoluted with priority towards 24 X 7 electricity access to its 1.3 billion citizens. Other domestic initiatives like 'Make in India', and the 'National Housing Mission' (NHM) are also expected to further increase the demand for energy in industrial and buildings sectors. In 2018-19, the primary energy demand in India increased1 by 4.7 % over the previous year, much higher than the average global increase, and around 50 % higher than that of the emerging economies. Out of the total electricity consumed in the building sector, about 75% is used in residential buildings. The gross electricity consumption in residential buildings has been rising sharply over the years. For instance, the consumption figure rose to about 260 TWh in 2016-17 from about 55 TWh in 1996-97. that is an increase by more than four times in 20 years. Projections show it rising to anywhere between 630 and 940 TWh by 2032. Among various reasons, increased use of decentralized room based air-conditioning units in homes for thermal comfort is an important reason contributing to this rapid increase in the electricity use in residential buildings. The demand for air-conditioning will continue its exponential growth with improvement in household incomes and will become the dominant contributor of GHG emissions nation-wide owing to increased electricity consumption. This situation calls for an immediate energy conservation action plan.

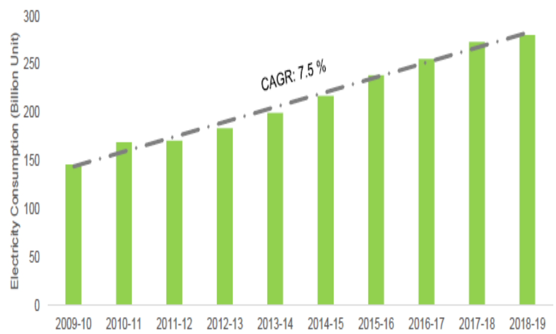

Fig. 2 Growth in Electricity consumption in last few years

The key factors behind this growth were rapid economic growth, rising per capita income, growing population, and increased urbanization rate resulting in higher appliance ownership. With urbanization this trend is expected to continue at least for the next decade. The electricity access having been provided to millions of new users in the past 4 years, appliance ownership, and thus the related energy demand is expected to rise further with household electricity consumption increasing 6 - 8 times by 2047 as per NITI Aayog's estimates.

3. METHODOLOGY

The devices included in this section are broadly classified into smart home devices (and appliances) and smart home retrofits. In most of the techno commercial analysis, the baseline is assumed based on the guidelines of BEE S & L scheme, using building energy simulation tools and energy saving potential is estimated based on various pilot studies, research publications, and manufacturer claim.

Some of the mentioned energy saving reference may not be directly applicable for Indian context (climate conditions, user behaviour and lifestyle, construction type, cost of energy). Hence, there is a need to conduct field studies and pilot trails, in multiple climatic zones and variable situations to compare conventional appliance used in home with smart home appliances (and devices). Summary of findings of techno commercial analysis of major smart home devices and retrofits (based on publicly available information) are presented below:

IR Blasters Enabled AC

Ease of control: Control the AC from anywhere using mobile app.

Scheduling: AC can be scheduled to operate in specific mode (for instance in night) as per user requirement.

Sequencing: User can program switching of multiple devices including AC with single command over app or Voice-based hub. For instance, while leaving for office, single command will switch off all devices linked with IR blaster.

Trigger: User can program switching of multiple devices including AC as per schedule. For instance, switch off all devices linked with IR blaster at 10:00 am.

Geofencing: User can program switching of multiple devices based on mobile location. For instance, once user more than 100 meters from home, all devices linked with IR will switch off.

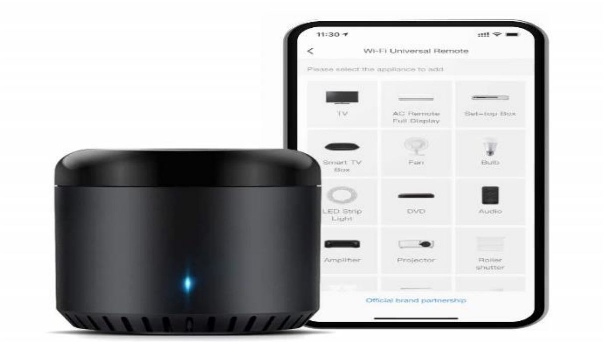

Fig.3 - IR Blaster for controlling appliances

Smart Plug 10A, Warranty: 1 year, Price – 740/- Rs

Compatible with light appliances like TVs, kettles, table fans, lamps, air purifier etc. With remote control through voice and app control you can control them conveniently using your phone or Google assistant and Alexa devices to switch on/off, or to set schedules and timers on them.

Energy Consumption Monitoring - Manage, track and conserve energy consumption of appliances efficiently with access to real time power monitoring.

Scheduler - Use the app to create customized schedules to automate your daily activities. Like schedule to switch on the air purifier to turn on at 8pm every night in the bedroom and switch off at 7:30am.

Timer - No more panic. Never forget to switch off an appliance again by setting up a smart timer on them. You can conserve energy or also protect your devices from overcharging like in the case of phone and laptop chargers.

Safety - In case, you are also someone who forgets if they have switched off a device or not, one can connect it to a plug and also remotely turn off a device. Save your high energy bills and your house from unprecedented damage.

Sharing & Grouping - Multi-person control of one device. And multiple devices can be grouped.

Voice Control compatibility - It works with Alexa and Google assistant devices. Simply make a voice command to control devices without having to physically interact with them.

Fig.4- Smart Plugs

Table-1 Description of smart measures and savings

S.no	Description of smart measures	Percentage Energy Savings (%)	Simple Payback Period (Year)
	Smart Appliances or device		
1	Smart Geyser	9% - 16%	1.6-3.4
2	Smart AC	17%	3.8
3	Smart Washing Machine	19%	3.9
4	Smart Lighting	40%	3
5	Smart External Blinds	29%-38%	4.7 – 7.2

Smart Retrofits			
6	Smart plug enabled geyser	1% - 8.5%	.25 - .6
7	Smart plug enabled washing machine	20%	0.8
8	Occupancy sensor for light and exhaust fan control	46%	2.7
9	Energy Monitoring System	4-12%	3
10	IR blaster enabled AC	9%	1.2

Table-2 Techno commercial analysis of IR blaster

S.No	Particular	Unit	Value
1	No. of AC	No.	1
2	Capacity	TR	1.5
3	Power rating (5 Star AC)	ISEER	3.6
4	Annual operating hours*	hours	1,600
5	Annual electricity consumption	kWh/year	2,344
6	Tariff of electricity	Rs. / kWh	6
7	Annual electricity cost	Rs. / year	14,065
Proposed Solution			
8	Idle running hours (is considered as 10% of the total operation time) - idle running of AC can be avoided with IR blaster using remote operation, scheduling, app based personal routine program, trigger and geo fencing	hours	160
ENERGY SAVINGS			
9	Annual energy savings by prevention of idle running	kWh/year	211
10	Annual electricity consumption by IR blaster	kWh/year	4
11	Net electricity savings	kWh/year	207
12	Total cost savings	Rs. / year	1,245
Investment			
13	Cost of IR Blaster	Rs.	1,500
Payback			
14	Simple Payback period	Year	1.2

For techno – commercial analysis a conventional 3-star AC is compared with similar AC coupled with IR Blaster. For baseline, a conventional AC of 1.5 TR capacity was considered. The conventional AC does not include features such as anywhere operation, scheduling, sequencing, go fencing and trigger option etc. Annual operating hours were considered as 1600 hours1.

For estimation of energy savings from IR blaster enabled AC, the idle running of conventional AC is considered as 160 hours per year. With IR Blaster, using features mentioned above like scheduling, sequencing, trigger and geo fencing the idle running of AC and other appliances can be prevented.

Table-3 Calculation of Energy Savings by the use of Smart Plug in HEMS

S. No	Particulars	No. of Units	Project Implementation cost (in Rs.)	Units Saving (in KWH / day)	Units Saving (in KWH / hour)	Units Saving (in KWH / Hour) (6 Months)	Consumer Cost Savings (@7 Rs/unit)	Payback Period in Years
1	**Smart Plug**	1	₹ 500.00	0.72	0.09	129.6	₹ 907.20	0.55
2	**Smart Plug**	100	₹ 50,000.00	72	9	12960	₹ 90,720.00	0.55
3	**Smart Plug**	1000	₹ 5,00,000.00	720	90	129600	₹ 9,07,200.00	0.55
4	**Smart Plug**	500000	₹ 25,00,00,000.00	360000	45000	64800000	₹ 45,36,00,000.00	0.55
1.5 KW inverter AC consumption per day = **Units watts* No. of hours/1000**								**12**

(1500*8/1000= 12 units) (* Taken average running Hour = 8/day**)**	
By increasing the temperature of **AC by 2 degree Celcius,** the energy savings will be **6%** (Approx.)	**0.72**

4. RESULTS AND DISCUSSION

In this work we are trying to find out the potential in changes of load from the residential demand side management by the use of smart retrofits, from the research we can see the retrofits of smart home makes considerable amount of savings and a very short duration of payback period. In the AC control by the use of smart plug that generally comes in the range of 500-1000 INR. The calculation has been made for the savings of one smart plug in a 1.5 ton of AC units savings in one unit is 0.72 units in a day. As per the analysis by the increase of temperature by 2 degree Celsius the energy savings will be 6 % and as the unit consumption is very high in case of air conditioning system the savings of 6 percent is also very high if it will be implemented in a large scale. So as we have a considered unit numbers of 5 Lakhs. The savings will be 648 lakh units that is a very huge amount and will impact directly in the peak load reduction of the power distribution company.

5. CONCLUSION AND FUTURE SCOPE

The major focus of all the demand side measures is to reduce the peak demand because in the states where the power generation is not surplus as per the demand. So the company has to purchase power and sell it to the consumers considering all factors like T & D losses and all other factors including services and profit for the company. At the peak time even the power purchase is very costly so we have to make the demand reduction at the time of peak and it can be done by the shifting of load at the time of peak. In future other demand side measures in other sectors like agricultural, commercial, and industrial and all the sectors demand side measures will make a considerable amount of peak load reduction and avoid the needs of new generating plants because the energy saved will be given to the new consumers. The energy efficiency and energy conservation will make a huge difference in the power consumption.

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