

## Implementation of Green Energy Initiatives in India: Status, Challenges and Solutions

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### Abstract

There is growing interest in creating the smart grid mainly reducing carbon footprint and outage. Countries with the vast population like china and India are in the race for implementation of the smart grid pilot project in selected areas. However, there are some serious technological and economic constraints on their implementation. This paper is an exclusive study on the status, challenges, and possible solution related to the technological aspects from India perspective. Since the smart meter is an integral component in the smart micro grid implementation, the technological issue and challenges are particularly discussed in this paper. An actual implementation of a smart meter for Indian domestic consumers in laboratory environment shows the possibility of its adoption in residences.

**Keywords-** Smart Grid, Smart Meter, Power quality, AMI.

### 1. Introduction

India is the seventh biggest nation by topographical territory and the second biggest by the populace. India is the world's fourth biggest vitality purchaser after the United States of America (USA), China and Russia sharing 5% of world's aggregate utilize. As indicated by the service of force Government of India (GOI), toward the finish of July 2017, the introduced control era limit of India is around 230GW however per individual utilization of power in India is around one-fourth normal of the all over the world. This most minimal score is urging the power framework to develop expedient. The twelfth five years, arrange focus for renewable vitality era (REG) is 36 GW which will expand the current 14% share REG to around 20% before the finish of 2020, to accomplish this objective needs a quick pace in renewable vitality era share. India initiated a National Mission on Electrical Mobility (NMEM) with the focus of 6 million Electric Vehicles (EVs) by 2020. For the capable execution of this EV program, an updated and more astute electrical circulation system is required. This system will control the charging of a few EVs from a similar feeder (charger). In this paper the creators introduce a look on the status of various green tech activities; pilot extends in the India and difficulties in their usage. Creators likewise

show the related arrangement and cure for better execution of the green innovation extend. A shrewd network is a developed framework that diminishes power request and supply crevice in a practical, dependable and monetary path, based on cutting-edge metering foundation (AMI) and tuned to encourage the joining of all included. Brilliant matrices give more power to take care of rising demand, increment dependability and nature of force supplies, increment vitality proficiency, ready to incorporate low carbon vitality sources into power systems to decrease the ecological impact. Savvy matrices have request reaction ability to help adjust electrical utilization with supply and in addition, the imminent to coordinate new innovations to empower vitality stockpiling gadgets and the utilization of electric vehicles in substantial scale. Electrical frameworks will experience a premier progression, enhancing unfaltering quality with renewable vitality era and lessening electrical misfortunes, uses and upkeep costs. A more brilliant lattice will give shoppers a superior control over vitality cost and a more reliable vitality supply. The natural advantages of a more intelligent lattice likewise incorporate control stack administration amid pinnacle hours, reconciliation of more renewable power assets, and lessened CO<sub>2</sub> releases.

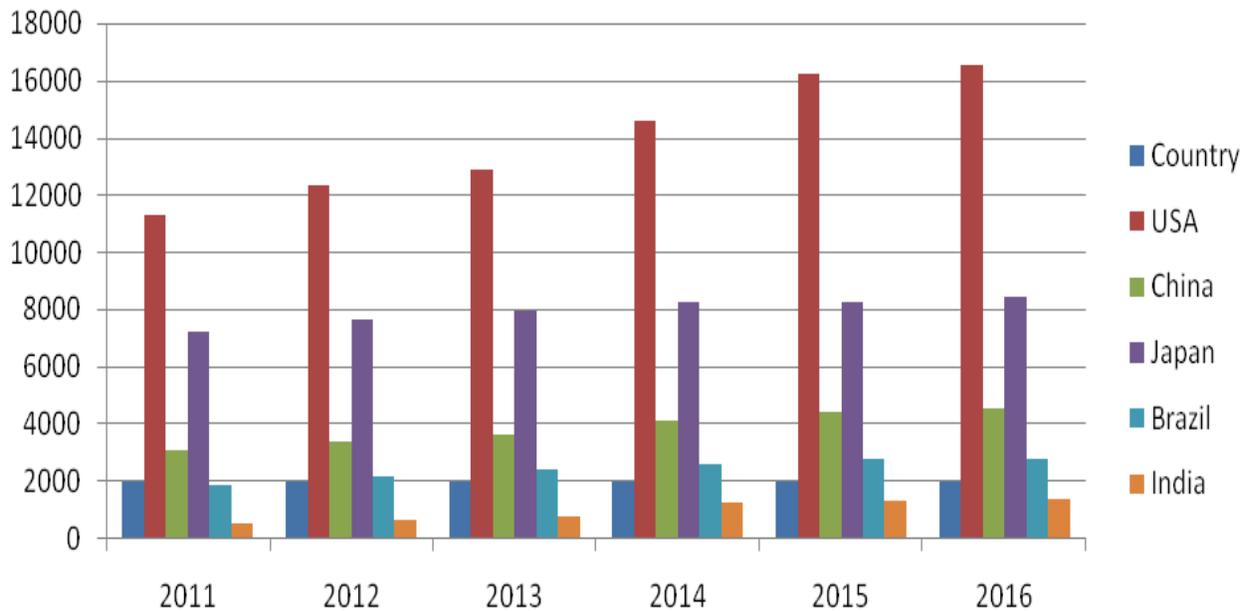


Figure 1. Per Capita consumption of different country (Source: CIA World Factbook)

## 2. Status of Smart Grid

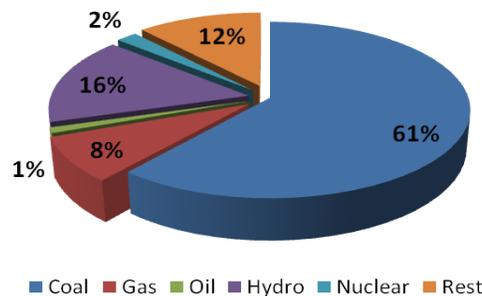
As indicated by service of force, India's transmission and conveyance normal misfortunes are 24% of aggregate power generation in a few states as high as 58%, including non-specialized misfortunes, for example, vitality burglary misfortunes as may go as high as half. The aggregate normal misfortunes in India are around 56.30% in a decade ago. India's per capita power utilization is around 1390kWh which low with contrast with world's normal per capita power utilization which is 3373kWh. The Figure 1 is demonstrating the per capita power employments

of some nation in the time of 2013-16. To enhance the per capita power utilizes and decrease the T&C misfortune, the Government of India (GoI) takes to start and propelled shrewd matrix pilot extends in a few states. Table 1 demonstrates the short presentation of Smart framework pilot extends in India.

**Table 1. Smart grid-smart meter pilot projects in power distribution sector in India**

Sr.	Utility	Functions	No. consumer	Remarks/benefits
1	CESC, Mysore	AMIR, AMII, OM, PLM, MG/ DG	21,824	151.89 MUs input energy consumption, reduction of AT&C losses. Reduce load shedding and improve billing process.
2	APCPDCL, Andhra Pradesh	AMIR, AMII, PLM, OM, PGM	11,904	Implementation of IT and SCADA. Peak load and outage management, reduction of AT&C loss.
3	APDCL, Assam	AMIR, AMII, PLM, OM, DG, PQM	15000	Implementation of IT and SCADA, integration of DG. Reduction of AT&C losses and load shedding. Improve billing process.
4	UGVCL, Gujarat	AMIR, AMII, PLM, OM, PLM, PQM	39,422	1700 MUs input energy consumption, outage and power quality management. Reduction of AT&C losses and peak load.
5	MSEDCL, Maharashtra	AMIR, AMII, OM	25,629	261.6 MUs input energy consumption. Reduction of AT&C losses and load shedding. Improve billing process.
6	UHBVN, Haryana	AMIR, AMII, PLM	30,544	131.8 MUs input energy consumption, reduced distribution loss, load management in peak hour.
7	TSECL, Tripura	AMIR, AMII, PLM	46,071	Reduce the distribution losses and peak load management. Improve billing process.
8	HPSEB, HP	AMII, OM, PLM, OQM	650	533 MUs input energy consumption, shifting peak load, reduction of penalties and outage.
9	PED, Pondicherry	AMIR, AMII	87,031	367 MUs input energy consumption. Reduction of Distribution losses cost of billing.
10	JVVNL, Rajasthan	AMIR, AMII, PLM	2646	374.68 MU input energy consumption, reduction of AT&C losses and peak load shifting of loads.
11	CSPDCL, Chhattisgarh	AMII, PLM	508	2140.86 MUs input energy consumption. Reduction of distribution and T&D losses, peak load management.
12	PSPCL, Punjab	OM	9000	Installation of 9000 SMS. Reduction of feeder outage restoration time.
13	KSEB, Kerala	AMII	25,078	Total 2108 MUs input energy consumption. Reduction of AT&C losses by automation of power system.
14	WBSEBDCL, West Bengal	AMII	4404	42 MUs input energy consumption, Reduction of AT&C losses and peak load management.

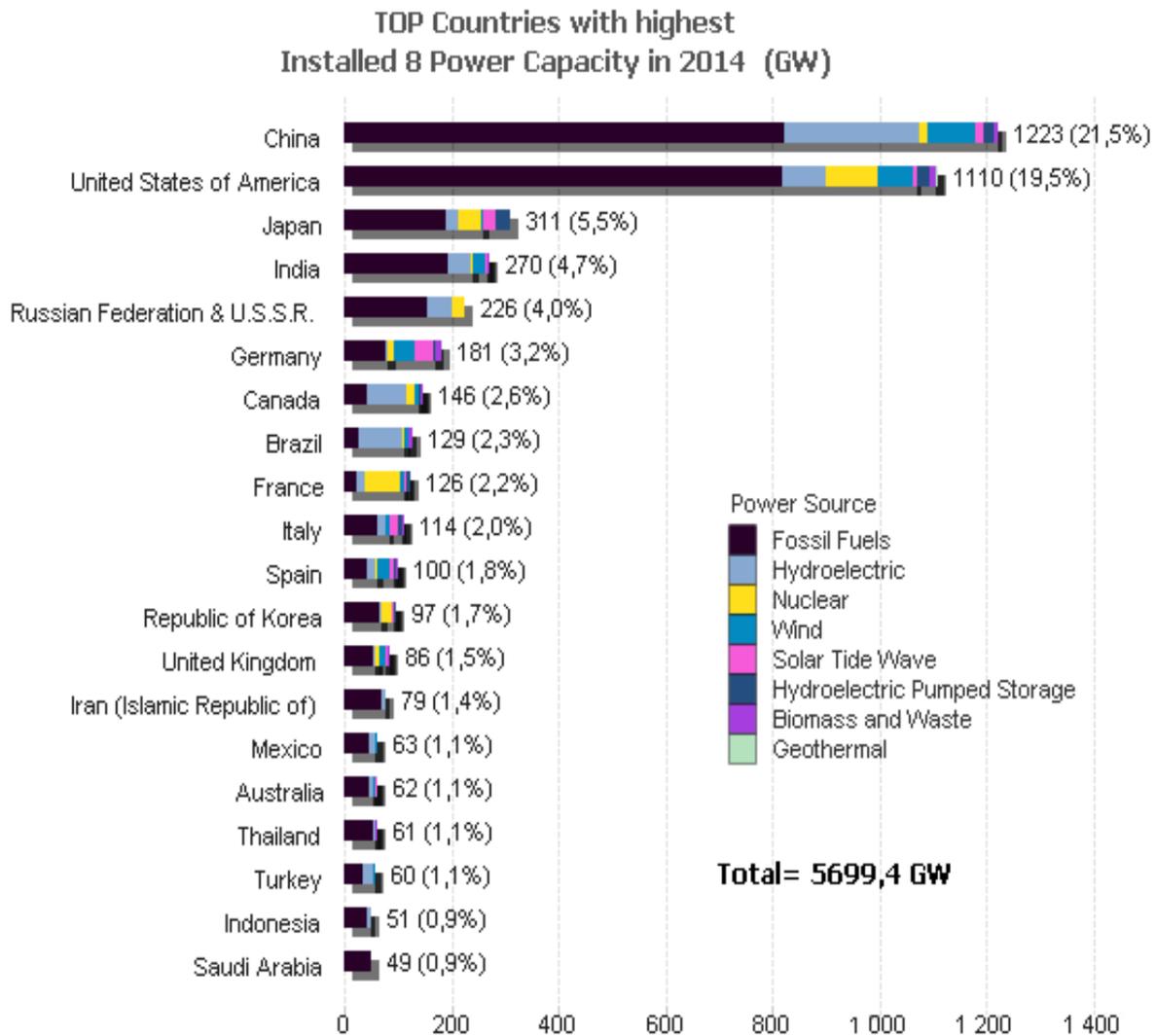
\*(AMIR- Advance Meter Infra Structure for Residential consumers, AMII- Advance Meter Infra Structure for Industrial consumers, OM- Outage Management, PLM- Peak Load Management, PQM- Power Quality Management, MG- Micro-Grid. DG- Distributed Generation)



**Figure 2. Different electricity generation sources in India (till 2016)**

In India, the coal is a noteworthy article utilized for power era roughly 61% of power is produced utilizing coal as appeared in Figure 2. Hydro creates the 16% of the aggregate power. To diminish the coal partakes in an era, the Solar PV (Photo-Voltaic) framework and wind control frameworks are utilized as significant advances utilized under Renewable and Green Energy Resources (RGER) for power era.

In India, the commitments of renewable and efficient power vitality assets are still less around 12% of aggregate power is created by renewable sources. The rising utilization of coal in power era expands the CO2 release and dirties nature and this is likewise in charge of greenhouse impact.



**Figure 3. Comparison of power sources utilization and status world-wide**

Figure 3 demonstrating an examination of various renewable source nations wise. This figure unmistakably demonstrates that china secures the main position and creates 71GW power utilizing renewable sources and 62GW is produced by wind control framework as it were. India secures 6th position on the utilization of renewable and efficient power vitality assets, 90% of aggregate vitality is produced utilizing wind control framework as it were. Govt. of India (GoI) declared the new Electricity Act of 2003. The point of the power demonstration is to change power laws and bringing back the remote venture.

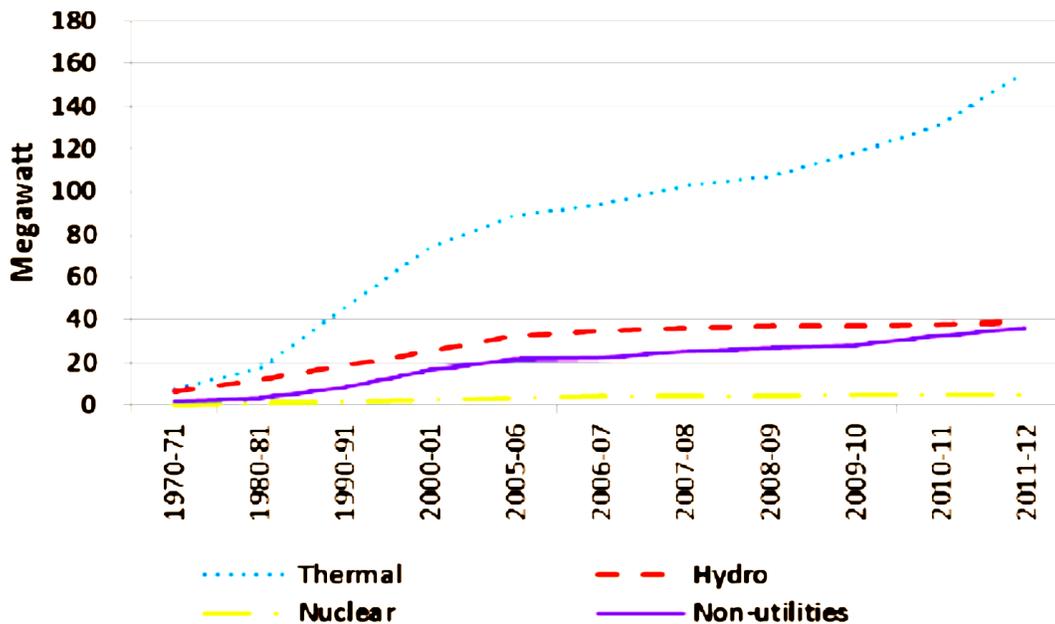


Figure 4. A rising share of thermal power since 1971

In Figure 4 it can be revealed that the use of thermal plant to generate the electricity is tremendously increased in compare to the other resources like hydro power, nuclear power and other non-utilities. Table 2 showing the losses both AT&C and T&D, from this table it can be revealed that the losses are decreasing every year.

GoI began marking apparatuses with vitality use to help customers decide working expenses. Real businesses utilize vitality effective family unit apparatuses/lab instruments/types of gear to lessen vitality utilization and noteworthy change has been accomplished. For the change of India's lattice, the critical activity are (i) Improve metering Efficiency, (ii) Improve Billing and gathering frameworks, (iii) Mandate least measures of power from renewable, (iv) Require unique duty rates for renewable, (v) Make distinctive elements for circulation, transmission, and era unloading the State Electricity Board's benefits for the goal of possible privatization, (vi) Reduce the cost of power expanding end utilize proficiency and (vii) Create duty and clarity at

all levels giving appropriate review. As of late, the GoI additionally as of now enhances a considerable measure in the range of correspondence.

**Table 2. T&D and AT&C losses (In %)**

Year	T&D Losses (All India)	AT&C Losses
2007-08	27.20	29.45
2008-09	25.47	27.37
2009-10	25.39	26.58
2010-11	23.97	26.15
2011-12	23.65	26.63
2012-13	23.04	25.38
2013-14	21.46	22.70
2014-15	21.07	21.43

### **3. Some Initiative of Government of India**

Some dissemination utility and power area organizations began to proceed onward with brilliant metering ventures these are Power Grid Corporation of India Limited, Indian government's Smart Grid Task Force, Alstom India, BESCO, Grinpal Energy, Central Electricity Authority, TATA Power, Reliance Power and in addition Itron channel accomplices. Itron gives savvy network arrangements, conveying a standout amongst complete suites of items and administrations accessible to help utilities measure, oversee and investigate vitality and water assets.

Grinpal Energy Management, the vitality delivering arm of Saab Grintek, has started sending keen meters and progressed metering foundation in New Delhi, India. Saab Grintek is a differing innovation firm gaining practical experience in big business arrangements, vitality administration, flying frameworks, interchanges knowledge, and worldwide availability. The organization has created associations with governments and different associations all through Africa and the world. The principal sending starts in the Tata region, where Grinpal anticipated that would have 500,000 establishments' finishes by 2010.

A noteworthy venture taken up by Bangalore Electricity Supply Company (BESCO) to introduce 1.5 lakh 'shrewd meters' which give remote access to meter perusing and disengagement, has been minimized. It will now be a pilot extend before the vitality utility chooses to proceed with the venture over a bigger zone. The venture would have made customers foot the cost of these keen meters, which can cost anyplace between Rs 4,000 and 6,000 relying upon the providing organization. Other than of these pilot extends the GoI have been taken different activities to decrease the pinnacle stack.

### **3.1 Time-of-Use (TOU) Rate Pilot Project**

This pilot venture is an elements valuing framework. The shrewd meter (Hao et al., 2012; Zheng et al., 2013) is an urgent piece of this venture. Without a way to flag the evolving expense (and, therefore, cost) by the time of day, it won't be plausible to accomplish the most fundamental of advantages of the shrewd framework vision. TOU rates bode well from a monetary and business recognition, however, the strategy of creating them, getting them affirmed by controllers and acknowledged by clients has been loaded with challenges, and advance has been moderate. This has likewise been the situation in India. Getting comes about because of a substantial TOU pilot venture is fundamental for the power division – including organizations, controllers, and customers – to comprehend this idea and find out about the advantages TOU can empower.

### **3.2 Distributed RE Generation in Remote Rural Villages**

The hole amongst country and urban is a standout amongst the most inoperable issues in India's energy segment. There is low client thickness existing in country territories and all the more so in remote provincial zones, makes a characteristic disincentive to spread out the matrix and when the lattice is broadened, this marvel makes a disincentive for utilities to broad power access to more individuals. The reason for this pilot venture is to recognize ease vitality arrangements that don't require framework get to and energize them in provincial regions. Applications could involve existing advances (e.g., sun oriented water warming, sun oriented road lighting) to make conceivable agriculturists to check products costs, and so on.

### **3.3 Wastewater Treatment Plant Methane Capture**

Utilization of power in wastewater treatment plants is high in the urban range where it must be work 24X7 in a week and 365 days a year. Methane, a by-result of wastewater treatment, can be utilized to create power (Zhang and Li, 2011).

Methane is a savvy approach to fabricate new wastewater administrations to get the fuel an on location generator, it could diminish the measure of power, the neighborhood DISCOM would need to give and decrease the monetary effect of non-installment by the metropolitan treatment plant. The retrofit of a power era office at a setup wastewater treatment plant could accomplish comparable outcomes.

### **3.4 Off-Grid Renewable Energy for Irrigation Pumping**

India's 10,000,000 water system pumps are controlled by the power that is without given or at an ostensible duty. These broken however politically revise levies have brought on the inefficient utilization of water and power. Underground aquifers are being drained at an always expanding rate and gauges of power utilized for water system pumping range from 20% to 30% of the aggregate.

### **3.5 Replacement of Small-Scale Gensets with Renewable Energy and Connect them to the Grid**

India has around 20,000 MW limit, which is not associated with the framework; most is remain by an era of generally little modern organizations. These units run from 100 kW to 500 kW with, we assess, a normal size of 200 KW. Encourage the route needs to discover to associate even a small amount of this hostage ability to the framework would help close the India's supply-request crevice. The issue is that a large portion of this limit utilizes diesel for fuel which is a high carbon emitter.

### **3.6 Plug-in Hybrid Electric Vehicles**

Throughout the following 20 years, a considerable measure of small-scale urban communities will be created in India and the quantity of new autos to be sold, one interesting probability is coordinating "keen" houses and module mixture electric autos (PHEVs) in an all-encompassing way to deal with improving vitality utilize and capacity. GoI declared endowments for half and half and electric vehicles and plans to have on street 7 million electric vehicles by 2020 (online accessed on September 2015).

### **3.7 Smart Green Apartment Complex**

The estimation of a Leadership in Energy and Environmental Design (LEED) affirmed green building is settled and expanding in prevalence around the globe. Despite the fact that the development cost of a green building is around 15% to 20% higher than routine development, the higher first cost is more than counterbalance by the decrease in yearly working expenses. This venture would investigate utilizing brilliant network robotization to improve the LEED green building idea. It could incorporate errands to concentrate on the planned in private condos.

## **4. Smart Grid and its Necessity**

A brilliant framework can screen control spill out of era to utilization, and control the power stream or diminish the heap to match era continuously utilization. These are a few issues which are provoking the India shrewd network advancement:

- (i) Huge crevice in free market activity.
- (ii) Very high transmission and conveyance misfortunes.
- (iii) Primarily manual operation of the framework.
- (iv) Environmental effect.
- (v) Poor renewable vitality potential.
- (vi) Low metering productivity and least customer interest.
- (vii) Less usage of the propelled data innovation in the power network framework.
- (viii) Theft control.

## 5. Current Scenario of Smart Meter Application

A smart meter is a fundamental part of a savvy framework. The shrewd network is a blend of equipment, administration and revealing programming, worked on a canny interchanges framework. In the realm of the brilliant network, shoppers and service organizations alike have instruments to oversee, screen and react to vitality issues. The stream of power from the utility to shopper turns into a two-way discussion, sparing buyers cash, vitality, conveying more straightforwardness as far as end-client utilize, and decreasing carbon (CO<sub>2</sub>) emanations. Amid the last three-four years, broad and escalated look into endeavors is in progress at riotous pace for the use of savvy meters all through the world, especially in cutting edge nations. A large number of these nations have effectively created and fabricated keen meters and have been introduced or are being introduced. In India, be that as it may, we are at an exceptionally essential level with a few activities now being taken up at Government and top research establishments' levels. Much is required to be finished. There are some extremely difficult issues, be that as it may, with the use of brilliant meters. By and by, in India, computerized vitality meters (supplanting the old simple meters) are being used, yet they don't have the capacity to transmit or get "data" remotely.

## 6. Challenges and Solutions

The green advancements activities are confronting parcel of difficulties which can be characterized in two classes' i.e. specialized and nontechnical difficulties. The real obstacles for execution of keen metering arrangement in power appropriation utilities of India are poor monetary soundness of most state-possessed dispersion utilities, low attention to innovative advancements in the utility division, absence of facilitated national guide for the brilliant metering organization, and no demonstrated business feasibility for extensive scale savvy metering rollouts.

There is a requirement for every power dissemination utility, to set a thorough savvy metering usage technique which includes a mind-boggling blend of inner and outside difficulties as takes after.

- The specialized difficulties of new frameworks, new gadgets, new correspondences advancements, and a storm of new information can overpower.
- The affect on existing business forms should be distinguished, with new business forms characterized. The association needs to make it prepared for the critical and maybe radical changes that will happen.
- Customers, controllers and financial specialists need to comprehend the change and be persuaded that it is gainful. An effective relocation to a shrewd metering environment will require that every one of them grasp the vision, not just acknowledge it.

Every power conveyance utility in India needs to evaluate how its end-to-end conveyance and operational esteem chains will be influenced and decide how shrewd metering usage can increase the value of the client and different partners. Given adequate time and exertion, these difficulties are reasonable. The test for corporate pioneers is to make a mutual vision and connect with inside and outer partners in a typical concentration to team up and guarantee that brilliant metering advantages are conveyed taken a toll successfully. Specialized difficulties are identified with the Skill and information, information protection and security, poor electrical system.

### **6.1 Skill and Knowledge**

As the power organization move towards Smart Grid, there will be an overwhelming interest for another aptitude sets to satisfy the crevice of interest and supply, to need to grow new abilities in the examination, information administration and choice support. To tackle this issue, the quantities of specialists and administrators should be prepared to deal with the move. This changeover will require resource of both time and cash from both government and private division to bolster the better instruction programs that will help in building brilliant designers and chief for tomorrow. To convey such a change utilities need to consider how they can deal with the move so as to avoid over troubling of staff with change.

### **6.2 Information Security and Privacy**

Protection of information against unapproved get to and renouncement is a basic necessity for utilization and control information imparted inside the framework by (Efthymiou and Kalogridis, 2010; McDaniel and McLaughlin, 2009; Khurana et al., 2010) accepting that basic framework functionalities require that the information are trusted by both the utility suppliers and the clients. To give such privacy administrations won't be minor as it might include the reconciliation of various data security areas, for example, secure correspondence conventions, carefully designed equipment/programming and administrative structures on getting to control (Metke and Ekl, 2010).

### **6.3 Secure Integration**

The most generally talked about brilliant lattice security challenges concern the insurance of shrewd metering information against unapproved get to and renouncement. This is an essential prerequisite without which AMR information won't be trusted by either the utility suppliers or the clients. Arrangements are required on various levels: end to end secure correspondence conventions should be utilized, equipment segments (e.g. shrewd meters) need to withstand physical assaults, the framework needs to recognize produced/hacked parts, and savvy meter programming ought to be without bug (Farhangi, 2010; Ipakchi and Albuyeh, 2009; Wei et al., 2010).

#### **6.4 Poor Electrical System**

The deficient Grid Infrastructure of India is a noteworthy boundary to actualize the propelled keen framework innovation, to proceed with its way of good monetary development; it needs to manufacture a cutting edge, savvy network. It is just with a predictable, fiscally secure Smart Grid that India can give a steady situation to interests in electric foundation – an essential to settling the principal issues with the network.

#### **6.5 Low Metering Efficiency**

The business misfortunes are for the most part because of poor metering proficiency, robbery, and pilferage. This might be wiped out by change metering productivity and appropriate energy bookkeeping and examining with enhanced charging process. The metering efficiency need to be increase in order to improve the exploitation of generated power, here the smart metering comes in picture. Smart meter could be used for energy management, device identification, billing etc. (Kuruppu and Kulatunga, 2012).

#### **7. Conclusion**

The first stage of this paper presented the status of green energy. The government of India has taken some initiatives towards the implementation of renewable energy. Regardless the efforts of government, there are some serious technical and nontechnical challenges in the establishment of smart grids which were discussed in the latter stage. The authors highlighted the possible solutions and the suggestions for a particular challenge. In India where per capita energy consumption is very low mainly because of low generation and losses. On the other hand, high CO<sub>2</sub> discharge suggests the huge necessity of implementation of green energy. This paper motivates the research, development and the deployment of renewable energy.

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