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Loss Minimization through Smart Grid in Indian Power System

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ABSTRACT: *Smart Grids were introduced to make the grid operation smarter and quick. Smart-Grid operation, upon appropriate deployment can open up new avenue and opportunities with significant financial implications. Smart Grids can continue towards enhancement of power marketplace. The recent status of the authority market as well as initiations of Smart-Grids in India are studied to scrutinize the potential power market enhancement with the advent of Smart-Grids. This paper presents various Smart-Grid initiatives and implications in the context of power market evolution in India.Today's distribution utilities are facing the challenge of managing a network made up of assets originating from mature and proven designs, while having to integrate new technologies aimed at optimizing the quality of service to customers and the efficiency of its activities. The quantification and the minimization of the losses is important because it can lead to more economical operation of a power system.*

KEYWORDS*: Smart-grid, High level Scheduling****,*** *LV-grids, Grid Community, market power*

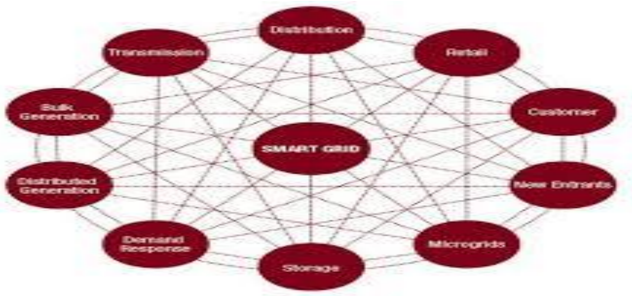
I. INTRODUCTION:

The first power replace of India was introduced in June 2008. Smart-Grid activity has been reported in some delivery pockets mostly by personal players. Many utilities in power sector have now Smart-Grid movement with high priority in their research. The priority of these functions depends on several factors such as policies, guideline, efficiency of the market, expenses and remuneration associated with the functions, and service provider and trader etc. Though there are various barrier for these innovative developments, the Government of India has some policies to maintain Smart-Grids in the distribution subdivision.[1]Grid computing means synchronized resource distribution and complexity solving in self-motivated, multi-institutional virtual organization [2]. Grid environments contain a large number of multifaceted services with variable functionalities. The incorporation of these services requires a flexible, extensible, and consensual resource administration and setting up solution, which is unavailable yet. Smart-Grids can bring in new market goods also. Smart-Grids can transfer data into valuable information and have the capacity to take local decision in distributed comportment, and can also offer self remedial. These features can be use for market improvement as resolution sustain. There is growing demand for "excellence power" in power market. Smart-Grids can offer valuable resolution to this demand. The mind of the smart grid is the DTC (Distribution Transformer Controller).

Figure 1. DTC and Energy Box[1]

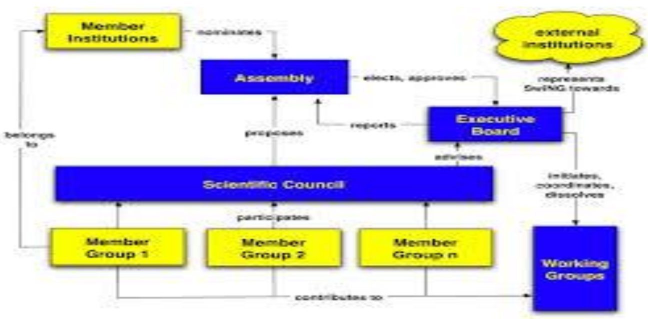
OVERVIEW OF INDIAN POWER MARKET : In India, electricity reform in progress with the review of Electricity deliver Act, 1948 and the Indian Electricity Act, 1910 which led to the electrical energy Act, 2003. The Electricity Act, 2003 has been bring about to make possible private sector contribution and to help cash impecunious state electricity boards to meet up electricity demand. The Electricity Act, 2003 envisage competition in electricity market, security of consumers ,benefit and provision of power for all. The act recommends the provision for national electricity rule, rural electrification, open way in transmission, phased open access in distribution, set state electricity regulatory commissions (SERCs), license free production and distribution, power trade optional metering, and stringent penalties for stealing of electricity. One more welcome step that the Indian electricity promote has taken is the realization of availability based tariff (ABT) which brought about the effective day-ahead scheduling and frequency sensitive charges for the difference from the program for efficient real-time corresponding and grid discipline.[4]Magnetizing loss can be minimized by minimizing the line voltage(in per unit terms).a number of paper has been write in the 1950s and 1960s ,which gives the similarity of actual precise of the transmission loss in an power system with concern of the loss coefficient. India's electricity grid experience from highest transmission and release losses in the world-nearly 27%.this is recognized to technical losses and stealing. The quantification and the minimization of the losses is important because it can lead to more reasonably priced operation of a power system. if we know how the losses come about, we can take steps to limit the losses. Hence if more losses can be minimized the power can be consumed capably. [5] To promote power trade in a free power marketplace, central electricity regulatory commission (CERC) permitted the setting up of Indian energy replace (IEX) which is the first power replace in India, in June 2008. At present, two power exchanges are operating in India, namely, IEX and Power Exchange India Limited (PXIL). These exchange have been residential as market based institutions for charge risk management to the electricity generator, delivery ,licensees, electricity traders, customers & other stake holders.

Smart-GRID Framework : In this part, the Smart-GRID Framework is introduced. Firstly, the intend goal and layered construction overview are presented. Then the Smart-GRID community communications and SG-Node configuration are illustrate, followed by an comprehensively argument on each relevant aspect.[6]



A. Design Goal : Smart-GRID has been planned to be a generic and modular outline in order to support intellectual and interoperable grid resource management using swarm intellect algorithms and multi-type grid scheduling strategy. The proposed solution is layer prearranged and aim at filling the gap linking grid applications, which act as the re- source consumers, and the grid resource low-level supervision systems, which behave as the resource providers. To this intention, Smart-GRID proposes an autonomic & evolutional grid community self-possessed of Smart-GRID Nodes (SG-Node), which will be illustrate in the subsequent secondary- section.[6]

B. Layered Architecture Overview : Smart-GRID framework is prearranged into two layers and one inside interface. The Smart Resource supervision Layer (SRML) is dependable for grid level dynamic arrangement and interoperation to serve grid applications with best use of the existing computing resources. The Smart Signaling Layer (SSL) is in incriminate of monitoring and constituting understanding on network and resources. Finally, the Data Warehouse Interface (DWI) is used to mediate the forecast and signaling layer. The overall design of the system is revealed in Figure[6]



C. Grid Community Infrastructure : As mention above, Smart-GRID aims at construct an incorporated high-level grid community. The grid com- munity is constitute of all the linked and engaged SG-Nodes. SG-Nodes can also work as interface when used to network with grid user or application, such as SG-Node A.[6]

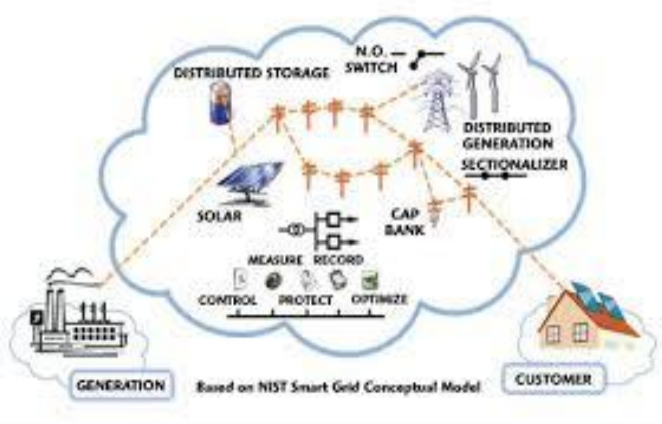


Figure :- Grid community infrastructure[2]

II. METHODOLOGY FOR LOSSES REDUCTION

Losses in Power System

Losses is define

$$\mathbf{P_{Loss} = P_G - P_R}$$

Where $\mathbf{P_{Loss}}$ = total losses $\mathbf{P_G}$ = power generation

$\mathbf{P_R}$= power received

Generated Power which doesn't used by customers (loads) is known as power loss.

$$P_{Loss} = RI^2$$

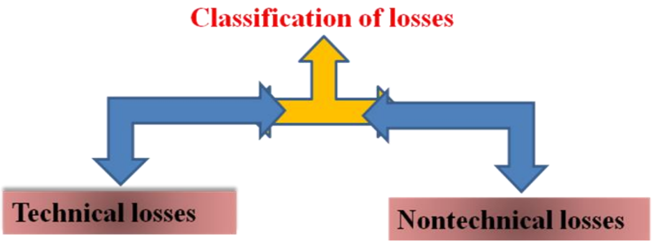


Fig.-Types of loss [5]

power supplied by EDP-Distribution in 2010 amounted to 48 TWh. Distribution grid losses amounted to 3.8 TWh (7.9% of supplied energy). Energy abounding in LV amounted to 25.3 TWh. Although there are no exact measurements, it is predictable that LV losses exceed 1.1 TWh. Furthermore, LV losses are propagate throughout MV and HV grids. LV losses are correlated with power flows in better voltage levels which, in turn, generate losses in those voltage levels. Therefore, reducing losses on LV grids also reduce losses in HV and MV grids.

EFFECT OF THE LOSSES:-

Losses cause various hurtful effects. ordinary effects are as follows:-

[1] Losses raise the operating & maintenance charge of running a power system.
[2] Thermal losses compact the overall lifetime of the electrical equipments.
[3] Losses responsible for the low power factor.
[4] Losses minimize the reliability of the power system.
[5] Losses reduced the efficiency of concert of the system.[5]

ANALYSIS OF LOSSES-

analysis concerning the impact on losses connected with different scenario or strategy:[3]

a. Losses due to utilization reduction;
b. Micro-generation impact on losses;
c. Optimization of MV grid design ;
d. Optimization of line current stability on LV grids;
e. Reactive power expenditure measurement;
f. Voltage profile analysis.

A. Losses due to consumption reduction : Smart-Grid creates opportunities to optimize energy end-use efficiency, thus allowing customers both to reduce electricity consumption and to shift loads from peak and full load hours to low load hours, reducing energy costs. Loss reduction due to consumption reduction and load shedding can be measured comparing between the energy supplied by the MV/LV substation and the energy delivered to all of the costumers before and after changes in consumption patterns, relating losses values on the grid with those pattern changes.In order to do that it is necessary to have a list of all of the costumers connected to each MV/LV substation, including information concerning the LV feeder and the phase to which they are associated, the quantity of energy deliver to each costumer and the energy deliver by each phase of each LV feeder.[3]

B. Micro-generation impact on losses : Micro-generation impact on losses is precise by comparing load flows and loss value before and after power generation or by compare real load flow and losses value with the micro-generation unit or units and the computer-generated (estimated) values that would occur without it. This investigation requires the availability of data apprehension bidirectional power flows to each costumer extreme, for each phase, and bi-directional power flows for each phase of each feeder linked to the MV/LV substation.[3]

C. Optimization of MV grid configuration : In order to execute this optimization it is compulsory to use data with reference to the bi-directional active energy flow in each MV/LV substation, the reactive power flow in each MV/LV substation and the same data for each MV feeder at the HV/MV substation.[3]

D. Optimization of line current balance on LV grids; Given the stochastic character of LV loads related with a LV feeder, the improvement of phase load imbalances implies minimization of the losses for a given time. Since LV loads have a load figure that varies on a daily, weekly and monthly basis, one can realize a ideal balance between phase currents on a given moment that, however, does not reduce losses for a given time due to the imbalance that may arise in different moments The necessary data to execute this optimization is the bidirectional power flow into each costumer, for each phase and the bi-directional power flows for each LV feeder.[3]

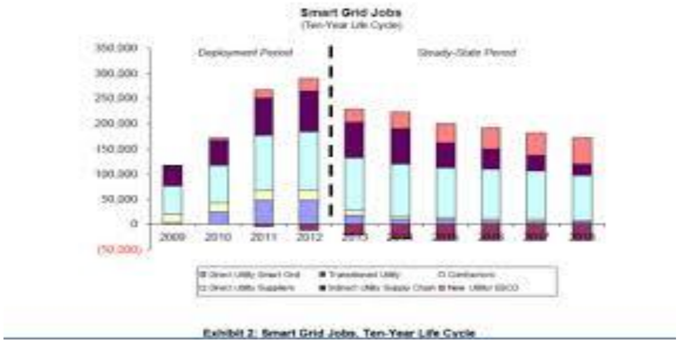


Fig.-Voltage profile[5]

E. Reactive power consumption : Reactive power flow are more critical outer surface low down load hours, when the contact on losses is greater due to the quadratic nature of Joule's losses. major *tg(ϕ)* as the coefficient among active and reactive power flow, it is compulsory to measure *tg(ϕ)* both at the establishment of the LV feeder and at each costumer point of liberate. Values of *tg(ϕ)* greater than 50% at the beginning of each feeder external low load hours specify the require to evaluate the technical and reasonably priced possibility of installing capacitors on the LV feeder, in order to decrease losses.[3]

F. Voltage profile analysis : MV/LV power transformers are prepared with off-load tap changers that permit to change the secondary voltage level. Having data relating voltage profiles on several locations of the LV grid, based on measurements performed on 4h intervals, it is possible to calculate the profit associated with varying the set point of the power transformer tap changers, rising the secondary voltage level in order to decrease current levels (a number of of the loads connected to a grid consume a given amount of power, not considering of the voltage level; thus, rising the voltage reduce the current on the same proportion).[3]

Fig.-Example of a customer load profile[3]

III. BENEFITS OF SMART-GRID

The electric power system is on the average of important transformation. The electric power in world demand is predictable to increase up-to 80% by 2030[7]. predictable revolution new fuel are developed this demand fulfill by increasing new coal, nuclear & natural gas electricity production plants. Not surprising world CO_2 emission are approximate to increase by 69% by 2030 as a results. The smart-grid help offset the increase in CO_2 emissions by slowing the increase in demand of electricity by which the global green house gas con be mitigate.
Smart –grid provides following profit-

[1] superior communications, automated controls and additional forms of information technology.
[2] It integrates new modern tools and technologies from production, transmission and distribution all the manner to customer appliances and apparatus [8].
[3] This concept, or dream, integrate power infrastructure, processes, devices, in sequence and markets into a corresponding and collaborative process that allows power to be generate, distributed and consumed more successfully and efficiently.
[4] "Smart-Grid" enable strategy at all levels within the grid (from utility to consumer) to separately sense, anticipate and respond to real-time situation by accessing, giving out and acting on real-time information.
[5] Smart-Grid is the convergence of information and equipped technology useful to the electric grid, allow sustainable options to consumers
[6] superior security, consistency and efficiency to utilities.
[7] A reorganized grid would generate a digital energy scheme that will mitigate the losses: [8], [9]
[8] identify and address budding problems on the system before they affect service,
[9] Respond to local and system-wide inputs and have much more in sequence about broader system problems,
[10] Incorporate extensive capacity, rapid, centralized communications superior diagnostics, and feedback control that rapidly return the system to a stable state after interruption or instability.
[11] Provide to customers with timely information and control
[12] options,
[13] organize and integrate distributed resources and production, together with renewable resources,
[14] incorporate "smart" appliances and customer devices like hybrid cars, exciting vehicles, etc.
[15] be able to heal itself –smart-grid expect and incentive respond to the system troubles in order to avoid power outage and power quality.

IV. FUTURE CHALENGES OF SMART-GRID

Electricity's share of total energy is predictable to continue rising in the coming decades[10], and the more smart processes introduced into the network. For example, controllers based on the power electronics individual with wide area sensing and supervision systems have the potential to pick up the situational understanding, exactitude, reliability & robustness of the power system. the 'key challenges' to the smart-grid include-

[1] strengthening the grid- ensure that there is sufficient transmission.
[2] capacity to interconnected energy resources, especially renewable resources.
[3] developing the decentralized architectures.
[4] active demand side enabling the all consumers, with or without their own generation, to pay an active role in the operation of the system.
[5] Capturing the benefits of the distributed generation and storage.
[6] Enhanced intelligence of generation, demand and most notably in the grid.
[7] Preparing the electric vehicles.
[8] Integrating intermittent generation- finding the best way of integrating intermittent generation including residential micro generation.

V. RESULTS ANALYSIS

The losses are an important component of consideration for improvement and thereby enhancing the accessible transfer capability of power system. The quantification and the minimization of the losses is important because it can guide to more reasonable operation of a power system. if we know how the losses arise, we can take steps to maximum value the losses. Hence if more losses can be minimize the power can be consumed capably.Smart-grid conception, or vision, integrate energy infrastructure, processes, devices, information and markets into a synchronized and collaborative process that allows power to be generated, distributed and extreme more effectively and capably. Smart-Grid is the junction of information and operational technology purposeful to the electric grid, allow sustainable options to consumers superior security, reliability and efficiency to utilities.

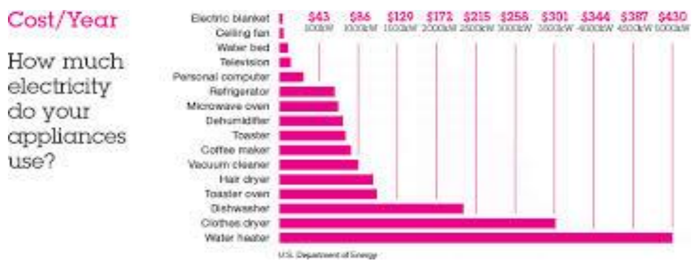
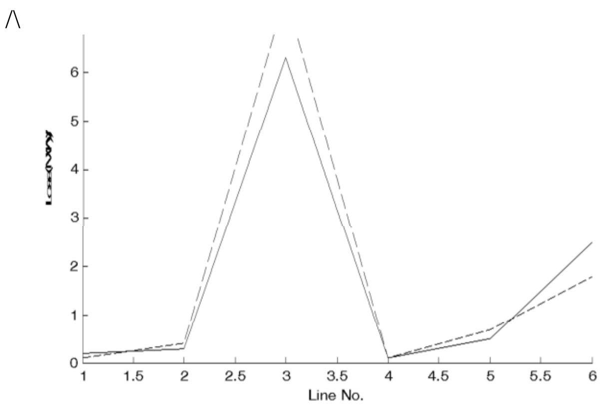


Fig. variation between cost and time period(year)[7]

Power System	Real Power Loss Reduction
9-Bus	6.6%
14-Bus	17%
30-Bus	9.4%



- - - - - without smart grid
_____ with smart grid

Figure:-Power System Losses Before and after Placing smart-grid[8]

VI. CONCLUSION

Smart-Grid infrastructure provide data that allow to adjust LV management paradigm, falling losses and enhancing quality of service to the costumers.These analyzes capability allow to learning LV grids with more detail. LV grids account for a important part of losses on a distribution grid. New methodologies were developed that allow to optimize LV grids in order to reduce line losses. In a preliminary case study concerning eight MV/LV substations loss decrease opportunities were identified that may result in a 12% loss decrease.The quantification and the minimization of the losses is important because it can lead to more reasonably priced course of action of a power system. if we know how the losses arise, we can take steps to limit the losses. Hence if more losses can be minimize the power can be extreme proficiently.

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