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SMART GRID framework for Pakistan "Perception to practicality"

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Abstract: As moving further into the digital age of the 21st century, Pakistan. and rest of the world is becoming increasingly dependent upon electric power. Despite the colossal potential of its energy resources, still Pakistan remains energy deficient.
As a consequence, the crucial energy supplies today are not adequate to meet even the present demand. Similarly Line losses are a major issue in Pakistan. We are losing 35 to 40 billion per annum due to inefficiency in power distribution [4], While continuing blackouts or load shedding as it is commonly known, has always been a staple of daily life in Pakistan (figure 1). the dilemma has turned out to be acute since the preceding couple of months.
The only way to tackle such colossal plight collectively is to implement smart grid infrastructure into our system.

Also integrated use of smart grid would enhance the co-operation between the different sectors of the energy mix to provide an optimal solution in the electrical energy scenario of Pakistan.
Smart grid is nothing but a concept/idea needed to run our present day Electrical power system in a more effective, more systematic and less error prone way. To achieve this way of wisdom, we must keep the end or the output required in our mind. Accommodating the present infrastructure with newer and more reliable modern day technologies are also a target of the Smart grid planning. Similarly Clean, green energy structure is an inherent requirement of smart grid development [6].It would provide a long term economic and social benefit to the existing structure of the society.

Key Words:

Electricity, Energy consumption, Power demand, power grids, Smart grid.

1. Introduction:

The total installed capacity of WAPDA(Water and power development authority) and KESC(Karachi electric supply corporation) totals around 19,500 megawatts **[1]** .Approximately two third of this power comes from thermal power plants (fossil fuels), one third is generated by water and about 2% comes from nuclear power plants [1] .Although the installed capacity is more then our present day requirement i.e.; 11,000 MW in winters and 17,500 MW in the summers, still the Pakistani consumer is not satisfied as the electricity reaching them is practically negligible. This petty aggregate of electricity is not at all complying with the routine demands of the dwellers. Having surplus generation, should not lead us with such a dilemma.
Similarly with the rapid increase in modernization, our present day electricity supply system has become inefficient rather then being satisfactory as it were before presenting us with more recurrent failures and substantial menaces. This electric supply grid has to be replaced to a much more intelligent and reliable solution. The Pakistani government is anticipating the energy crisis to worsen in the coming two years due to

a 50% increase in the demand and a rather slow improvement in the supply,
So an effectual solution to the above mentioned problems is stated commonly known as the “Smart grid”.
A smart-grid phenomena employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies [2] to create an improved electricity furnish chain.
Another very important factor in Smart grid planning is the incorporation of a more clever and transparent monitoring scheme that could be easily be accessed by the customer and also the utility company. Transmission and distribution facilities are also provided with the state of the art technology as such to give reliability and safe power transfer with intelligent control mechanism. Thus the basic concept behind Smart Grid is to add monitoring, scrutiny, control, and communication service altogether to the national electrical delivery system as to maximize the throughput of the system while reducing the energy expenditure.
The Smart Grid strategy will allow stakeholders to supply electricity more efficiency and economically feasible. This approach will enable the sustainability of the resources of the world in a more lasting manner thus enabling energy independence and reduction of the greenhouse effect by reducing fossil fuel consumption and establish more renewable sources on the grid.

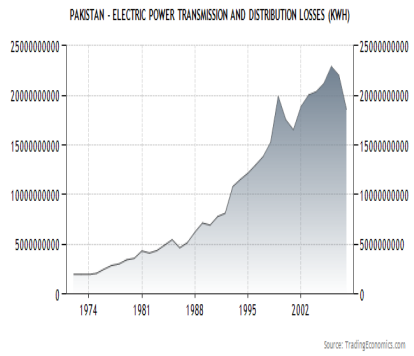

Figure 1.Transmission & Distribution losses courtesy Trading economics

2. STRATAGEM TO BE EMPLOYED.

Certainly this kind of theory requires to face numerous challenges and confrontations. Our first challenge is to develop a wholesome plan comprising of the different areas that need to be addressed. Thus on this note the definition of smart grid “The smart-grid is an electricity network that can intelligently integrate the actions of all users connected to it i.e.; generators, consumers and those that do both in order to efficiently deliver sustainable, economic and secure electricity supplies(figure 2). A smart-grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies” [2].
Now the question arises, that how to start the deployment of the Smart grid plan. Firstly very important to mention that the path to the Smart Grid is a lengthy and complex expedition that requires to be broken down into manageable and logical steps.

There are 3 main parts to any electricity supply system these include [1]:
1. Power generation including transmission
2. The actual distribution of the power and
3. The recovery or billing based on the usage

Thus to understand the idea we need to understand that all the blocks of the power system are of crucial importance .Deficiency in any of these services would destabilize the whole system and returning us back to the prior unpleasant scenario. With the smart grid concept, we should be able to tackle all the categories related to each of these systems in a more effective manner.

I. GENERATION.:

Looking from the Generation side, adding new power plants to the grid is of prime importance in this new age. Building new generation facilities ,to be inducted to the existing power system requires them to be in co-ordination with each other. This is especially important when considering the feasibility and working of certain generating plants over the others. Similarly Pakistan has clear skies and sunlight for almost all the months of the year, making it a strong candidate for Solar energy production; also it has strong wind tunnels through the Thar Desert and the majority of Sindh making Wind as an energy a dependable choice, that could be incorporated into the national grid. Having such different types of generating elements together, they must have the capability of Interoperability that is the ability of diverse systems and their components to work together, is of vital importance for the performance of the Smart Grid at every level. It enables amalgamation, effective collaboration and mutual
communication among the many interconnected elements of the electric power grid. Enhanced grid operation will give access to less expensive power sources. smart grid will increase throughput on existing power lines by providing more effective
ower flow control.This increased line capacity reduces

congestion (which requires more expensive units to run instead of lower-cost units) and thereby lowers generation costs to consumers. This kind of milestone is called as Advanced asset management or AAM [3].It deals with the use of all possible resources at their equipped stage working more effectively and managing these assets from a life cycle perspective, similarly interconnecting of these systems with a sensor based automated scheme. Smart grids allow more competent routing of power discrete units, with smaller number inoperative or wasted generators. Smart grids would, in principle, allow an overall lower level of generation, hence minimizing expenditures related to it.

II. TRANSMISSION:

Talking in terms of transmission facilities, the smart grid technology will provide Advanced Transmission Operations (**ATO**) [3] – the ATO objective is largely designed at civilizing transmission reliability and efficiency, as well as managing clogging (congestion) on the transmission system. ATO includes substation automation, superior safety and control of grid campaign and equipment and the integration of all these tools with up gradation approach."**FACTS" i.e.;** Flexible AC Transmission Control Devices, are advanced systems that can change the flow of power in transmission lines [4].These innovative designed devices aim Power flows through transmission grids in such a way that often it will flow in parts of the network where it is not wanted, and not flow in places that would be more economically desirable.

These are a family of devices based on solid-state power electronics which can alter the electrical Properties of lines and make power flow where it is essential the most thereby reducing losses and enabling effective power flow. Also the Pakistani. Power system oscillates at a frequency of 60 cycles Per second (60 Hz).

However, current and voltage do not alternate in phase (go up and down together). Furthermore, in order to move power over a long line, there has to be a difference in phase between the two ends of the line, but if that difference becomes too large, the line will no longer transmit power. There are very few measurements of phase being made across today's transmission systems. New Phase measurement units popularly known as "power systems health meters" work dynamically sampling the current and voltage many times at equal intervals of time, consequently giving an MRI of the power system. Intense integration of that information significantly improves the effectiveness of the scheme.

III. DISTRIBUTION.

Now articulating about the distribution segment for assessment, the approach to be used is of automated sensor based technology will help in scrutinizing loads that have to be shut down .Today, power systems are controlled centrally by human operators, assisted by advanced computer systems, where as this would allow the different elements of the distribution system to trigger signals that would initiate switching actions with negligible time lapse and minimal imprecision. This is particularly important in the case of emergency conditions such as thunder lightning, terror attacks etc. Also prioritizing loads on the basis of selectivity can be instinctively executed by smart grid. **Micro islanding**, a concept incorporating local DGs increasing the reliability of supply. But this concept is yet early to come into realization due to lack of regulatory reasons. Nevertheless, with the correct expertise, control coordination, and regulatory environment, there is no reason why this could not be done in a secure plus proficient way.

IV. CONSUMER LEVEL.

Furthermore now analyzing in terms of customer point of view, at present day, most customers only receive information through their monthly bill, which is usually delivered many days past decision have been taken, such as whether to turn the thermostat to a lower value or not. But smart meters having a display would tell observant consumers their existing tariff of electricity use, and its cost which would in turn give customers information to make informed decisions **i.e.;** having a readout that illustrates the clients their current tariff of electricity utilization, permitting them to fine-tune their expenditure stratum in factual occurrence. Also these meters could be inspected automatically without the hassle of sending meter readers to respective locations. Similarly a special electric rate feature to be incorporated under which the price per kilowatthour depends on the time of day called the **Time-of-day metering**. Automated control systems, having the consumer in charge himself would allow to prioritize circuits activation and shut down thus achieving high level of supremacy over their electricity expenditure.

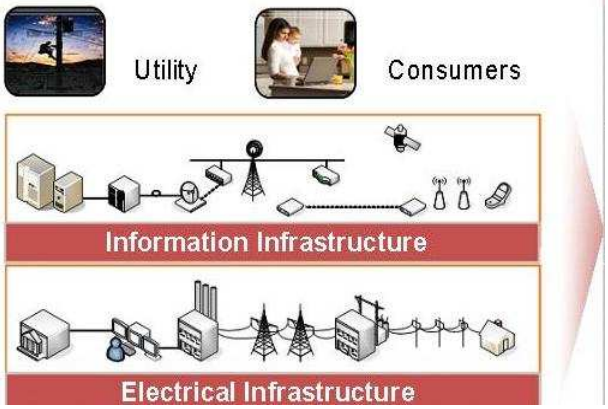

Figure 2.Smart grid infrastructure courtsy ASAT solutions-

3. Model 0f the Smart Grid

When developing the Smart grid, it is necessary to involve integration of the power system with the telecommunication technology and a sensor network. The equipment used to build a smart grid consists of communications, computers, sensors, and control devices. The communications infrastructure enables the passing of information between all components of the power system (figures3,4), between individual customers and central computers, and between buyers and sellers of electric power [8].

Having an intelligent communication incorporated into each circuit breaker, capacitor and other electrical equipment within the power system will allow a comprehensive record to be shaped and preserved with no trouble and involuntarily.

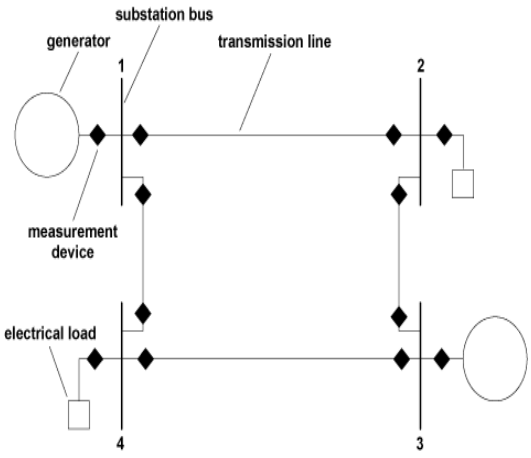

Figure 3

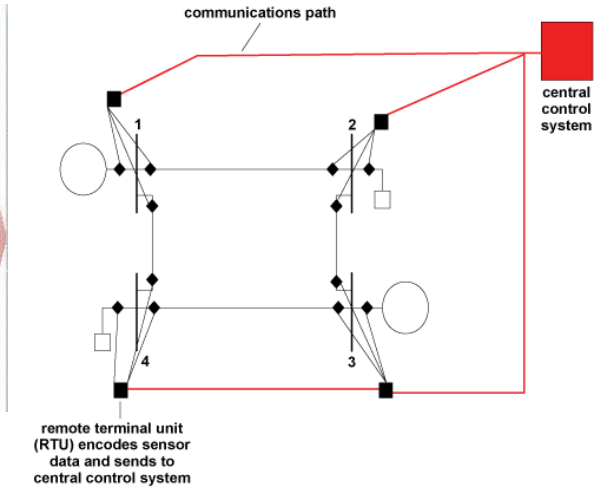

Figure4. Traditional power system communications, central control computers, and sensors. (*Bruce F. Wollenberg, Massoud Amin.)*

4. WORLDWIDE INITIATIVES AND PRACTICES.

Introperatability is the capability to build assorted arrangement of systems and equipment to work in a synchronized manner. To make a flawless synchronized system operation a need is there to make the whole system homogeneous. Unessential
divergence in equipment and scheme to meet differing standards enhances expenditure, which in the long run, burdens the consumers. Developing standards for such critical and large infrastructure is complex challenge. Establishment of standards for the Smart Grid requires efforts at national, regional and international levels. While electric utilities typically operate within national boundaries, there are interconnections across borders, such as between the United States, Canada, and Mexico in North America, and among member states of the European Union.. In the United States, Congress recognized the important role of standards and assigned the responsibility for coordinating the development of interoperability standards for the U.S. Smart Grid to the National Institute of Standards and Technology (NIST) (figure 5) through the Energy Independence and Security Act of 2007[9].Similarly Japan has developed an initial standards roadmap for the smart grid and has also formed a Smart Community Alliance. The government of South Korea has announced a plan to build a national smart grid network and is beginning work on a standards roadmap. In China, the State Grid Corporation has developed a draft Framework and Roadmap for Strong and Smart Grid Standards. International collaboration among these efforts is underway through a recently established International

Smart Grid Action Network (ISGAN) under the auspices of the Clean Energy Ministerial [9].
Pakistan is also not behind the other nations and going towards the road of progress.
The U.S. will work with the Karachi Electric Supply Company (KESC)to conduct a study to determine the viability of an integrated Smart Grid system in Karachi. The project includes the potential for a large Smart Grid pilot project. According to and [12], KESC which generates and supplies electric power to Karachi with a population of 17 million plans to install a Smart Grid which overlays the electricity distribution grid with an information and net metering system and delivers electricity to consumers using digital technology with two-way communications to control appliances at consumers' homes to save energy, reduce cost and increase reliability and transparency [11][12].
Similarly a pilot project is underway, managed by LESCO (Lahore Electric Supply Company) which provides electric services to areas of Lahore, Kasur, Okara and Sheikhupura in Pakistan having a 100 meter AMR trial using GPRS for Industrial Consumers. The project tasks focus on Energy Loss and feeder identification of theft in a specified distribution network.

Figure 5.Ovarall model courtesy NIST

5. CONCLUSION.

Now getting to the overall vision of smart grid ,it can expected to represent a longer-term promise. The motivation would represent the older grid into a much more proficient, reliable, quality focused, efficient, resilient and green solution. Also looking at the present scenario where the number of power-hungry digital components is exponentially on the rise, it makes it imperative to make our energy infrastructure more improved so as to achieve long run stability in the field of energy.

It is a fact that smart grid implementation in Pakistan is no one time project but needs extensive planning. Studies of potential benefits suggest that transformation of the power grid over the next 20 years could result in substantial increases in productivity and GDP growth, reduced carbon emission, and increased national security[1].
Grid remains our national engine Its importance to our economy, our national security, and to the lives of the hundreds of millions it serves cannot be overstated. The overall message is exciting and optimistic; it represents a fundamental change from classical grids to new architectures with new concepts. It heralds new benefits for all in the stakeholder chain from governments through to end electricity users at home and in businesses[7].Many countries in the globe are engaged in this great trend and have established trial platforms to see the outcomes as to achieve experimental and quantitative results.. As Pakistan is in the initial stages of this deployment, thus an extensive planning in this sector is required. By proper organization and harmonious expansion, it is not far that Pakistan would also be in the category of energy abundant nations of the world.

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