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Electrical Energy Conservation: Some Issues

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Abstract— *Due to high energy consumption in India, modern energy-efficient technologies are desperately needed and to be included in the national energy policy. Such technologies could be investigated in the areas of electrical equipment's, energy integration in buildings, and energy supporting tools. It is believed that a considerable saving in the investments of constructing new power stations could be attained; and consequently the energy conservation policy will be seriously improved in the forthcoming years, and the requirement of energy generating capacity will be reduced accordingly. Here in this paper, both renewable and non-renewable energy sources have been briefly described. Various energy conservation methods (general guidelines) have been presented to save energy. Saving energy by means of wise use of available energy is equivalent to energy generation.*

I. Introduction

The energy consumption per capita of the majority of population is considerably increased especially in the developed world. Energy growth in developing countries is also realized recently due to major developments in several sectors such as residential, industry, and agriculture. The primary energy sources such as crude oil, natural gas, and other conventional sources are limited formed by geological processes through solar energy accumulation into the earth over millions of years. Due to their fluctuations in reserves and prices and due to increased costs of power stations, it is, therefore, so important to consider for conserving energy and its utilization. Energy conservation could be defined as an applied technique in energy utilization without affecting the standard of living in the society. Energy conservation will definitely save investments of constructing and
generating capacities of electrical energy and consequently will enhance the current economy of the nations [4,6,2,5]. Because of the limited amount of nonrenewable energy sources on Earth, it is important to conserve our current supply or to use renewable sources so that our natural resources will be available for future generations. Energy conservation is also important because consumption of nonrenewable sources impacts the environment. Specifically, our use of fossil fuels contributes to air and water pollution. For example, carbon dioxide is produced when oil, coal, and gas combust in power stations, heating systems, and car engines. Carbon dioxide in the atmosphere acts as a transparent blanket that contributes to the global warming of the earth, or "greenhouse effect." It is possible that this warming trend could significantly alter our weather. Possible impacts include a threat to human health, environmental impacts such as rising sea levels that can damage coastal areas, and major changes in vegetation growth patterns that could cause some plant and animal species to become extinct. Sulfur dioxide is also emitted into the air when coal is burned. The sulfur dioxide reacts with water and oxygen in the clouds to form precipitation known as "acid rain." Acid rain can kill fish and trees and damage limestone buildings and statues [1-3]. This paper discusses various strategies to be evolved for meeting energy demand, efficient use of energy and its conservation emerges out to be the least cost option in any given strategies, apart from being environmentally benign.

The organization of the paper includes need of energy conservation in section II, section III comprises of an sources of energy conservation, while section IV concludes with various aspects mentioned in the paper.

II. Need of Energy Conservation

Because of the limited amount of nonrenewable energy sources on Earth, it is important to conserve our current supply or to use renewable sources so that our natural resources will be available for future generations.

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Sulfur dioxide is also emitted into the air when coal is burned. The sulfur dioxide reacts with water and oxygen in the clouds

to form precipitation known as "acid rain." Acid rain can kill fish and trees and damage limestone buildings and statues.
You can help solve these global problems. In the U.S., the average family's energy use generates over 11,200 pounds of air pollutants each year. Therefore, every unit (or kilowatt) of electricity conserved reduces the environmental impact of energy use

III. SOURCE OF ENERGY CONSERVATION

2.1 Solar Energy: Solar power uses the sun's energy and light to provide heat, light, and electricity for homes. It is the primary source of all energy forms on the earth. It is one such energy which helps in maintaining the ecological balance through the process of photosynthesis and green house effect. We have been using sun to dry clothes and boil food for generations. But now number of techno powers which have been developed to make full use of solar energy such as[7]:

- ✓ **Photovoltaic systems:** By these systems the electricity could be produced directly from the sunlight.
- ✓ **Solar Process Space heating and cooling:** It is the commercial and industrial use of sun's heat.
- ✓ **Solar Hot Water:** This is the process to heat water with solar energy.
- ✓ **Solar Power plants:** To produce electricity by using the suns heat.
- ✓ **Passive Solar heating and day lighting:** Use solar energy to heat buildings.

2.2 Wind Energy:
Wind energy is often used to generate the mechanical power or the electricity. In the country like India, wind energy holds the great importance because of large hilly, coastal and desert areas. In the rural areas it is used to pump water and grind grain. The benefit of wind energy is that it is fully pollution free and is ecofriendly too. It costs low and the generation of power is continuous. It is the most effective way to conserve the energy and prevent the environment.

2.3 Geothermal Energy:
Geothermal energy is used in the form of thermal energy, electrical energy, nuclear energy, mechanical energy, chemical energy and light energy. It uses heat energy from beneath the surface of the earth. It was first used to produce electricity in the Italy in 1903. Geothermal energy has the major environment benefit as it prevents air pollution. It is particularly important in the inland nations such as Indian Oceans and the pacific regions. Energy generation from geothermal sources is only possible in few places under unique geographic conditions.

2.4 Wave Energy:

Ocean waves contain large amount of energy, which can be extracted through Ocean winds, Ocean currents, Ocean geothermal etc. if the barrage is built across the river, electricity can be obtained by the flow of water through turbines as the tide rise and falls.

2.5 Hydroelectric Energy:

Another renewable source of energy is the hydroelectric energy, which is produced from fast flowing water. The process is pollution free. The movement of water spins the turbines which in turn generate electricity.

2.6 Biomass Energy:

Biomass is the plant and animal waste which is used as the energy. Biomass energy like manure from livestock, plant waste etc can be used to generate electricity, fuel, light, and heat. Biomass energy can be directly obtained from plants and indirectly from the animal waste.

IV. LITERATURE REVIEW

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A. Review on DSM

Usually, the goal of demand side management is to encourage the consumer to use less energy during peak hours, or to move the time of energy use to off-peak times such as nighttime and weekends. Peak demand management does not necessarily decrease total energy consumption, but could be expected to reduce the need for investments in networks and/or power plants for meeting peak demands. An example is the use of energy storage units to store energy during off-peak hours and discharge them during peak hours. A newer application for DSM is to aid grid operators in balancing intermittent generation from wind and solar units, particularly when the timing and magnitude of energy demand does not coincide with the renewable generation.

An introduction [23] on demand side management and demand response, including drivers and benefits that would enable user side load control. This would potentially balance demand side with supply side more effectively and would also reduce peak demand and make the whole system more efficient.

Demand side management is associated to smart grids and means adapting the electricity demand to the electricity production and the available electricity in the grid. It is considered that smart grids and demand side management hold potential to facilitate an increased share of renewable energy sources and to reduce the need for the current power reserve, which is based on fossil energy sources. The system integration of large amounts of renewable energy systems with the grid [7]–[9] is widely studied by many researchers, but only few of them [13-15] address these problems in connection with a consumers' potential participation to the electricity market, or analyze the additional balancing costs due to intermittent and partially predictable availability of renewable energy systems.

Demand side management alters customers' electricity consumption patterns to produce the desired changes in the load shapes of power distribution systems. The authors [50] present a demand side management strategy that can be employed in the future smart grid. The strategy is a generalized technique based on load shifting, in which a heuristic based evolutionary algorithm is developed for solving the problem.

It is estimated that power consumption in buildings worldwide accounts for approximately 40% of global energy consumption [51]. Therefore, improving energy efficiency in buildings is a critical issue for the reduction of carbon footprint and hence motivates the development of the smart building, in which almost all the appliances are manageable and the coordination of energy consumption is carried out locally. A key concept related to the smart building is demand side management (DSM). Essentially, DSM "is the planning, implementation, and monitoring of those utility activities designed to influence customer use of electricity in ways that will produce desired changes in the utilities load shape" [52]. A framework for, system architecture for load management in smart buildings, that enables autonomous demand side load management is proposed[53], which adopts a structure with three main layers that include admission control, load balancing, and demand response management.

In smart grids, it is an existing challenge to adopt appropriate DSM (demand side management) programs to balance the power supply and demand effectively. These studies [24] proposed a DSM algorithm for residential customers to reduce peak load of a smart grid. The challenge of existing several suppliers competing to meet the load demand is addressed by formulating the DSM problem as two objectives. One aims to maximize the suppliers' profit and the other one aims to maximize the customers' payoff.

B. Review on smart grids

A smart grid is described by Lee, Jung, Kim, Lee, & Kim [1] to consist of three layers: a physical power layer, a data transport and control layer and an application layer. An innovative system for Smart Grid (SG) management is given in [3] aiming at minimizing the total costs supported for carrying out the delivery of energy to consumers. These costs include the production costs of distributed generators, the cost of the power provided by the primary substation, and the cost associated with grid power losses.

The urgency for Smart Grids in India emerges from the key challenges that the industry is currently facing. India operates the 3rd largest transmission and distribution network in the world, yet faces a number of challenges such as: inadequate access to electricity, supply shortfalls (peak and energy), huge network losses, poor quality and reliability and rampant, theft. The evolution towards Smart Grid would address these issues and transform the existing grid in to a more efficient, reliable, safe and less constrained grid that would help provide access to electricity to all. Authors [4] discussed the developments in Smart Grid Sector in Indian paradigm, mainly on Demand Response and the possible attempts to realize Demand Response by the power grid authorities, both government and private.

Wind power generation has been the focus in developing modern electrical generation technologies. In order to fully utilize potential benefits and to minimize adverse impacts of wind power generation , many research [5] efforts have been devoted to exploring the technical and economic contribution of wind power in power systems.

In literature both [2] energy flow and operation characteristics of stand-alone wind/PV hybrid power systems are analyzed to achieve its optimal and reliable operation. The transition of its various operation modes and working states are established. A coordination control method that contains maximum power tracking control, load tracking control, charge and discharge control for battery as well as operation with protection is used to optimize energy management. Thus the suggested control method is helpful to optimize stand-alone wind/PV hybrid power system operation.

Authors proposed [6] a stochastic optimization algorithm that aims to minimize the expectation of the system power losses by controlling wind turbine (WT) power factors. This objective of the optimization is subject to the probability constraints of bus voltage and line current requirements.

Smart meters are to mutual benefit for utility and consumer. The smart meter makes a greener difference. These meters are able to communicate with the data management system which is placed on a server either at the utility or at the system provider that has a Smart disconnect/reconnect which allows the utility to switch off the power remotely and to switch the power back. In [49] authors defined a smart power infrastructure, where several subscribers share a common energy source. Each subscriber is equipped with an energy consumption Controller (ECC) unit as part of its smart meter. that the energy provider can encourage some desirable consumption patterns among the subscribers by means of the proposed real-time pricing interactions

For implementation of distributed generation (DG) and smart grid (SG) projects in developing countries, like those in Latin America, careful analyses must be conducted in order to understand the technical and economic impacts of such initiatives. Policies fostered by strong government support like the Energy Independence and Security Act (EISA) [16] and the American Recovery and Reinvestment Act (ARRA) [17] in the U.S., the Canada's Action on Climate Change [18], or EUROPE 2020 in the European Union [19], may contain objectives and drivers not suitable or equally applicable to Latin America's needs [20-22].

V. Features in the Smart Grid and Demand response

An overview of the demand response system and devices according to the report by U.S. Department of Energy (2012) is shown in Figure 7. This section aims to describe some of the important elements in the smart grid and demand side management.

- *Smart meters* The smart grid includes different elements but one feature that, is considered a key element for the smart grid is the smart meter which allows continuous metering and distance reading of the energy consumption. In order to give consumers offers that reflect actual consumption and in order to have flexible energy demand it is regarded by the [45] that the time interval for reading should be at least hourly.

- *Aggregation:* The aggregator concept comes from the internet industry. The concept means that the aggregator compiles electricity consumers and can control the electric load remotely. The end-user is paid for not using electricity during peak load periods and the distribution companies and the grid operator pays the aggregator for the load reduction. The aggregation concept allows for some slightly different approaches to the business model design. In case of a dynamic pricing model the aggregator could for example assist the customer in optimizing the energy use according to the electricity price and thus lowering the electricity bill for the customer while being able to sell the load reduction.
- *Electrical vehicles:* The increasing share of electrical vehicles is a relevant issue for the smart grid development and demand side management. Loading of the electrical vehicles should be preferably be conducted during night hours. This, because it is important that the electrical vehicles are loaded during off peak periods in order to not disrupt the existing electricity system.
- *Standardization* : Standardization is identified as a key issue for smart grid since there are many different actors involved in the chain from the generation to the household appliances [46]. The three European standards organisations have worked together in a Joint Working Group and produced a report on standardisation for European smart grid standardisation [46] According news presented in [47] interoperability is a crucial issue for smart grid standardisation. The issue concerns securing that different products designed to match a certain standard have signals and interfaces that match and that the products actually can work together.
- *Indirect and direct control:* In the report by [42] it is explained that there are two ways of controlling the customer energy use: indirect and direct. Direct control of the energy use means that a contract is reached where the customer allows direct control over the energy output. Indirect control means that different types of contracts are used to give incentives that will motivate the customer to adapt their energy use. No certainty of the customer reaction is given by using indirect control but with experience the supplier and grid owner could predict the reactions. For this alternative it is also possible for the customer to have a device (a so called Home Area Network) that controls the appliances according to the electricity price or outside temperature [42].
- *Tariff and price models:* The term tariff is often used inconsistently; in some cases is used to describe only the network charges and in other cases it is used to describe the entire charges for electricity including the network charges. Here the term tariff is used for the network charges and not the charges connected to the amount of electricity used. The main alternatives that seem to be discussed for the use of steering demand from peak load periods are time of use tariffs, critical peak pricing and real time pricing.

- *Smart grid solutions emerging to manage continuous balancing of the system include:*

• *Better forecasting*. Widespread instrumentation and advanced computer models allow system operators to better predict and manage RE variability and uncertainty.

• *Smart inverters*. Inverters and other power electronics can provide control to system operators, as well as to automatically provide some level of grid support.

• *Demand response*. Smart meters, coupled with intelligent appliances and even industrial-scale loads, can allow demand-side contributions to balancing.

• *Integrated storage*. Storage can help to smooth short-term variations in RE output, as well as to manage mismatches in supply and demand.

• *Real-time system awareness and management*. Instrumentation and control equipment across transmission and distributions networks allows system operators to have real-time awareness of system conditions, and increasingly, the ability to actively manage grid behavior.

V. CONCLUSION

In 21st century, if India dreams to emerge as a developed nation, energy efficiency and energy conservation integrated with IT infrastructure is required to be implemented. demand side management in Smart grid is one such option which can drive India an inch closer to be a developed nation.
Load Forecasting and dynamic pricing schemes helps the electric utilities in the implementation of DSM strategies in smart grid environment. These DSM techniques help the utilities in the future planning and operation of power system. In this work, a detailed review DSM and schemes in smart grids has been presented .From a utility point of view it would seem that a sensible business approach would be the promotion of consumption thereby increasing sales. This would be true if there were an excess of capacity and revenues were the only important factor in an energy supply system.

However, increased revenues does not translate necessarily in higher profits and in some situations a least-cost planning approach would/could prove the implementation of DSM measures to be more profitable than investing in new generating capacity. Utilities might therefore be better advised to promote DSM and energy saving. From an environmental perspective, a decrease in energy demand due to improved efficiency reduces the environmental impact of energy consumption associated with a particular level of production or other activity.

ACKNOWLEDGMENT *(Heading 5)*

The preferred spelling of the word "acknowledgment" in America is without an "e" after the "g." Avoid the stilted expression "one of us (R. B. G.) thanks ...". Instead, try "R. B. G. thanks...". Put sponsor acknowledgments in the unnumbered footnote on the first page.

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