Nanotechnology: An Advanced Resolution to Energy Sector Glitches for Emerging Countries

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***Abstract*—Developing countries need continuous energy supply to power their developing economies while also assisting in the growth of their populations. Scheduled power outages attributable to underfunded power generating capability focus emphasis on investment in renewable energy sources. With increased demand, current energy consumption in these countries would exacerbate global warming problems related to greenhouse gas emissions. As a result, investing in sustainable energy sources such as green energy provided by solar and wind energies is important. The irregularity and volatility of energy supply has been a big issue for the world's developing countries. There is a critical demand for more energy in emerging nations, and this results in a need for increased energy production and a more competitive and stable economy. That's why nanotechnology is so important. While a key technological issue of the 21st century is the use of nanotechnology for the production, transfer, and delivery of sustainable, appropriate, safe, inexpensive, and stable electricity, the primary area in which the scientific community is striving to meet this goal is not within the semiconductor industry, but in another important sector: nuclear energy.**

I. Introduction

Any nation's socioeconomic and technical growth is heavily reliant on electricity. Power scarcity has become a significant obstacle to industrial and domestic use in developed countries. There are countries with abundant natural resources for electricity production, but electricity issues are impeding their growth [1]. It is generally acknowledged that there is a close connection between socioeconomic growth and the supply of electricity.

Industries and households have stepped up their usage of generators to compensate for the shortfall in electricity supply. As the fuel in the generator set is incompletely combusted, carbon monoxide is produced, which is then discharged into the environment, increasing the amount of greenhouse gases in the atmosphere.

Nanotechnology, a relatively recent branch of research, refers to any technology with components smaller than 100 nanometres. A single virus particle has a diameter of around 100 nanometres. Nanofabrication is a significant subfield of nanotechnology linked to electricity. The method of developing and fabricating nanoscale structures is known as nanofabrication. The invention of devices smaller than 100 nanometres opens more doors for the development of novel methods of capturing, storing, and transferring electricity. The intrinsic degree of control that nanofabrication will provide scientists and engineers with will be crucial in having the capacity of solving many of the challenges that the planet is currently faced with the new generation of energy technology.

II. Shortage of Electricity in Developing Countries

A. Generation

All these challenges together make it difficult for developing countries to meet their energy needs: they have a limited amount of generation availability, poor and delayed facility maintenance, limited funding for power stations, outdated equipment, safety facilities, and operational vehicles, and a shortage of exploration to tap available energy resources.

Nigeria, for example, has 7,876 MW of installed capacity, but only 4,000 MW of installed capacity as of December 2009. In the context of the discussion above, the seven current generating stations that are more than 20 years old provide a grand total of only about 2,700 MW of electricity, far less than the anticipated peak demand of 8,900 MW. This places a huge pressure on the nation [11].

In India, electricity demand exceeds generating

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capability, and the shortfall difference represented by load control interruption ranged from 17.7 percent in 2005 to 23.7 percent in 2007 [14]. In the Indian state of Maharashtra, usable power production was 9049MW, while demand was 14749MW [14]. Electricity energy demand is forecast to increase to approximately 167TWh in Maharashtra and approximately 1392TWh across India by 2016-2017, up from 106.643TWh in Maharashtra and 697.961TWh across India in 2006-2007. By 2016-2017, Maharashtra's peak load is forecast to be 28347.752MW [14]. Pakistani energy users, on the other side, face power outages that can last up to 20 hours a day [13]. There is a 4500 MW deficit in the country's power supply.

B. Transmission

No part of the globe can be reached by Nigeria's transmission infrastructure. Right now, the transmission system's maximum transmission power is 4,000 MW, and it is quite delicate, making it very sensitive to outages. This analysis identifies the following problems: The present allocation of Federal resources is not sufficient to satisfy all of the grid's requirements; portions of the country are currently not receiving power; and the present maximum wheeling capacity of the system is 4,000 MW, which is significantly below the needed national demands.

Also, consider India: the electricity grid failure that occurred in July 2012, which impacted over 700 million people, was the worst grid failure in history. A great deal of the grid stability in India has been enhanced by the deployment of the Availability Based Tariff (ABT). The all-time greatest peak demand on the consolidated grid has never exceeded 151,000 MW, while the all-time peak load on June 30, 2014, was 136,000 MW. The largest demand factor obtained by substations with a KV rating of 200 is roughly 61.91 percent. Due to their capacity, operational output, and high voltage transmission lines with low demand factor, vast capacity substations and huge networks of high voltage transmission lines with low demand factor are unable to fulfill peak power demand. The percentage of India's total network technical losses that is attributable to technical failure was 23.65 percent in 2013, compared to an international average of less than 15 percent. A total national T&D loss was estimated to be around 24% in 2011, and the government has set a target of increasing this number to 17.1% by 2017 and 14.1% by 2022. Of the total of non-technical damages, a significant percentage is attributable to illegal line tapping, and inaccurate electric meters that overestimate actual demand contribute to poorer payment collection. A case study done in Kerala showed that repairing or replacing faulty meters might reduce distribution losses from 34% to 29%.

Transmission Line Dependence on Schedule: To reach the 11th plan goal of expanded transmission ability, development activity is expected to need to be significantly increased. A large portion of this improvement is likely to be in the North Eastern zone, Sikkim, and Bhutan, where the geography is challenging and the margin of error for project implementation is low. More transmission capacity is needed to move power from surplus regions to deficit regions and to allow electricity trading. This is critical in order to achieve the goal of 'Power for Everyone.' As a result, the importance of carrying out transmission schemes cannot be overstated. In this sense, it is critical to instill solid project management concepts in the sector in order to ensure project execution on schedule.

III. Dissemination and Advertising

Many regions of Nigeria have outdated distribution networks, uneven power levels, and difficulties with paying. Ensuring enough network coverage and reliable power supply, as well as efficient customer service and marketing, are critical for departments that interface with the public. Some of the major problems identified in this report are inadequate network coverage, overloaded transformers, and defective Feeder Pillars, insufficient distribution lines, a bad billing system, poor practices by employees, and deficient logistics facilities, such as tools and working vehicles.

In India, peak shortages are equivalent to 14%, and there have been sporadic surpluses of energy to the tune of 200 MW that may go unused due to transmission and distribution restrictions. This involve technical flaws that impede effective transmission and delivery, as well as power theft and misuse. Across India, power theft between generation and supply can range from 20% to 40%. According to the Ministry of Power, outright theft alone costs the country 200 billion rupees every year. According to analysts, even the commonly cited national average of 21% T&D losses is an underestimation of what is currently lost between power production and final supply. According to state-level research, the real numbers could be twice the official average. Such declines amount to 9.1 percent in Singapore and 10.2 percent in the Republic of Korea.

IV. Solar Energy based Nanotechnology

It is also critical to make people aware of the fundamental method used by a normal solar cell till the debut of new nanotechnology-based solar devices. The term for ordinary solar cells is "photovoltaic cells." Silicon is a semiconducting material that serves as the basis for the cells that are formed of this. Light makes contact with the cells, and photons use electricity to fuel themselves. When silicon is hit with this tremendous amount of energy, electrons are knocked out of the silicon, causing them to vibrate. The introduction of certain impurities to silicon, such as phosphorus or boron, may produce an

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electric field. This electric field behaves as a diode, in that it only enables electrons to move in one way. Also, because of this, an electron has been found, and is known as electricity [6]. Most conventional solar cells have efficiency of 10% or less, and they are also expensive to make. The first inefficiency or disadvantage is inherent to silicon-based batteries [5]. Because the incoming photons or light must have the correct strength, known as the band gap energy, to knock out an electron, this is known as the photoelectric effect. For light to pass through the band gap, its intensity must be smaller than the energy contained inside the band gap. A temperature differential exists between the two objects, but if it contains more energy than the band gap, the surplus energy will be lost as heat [7].

The nanotechnology solar cell stands out in its ability to generate power and it's comparatively low cost. A thin-film copper indium gallium selenide (CIGS) based PV semiconductor is utilized in a printing process to deposit a thin-film, copper indium gallium selenide (CIGS) based PV semiconductor, which results in an effective, long-lasting solar cell [3]. The semiconductor used a printing technology that was ten times faster than typical high-vacuum deposition thin-film technology. CIGS semiconductors were produced on low-cost conductive aluminum foil by applying the principles of printing economics to semiconductor fabrication. A new kind of thin-film solar cell that could handle up to 25 times more current than any other thin-film technology available at the time could handle light as thin as 8 microns [8].

Because nanotech solar cells are less sensitive to sunlight, they can be constructed independently of solar panel components. The initial step was to fit the cells into circuits and then use lamination to bind the cells together into sheets (encapsulating the solar cells between two panes of tempered glass). There were 84 nanotech solar cells on a 2-square-meter panel, weighing 8.6kg, placed in a grid on a sample piece [11]. Copper indium gallium diselenide-based PV thin-film technologies developed in a laboratory reached an efficiency of around 19.9 percent in sunlight-to-electricity conversion. With respect to this thin-film technology, this is far superior than competing thin-film technologies, which employ mono-crystalline silicon to absorb 20% of sunlight and transform it into energy, although thin-film cells cost far more too standard silicon [4].

A comprehensive analysis performed by the National Renewable Energy Laboratory (NREL) shows that in 2011, using a nanotech CIGS roll-printing process, 17.1% of the total active area on the foil was used to produce electricity, and CIGS roll-printing results in electricity generation, low manufacturing costs, and good durability and ease of installation due to simplicity and light weight. Too far, no other printed solar cell has reached this milestone [8].

V. Transmission Based on Nanotechnology

Nanotechnology might be used to make electricity transmission lines more dependable. A number of nanomaterials and nanotechnology-related technologies are critical to the delivery of power. ACSR pipe is the conventional overhead conductor that is compared with different materials. Overhead conductors were found to have a five-fold increase in the amount of capacity over existing ROWs at current prices, and as a result, the creation of aluminum conductor composite reinforced (ACCR) wire was done. Using a special process, ACCR overhead conductors are created out of aluminum that has been processed in new ways to provide high-performance and durable conductors that can withstand heat and environmental factors. It is from the nano-crystalline aluminium oxide fibers put in the high-pinity 3M aluminium matrix core wires that the strength and lifespan of the ACCR wire was produced [2].

They may be mixed safely, even when mixed with other ingredients which may include highly reactive chemicals or cause strength losses. In conventional cables, the steel is utilized, but in the new design, a synthetic polymer is used [10].

CNTs, also known as single-walled CNTs, have far higher electrical conductivity than carbon nanotubes (CNTs) (more than 10 times greater than copper). Reinforced CNTs possess the three properties of resilience, elasticity, and tensile strength, making them far more efficient than conventional power lines when they are woven into wires and cables [11].

Furthermore, the grid might be revolutionized by using nanowires, known as quantum wires (QWs) or armchair QWs. Despite having just one-sixth the weight, QW has far superior electrical conductivity compared to copper, yet it is twice as heavy as steel. A grid made composed of transmission wires built to fit lengthwise into the conduit will have no resistance or line losses. Grid qualities are capable of withstanding varying weather conditions and lack sag [11].

VI. Other Electrical Transmission Infrastructure

Nanotechnology applications can aid in the improvement of other elements of the electric transmission system, theoretically lowering environmental impacts. The following explanations are for transformers, substations, and sensors.

1. Transformers: More effective coolants for transformers may be available by the use of nano-materials-containing fluids, which might minimize transformers' footprints or even their number. Particles less than a billionth of a meter increase heat transfer and particles of a similar size transfer heat better than liquid particles. Nanoparticles have a higher surface

area for heat transmission than bigger objects, and this allows them to float in liquids for a longer period of time. Better transformers are possible by using nanometer-sized particles in the fabrication of High Temperature Superconductors (HTS), which eliminates the need for flammable liquids, resulting in smaller, more versatile transformers [10].

2. Substations: Load-leveling peak shaving, delivery of uninterruptible power to substation switchgear, and starting of a backup power system are all assisted by substation batteries. A smaller and more compact battery pack would have the potential to restrict substation footprints, as well as the number of substations that may be placed inside a ROW [11].
3. Instruments: Nanoelectronics has the ability to transform sensors and power control systems. Sensors created by nanotechnology will be self-calibrating and self-diagnosing. When complications were expected or encountered, they might make trouble calls to technicians. Such sensors may also allow real-time remote control of infrastructure [11].

VII. Storage of Energy

To be able to store energy locally, the capability to store resources limits the amount of electricity that must be sent via power lines to meet peak demand. Power down and energy storage are required to make base load power less dependent on conventional production, such as fossil fuels, and to make the growth of sustainable and dispersed generating technologies, like as wind turbines, both economically and environmentally feasible. Solar and wind energy would benefit greatly from an increase in energy storage capacity. The use of nanotechnology is particularly important in distributed generation, since it increases the cost-effectiveness of energy storage devices such as batteries, capacitors, and fuel cells [12].

A. Batteries

CNTs are efficient electrical conductors, and have huge surface areas because of their longitudinal architecture. This also enables them to be exposed to the electrolyte of a battery, which means that they have huge surface areas. In batteries with CNT-based electrodes, CNT-based electrodes enable the use of electrodes that generate more electricity than standard electrodes. Because this capability to increase the output of energy from a given quantity of material implies that batteries will be smaller and lighter, meaning that new uses are possible.

In the anode of a rechargeable lithium-ion battery, a nano-structven spinet (a hard, glassy mineral) is used as the electrode material instead of graphite, resulting in improved efficiency and safety. As a result, charging time may be measured in minutes rather than hours. Because nano-structural materials lengthen battery longevity by ten to twenty times and increase battery performance across a broader temperature range, a whopping 75% of battery capacity is useable at temperatures ranging from 40 degrees Celsius to over 67 degrees Celsius [12].

B. Capacitors

Although batteries, which use chemical processes to create electrical energy, may store vast amounts of energy, after being used they have to be destroyed since they no longer contain enough charge. Capacitors, in contrast, have a variable capacitor, with two metal electrodes serving as its electrodes. Capacitors are designed to work quickly and endure for a long period, although they only hold a quarter of the energy of comparable-sized chemical batteries. The millions of nano-tubes on the capacitor electrodes allows the electrode surface area to be expanded, which increases the amount of energy that they will store. The contemporary technology blends the energy of today's batteries with the longevity and rapid charge capabilities of capacitors, and the effects of this can be seen in a wide range of systems requiring a battery [13].

Miniature sensors placed within a transmission network could have links to previously inaccessible data and knowledge. The ability to see the energized state of service feeders in real time would speed up failure reconstruction and make step balancing and line failure simpler to handle. Additionally, it contributes to the overall activity of the delivery feeder network.

III. Conclusion

This article provides much information, so be sure to remember that the government should assist in nanotechnology research as well as make things easier for new technology adoption. People can also be educated on technologies and potential adaptations to electricity production. Furthermore, researchers can devote more time to this emerging profitable technology, which has numerous applications in the economy

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