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Solar Energy: Trends and Enabling Technologies for Green Electricity

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Abstract—*Shortage of energy is dangerously affecting the economic growth of the developing Countries. The global demand for energy is currently growing out of limits of installable generation capacity. To meet future energy demands with efficacy, energy security and reliability must be improved and alternative renewable energy sources and systems (ARESS) must be investigated aggressively. An effective energy solution should be able to address long-term issues by utilizing alternative and renewable energy sources and Conversion Technologies. Of the many available renewable sources of energy, solar energy is clearly a promising option as it is extensively available. Solar power, especially as it reaches more competitive levels with other energy sources in terms of cost, may serve to sustain the lives of millions of underprivileged people in developing countries by Optimum utility-scale solar energy Systems. (OUSSES).*

This paper illustrates the need for the utilization of alternative energy sources, evaluates the global scenario of installed generation systems, reviews technologies underlying various solar powered devices, and discusses several applications and challenges in this area of Green Electricity(GE) by Optimum utility-scale solar energy Systems(OUSSES) and related conversion Technologies.

Index Terms*: Alternative Renewable Energy Sources and*

Systems (ARESS) ,Optimum Utility-Scale Solar Energy Systems (OUSSES) ,Green Electricity (GE), Conversion Technologies (CT)

1. INTRODUCTION

The future global economy is likely to consume ever more energy, especially with the rising energy demand of developing countries such as China and India. At the same time, the tremendous risk of climate change associated with the use of fossil fuels makes supplying this energy increasingly difficult. In the past, there has been a constant attempt to find an alternate way to satisfy the growing energy needs of the global population – the huge majority still living in poverty – without preying the resources that will be needed by future generations, polluting our ecosystems, and putting undue pressure on the energy-rich regions of the world. In achieving this, the main problem faced is the blast in demand due to both, the quick increase in population and the efforts of the most strongly populated regions of the world to develop their economies. In just one generation, the global population has increased by approx. 2 billion, with a most important contribution from developing countries. Also, it is a known fact that energy demand raises at a rate that is proportional to economic growth. On this basis, the International Energy Agency (IEA) estimates that developing countries will require to double their present generation capability in order to meet the increasing demand for power by the year 2020. show rising levels of demand over the next three decades, led by strong increases in countries outside of the Organization for Economic Cooperation and Development (OECD) [3], particularly in Asia. Non-OECD Asia, including China and India, account for more than half of the world's total increase in energy consumption over the 2012 to 2040 projection period. By 2040, energy use in non-OECD Asia exceeds that of the entire OECD by 40 quadrillion British thermal units (Btu). In the International Energy Outlook (IEO) 2016 [1], total world energy consumption rises from 549 quadrillion Btu in 2012 to 815 quadrillion Btu in 2040, an increase of 48%.

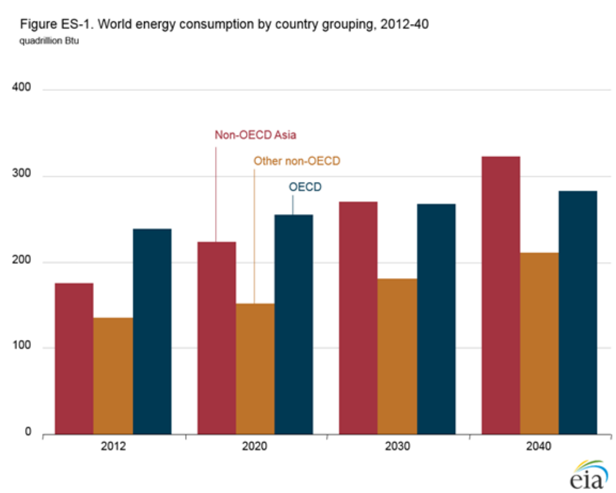

Fig. 1: World Energy Consumption By Country Grouping

Most of the world's energy growth will occur in the non-OECD nations, where relatively strong, long-term economic growth drives increasing demand for energy.

Non-OECD energy consumption increases by 71% between 2012 and 2040 compared with an increase of 18% in OECD nations. Energy use in the combined non-OECD region first exceeded that of the OECD in 2007 and by 2012, non-OECD countries accounted for 57% of total world energy consumption. By 2040, almost two-thirds of the world's primary energy will be consumed in the non-OECD economies, as shown in following Fig. (1). In spite of several policies, and investments for increasing generation capacity, the number of non-electrified areas in developing countries has not changed significantly. need of access to electricity continues to be one of the major reasons that citizens of non-electrified communities are still poor [2]. So, it is significantly important to create the required infra- structure and establish the needed distributed energy generation resources to satisfy global energy needs.

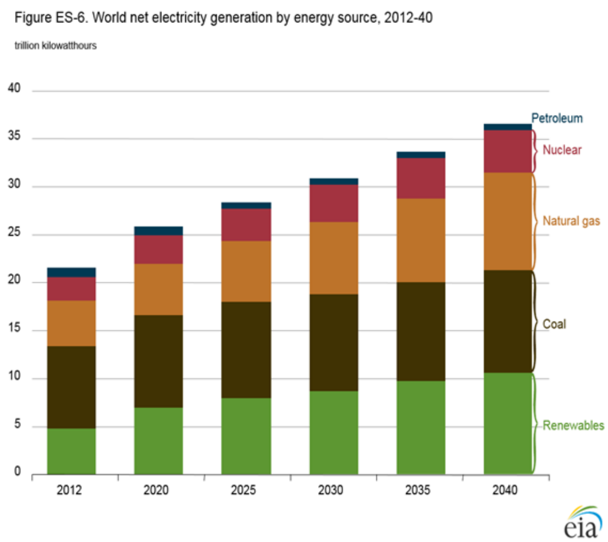

Fig. 2: World Net Electricity Generation By Energy Source

World net electricity generation increases by 69% in the from 21.6 trillion kilowatthours (kWh) in 2012 to 25.8 trillion kWh in 2020 and to 36.5 trillion kWh in 2040. The electric power sector remains among the most dynamic areas of growth among all energy markets. Electricity is the world's fastest-growing form of end-use energy consumption, as it has been for many decades. The strongest growth in electricity generation is projected to occur among the developing, non-OECD nations. Increases in non-OECD electricity generation average 2.5%/year from 2012 to 2040. In the OECD nations, where infrastructures are more mature and population growth is relatively slow or declining, electric power generation increases by an average of 1.2%/year from 2012 to 2040. Long-term global prospects continue to improve for generation from renewable energy sources, natural gas, and nuclear power (Figure 2). Renewables are the fastest-growing source of energy for electricity generation, with average increases of 2.9%/year from 2012 to 2040.

Renewable energy is not a new concept, but it continues to quickly emerge as an alternative to fossil fuels and other delete-ious energy sources. The potential of renewable energy sources is huge as they can produce many times the world's total energy demand. Such as some studies have indicated that approx. 1000 times the global energy requirement can be fulfilled by using solar energy; however, only 0.02% of solar energy is currently utilized [3]. Renewable energy Sources For example: hydropower, geothermal energy, wind energy, biomass and solar energy, resources. A change to renewable energy systems is increasingly likely as their costs continue to decrease while the cost of fossil fuels continues to increase. In the past 30 years, solar system and wind power system have continued to get better their performance characteristics and have experienced quick sales growth. The main and generation costs associated with these type of systems have also been compact significantly. Because of these developments, market opportunities now exist to both innovate and take advantage of promising markets in order to encourage renewable energy technologies, mainly with additional assistance of governmental and popular reaction. The development and use of renewable energy sources can improve diversity in energy supply markets, contribute to securing long term sustainable energy supplies, help reduce local and global atmospheric emissions, and provide commercially striking options to meet specific energy service needs. The use of renewable energy is also becoming increasingly important to slow the effects of climate change. Solar technologies are an extremely promising renewable resource considering their ever-increasing output efficiencies and capacity to be utilized in a variety of locations.

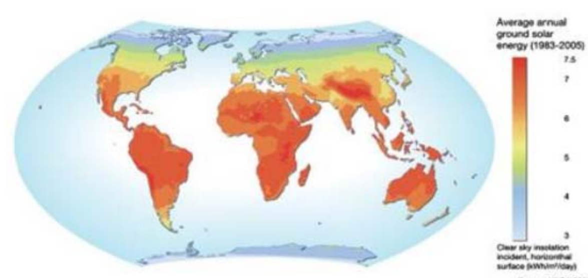

Fig. 3: World Solar Energy Potential

Most developing countries are located in regions with optimal access to the sun's rays. This is shown above in Fig. 2 For example, India's solar power reception is about 5.4 x 1015 kWh per year. and the average radiation in steamy and sub-steamy regions located in developing countries can be compared to that of annual global radiation of about 1600–2200 kWh/m2 [4].

1. Most of the available fossil fuel and energy resources can only be used by exploiting the ecosystem, which leads to social decline.

2. Increasing global independence of fossil fuels quickens the need for solar technology, rises enhancement of required research, and thereby lowers related costs.

3. Solar systems are relatively affordable and applicable to bothhouses and villages, as households of industrialized nations are using more solar power than ever before.

4. Within solar technologies, inert solar designs shine when considering renewable energy for buildings, and can be coupled with solar panels to achieve maximum comfort and sustainability.

2. Solar Technologies for Green Electricity Solar energy can be transformed into electrical energy using various technologies such as photovoltaic (PV) panels, concentrated solar power (CSP), and concentrated photovoltaic's (CVT) [5]. The following sub-sections explain these currently available technologies.

I. Solar Photovoltaic's

Solar photovoltaic's (PV) modules are solid-state semiconductor devices that change sunlight into direct-current (DC) electricity. Materials used on Photovoltaic (PV) panels are silicon (monocrystalline, polycrystalline and micro-crystalline), cadmium telluride and copper indium selenide [6]. Photovoltaic (PV) production has been doubling every 2 years, increasing by an average of approx. 48% each year from last 10 years, making it the world's fastest-growing energy technology [7]. approx.90% of the current generating capacity from PV consists of grid-tied electrical systems. Such installations may be ground-mounted or built on the roof or walls of a building, hence called building integrated photovoltaics (BIPV).

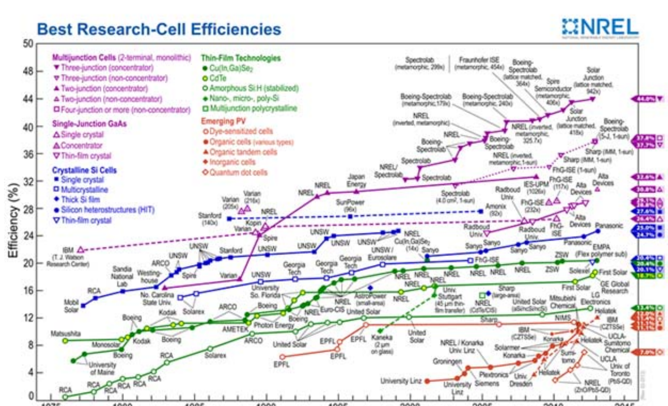

Fig. 4: Solar PV Technologies Efficiency

Modern Solar Photovoltaic (PV) power stations have capacities ranging from 10 to 60 MW although proposed solar Photovoltaic(PV) power stations will have a capacity of 150 MW or more [8].

A typical Photovoltaic (PV) panel can now operate for up to 10 years at 90% of its rated power capacity and for up to 25 years at 80% of its rated power capacity.

Best Research-Cell Efficiencies Chart

Divided into four main segments, this complex chart plots the improvements in efficiency for the commonly agreed four types of photovoltaic technologies:

- Multijunction Cells: as used in space applications and concentrated PV applications; a "wafer"-based technology also called "1st Generation"
- Crystalline Si Cells: the most commonly seen PV panels today; a "wafer"-based technology also called "1st Generation"
- Thin-Film Technologies: also known as "2nd Generation" photovoltaic technology
- Emerging PV: often called "3rd Generation" PV technology, and including Perovskite Solar Cells.

II. Concentrated solar power systems Photovoltaic (PV) panels can sometimes be inefficient in capturing all available energy from sunlight due to their shape and variation in solar intensity throughout the day. An alternative way to efficiently capture maximum solar energy is with the help of concentrated solar power (CSP) systems. In Concentrated solar power (CSP) systems lenses or mirrors are use to focus sunlight covered over a large area into a small area to produce electrical energy. Solar concentrators are mounted on the solar tracker to remain track of the position of the sun. As long as the temperature is at an optimum point for a junction of cells, the solar cells will operate with high efficiency. If these systems are installed at a large solar plant, then they can be used to make sure that the harnessed energy is more effectively changed to heat. Parabolic trough solar thermal systems are the only Concentrated solar power (CSP) systems which are available commercially. Concentrated solar power (CSP) systems use parabolic, trough-shaped mirrors to focus sunlight on thermally efficient receiver tubes that hold a heat transfer fluid. This heat transfer fluid is heated to approx. 39000C (73410F) and pumped through a series of heat exchangers to make superheated steam that powers a conventional turbine generator to produce electricity.

3. Cost of electricity generated from solar systems

Due to advancement in technology and enhancement in manufacturing scale and sophistication, the cost of Photovoltaic (PV) cells has decreased steadily since the first solar cells were manufactured [9]. Although the cost of electricity produced from Photovoltaic (PV) systems is still higher than the other competing technologies, this cost is expected to continue to decrease steadily. The cost of Photovoltaic (PV) installation was Rs.105 per unit of generating capacity in 2009 which came-down to about Rs.76 in 2011. According to industry analysis, this price is slated to reach Rs.57 per unit of generating capacity by 2013. These potential reductions in cost, combined with the reliability, simplicity, versatility, and low environmental impact of Photovoltaic (PV) systems, should help Photovoltaic (PV) systems to become highly utilized sources of economical, premium-quality power over the next 20-30 years.

Now a day in India, the minimum cost of energy from Solar Photovoltaic (PV) is Rs 12.00/kWh and from Concentrated solar power (CSP) systems is Rs.19.00/kWh [10]. Solar electric prices today are at approximately Rs.17.00/kWh, or near about 2–5 times the installation location and local electric rates. This is because of the high installation costs involved.. Demand for solar powered systems is very high in countries with high electricity tariffs.

2. CHALLENGES TO SOLAR ENERGY

Fundamental challenges faced by solar energy system (SES). Are the cost, manufacturing procedure, and waste products.In order to implement solar energy system (SES) at a large scale, technology needs to be cost effective compared to fossil fuels or nuclear energy based generation systems. In addition, educating customers about the advantages and marketing the solar energy products can be costly and difficult in rural areas, due to low literacy rates. Impractical political promises or plans for rural electrification can also be a barrier for market expansion [20]. Power generation using solar energy system (SES) is weather-dependent and the trend of generation cannot be fully predicted. Due to the intermittency in power generation, solar energy system (SES) might not be a good choice for a continuous load requirement, and raises reliability and power quality issues. Because of this, solar energy system (SES) has to beoperated in conjunction with the utility grid or some kind of energy storage in order to achieve required continuity in power supply. The grid-connected operation leads to other set of issues related to voltage stability, reactive power demand, etc. Another problem associated with using solar energy system (SES) is that the energy generated by the solar energy systems (SES) is DC, that has to bechanged to AC before utilizing it for home appliances or before feeding it back to the utility grid. Solar energy devices produce no air or water pollution and no greenhouse gases, but do have someindirect impacts on the environment. Like there are some toxic materials and chemicals, and different solvents and alcohols which are used in the manufacturing process of phoovoltai cells. In addition, large solar thermal power plants can harm ecosystems if not properly managed. Such as birds and insects can be killed if they fly into a concentrated beam of sunlight, such as that created by a ‘‘solar power tower.’’ CSPs also use potentially hazardous fluids (to transfer heat) that require proper handling and disposal. The use of CSP on a large scale could also lead to water pollution, since water is required for regular cleaning of the concentrators and receivers and for cooling the turbine-generator.

3. CONCLUSIONS

Solar power is proving to be an attractive opportunity in terms of both business and power generation. Significant improvements have already been accomplished by numerous international, governmental, and non-governmental organizations including the funding and development of projects involving renewable energy systems for various developed as well as developing nations. This progress is transforming rundown conditions into quality living spaces and providing new luxuries to those who were once lacking. Ecosystems, developing societies, and the solar energy market will only benefit from an increase in solar photovoltaic (PV) solar energy system (SES) System installations and alternative renewable energy sources and systems (ARESS) must be investigated aggressively.. Funding for these systems, however, is a challenging aspect when considering the extensive demand. Luckily, as more and more organizations helper their financial, professional and technical services, solar energy is becoming more cost effective. While progress has been slow but steady over the last two decades, the current efforts of industry leaders and researchers have greatly reduced costs and improved efficiencies’, thus increasing the demand for solar energy system (SES).

REFERENCES

[1] US Department of Energy. International energy outlook 2009. Technical report DOE/EIA-0484; US Department of Energy; 2016 http://www.eia.doe. gov/oiaf/ieo/pdf/0484(2016).pdf.

[2] Khatib H. Renewable energy in developing countries. In: Proceedings of the international conference on renewable energy—clean power, London, UK; 1993. p. 1–6.

[3] Xia X, Xia J. Evaluation of potential for developing renewable sources of energy to facilitate development in developing countries. In: Proceedings of the Asia-Pacific power and energy engineering conference, Chengdu, China; 2010. p. 1–3.

[4] US Energy Information Administration. World map of solar resources; 2011

[5] Solar updraft tower; 2010 /http://www.renewable-energy-info.com/solar/updraft-tower.htmlS.

[6] Razykov T, Ferekides C, Morel D, Stefanakos E, Ullal H, Upadhyaya H. Solar photovoltaic electricity: current status and future prospects. Solar Energy 2011;85(8):1580–608.

[7] Kropp R. Solar expected to maintain its status as the world’s fastest-growing energy technology /http://www.socialfunds.com/news/article.cgi/2639.htmlS; 2009.

[8] Jacobson M. Review of solutions to global warming, air pollution, and energy security. Technical report. Stanford; 2008.

[9] Swanson R. Photovoltaics power up. Science Magazine 2009;324:891–2.

[10] Levelized cost of new generation resources in the annual energy outlook 2011; 2010 /http://www.eia.gov/oiaf/aeo/electricity_generation.htmlS.

[11] Candanedo J, Athienitis A. A systematic approach for energy design of advanced solar houses. In: IEEE electrical power & energy conference, Montreal, Canada; 2009. p. 1–6.

[12] Khennas S, Barnett A. Best practices for sustainable development of micro hydro power in developing countries. Technical report. Department for International Development, UK; 2000.

[13] Wang X, Shi J. Piezoelectric nanogenerators for self-powered nanodevices. In: Ciofani G, Menciassi A, editors. Piezoelectric nanomaterials for biomedical applications. nanomedicine and nanotoxicology. Berlin, Heidelberg: Springer; 2012. p. 135–72.