Review on Green Technology for Sustainable Development

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ABSTRACT : *This paper presents a review of green technology. The details regarding different types of modern and eco friendly manufacturing technologies that are being practiced by various industries are discussed. The prominence and steps to be followed for adopting green manufacturing technology is synopsized. The use and necessity of environmental friendly manufacturing technology mainly focuses upon economic sustainable development. Green technology is the major step in order to have sustainable environment. But, environmental and social sustainability factors go hand in hand; the impact and efficiency of a technology should be analyzed before the actual implementation takes place. The urgent need to replace existing manufacturing technology with eco-friendly methodology is highlighted. The examples of different companies across the world implementing green manufacturing technologies are discussed which the prime requirement for today's era. The energy consumption after using renewable energy resources is compared to that of the usage of conventional energy resources. This reviews Green technologies and put some light on the challenges and hardships faced in advancing and implementing green technologies and trends that lead to sustainability.*

KEYWORDS *Green Technologies: Literature Review; Eco-Friendly Technologies, Sustainable Development of Green Skills*

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I.   INTRODUCTION

Green technologies are eco-friendly technologies that result in economic and social sustainability [1, 2]. Green technologies may sound a sophisticated name, but it means no other than clean technology. It serves as a direction to create a new technology that will be beneficial for the future generations. Before overviewing and understanding the depth of literature a clarification on the concept of "green innovation" and "sustainable technologies" was needed to understand which is included in our analysis. We realized that other notions (i.e. ecological innovation, environmental innovation, and sustainable innovation) are used on similar topics by other scholars. Therefore, we predominantly dedicated our attention on the discussions of the different notions contributing to a better understanding on how "green innovation" and "green technology" is defined also which notions can be used as synonyms but have contrast meaning. In the following, we briefly reviewed a number of cited definitions. In the earlier days, green technologies were known as environmental technologies [3]. From Information System perspectives, green technologies encompass environmental friendly products that reduce the production of Greenhouses Gases (GHGs), and at the same time it helps to reduce the negative impacts on the environment. Therefore, sustainable development must satisfy all the three dimensions, i.e., social, economic and environment [4, 5]. Over the years the environmental impact of Information Technology got associated with sustainability and the term "Green" got associated with Computing/IT. The metrics changed from profitability to carbon emissions, footprints etc. Over the last five-six years Sustainability issues mostly dealt with environmental impact and the "Green" word has become ubiquitous in IT Industry. However, an important concern here is that the issue of Green IT is getting deeper and complicated with plethora of Green Technologies and eco-friendly solutions. Therefore, the number of articles published in Green IT field is increasing over the recent past exhibiting greater concerns of its environmental impact. Nowadays industries consume more energy than what it is required; hence it results in more pollution. This is the primary reason to create a managerial system based on green processes and products to decrease the pollution. Government, companies and industries have been seeking methods and techniques to reduce the waste, because of the harmful

effects on the earth's ecosystem which results in ozone layer depletion. The other harmful factors are : water contamination, global warming and deforestation which are the root cause for the imbalance in ecosystem. However, in roofed and packed environment such as offices with mechanical ventilation, tools like computers may lead to sensory pollution loads [6, 7]. The personal computers or PC'S are considered as the main source of indoor pollution. Furthermore, when PCs are serviced for every three months, then the sensory pollution load of every singular one is 3.4 Olfactus (olf: The olf is a unit used to measure the strength of a pollution source) [8, 7]. Chemical analysis detects the pollutants emitted by PCs. The most remarkable chemicals involve phenol, toluene, 2-Ethylhexanol, formaldehyde, and styrene [6]. Therefore, these types of pollutants include an indispensable adverse effect on the air quality, not only in the office areas but also in our houses as well. In addition, NPR (National Public Radio) reported by Chris Arnold in 2004 from Environmental Protection Agency (EPA) officials said: Computers and their monitors in the United States have the responsibility for the unessential creation of millions of tons of greenhouse gases per year [9]. Besides, as the whole globe has been talking about going green, everybody can chip-in his/her bit for saving environment, energy and money. Commonly, PCs and other IT equipment consume a great amount of electricity and have high carbon emission level. Moreover, the utilization of green technology is especially designed to minimize power consumption and to maintain a greener and cleaner environment [7].

Need for green manufacturing technologies:
      A business is successful if it focuses on the trends within the industry and the global market. Nowadays in any developed or developing country a common word is being echoed in every industrial sector i.e., "Green Technology". It is mainly associated with production industry. Due to various production techniques there have been many green house gases released into the atmosphere since 100 years which unfortunately lead to environmentally detrimental phenomena of 'global warming'. And now it's really high time for us to understand and take some serious initiatives in order to save our mother Earth. Hence many sustainable practices and eco-friendly operations have been standardized in every industry. There is enormous amount of energy consumption in conventional manufacturing methods; hence we must switch to some sustainable measures for our betterment.

Benefits of Green Computing:
➢ Reduced energy usage from green computing techniques translates into lower carbon dioxide emissions, stemming from a reduction in the fossil fuel used in power plants and transportation.
➢ Conserving resources means less energy is required to produce, use, and dispose of products.
➢ Saving energy and resources saves money.
➢ Green computing even includes changing government policy to encourage recycling and lowering energy use by individuals and businesses.
➢ Reduce the risk existing in the laptops such as chemical known to cause cancer, nerve damage and immune reactions in humans.

      In this paper, we have provided an overview on green technologies, Different Types of Green Manufacturing Technologies and current trends that lead to sustainability. The rest of paper is organized as follows. We have discussed Green Technology Implementations and Explanation over Worldwide Scenario. Next, in 'Challenges faced by Green Technologies' section, further, the potential benefits of green technologies are delineated in 'Opportunities for Green Technology Markets' section. Finally, the study conclusions, author perspectives, and future research directions have been provided in 'Conclusions' section.

An Overview of Green Technologies:
      Green technology also contributes in various areas like Energy, Green Building, Environmental Purchasing, Chemistry and Nanotechnology. Energy is an essential part of our everyday life, which is also needed to be conserved and use in an efficient manner. Buildings can be considered as a great example that uses eco-friendly techniques for example "Green Building" which encompasses everything from the use of building materials. Government on the other hand supports the innovative research of the products which can be used as an alternative option. In the field of chemistry, there is invention, design, innovation and application of chemical products and processes to reduce and eliminate the use of hazardous substances. And lastly, the nanotechnology today has innovated to involve the manipulation of materials with a scale of nanometer. Scientists believes that the mastery of this subject will transform the way of manufacturing and is considered as an application of green chemistry and green engineering principles to this field of technology.

Different Types of Green Manufacturing Technologies:
➢ Operation of Energy Audits- The prime step for an industry to meet the eco-friendly status is to conduct energy audit on the day to day basis and to observe where energy is being consumed in large amount and

replace it with green-technical equipment. For example replacing traditional light bulbs with Compact Fluorescent Light Bulbs (CFLs). The change in consumption doesn't get notified at once, but in long run there will be change in energy consumption. As there is declination in availability of fossil fuels and the global ecological balance is also being disturbed, hence the only survival strategy is to minimize the energy consumption. This holds for an industry as well as for an individual. Green products, which are embodied with less usage of energy, when employed in manufacturing and production would enhance the reduction in carbon emissions.

➢ Use of Renewable and alternative energy – Shifting from consumption of conventional power which is produced by fossil fuels to power produced by solar, wind, tides, biomass etc. is the need of the hour. It's always a better option to construct our own eco-power source on-site in order to fulfill the requirement and emissions are reduced. Governments take initiatives to provide incentives and tax free production of power from green technologies. If it's not possible to build an economic source then buying a conventional source would be much more costly. The costs incurred for the construction of green power sources may be high, but if we compare the ecological benefits and optimization of energy, that would be a huge success in long term.

➢ Application of 3 R's (Reduce, Reuse and Recycle) – Another way to reduce the production cost is to recycle the production waste effectively.

➢ Minimize the usage of water – Many industries are the main cause of water pollution – mainly chemical, textile, and leather and construction industries. They directly impact our lives and can have hazardous effects. we can accomplish this by:

➢ Choosing alternative manufacturing techniques.

➢ Usage of telecommuting.

➢ Usage electronic mails rather than paper.

➢ Shifting to hybrid vehicles.

Green Technology Implementations and Explanation over Worldwide Scenario:

Tennessee, US.

The Department of Energy National Laboratories devoted 3 plants; Y-12, X-10, and K-25 to the Manhattan project during WWII to develop nuclear weapons. Most notoriously, the top-secret complex Y-12, which was used for enriching Uranium to create the bombs used in Hiroshima.

Toxic wastes, including Uranium, were buried in underground 'ponds'. Millions of gallons worth of waste from nuclear weaponry manufacturing were dumped into the ponds. That is until 1984, when the ponds were drained, capped and transformed into a parking lot. This however didn't prevent the highly-mobile; water soluble Uranium (VI) into leaking into the local groundwater. When checked, the water contained up to a thousand times the legal concentration of Uranium.

Efforts were made by the DoE to decrease the concentration of Uranium. First, bioremediation, which utilizes living systems such as microbes and bacteria to reduce the contaminants in the soil to forms that are less dangerous. The mixture that was going to be bio-remediated contained PCE (a form of Chlorocarbon), Nickel, and Aluminum, which microbes wouldn't survive. So, a vacuum stripper and carbon filters were introduced to remove volatile organic toxins. The treated mix would then be passed onto holding tanks that remove the aluminum. After this step, the mixture would be pumped into a fluidized bed reactor where micro-organisms would denitrify the nitrates, and finally the mix would be pumped back underground where microbes can convert the highly mobile Uranium (VI) into stable non-reactive, insoluble Uranium (IV).

The use of conventional technology would have exhausted around $300 billion; however the use of bioremediation cuts down that cost significantly. Additionally, it's a much safer process rather than digging out and trucking the contaminated materials, as humans isn't exposed to the toxicity.

Bangkok, Thailand.

A clean-tech company, called *Dyecoo*, invented a textile dying machine that uses CO_2 , instead of water. A kilogram of fabric usually uses 100-250 liters of water to be dyed. Instead, *Dyecoo* uses liquid CO_2 to dye their fabric, and the CO_2 can be recycled again. No water is used in the process at all. This cuts costs, as no wastewater treatment is required, and the dying process is faster, resulting is less total energy consumption. Many companies have shown interest in *Dycoo'*s innovation, including IKEA, Puma, and Nike.

Arizona, US.

A 'combined-cycle natural gas power plant' in Arizona that goes by the name *APS Redhawk Power Generating Plant* burns natural gas to power turbines which generate around a thousand megawatts of electricity. The waste products of this process are water and carbon dioxide. *APS* teamed up with *Green fuel Technologies* to find a greener method to discard of the CO_2 .

First, several strains of algae are grown by biologists in special nurseries. The algae are raised to adapt to the particular area of Arizona to maintain their resistance and immunity, then they are transferred to

bioreactor tanks. The CO_2 and water from the natural gas incineration are piped to the bioreactors, which evenly allocate the sunlight and carbon dioxide to the algae. Finally, the algae respire and photosynthesize using up the CO_2 and releasing only oxygen. The project doesn't stop there, however. The algae are later harvested and used in several ways;

➢ They're used to make biodiesel.
➢ Starch is extracted from the algae to produce ethanol.
➢ Algae proteins are used for cattle feed.
➢ Harvested algae can be dried and burnt again at the power plant.

<u>Pisa, Italy</u>

Enrico Dini, a robot specialist and the founder of *D-shape*, designed a 3D printer that uses local materials, such as sand and gravel, or recycled materials, such as shredded tire and left-over plant matter, to print models.

In 2012, Dini designed an artificial coral reef, which has been tested in England and the Middle East, for maritime restoration and coastal renewal; a project that allows fish to colonize the coral without resulting in any harm to the environment, as the process produces low carbon footprint.

Challenges Faced by Green Technology:

Technologies have impacted our society and its environment in many ways and helped in developing more advanced economies such as today's global economy [10]. Green technologies are environment healing technologies. They minimize environmental damages brought by technologies created by the humans for their conveniences [11]. However, green technologies have been facing challenges that make it much harder to realize their set goals. Such challenges include marketing challenges, economies of scales, financing problems, and regulatory and technical challenges [12]. Any technology is not just a set of engineering achievements, but is centrally positioned within profoundly cultural and environmental boundaries. CO2 emission is one of the major factors for causing climate change, so there is a problem in balancing environmental and business concerns. It has been facing several socio economic as well as technical challenges to balance the same.

Opportunities for Green Technology Markets:

Green technologies consist of complicated and expensive but simplest technology advancements. They serve basic human needs and can provide new possibilities of exploring and improving comfort and leisure in human lives [11]. Green technologies offers new and interesting opportunities to construct and develop an extra durable and energy efficient materials to provide a reliable energy source [8, 13]. New eco-friendly products and services can be created by aiming the increasing growth rate while using minimum resources and causing minimum damage to the environment.

Reducing the number of resources used in developing green products would significantly reduce adverse impacts, hence avoiding economic and environmental collapse. Green technology market has identified renewable energy, water recycling and treatment services, the most substantial factors for export opportunities and growth. Green technologies have an open chance to be a competitive and powerful green technology sector in developing countries. This can be vital in spreading and extending green technology advancements and help to minimize the damages created by industrial growth [12].

II. CONCLUSION:

Green technologies are not confined to regulate the pollution or recycling processes but it focuses on reducing the impact of manufacturing processes at each every stage of production. Green Manufacturing focuses on primary goals such as minimization of emissions, effluents, accidents, use of virgin and non renewable energy resources, life cycle cost, product and services. From the above, we can conclude that green technology is an essential need for today. Since conventional technology is challenging sustainability, green technologies should be carried out to ensure sustainability of the eco-social environment. Though there are some shortcomings in the implementation of clean technology, but, if we see its long-term benefits, our future generation will surely be benefitted. Also, technology will help us to conserve our limited sources. Thus, the easiest way to maintain economic, environmental and social sustainability is education. The role and directions of skill training institutions should be aligned with the needs and wants of the industrial sectors. Therefore, it is imperative for the skill training institutions to revise and revamp their curriculum in order to produce graduates with green skills to cater for the demand of manpower market. We strongly believe that there are many more skills that are not mentioned in this paper. Further studies should be more focused by determining specific green skills needed in certain sectors, such as computer manufacturing sector, construction sector, tourism, waste management industry, and so on.

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