



## **OPPORTUNITIES & CHALLENGES FOR GREEN TECHNOLOGIES IN 21<sup>st</sup> CENTURY**

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### **Abstract:**

*Technology has affected the society and its surroundings in many ways and helped to develop more advanced economies including today's global economy. Science has contributed many technologies to the society which include Aircraft technology, Automobile technology, Biotechnology, Computer technology, Telecommunication technology, Internet technology, Renewable energy technology, Atomic & Nuclear technology, Nanotechnology, Space technology etc. have changed the lifestyle of the people and provided comfortability. In order to sustain this comfort of people in the society, they have to worry about the sustainability of the surrounding environment. In this paper, we propose how the technologies can be made sustainable by adding green component so that they can avoid environmental degradation and converted into green technologies to provide a clean environment for future generations. The paper also discuss the opportunities and challenges for green technology for agriculture, green technology for potable water, green technology for renewable energy, green technology for buildings, green technology for aircraft and space exploration, green technology for education, green technology for food & processing, and green technology for health and medicine in 21<sup>st</sup> century.*

**Index Terms:** Green Technologies, Sustainability & Green Society

### **1. Introduction:**

Technology is defined as a set of processes for making, modifying, using, and knowing of tools, machines, techniques, crafts, systems, and methods of organizing them in order to solving a problem, improving a pre-existing solution to a problem, achieving a goal, handling an applied input/output relation or perform a specific function. Technologies considerably affect human beings and other animal species' ability to control and adapt to their natural environments. Technology has affected society and its surroundings in many ways has helped to develop more advanced economies (including today's global economy) and has supported the rise of a leisure class people even with laziness & lethargy. Science has contributed many technologies to the society which include Aircraft technology, Automobile technology, Bio-technology, Computer technology, Telecommunication technology, Internet technology, Renewable energy technology, Atomic & Nuclear technology, Nanotechnology, Space technology etc. have changed the lifestyle of the people and provided comfortability. In order to sustain this comfortness of people in the society, they have to vary about sustainability of the surrounding environment.

Technology is the branch of scientific knowledge that deals with the creation, application and use of technical means and their interrelation with human life, society, and the environment, drawing upon such subjects as engineering, applied science, pure science and industrial arts. Many technological processes generate unwanted by-products, which give rise to pollution, and deplete natural resources, to the detriment of Earth's environment. Implementations of new technology influence the culture and values of a society and often raises new ethical questions. To improve any present

systems in the society, it is normal practice that such systems have to be compared with an hypothetical, predicted system of that kind called "Ideal system". The word 'Ideal system' refers to the system which has ideal characteristics i.e., perfect in every way. It is what the mind pictures as being perfect [1]. The concept of ideal engine, ideal switch, ideal voltage source, ideal current source, ideal semiconductor devices like ideal diodes, ideal transistors, amplifiers etc. have been defined and taken as standards to improve the quality and performance of such practical devices or systems. It is found that, by keeping such hypothetical devices or systems in mind, researchers have continuously been improving the characteristics/properties of practical devices / systems to upgrade their performances. Hence ideal technology model is essential to plan the improvement in the performance of any practical technology. The concept of ideal technology can be predicted as a technology which can solve all basic needs of human beings and provide luxurious comfortable life without affecting the society and environment. Ideal technology should have characteristics in order to elevate the quality of life to unique level with perfect equality so that every human being in this universe should lead happy and comfortable life and realize the so called concept of heaven on earth. Based on various factors which decides the ideal technology system characteristics, a model consisting of input conditions, output conditions, environmental conditions and system requirements [2]. The input properties are (1) Manipulate the fundamental nature of matter to provide solutions to basic and advanced problems of mankind. (2) Inexpensive & self reliable in terms of resources to make it attractive to be used by people/countries of varied economical situations. (3) Ubiquitous so that the technology provide solutions and services at anytime, anywhere, any amount of time to the users. (4) Affordable to everybody so that it uses common materials available in nature and manipulate effectively to the need of human being at affordable cost. The Output properties are (1) Solve basic needs like food, drinking water, renewable energy, clothing, shelter, health and clean environment. (2) Provide comfort life to the users by providing solutions to their desires. (3) Equality ; ideal technology provide equal opportunity and similar solutions to every user irrespective of their gender, religion, background, education, economic status, and country of origin. (4) Automation; ideal technology automate all processes in every type of industries to avoid human interference in work/control in order to provide expected output based on programming. (5) Immortality is the ultimate goal of ideal technology so that it can create an avenue for deathless situation or enhancement of human life span. The System Requirement Properties are (1) General purpose technology to support all fields and problems of human & living beings on the earth. (2) Self-directed & self controlled & self regulated so that the technology can control itself in order to achieve its goal. (3) Easy, simple, quick & user friendly to solve all type of problems and to provide quick ideal solution. (4) Scalable so that it is used for solving small and simple problem to large and complex problems of life. (5) Omni-potent to identify and solve problems and provide comfortability to human being and feeling him like God. (6) Exploring new opportunities to improve and explore comfortability and further leisure in life of people. (7) Infinite potential for further development of life in the universe. The Environment/external Properties are (1) Maintain clean environment through its processes and avoids foot print of processes while achieving specific function. (2) Infinite business opportunities by creating new products / services with ideal characteristics. (3) Adaptive to any situations to achieve stated goal. (4) No side effects so that it should be safe for users, and environment. Any technology which has the above properties/characteristics is considered as ideal technology and the

conventional technologies have serious drawbacks/limitations in terms of the above properties [2].

One of the properties of ideal technology is sustainability and zero green gas emission to environment i.e., ideal technology is green technology. In this paper, we propose how the technologies can be made sustainable by adding green component so that they can avoid environmental degradation and converted into green technologies to provide clean environment for future generations. The paper also discuss the opportunities and challenges for green technology for agriculture, green technology for potable water, green technology for renewable energy, green technology for buildings, green technology for aircraft and space exploration, green technology for industrial automation, green technology for computers and communication, green technology for education, green technology for food & processing, and green technology for health and medicine in 21<sup>st</sup> century.

## **2. Sustainability:**

A sustainable society is founded on equal access to nutritious food, clean drinking water, health care, smart shelter, education, energy, economic opportunities and employment. In this ideal society, humans live in harmony with their natural environment, conserving resources not only for their own generation, but also for their future generations. Each citizen enjoys a high quality of life and there is social justice for all. Many technologies like nanotechnology, next generation nuclear power, bio-fuels, bio-plastics, smart monitoring & prediction analysis, tidal energy etc. are some of the possible sustainable technologies for future. Sustainable cities need sustainable technology for construction, maintenance and further growth. Sustainable Construction like recycled construction materials, green roofs for storm water management, zero-energy buildings (those that generate at least as much renewable energy as they use), natural ventilation systems, etc, Sustainable infrastructures like sustainable urban drainage systems, low-irrigation landscaping, renewable energy sources such as biogas created from sewage, etc. Sustainable Transport Systems like public trains and buses that run on renewable fuels, coordinated bike paths and walkways, increased access to transport, tolls for private vehicle use, etc., and sustainable local resource production: like recycled rainwater for drinking and irrigation, farm scrapers, urban agricultural plots, farmers markets, etc. By means finding means to decrease the cost of production, maintenance, improving government policies to support research and adoption of such technologies, and educating people to promote and use such technologies in day-to-day life the sustainable technologies can be promoted.

## **3. Green Technologies:**

Green Technology (GT) is environmental healing technology that reduces environmental damages created by the products and technologies for peoples' conveniences. It is believed that GT promises to augment farm profitability while reducing environmental degradation and conserving natural resources. Green technologies are sustainable technologies which will not create footprint when used for various processes/applications. Green technologies support the use of natural organic resources and avoid production of green gasses. They also consume less resource and do not support to increase the entropy of the universe. Green technologies do not support any kind of environmental degradation. They support automation of every process and hence avoid human intervention. Since they do not support environmental degradation and contribute to creating the footprint, they are sustainable, improves the lifestyle of the people and contribute for human comfortability. The major technologies used in present day like Aircraft technology,

Automobile technology, Biotechnology, Computer technology, Telecommunication technology, Internet technology, Renewable energy technology, Atomic & Nuclear technology, Nanotechnology, Space technology etc. can be made green using the principle of green technology [3-17]. Such green technologies may contribute to solving problems of the society both basic and advanced kind of civilization. The objectives of green technologies in some of the basic and advanced fields of society are listed in table 1.

Table 1: Objectives of green technologies in various areas of the society

S.No	Area	Objectives of green technologies
1	Agriculture	To avoid environmental degradation in agricultural processes.
2	Food Processing	To eliminate poisonous contents in food and to avoid green gas emission and environmental degradation in all food packaging processes.
3	Potable water	To large scale filter used water and sea water through green processes without environmental degradation.
4	Sustainable Energy	To develop technologies for harvesting potential natural energy sources to generate required energy to human civilization without degrading environment.
5	Consumer products	To produce variety of new generation consumer products without side effects and without degrading environment in any production, packaging and in actual use by consumers.
6	Automobiles	To produce energy efficient, zero emission automobiles using renewable energy processes.
7	Construction	To build environmental friendly, energy efficient, smart buildings.
8	Industrial Automation	To develop industrial processes which are environmental friendly, no green gas emission, recyclable waste products using green energy.
9	Computer and Information Communication	To develop and utilize environmental friendly, recyclable electronic and computer components which uses renewable energy and efficient performance.
10	Education	Use of green technology in all education services.
11	Health	Use of green technology and green processes in all health and medical services.
12	Aircraft & Space Travel	Use of green energy and green materials and environmental friendly processes in air and space travel.

#### **4. Nanotechnology as Green Technology:**

The emerging nanotechnology is expected to solve both basic needs and comfort wants of human beings. The basic needs of human being are food, drinking water, energy, cloth, shelter, health and environment and the comfort wants are realizing the automation in every field, space travel and expanded lifespan and so on. Nanotechnology is the manipulation of matter on an atomic, molecular, and supramolecular scale. The earliest, widespread description of nanotechnology [3-9],

referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macroscale products, also now referred to as molecular nanotechnology. Planned and controlled development in nanotechnology leads to environmental sustainability and hence can be used as green technology. Some of the applications of nanotechnology initially thought as green technology are:

- ✓ Clean, secure, affordable, renewable energy;
- ✓ Stronger, lighter, more durable recyclable materials;
- ✓ Low-cost filters to provide clean drinking water from seawater;
- ✓ Medical devices and drugs to detect and treat diseases more effectively with fewer or no side effects;
- ✓ Lighting that uses a fraction of the energy associated with conventional systems;
- ✓ Sensors to detect and identify harmful chemical and biological agents; and
- ✓ Techniques to clean up harmful chemicals in the environment.
- ✓ Green building and sustainable infrastructure.
- ✓ Modified production processes to minimize green gas emission.

The green Nanotechnology is going to be evolving as a general-purpose technology due to its applications in all areas of society. Hence in the advanced form, it will have a significant impact on almost all industries and all areas of society by offering better built, longer lasting, cleaner, safer, and smarter products for the home, for communications, for medicine, for transportation, for agriculture, and for the industry in general. Thus by controlled utilization of nanotechnology for environmental sustainability, it can be developed as green technology for sustainable society.

#### **5. Green Technology for Agriculture and Food:**

The green technology should be efficient, practical, cost effective and free from pollution. The sustainability factor should be looked at the ability of the agricultural land to maintain acceptable levels of production over a long period of time, without degrading the environment. Some define sustainability as the maintenance of productivity under stress conditions. Agricultural sustainability in this context should seek to maximize food production within constraints of profitability. The specific Challenges for green technology in agriculture are:

- ✓ Identifying appropriate technology suitable for income generation through sustainable agriculture i.e., ecological agriculture, rural renewable energy, etc;
- ✓ Examining the impact and implications of national policies for making recommendations for the extension of appropriate technology;
- ✓ Diagnosing policy-level impact of such green technology (GT) on rural income generation under the sustainable agriculture development framework;
- ✓ Reviewing the challenges and available policy options for the adoption of GT sustainable agriculture integrates three main goals-environmental health, economic profitability, and social and economic equity.

Some of the opportunities towards sustainable agriculture are:

(1) Integrated Pest Management (IPM), (2) Rotational Grazing, (3) Soil conservation, (4) Water quality/wetlands, (5) Cover crops, (6) Crop/ landscape diversity, (7) Nutrient management, (8) Agro-forestry, and (9) Marketing of green products.

The revolution in the challenge is to make applied technology competitive and sustainable nanotechnology innovations in agriculture are expected to solve the problems in the food sector and maximize productivity in agriculture. There is an ever-increasing demand for food and adequate nutrition and nanotechnology will provide solutions through precision farming using nanosensors, nano-pesticides, and inexpensive decentralized water purification. A more advanced nanotechnology

solution will be plant gene therapy; creating pest resistant, high yield crops that require less water etc. which also supports a sustainable environment.

#### **6. Green Technology for Potable Water:**

Nanotechnology has the potential to provide efficient, cost-effective and environmentally sustainable solutions for supplying portable water for human use and clean water for agricultural and industrial uses. Nanotechnology innovations in low-cost water purification are expected to solve drinking water problem of the world by providing sustainable drinking water to everybody making it as green technology. Water is one of the Earth's most precious natural resources. Most of it is saltwater. Fresh usable water is only 3% of the world's supply and two-thirds of that is frozen in glaciers, ice caps and icebergs. The remaining 1% is available for human consumption. Today 1.1 billion people don't have access to safe water and 2.4 billion lack sanitation facilities. 80% of developing world diseases are water-borne with an estimate of 3.4 million deaths, mostly children, due to water-related diseases. Demand for fresh water is increasing. Agriculture currently uses 70% of the world's water supply. To feed 2 billion more by the year 2030 there will be a 60% increase in demand on the water supply. Considering the current rates of consumption, population, and development, some two-thirds of the world population will be affected by droughts by the year 2050. Nanotechnology as a green technology will provide a solution for this challenge through inexpensive decentralized water purification, detection on the molecular level of contaminants, and greatly improved filtration systems. This helps to recycle rain water into clean drinking water, conversion of sea water into drinking water large scale at very low cost. Water purification plants functioning using green nanotechnology can produce a large amount of drinking water using renewable solar or wind energy so that the water purification plant can be sustainable with minimum maintenance cost.

#### **7. Green Technology for Sustainable Energy:**

Nanotechnology innovations in renewable energy solve entire energy requirement of human beings for their basic needs and for the comfortable life. Balancing human beings need for energy with the environmental cost to our planet is a major challenge. Demand for energy on earth is forecasted as increasing 50% by the year 2025 with most of these being fossil fuels. Currently over 1.4 billion humans have no access to electricity and 2.2 billion rely on plant material, vegetation, or agricultural waste as an energy and heating source. Our fossil fuel consumption is escalating and could become double by the year 2025. Meanwhile, Earth's glaciers are receding, the CO<sub>2</sub> concentrations in the atmosphere have nearly doubled, and world temperatures, recorded since 1861, were the hottest in three of the past five years. 1998 was the warmest on record, 2001 came in the second warmest and 2004 was the fourth warmest. Nanotechnology will help to solve our need for energy solutions through more efficient lighting, fuel cells, hydrogen storage, solar cells, locally distributed power generation, and decentralized generation and storage by reinventing the power grid. Nanotechnology as green technology supports large-scale renewable solar energy and wind energy production and distribution at low cost without any environmental degradation, contributing sustainable energy solution. Even though research in nanotechnology is progress towards developing highly efficient solar cells, the challenge is to achieve 100 % solar conversion efficiency.

#### **8. Green Building Technologies:**

Nanotechnology offers interesting new opportunities in the construction sector providing green solutions through the development of energy efficient, ultra high strength, extra durable, extremely lightweight construction materials. Preceded by the

IT and software revolution, nanotechnology is expected to usher a new paradigm shift in all spheres of construction technology. Nanotechnology is recognised as a revolutionary green technology that can help address key needs of green buildings relating to energy, environment, and health aspects. Nano-modification of cement is an emerging field. Synthesis and assembly of materials in the nanometer scale offers the possibility for the development of new cement additives such as novel super-plasticisers and nanoparticles. It is now possible to manipulate the fundamental structure of cement phases to control concrete properties, performance, and durability. Nano-modification also provides crucial information for predicting the service life of concrete more accurately and insights on improving it further. The challenges lie in how to improve energy efficiency and heat control of the buildings, how to improve the speed and durability of construction etc. using green nanotechnology.

### **9. Green Technology for Aircraft & Space Travel:**

The challenges faced by humanity on the earth are the result of our ambition of flying everybody at low cost which created heavy demand on various resources and raw materials. Many of these materials can be found in space but the expense to extract them is a major barrier. In addition to cost, other obstacles to developing space are safety, reliability, and performance. According to the National Space Society, there are four reasons why we need to pursue space exploration and colonization. These reasons—survival, growth, prosperity, and curiosity—all point to the fact that we, as a species, want more room. Space exploration will give us a means to monitor the health of our planet, a source of resources and an outlet for our imagination. Nanotechnology as green technology will create the ability for humans to operate in space more safely. Potential applications where nanotechnology will impact space exploration are propulsion fuels, coatings, structural materials, smart uniforms, electronics, and life support environments. Green nanotechnology is expected to provide materials which will be more efficient, stronger, self-healing and lighter than what is currently available.

### **10. Green Technology for Education:**

Green higher education is all about creating of knowledge, skills, attitudes and values related to the environment. It's more needed in higher education because of the dependence of environment with the economy. Higher education plays a pivotal role in creating and developing human capital. This resource that is created should not just look at the economic point of business but societal aspect as well. The demands for green jobs are on high. The solar energy and wind energy has to be still be utilized to reach out the masses in an efficient manner which calls for efficient green managers. From the construction industry to all management sector there is a need to create sustainable future which means that many green-oriented graduates are needed. The infrastructure has to be in such a way that buildings, energy costs, reliability and performance which has a positive impact on the environment. The faculties will be promoting learning in a conducive environment where they will address local, regional and national development issues. The systems, processes, structures, procedures and devices to learn green are eco-friendly ways. Green can be used in a large way when it is open and distance learning. Continuous research on green jobs, green concepts, and promotion of it in operations management is needed. The college resources should be in a manner of commitment by top administrators, building facilities, faculties who believe in green ideology, a curriculum that supports philanthropic and interest amongst students. It is essential that sustainability is brought into the business model. The environment provides typical challenges to the current and future generation in terms of climate change, resources getting depleted, water issues, poverty, food and war

issues, environment caused diseases and pollution. This is further accelerated in developing countries because of less economic development and high population explosion. Initiatives taken from the colleges and universities will help students develop knowledge, skills and attitudes to fighting with these issues. As a university, they have an important role in reviewing the various courses and degrees and address issues which address about sustainability. The teachers who are a crucial stake in this system have a great role to keep updated and informed and transfer knowledge an innovative way. The whole methodology of teaching should be learning oriented rather than teaching oriented. Pedagogy should include the real world learning experiences so that the learning is very fruitful. The subjects that can be added in this kind of systems are agriculture, organic farming, climate and atmosphere, green tourism, green medical services, green transportation etc. In this form people, planet, and profit will be achieved in all industries. Green education also includes enhancing student knowledge in using green technology. Computer and information technologies are already considered as green technologies due to their contribution to clean environment in many industrial automation processes. Green nanotechnology has been described as the development of clean technologies, to minimize potential environmental and human health risks associated with the manufacture and use of nanotechnology products, and to encourage replacement of existing products with new nanoproducts that are more environmentally friendly throughout their lifecycle. Green nanotechnology is the study of how nanotechnology can benefit the environment, such as by using less energy during the manufacturing process, the ability to recycle products after use, and using eco-friendly materials [18].

#### **11. Green Technology for Health & Medicine:**

The important and major area of green nanotechnology research is in human health. Humans are living longer lives. In the previous centuries, men and women expected to live to 48 and 51 years respectively. But life expectancy is now 74 and 80 years and could be significantly longer with anti-aging advancements currently being developed. At the same time, 30 new highly infectious diseases have been discovered in the last 20 years. These diseases account for 30% of the deaths worldwide and include HIV/AIDS, Ebola, and the Avian Flu. HIV/AIDS. According to the World Cancer Report, there could be a 50% increase to 15 million new cases in the year 2020 primarily attributed to an aging population worldwide. Green nanotechnology research provides tremendous opportunity in making progress in the medical field. Some of the nanotechnology applications in the arena will be inexpensive and rapid diagnostics, new methods of drug delivery, and faster development of new drugs. Some longer-term and even more powerful nanotechnology solutions will repair DNA and cellular damage and customize drug therapy. The longer-term applications of advanced nanotechnology for sustainable health and longevity are explored. Developments are expected in pharmaceuticals and green nanotechnology, which allows patients to drink fluids containing nanorobots programmed to attack and reconstruct the molecular structure of cancer cells and viruses. There's even speculation that nanorobots could slow or reverse the aging process, and life expectancy could increase significantly. Nanorobots could also be programmed to perform delicate surgeries such nano-surgeons could work at a level a thousand times more precise than the sharpest scalpel. By working on such a small scale, a nanorobot could operate without leaving the scars that conventional surgery does. Additionally, nanorobots could change our physical appearance. They could be programmed to perform cosmetic surgery, rearranging the

atoms of the human body to change his ears, nose, eye colour or any other physical feature he wishes to alter [2].

The green nanotechnology may be able to extend our lives by helping to eradicate life-threatening diseases such as cancer, and the other is by repairing damage to our bodies at the cellular level--a nano version of the fountain of youth. The extension of the human lifespan could be also facilitated through the removal of a substance called lipofuscin from certain types of non-dividing cells, including the brain, heart, liver, kidneys and eyes. Lipofuscin is a metabolic end product that accumulates primarily within lysosomes (the garbage disposal organelles within cells). It's thought that when lipofuscin accumulates to certain levels, it begins to negatively impact cell function, which eventually manifests in many age-related conditions. It is proposed that humans might live as long as 1,000 years under the appropriate rejuvenation therapies. In 30 or 40 years, we'll have microscopic machines travelling through our bodies, repairing damaged cells and organs, effectively wiping out diseases. The nanotechnology will also be used to back up our memories and personalities. And in 35 to 40 years, we literally will be immortal [3-7].

## **12. Green Technology for Food & Processing:**

Food is an essential component of life and human existence. Since the beginning of time, humans have had to eat to survive. Finding a balance between food supply and demand in a manner that is sustainable and which ensures the long-term survival of the human species will be one of the most important challenges for humankind. Heavy population growth in the world during the last several centuries has made the need for sustainable food production and processing technologies even more important. Green technologies in food and food processing sector have challenges associated with the use of technologies to reduce the generation of process-induced toxins; social factors that influence consumer perceptions about some of the current and emerging agri-food technologies including nanotechnology, and the need and importance of biodiversity in maintaining sustainable diets of world populations [19]. Food processing is a diversified sector encompassing the use of various raw materials, processes, and end products and need special attention for maintaining quality, safety, and nutritional properties through green technology. Various technologies like Biopreservation, Electromagnetic wave heating, Electric and magnetic fields, Nonthermal technologies etc. under the broad umbrella of biotechnology and nanotechnology have potential opportunities to reduce process-induced toxins in the food and environmental impact of food production and processing.

## **13. Conclusion:**

Technology has affected the society and its surroundings in many ways and helped to develop more advanced economies including today's global economy. Science has contributed many technologies to the society which include Aircraft technology, Automobile technology, Biotechnology, Computer technology, Telecommunication technology, Internet technology, Renewable energy technology, Atomic & Nuclear technology, Nanotechnology, Space technology etc. have changed the lifestyle of the people and provided comfortability. In order to sustain this comfortness of people in the society, they have to worry about the sustainability of the surrounding environment. In this paper, we propose how the technologies can be made sustainable by adding green component so that they can avoid environmental degradation and converted into green technologies to provide a clean environment for future generations. The paper also discuss the opportunities and challenges for green technology for agriculture, green technology for potable water, green technology for renewable energy, green technology

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