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RECENT ADVANCEMENTS IN GREEN TECHNOLOGY

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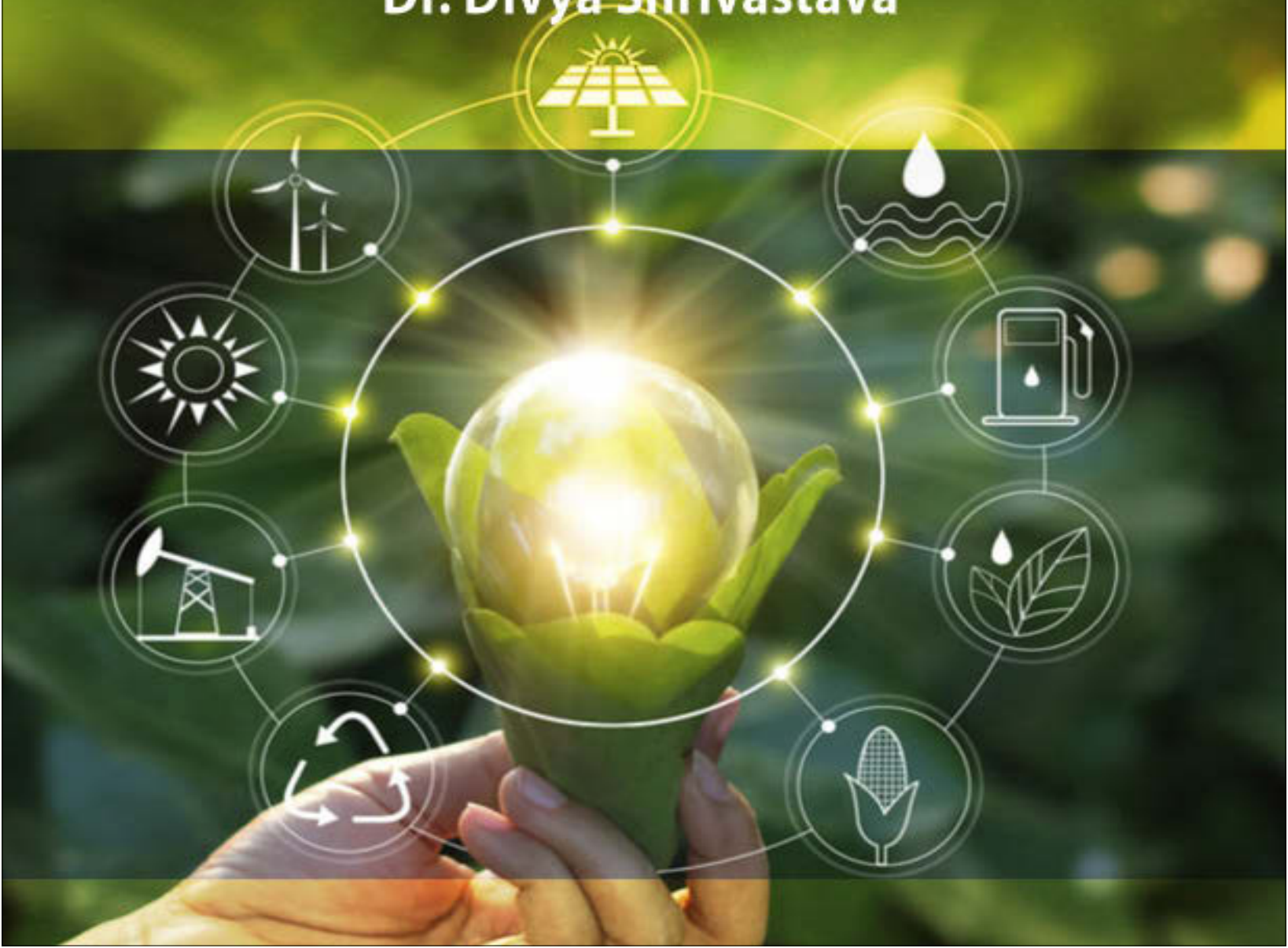

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CHAPTER 1

AN OVERVIEW OF GREEN TECHNOLOGY

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The growth of the energy sector is intimately related to economic development. Fossil fuels make up the majority of the world's commercial energy supply, and the resulting emissions are to blame for many environmental issues on a worldwide scale. It is anticipated that these levels of energy output and consumption from existing energy sources are not only challenging to attain but also unsustainable. Therefore, in order to control the rise of energy, energy use efficiency must be improved, and in order to lessen the negative effects of energy use on the environment, clean energy contribution must be enhanced. An encouraging substitute for conventional energy sources is green energy. There is a gap between renewable energy's potential and its implementation since they only make up a small percentage of the world's (commercial) energy consumption. This gap is caused by the implementation hurdles. In order to develop creative policy approaches for the domestic and international funding of renewable energy technologies, these obstacles (financial and non-financial) must be recognised and addressed. Utilizing contemporary technology, renewable energy may significantly contribute to meeting fundamental energy demands eco-friendly technology. The Rio Declaration, which was approved during the United Nations Conference on Environment and Development in Rio, highlights the right to a productive and healthy life in accord with the incorporation of environmental protection into the development process

Technology is characterized as a collection of procedures for developing, converting, exhausting, and interpreting apparatuses, machineries, processes, skills, systems, and approaches to shaping them towards solving an issue, improvise a foregoing explanation for problems, achieve an objective, maintain an functional contribution/production relationship, or execute a particular purpose. Technology has had a significant impact on the life of humans and other animal species. Technology has also had a significant impact on humanity and its surroundings in a variety of areas. It has aided in the growth of many more industrialized nations' economies and has aided in the creation of leisure class people, including their lethargy and laziness. Biotechnology research, including internet technology, nuclear technology, nanotechnology, air craft technology, and green energy technology, has applied various beneficial innovations to society, and these technologies also improved people's standard of living and delivered comfort ability.

Green technology has become a major trend and development in the twenty-first century as a result of the escalating worldwide environmental issues, such as global warming, climate change, and the depletion of energy supplies. In the future, it is anticipated that the development would give rise to global, sustainable, and macroeconomic forces that will have an influence on economies,

society, cultures, and way of life. In reality, the "information explosion" of the 1960s has been compared to contemporary green technology advancements, which have shown signs of significant innovation and improvements in everyday life. Green technology development must be sustainable, and environmental concerns and growths need to be tackled in a way that reinforces one another. Economic projections and the prospective prognosis for green technology are encouraging. Carefully examining its effects is necessary, taking into account both economic and environmental efficacy. In order to achieve sustainability and growth in the economy as a whole in a way that is both efficient and cost-effective, it is crucial to highlight the value of seeking out win-win solutions. This chapter offers a comprehensive view of the potential and problems associated with green technology in light of the global movement towards sustainable development. An overview of cutting-edge green technology is provided. Challenges from the market, technology, financing, and regulatory perspectives are also outlined, along with opportunities for end users, solution providers, financial investors, regulators, policy-makers, and other stakeholders to address these issues and foster the expansion of the green technology market.

The invention and use of goods, machinery, and systems that preserve natural resources and the environment while minimising or mitigating the harmful effects of human activity on the environment are both examples of the use of green technology. Although "Green Technology" is a more fashionable word, it has the same meaning as "Clean Technology" or the more widely accepted "Environmental Technology". The area of green technology includes a variety of environmentally beneficial approaches and products that are constantly developing, ranging from systems for managing greenhouse gas audits to ways for producing non-conventional energy sources like solar power. The creation of green technologies must be sustainable, which is defined as "balancing the satisfaction of human needs with the conservation of the natural environment and resources such that these requirements may be supplied not only in the present but in the indefinite future." The environment-social-economic (ESE) trinity, which satisfies "bearable" environmental and social impacts, "equitable" social and economic solutions, and "viable" economic and environmental possibilities, may be used to realise the goals of sustainable development.

The treatment of water and wastewater, the reduction of air pollution, the cleaning up of the environment, the management of waste, and energy saving all make use of conventional green technology. The next sections go over some fundamental concepts and how green technology are used in different industries. Looking from the other side of this technological globe, there are certain unnecessary derivatives generated by using such technologies in abundance, which result in environmental waste, natural resource exhaustion, and harm to the earth's ecosystem. The ethical dilemma arises as a result of the impact of novel technology on values and society. To reform a society's current structure, it is common practice to equate it to a future, expected system of the kind known as "ideal systems," which refers to systems that have ideal features that are flawless in any way. It has been determined that scientists have continually developed the characteristics of realistic devices to enhance their performances by having those imaginary devices in mind. One of the features of ideal technology is the potential to be renewable and emit zero greenhouse gases into the atmosphere ideal technology is green technology.

Green technology, also known as sustainable technology, takes into account the long- and short-term impact something has on the environment. Green products are by definition, environmentally friendly. Energy efficiency, recycling, health and safety concerns, renewable resources, and more all go into the making of a green product or technology.

It is obvious in 2020 to most of the world population that green technologies are the salvation army of mother earth and the universe. In the last 50 years, the universe has suffered rapid changes in climate. Our planet suffers from increasingly severe droughts, rising seawater levels, seawater acidification, increased depletion of groundwater reserves, and global rise of earth temperature. The rapid spread of diseases and macro-parasites and the extinction of species are the direct results of climate changes. These changes may be irreversible if countries, governments, and citizens do not act rapidly to save the planet.

The high-tech industrial revolution in the last 50 years depleted and ruined the planet natural resources. Electronic waste, plastics, and food garbage contain dangerous chemicals that pollute soil and groundwater with toxic chemicals that cannot be removed from our drinking water supply. These toxic materials can be found in food crops and livestock grown on contaminated soil. These toxic wastes and air pollution affect significantly our health. The planet oceans, seas, and lakes suffer from plastic pollution. Plastic wastes destroy the ocean habitats of sea creatures around the world. Plastic pollution kills fishes, birds, and other species. Plastic large pieces pose choking and strangulation hazards. Tiny plastic particles are making their way into the bottom of the food chain. Fishes swallow plastic waste and become contaminated. These fishes are subsequently harvested for human consumption. The contaminated fishes may be found in our plate and in our stomach.

Renewable green energy, waste management, and recycling are the main challenges and topics in the research and innovation in green technologies. The book is divided into three sections. Section 1 presents innovations in green electronic technologies. Section 2 presents recycling and waste management. Innovation and economics in global green technologies are presented in Section 3.

Here a just a few reasons why going green is in everyone's best interest:

A. Inventors should know that green inventions and clean technologies are good business. These are fast-growing markets with growing profits.

B. Consumers should know that buying green inventions can reduce energy bills and are often safer and healthier than non-green counterparts.

C. Even making small changes can have a large-term impact. For instance, consider the waste created by plastic water bottles. Of course, drinking lots of water is a healthy practice but changing out reusable water bottles for disposable ones is health-promoting, eco-friendly, and green.

Cradle-to-cradle design (C2C), often known as eco-design, is a policy instrument that aims to enhance the environmental performance of goods throughout their lifespan by inserting certain criteria at the design stage. Numerous approaches to eco-design are possible, including life-cycle analysis, checklists, recommendations, and checklists. Eco-design, in contrast, has a direct impact on how the product is created, made, packed, transported, used, and disposed of. Eco-labelling

contributes to the disclosure of information about the goods to help customers make educated choices. By identifying and removing inefficient items from the market, eco-design may be a key factor in greening markets.

Through the Ecodesign Directive, the European Union is making significant efforts to develop and advance eco-design. The Ecodesign Directive establishes life-cycle-based minimum energy efficiency criteria and other environmental requirements for 32 indicated product classes, including electronic appliances and office lighting. Depending on the relevant product groupings, different implementation measures are used. Depending on their potential for energy savings and market size, nine broader product groupings might be included for the years 2012 to 2014. Windows, steam boilers (less than 50MW), electrical cables, business servers, storage and associated equipment, and smart appliances/meters are among the categories being taken into account. The working plan predicts that by 2030, these key product groupings will have saved 1,157 TWh of energy annually.

Technology transfer is a two-way process, not a passive one. Both supply and demand factors must be taken into account to encourage the transfer of green technologies from industrialised economies to the developing world. On the supply side, investors and businesspeople who take part in technology transfers look for an enabling environment in developing nations that includes the ability and infrastructure to support production and management as well as the laws that support further advancement of green technology. For green technologies to be successfully absorbed on the demand side, there must be local demand (pull factors). If developing nations want to adopt strategies for green growth that are sustainable, they must foster the transfer of green technologies by developing the technical capacity and institutional framework necessary for them to take in, modify, and advance the transferred systems and components. Currently, the largest emerging economies, including China, Brazil, and India, are where the majority of the transfer of green technology is taking place. However, it is not totally unidirectional. In many other ways, it also occurs between, within, and between industrialised and developing nations. Simple buying and selling is the most common transfer route. The establishment of increasingly complex platforms aimed at creating, transferring, and employing technology, such as joint ventures, strategic alliances, and R&D services, as well as in-licensing and out-licensing agreements about possible innovations and related know-how. The acquisition of knowledge of various technologies via specialised programmes, technical support, training, and education is another transfer channel.

A broad phrase used to describe the application of science and technology to the development of environmentally friendly goods and services is "green technology." Green technology is associated with cleantech, which is more explicitly used to describe goods or services that increase operational effectiveness while lowering prices, energy use, waste, or adverse environmental consequences. Protecting the environment, repairing environmental harm from the past, and preserving the natural resources of the planet are the objectives of green technology. A booming business that has drawn significant sums of financial money is green technology.

The application of green technology may be a corporate or industry goal. These objectives are often included in an organization's environmental, sustainability, and governance (ESG) statement or even in the mission statement of a corporation. Socially conscious investors are increasingly trying to focus their potential investments to only include businesses that use or create green

technology. Even though green technology has grown in popularity in the current day, certain aspects of these business strategies date back to the Industrial Revolution. Manufacturers have attempted to lessen the harmful environmental externalities of coal-burning industrial plants by changing manufacturing methods to create less soot or waste byproducts since the early 19th century, when scientists started to examine the ecological effects of these facilities. The Second World War was one of the most significant turning points in American history. More than 400,000 volunteers started gathering metal, paper, rubber, and other supplies for the war effort in an attempt to cut down on consumption and waste. Scientists like Rachel Carson started issuing warnings about the dangers of chemical pesticides after the war, and medical professionals overseas began describing unexplained ailments linked to nuclear radiation. Many consider this time period to be the birthplace of the ecology movement, which attempted to protect ecosystems and resources while educating the public about the dangers of rogue technology.

Government agencies began to gradually understand how important it is to conserve natural resources. Over the next decades, curbside recycling systems spread, increasing public awareness of home garbage. Since its founding in 1970, the Environmental Protection Agency has imposed strict regulations on waste generation, pollution, and the use of coal scrubbers and other environmentally friendly technology. There is no acknowledged definition of green technology on a global scale. The concept may be roughly described as technology with the potential to considerably outperform existing technology in terms of the environment. Although it is no longer frequently used, it is connected to the phrase "environmentally sound technology," which was established under Agenda 21 of the United Nations Conference on Environment and Development. Environmentally friendly technologies, according to Agenda 21, are designed to "protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substituted."

Climate-smart, climate-friendly, and low-carbon technology are additional phrases that are associated with green technology. What it does Green technology encompasses process and product innovations that produce little to no waste, improve resource and energy efficiency, and reduce pollution. They also encompass "end-of-the-pipe" pollution treatment technology. In addition to individual technologies, green technology also refers to systems, which include organisational and management practises as well as knowledge, methods, commodities, and services. Different types of green technologies A wide range of manufacturing and consumption technologies are included in green technology. Utilizing environmental technology for monitoring, evaluation, pollution prevention and control, remediation, and restoration are all part of the adoption and usage of green technologies. Technologies for monitoring and assessment are used to gauge and monitor environmental conditions, including the discharge of hazardous natural or man-made pollutants.

Technologies for prevention prevent the creation of ecologically harmful chemicals or modify human actions to reduce environmental harm; they include product replacement or the redesign of an entire manufacturing process rather than the use of new machinery. Hazardous chemicals are rendered harmless by control technologies before they reach the environment. Technologies for remediation and restoration include procedures intended to restore ecosystems that have been damaged by human or natural factors.

The first significant recycling initiative in the US was started during World War II. Tens of thousands of tonnes of garbage were recycled by almost 500,000 volunteers in support of the war effort.

Green technology

The term "green technology" refers to a wide category that includes several types of environmental cleanup. While addressing local environmental risks is a top priority, climate change and carbon emissions are now among the most urgent global challenges. Some people work to safeguard certain habitats or threatened species. Others look for more sustainable options to protect the limited natural resources.

Energy Alternatives

Many companies are working to design alternative energy sources that do not contribute to atmospheric carbon in order to provide a viable substitute for fossil fuels. At the consumer level, solar and wind energy are currently among the most economical energy sources, and solar panels are accessible to American homes. Tidal and geothermal energy are two possibilities that have not yet been widely used.

Electric cars

The Environmental Protection Agency estimates that transportation-related activities contribute close to one-third of the nation's greenhouse gas emissions. In order to lower automobile emissions, several manufacturers are looking at switching to electrical power or building more fuel-efficient engines. However, a number of advancements in other areas are needed for electric cars, including infrastructure for charging and high-capacity rechargeable batteries. The advantages of electric cars are further constrained by the continued use of fossil fuels in many power networks.

Sustainable Farming

The environmental impact of farming and raising livestock is significant, including the high expenses of using land and water as well as the effects of pesticides, fertilisers, and animal waste on the ecosystem. Thus, there are several applications for green technology in the agricultural sector. For instance, the use of organic agricultural methods, improvements in cow feed, and meat alternatives may all help to lessen the harm caused by animal consumption and soil depletion.

Recycling

By reusing materials or identifying environmentally friendly alternatives, recycling aims to save finite resources. The most popular recycling methods involve plastic, glass, paper, and metal debris, but more complex processes may be used to recover pricey raw materials from e-waste or vehicle components.

Capturing carbon

A collection of experimental technologies known as carbon capture aim to absorb and store greenhouse gases either at the site of combustion or from the atmosphere. The fossil fuel business has actively pushed this technology, but it hasn't yet lived up to expectations. In comparison to yearly emissions, the biggest carbon capture plant can only hold 4,000 tonnes of carbon dioxide per year.

Despite being a vast and difficult-to-define category, several forms of green technology have seen widespread acceptance. In order to achieve this aim, significant investments would need to be made in alternatives such paper replacements, bioplastics, or recycling technology. Several nations have started attempts to ban single-use plastics. For instance, Singapore has promised to accomplish 70% recycling by 2030. With fossil fuels acknowledged as a major contributor to climate change, renewable energy is another frontier for the adoption of green technology. The Energy Information Administration estimates that the combined contribution of solar and wind power accounted for 70% of the additional energy capacity installed in 2021. In 2020, the total amount invested globally in renewable energy sources will have surpassed $300 billion.

Green technologies aim to protect biodiversity and conserve the earth's resources, but there are few methods to achieve this without also having an impact on the environment. In some circumstances, lowering environmental expenses in one area entails having a negative effect in another.

Lithium, for instance, is often extracted by strip mining from South American rain forests and is used in the batteries of electric cars. Hydroelectric dams have tremendous effects on the salmon and other species that depend on such streams but minimal carbon emissions. Solar panels and wind turbines are two examples of green energy technologies that need a variety of rare minerals that can only be mined with diesel-powered mining equipment. Green technology is not inherently doomed, but it does need thorough analysis to make sure that the advantages exceed the drawbacks. Although green technology has been present for the previous 20 years, it has lately grown in popularity as the urgency of addressing global warming increases. In reality, the market for green technology and sustainability was estimated to be worth $8.79 billion in 2019, and by 2027, it is anticipated to grow to $48.36 billion. That is a growth rate of 24.3% over an 8-year period.

Green technology has dipped into a variety of areas to benefit the environment, from electric scooters to employing green products. Although the expansion of green technology is not unexpected, it is important to note that it is the answer to many of the world's environmental problems, including global warming, greenhouse gas emissions, and the preservation of biodiversity. The goal of green technology is to swap out harmful goods, methods, or materials with ones that do not disturb the environment or deplete its resources.

Need of green technology

Technology already hurts the environment, right? On the other hand, when used appropriately and efficiently, technology offers solutions. Here are the explanations for why we now more than ever need to put them into practise. The transportation industry alone in the UK contributes the most destructive pollutants and accounts for 28% of the nation's greenhouse gas emissions. These include the emissions from ships, aircraft, trains, and automobiles. Using electric cars has emerged

as a popular and expanding greener transportation option to help decrease the generation of greenhouse gases. Eco electric scooters are among the most utilized electric vehicles in the world. The public may find accessible public electric scooters in a number of countries, including Australia, the UK, the US, France, and Singapore, thanks to ride-sharing firms like Lime and Bird. Electric scooters don't produce any toxic gases since they don't need gasoline. According to a Paris research, encouraging commuters to use e-scooters prevented 330 tonnes of carbon emissions from entering the environment. E-scooter ride-sharing businesses are also changing the scooters' lifespan from manufacture to recharging in an effort to lessen their environmental effect. The use of electric vehicles for personal and public transportation is just getting started, starting with eco-friendly electric scooters. The amount of greenhouse gases in the environment would be greatly reduced, particularly in the coming years, if more people could employ green technology for transportation.

Provides a cleaner source of energy

According to a 2019 survey, 84% of the world's population continues to consume fossil fuels even though the globe is moving toward renewable energy sources. Fossil fuels are unfortunately non-renewable and will soon run out, hence it's critical that people move to more environmentally friendly energy. With green technology, people may continue to use geothermal wells, solar panels, wind turbines, dams, and other natural energy sources. Utilizing alternative energy will prevent the depletion of fossil resources, reduce greenhouse gas emissions, and delay global warming. In addition to this, green technology provides solutions like metallic foams, eco-friendly battery technologies, and green structures. Additionally, scientists are coming up with innovative methods to produce energy utilising equipment like thermal energy collectors, fuel cells, and lithium-air batteries.

Despite the fact that the globe is mainly encircled by water, just 1.2% of it is potable. By 2025, it is predicted that 1.8 billion people would not have access to clean drinking water due to rising freshwater usage. Innovations like the SunSpring Hybrid, which filters and transforms contaminated water into clean drinking water, help green technology overcome this challenge. In fact, the SunSpring Hybrid is capable of converting 20,000 litres of impure water from wells or rivers into potable water each day. Additionally, since it is powered by solar panels, this gadget may operate without electricity in remote locations. Because of this, it is useful for tiny settlements that are located close to water or who have experienced natural catastrophes. Lack of safe drinking water is a problem that has to be addressed today because of growing water usage and climate change since tomorrow may be too late.

Protects wildlife

Because of human activity, natural catastrophes, illness, and climate change, among other things, wildlife is continuously in danger. Technology is mostly used by wildlife researchers to observe animals in the wild. For instance, they utilise bio-logging and bio-telemetry to gather information on the behaviour, physiology, and other characteristics of elusive creatures without disturbing nature or putting researchers in risk. Researchers also use technology to instruct people, particularly students, via guidebooks or virtual tour guides. Additionally, zoological parks and

marine institutions integrate technology to encourage wildlife protection while giving visitors meaningful animal experiences.

All of these initiatives to research and enhance animal conservation will aid in meeting evolving conservation requirements. Technology that is always being developed will aid in preventing the ecosystem's alterations.

In the end, green technology helps people to undo the damaging consequences of human activity on the environment. Communities, governments, and organisations should make considerable, ongoing efforts to adopt green technology and scale them up. As a consequence of simple access, more individuals may employ green technology, which will have a long-term negative effect on the environment.

Impact of green technologies across industries

In Nanotechnology

The study of materials at the molecular, atomic, and highly complexed levels is known as nanotechnology. As nanotechnology develops, it must meet the basic requirements and expectations of humans. Humans need food, clean water, clothes, energy, housing, a comfortable environment, and other things as well, which makes it necessary to computerise every aspect of existence, extend lifespans, and other things. Green technology is a term used to describe planned and controlled nanotechnology manufacturing that helps to safeguard the environment. By producing better-built, safer, more durable, intelligent, and healthier products for the home, electronics, medicine, transportation, agriculture, and companies, green nanotechnology has the potential to have a significant impact on almost all industries and areas of culture. Thus, if nanotechnology is applied in a controlled way for environmental sustainability, it may be developed as a renewable technology for a sustainable culture.

Green Technology in Agriculture and Food

Finding an acceptable approach for capital production through sustainable agriculture, investigating the effects, and suggesting national standards for approving the expansion of suitable technology are all challenges for green technology in agriculture and food. Farming innovations built on environmentally friendly, sustainable technology are meant to address issues in the food sector and boost agricultural output. When there is a growing need for food and adequate nutrition, green technology will help by enabling precision cultivation, Nano-pesticides, and low-cost decentralised water sanitization.

Green Technology for Drinkable Water

By providing everyone with dependable drinkable water, green technology breakthroughs for low-cost water decontamination are predicted to solve the world's potable water crisis. The need for water would have increased by 60% by 2030 in order to feed an additional 2 billion people. Based on present rates of consumption, development, and population, two-thirds of the world's economy will be threatened by scarcities by the year 2050. Green technology will provide a solution by

detecting contaminants at the molecular level, using cost-effective targeted water decontamination, and developing far better purification systems. This helps with both the large-scale, low-cost recycling of saltwater into usable drinking water and the reprocessing of rainfall into clean, potable water.

Green Technology for Sustainable Energy

By 2025, it is anticipated that the demand for energy will have increased by 50% globally, with natural fuels being primarily responsible for this surge. Around 1.4 billion people lack access to electricity, while 2.2 billion rely on vegetative materials, flora, and agricultural waste for heat and light. Green technologies will solve the requirement for energy sources by improving lighting, energy cells, solar cells, hydrogen storage, locally distributed power supply, and regionalized generation and loading via the redesign of the power network. Inexhaustible solar and wind energy may be created and distributed on a large scale using nanotechnology at a cheap cost without causing more environmental harm, paving the way for a clean energy strategy.

Green Technology in Building Construction

Green technology offers the construction sector exciting new opportunities, such as the development of very strong, unbelievably lightweight, and highly energy-efficient building materials. Now, it is feasible to control the basic design of cement phases to monitor the characteristics, appearance, and hardness of concrete. Additionally, nano-modification offers crucial data for more precisely forecasting the material's operational life as well as insights into how to further enhance it.

Green Technology in Aircraft and Space Travel

Space travel would provide us a tool to gauge the health of the planet, a source of energy, and an empty canvas on which to unleash our imagination. Green technology will enable humans to live in space more sustainably. Green technology may impact space travel in a variety of ways, including impulsion oils, coverings, basic materials, intelligent outfits, sensors, and life-sustaining surroundings. Green nanotechnology is anticipated to create materials that are more potent, durable, self-healing, and light-weight than those that are already available.

Green medicine and healthcare technology

A significant and vital area of green nanotechnology research is human wellbeing. Green nanotechnology research offers several opportunities for medical sector innovation. Green technology applications in this area include quick and accurate diagnostics, inventive medication delivery systems, and more efficient drug development. Long-term and much more controlled advancements in green nanotechnology will repair DNA (deoxyribonucleic acid) and cellular damage and change medication treatment. It has been suggested that individuals might live up to 1,000 years if given the correct rejuvenation treatments. In 30 or 40 years, microscope machines will be able to fly inside human bodies, repairing harmed cells and tissues and successfully curing illnesses.

Green Technology in Food and Food Processing: One of humanity's greatest problems will be finding a sustainable balance between food availability and demand that secures the long-term survival of the human race. Green technologies in the food and food processing business must work with specialists to reduce the production of process-induced pollutants. A few of the technologies include biological preservation, non-thermal technologies, electronic and magnetic wave warming, and electrical and magnetic fields. Under the broad field of nanotechnology and biotechnology, there may be opportunities to eliminate process-induced toxins in foods as well as the environmental effects of food production and storage.

Green Solutions:

While there are many variables that contribute to the depletion of natural resources and pollution of the environment, consumer purchasing patterns and daily routines are the most significant. For instance, if every office worker used one less staple each day, we could save 120 tonnes of metal. Simple improvements may have a significant impact. Over 14 billion pounds of trash are dumped into the kingdom's waters each year. Plastic, which is hazardous to marine life, makes up the bulk of it. Millions of actions made without consideration for the effects on the environment have directly contributed to the decline in ecological quality. And the fact that around 75% of the garbage in landfills is biodegradable, despite how awful these numbers are, individuals have the potential to make a difference in the world. Many people don't realise how powerful the discrete can be, particularly when it comes to issues that are important to them. Only consumers have the power to change the world; although while it may not seem like it, they really have a significant impact over how businesses operate.

Sometimes, the growth and implementation of green technologies are hampered by the absence of a generally accepted classification system. China established the Green Technology Bank (GTB) in 2016 as a digital repository for green technology data in order to advance and safeguard sustainability research and development. In order to establish a cogent measure for classifying these talents, this study designed a level three classification system of green technology (CSGT) utilising an amalgam technique that assimilates bottom-up and top-down approaches. According to the planned CSGT, green technologies are organised into five primary classes that include ecological quality, resource usage, energy consumption, safe living, and environmental protection, along with 30 secondary categories and 87 tertiary groups. The CSGT enabled the examination of 2453 particular instances of renewable energy. The findings gave decision-makers and green investors vital facts to understand how green technology has expanded from the perspectives of many bases, divisions, implementation phases, and geographical delivery.

The development of more industrialised economies, such as the contemporary financial sector, has been facilitated by technology, which has had a wide range of effects on society and the global community. Aviation technology, automobile technology, biotechnology, electronic technology, telecommunication technology, Internet technology, clean energy technology, atomic and industrial technology, nanotechnology, and space technology are just a few examples of the advancements that science has made to society. These modernizations in technology have improved people's lives and given warmth. People must be on the lookout for the welfare of the environment if they want to maintain their comfort in society. The advantages and drawbacks of green technology in irrigation, drinkable water, solar energy, buildings, aeroplanes, and space

travel, as well as in education, food production, and health and medicine in the twenty-first century, are further discussed in the article. Countries require well-defined action plans and metrics to monitor sustainable development and green growth. The transition to green technology should aid in stabilising international initiatives that seek to enhance societal wealth and human well-being while minimising adverse effects. Green technology encourages people to live their lives in a more ecologically responsible way, which is one of its most alluring features. With a broad variety of green appliances available, it is now feasible to live a more ecologically responsible lifestyle.

The expertise for protecting the environment and natural resources while minimising human participation is known as "green technology." It has the flexibility to work in a variety of fields, including biofuel, eco-forestry, renewable energy, and solid waste management. However, implementing every technology at once without taking into account the advantages and disadvantages unique to each nation is neither practical nor necessary. A crucial step in assisting communities in choosing the technology that best suits their needs is the selection of tools and procedures. In other words, suitable technology seeks for those innovations that improve the way that money is distributed, how people develop, how the environment is treated, and how political power is distributed. Hooman Abadi as well as Mohd. Wira Mohd Shafiei In his article "Design Criteria for Sustainable Development in Appropriate Technology: Technology as if People Matter," Robert (1998) offered the seven criteria to evaluate the appropriateness of technology.

A) System Independence:

This refers to a technical device's capacity to function independently in order to do the needed task. To determine the technology's system independence, it will be examined if it would demand disproportionately more labour or capital.

B) Perception of Modernity:

By using technology, people should see themselves as contemporary. The message is that people are realising that technical devices may both satisfy a fundamental human need and raise the social standing of the user. The social position of those who embrace the modernity image must either rise or stay the same.

C) Individual vs. Collective Technology:

This distinction refers to how the technology is used in relation to society and cultural norms. In other words, it is a methodical evaluation of technology that is built on a team approach and grows increasingly reliant on systems. A civilization that values the individual or the nuclear family will need more technology that is independent of systems. Technologies that can be used by a group are more likely to be accepted since group action lowers transaction costs.

D) Cost of Technology:

Since cost is the primary element influencing whether or not suitable technology is used in emerging countries, the affordability of the technology is a crucial signal for their broader adoption.

E) Risk Factor:

Understanding how well technology integrates into the local production system and the system that indicates how system dependent or independent the technology is are crucial factors. This shows that it is important to comprehend both internal and external risk. Prior to implementing new technology, risk analysis is essential, but it is almost difficult to completely eliminate all hazards.

F) Technology's ability to evolve:

If the device is static, it will mostly represent temporary fixes to much bigger issues. Expect the technology to compete on a regional, national, and worldwide scale as it promotes further growth through boosting capabilities to expand.

G) Technology with a Single Purpose vs. Technology with Multiple Purposes:

As opposed to technology with a single purpose, multifunctional technologies provide a range of uses (e.g. a tiller who can be used for tilling the land, powering water pump, and drying rice)

Green technologies that are feasible.

The following are a few of the chosen renewable energy technologies:

A) Solar Photovoltaic:

Using semi-conductor modules, solar photovoltaic technology turns sunlight into energy. Additionally, they may be utilised for communication, cooling, and battery charging. Solar photovoltaic energy may be used as a green agricultural energy source for pest control, village street lighting, and rural home illumination. This next generation of solar energy has the potential to be one of the most cost-effective and effective energy sources in the future due to the technology's ability to generate high-power, low-cost photovoltaic cells.

B) Wind Energy:

The wind industry is seeing a growth. Its significance is growing since, in comparison to other energy sources, wind energy emits less air pollutants or greenhouse gases. A tried-and-true technology is the wind turbine for the creation of electrical or mechanical power. Wind turbines of capacities ranging from 900 W to 50 kW, which are available throughout 75% of the globe, may be used off-grid for pumping and purifying drinking water, irrigation, telecommunications, houses, schools, and clinics, as well as to augment bigger power plants. Without emitting any carbon dioxide, wind turbines used to pump water for irrigation may boost agricultural development.

C) Biofuel:

Biofuels like bioethanol and biodiesel have the potential to take up a significant portion of the future energy pie. Analyzing biofuel as a green agricultural technique must be done with caution.

Concerns about food security, environmental dangers, and threats to biological variety are all factors that must be considered when examining the sustainability of the relationship between agriculture and biofuel. Additionally, the transformation of the wasteland into farmland with a few crop alternatives might be seen as beneficial effects.

D) Biogas:

Methanogenic bacteria decompose organic materials anaerobically to produce biogas. Bio gas is acceptable due to the fact that it uses organic agricultural waste and turns it into fuel and fertiliser. Wood fuel, agricultural waste, animal manure, and kerosene savings are all direct effects of biogas. Crop yield and soil fertility have both increased, as well. Additionally, bio gas promotes cleanliness in the home or community and addresses the issue of indoor air pollution. According to estimates, India has 12 million biogas plants. There might be 1.9 million biogas plants in Nepal. Palm Oil Mill Effluent (POME) may produce 177 MW in Malaysia.

CHAPTER 2

GREEN TECHNOLOGY AS CLEAN TECHNOLOGY

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In the early days, before the industry revolution, people were using the main source, the sun, to generating the heat, they also used the other source to assist their daily life, such as horses as their transportation use, animals like cows and donkeys as their labors, and the wind will use to move the sails and generate the simple machine. However, since the first introduce of modern steam engine by Thomas Newcomen and James Watt in the mid1700s, people found the possibility of make use of the power of steam. The single steam engines were soon became powering locomotives, factories and farm implements after the coal dug from the miles of England and Appalachia. In the 1800s, more and more natural resources were founded useful and able to bring us a zillion of convenience, such as the oil and petroleum which use in processed the gasoline for machine combustion after that. However, this ease has brought a lot of energy crisis all around the world today due to the huge consumption on the fossil fuels such as the oil, coal and the natural gas in the past decade.

Nowadays, green technology can refer to many different things, such as clean energy, renewable energy, sustainable energy, waste management and energy conservation. However, it is hard to find a history specify for green technology in the past. During the 1900s, there were a series of energy crisis in the Middle East and things getting worse in year 1973 when the embargo imposed by the oil producers of Iraq on America led the price of crude oil to rise from $3 per barrel to $12 in year 1974 and almost reach a average price of $45 in year 1980. While green tech has become increasingly popular in the modern age, elements of these business practices have been in use since the Industrial Revolution. Beginning in the early 19th century, scientists began to observe the ecological impacts of coal-burning industrial plants, and manufacturers have sought to reduce their negative environmental externalities by altering production processes to produce less soot or waste byproducts.

Coal, and subsequently oil and natural gases, were the main energy sources used throughout the industrial revolution, which started in the latter part of the 18th century. These are the planet's limited resources, which are rapidly running out. According to some assessments, the world's oil, gas, and coal reserves are expected to last 42, 56, and 118 years, respectively, at the present pace of use. In addition to placing a strain on the overall amount of resources and their availability, burning massive amounts of coal, oil, and other fossil fuels is to blame for the degradation of the ecosystem and for having a substantial impact on global warming. Our task is to harness energy in a manner that reduces CO_2 emissions while simultaneously protecting the environment and ecological equilibrium.

Green technologies, also referred to as "Clean Technologies," include waste-to-energy, solar, wind, and modest hydropower. These technologies are created and marketed as alternative energy sources that contribute little to no to climate change and provide sustainable energy services to fulfil the world's energy needs. Due to their very low carbon content, these green technologies offer a significant potential to fulfil future energy demands without negatively affecting the environment. The United Nations General Assembly first referred to the necessity for an energy transition as "The international community will need to move quickly and significantly away from the current, mostly hydrocarbon-based global economy. In an effort to save hydrocarbons for non-energy and non-replaceable needs, it will have to depend more and more on innovative and renewable energy sources."

At the New Energy and Renewable Energy Conference held by the United Nations in Nairobi in August 1981, the 150 countries of the globe stressed the notion of renewable energy even further. It was made very explicit in the definition of renewable energy that it was created and used using new materials and technologies. Because it is environmentally friendly, can be restored, and has a sustainable development, renewable energy differs from conventional fossil fuels. Solar, wind, small hydro, biomass, and waste to energy are only a few examples of the primary categories of green technology. This green or renewable technology aids in supplying today's energy demands without sacrificing environmental concerns or future energy requirements.

In the United States, one of the most important milestones was the Second World War. In order to reduce consumption and waste, more than 400,000 volunteers began collecting metal, paper, rubber, and other materials for the war effort. Following the war, scientists like Rachel Carson began warning of the consequences of chemical pesticides, while doctors abroad reported mysterious illnesses associated with nuclear radiation. Many point to this era as the genesis of the ecological movement, which sought to preserve ecosystems and resources while raising awareness of the consequences of runaway technology.

Government bodies slowly recognized the importance of protecting environmental resources. Curbside recycling programs became common over the following decades, raising awareness about household waste. The Environmental Protection Agency, established in 1970, set firm requirements on pollution and waste and established mandates for coal scrubbers and other clean technologies. In the United States, the first major recycling program was launched during World War II. Nearly half a million volunteers pitched in, recycling tens of thousands of tons of waste to help the war effort.

As the world starts implementing green technology, organizations are increasingly being urged to go green because of legislation, public relations and economics. In fact, terms like Green Computing (gC) and Green IT (gIT) are now mainstream department names that reflect the effort to align IT departments with more sustainable IT processes. Such processes include increasing the longevity of a product and creating energy-efficient data centers and storage devices. In addition, enhancing office environments by improving efficiencies in the deployment process can help reduce spikes in network traffic while minimizing disruption to user productivity. This also has the benefit of enabling IT staff to spend more time ensuring your business is up and running at optimal speeds.

Terms like Green Computing and Green IT are not merely passing trends, these are terms that highlight the shift to transform the way organizations conduct their business in a much more economical and socially responsible way.

Although it may seem like a huge task to accomplish, there are simple and practical steps that can quickly get companies closer to these energy saving and environmentally-friendly initiatives:

A. Shut off high energy consumption devices such as CPUs and laser printers when not being used for long periods of time.
B. Using notebook and laptops instead of desktop computers helps save on energy and also requires less space and set up times.
C. Use LCD monitors instead of cathode-ray-tubes.
D. Collocation of computers, data centers and servers to minimize energy usage and reduce IT costs.
E. Minimize the need for print jobs and invest in using recycled paper waste.
F. Adhere to government policies regarding the safe disposal of e-waste.

Companies are adopting green technology efforts and replacing the outdated "business as usual" approach all throughout the corporate landscapes of the globe. Companies like Macquarie Telecom, based in Australia, have not only been successful in integrating green technology into their operations, but they are also experts at assisting other businesses in doing the same. Some of the ways they do this include providing services like setting up smart networks, colocating data centres, and managed private and public clouds for mid-size companies and corporate IT departments. Going green has become into a significant commercial risk that no company can afford to accept.

Technology has existed for a lot longer than most of us can recall. Most people assume that it has always existed in some capacity. Because you must first describe technology, it is difficult to pinpoint the precise moment when it was created. Technology throughout the Stone Age consisted of tools, weapons, and even fire for hunting. Later technologies consisted of metal-forged implements and weaponry. The wheel, which was constructed about 9500 BCE, is regarded as one of the most significant pieces of technology ever made since it allowed its users to move products considerably more efficiently. The pyramids were constructed by the Egyptians, who were recognised for their technical prowess and advanced technology. The Chinese were renowned for their many technological innovations, including the printing press, suspension bridges, paper, cast iron, gunpowder, and several more creations that are still in use today.

Greeks

The Greeks were renowned for their many innovations in addition to their extraordinarily ornate architecture. The earliest mechanical technology, a watermill, was really developed by the Greeks. The Greeks were noted for their wind power experiments, creating a wind wheel that could play an organ. The Greeks' steam-powered engine, known as the Aeolipile, was, nonetheless, their most significant creation.

The Aeolipile functioned as a radial steam turbine without blades that rotates when the centre water container is heated. Steam jets that leave the turbine then provide torque in a manner similar to a rocket engine. The name, which means "the ball of Aeolus" in Greek and Latin, is formed from the Greek letter o and the Latin word pila. Aeolus is the Greek deity of the wind and air. The development of mechanical technology occurred throughout the Greek era, which is undoubtedly the most significant period in history. The Antikythera mechanism, a more recent discovery from an ancient shipwreck, is one of the final Greek innovations. This piece of equipment functions as the world's first analogue computer, an orrery for predicting astronomical positions and eclipses for calendrical and astrological purposes, and the earliest known astronomical position. The Olympiads, often known as the cycles of the ancient Olympic Games, were observed by this magnificent piece of equipment. It is thought that this piece of technology, which was made up of several teeth and gears, was developed between 150 and 100 BC. Because of how sophisticated this mechanism was, astromechanical clocks from the fourteenth century were the first to use comparable technology.

Renaissance and mediaeval

The Renaissance and the Middle Ages are two further well-known historical eras. Another significant period of technical advancement occurred during this period. Vertical windmills, mechanical clocks, and glasses were all produced at this time. The first push button and the watermark to deter forgery were both developed in the mediaeval era. In addition to other well-known achievements, sailing technology advanced significantly during this age of discovery. The Scientific Revolution, as well as the Rebirth of Architecture and Art, occurred during the Renaissance, also known as the Rebirth. The cast metal type printing press was developed around this time, enabling the production of more volumes.

The industry revolution

The industrial revolution was one of the final significant eras. Consumer spending increased at this period, forcing the businesses that already existed to increase supply to meet the demand. Mining, textile manufacture, and steam-powered transportation were all introduced. Due to the nine children's tiny stature, which allowed them to reach the smallest elements of the equipment and fix them, this is also one of the first instances of child labour being utilised in industries. Utilizing coal, a cheap resource that seemed to be in plentiful supply, was one of the key factors that sparked the industrial revolution. Everything during this period was powered by coal, including houses and industries. Like it is now, pollution was at an extremely high level throughout this period. People in London used to refer to the persistent fog as "pea soupers," indicating that it was as thick as pea soup. The original steam engines, which subsequently made way for the vehicle, were created because to the plentiful supply of coal.

Twentieth century

Steam engines were used in railways and steamboats throughout the nineteenth century. The telegraph was developed to increase railroad safety by allowing stations to communicate with one another and prevent mishaps. In addition, other technologies were developed, such as the incandescent light bulb, which is still in use today. Because employees now worked in shifts, more

items could be produced. The development of sewing machines at this period allowed for the mechanisation of several sectors, including the shoe business. Many companies have used steam to power their facilities ever since the invention of steam engines. In principle, this may appear environmentally friendly, however the city had high pollution levels since wood and/or coal were utilised. At the time petroleum was found, but research on it was still ongoing, thus little was known about it.

The twentieth century, with its mass manufacturing, assembly lines, and the introduction of the vehicle at its inception, may have seen the greatest amount of change. Early computers, cell phones, more advanced radios, and jet engines were all products of military research. Electricity was created earlier, but it was too costly for broad use, so only the affluent could buy it. During this period, electricity grew more accessible. The World Wide Web, sometimes known as the internet, and GPS technology were developed around the close of the 20th century.

Finally, we reach the twenty-first century and the present. It's still early in this century, so it's unclear how far mankind will go technologically. Since they are more readily available and dependable than they were in the previous century, the majority of people have access to mobile phones and computers. These days, research is being done on quantum computers, drones, nanotechnology, alternative fuels, virtual reality, and many other things. The huge hadron collider, which has been used to find dark matter and the higgs boson, might be said to be one of the most significant pieces of technology to date. During this time, humans have also deployed robots to Mars, one of which is now transmitting data to NASA regularly. NASA and other organisations are attempting to improve space suits and ships so that they can better protect the people inside of them from solar radiation. There are plans to transport humans to Mars, a journey that was previously thought to be a one-way trip owing to solar radiation. In 2030, 61 years after the first Moon landing, NASA plans to send a human expedition to Mars.

Sadly, despite being the greatest polluter, coal is still used to provide 44% of the world's power today. Since green technology is a more recent idea, it is less common. The practise of ecologically friendly computing is the aim of green technology. By building computers and associated items and disposing of them in an ecologically sustainable manner, green computing seeks to reduce the harm that IT activities do to the environment. Particularly if they are no longer in use, these earlier innovations may not all appear to be relevant now. In actuality, each of these innovations had a use. You inquire what their objectives are. Consider them like steps; while they may appear minor at first, each step ultimately leads to a destination or an outcome.

Green technology has been used for a lot longer than most people realise. The bulk of people seem to be utterly unfamiliar with green technologies. Renewable energy and green technologies have existed for thousands of years. The Egyptians employed wind to propel ships across the ocean as early as 7000 years ago. The main renewable energy sources throughout history have been human labour, animal power, water power, wind power, and firewood. Wind turbines were used to power agricultural irrigation systems in the 1800s, and John Etzler wrote a novel in 1830 that described a metropolis that was powered by wind, tidal, and sun energy. When fossil fuels were first being utilised in the 1860s, many were concerned about a possible shortage. The day will come when Europe's industry will no longer be able to find the natural resources that are so vital to it. While

not endless, petroleum springs and coal seams are often fast disappearing. Will man then revert back to the force of the wind and water? Or will he go to where the most intense source of heat radiates its beams to everyone? History will reveal what is to come. Amazingly, individuals wanted to return to more renewable technologies because they were worried about the finite supply of fossil fuels. Because of our current reliance on fossil fuels, switching to other energy seems to be an insurmountable challenge. Wind energy has been used to drive boats on the Nile River since 5000 B.C., and it is being used today, mostly for commercial purposes. These devices must be properly positioned since the wind a wind turbine generates is only as good as the wind it receives. Typically, wind turbines are grouped together to form "wind farms." Thermal energy that is stored in the ground is the source of geothermal energy. It's not known how long it's been around, but it's only found in a few places. Some geothermal energy sites were formerly utilised as hot springs or even for house heating, but they are now employed to produce electricity.

Solar power is a relatively new technology because it needs very elaborate, pricey panels that can store solar energy. Homes and even flat, sun-drenched areas like deserts often utilise solar energy. You may save the energy or sell it to someone who needs it. Hydropower produces energy by harnessing the force of moving water. It produced 70% of all the renewable energy produced in 2015 and 16.6% of the world's power. There are numerous different types of hydro-power, including dams, rivers, and other modest projects. The most popular renewable energy source, hydropower is already generated in more than 150 nations.

Did you know that solar energy was commonly utilised to heat showers in California in the 1900s? Or that windmills were used to raise water in the Midwest to aid with drought? Or that electric taxi taxis were often used in Manhattan in the 1900s? The first electric vehicle, the electrobat, was really invented by the electric vehicle corporation (EVC). Despite having a limited range of 50 to 100 miles, it was nonetheless amazing. However, the identity of the two individuals who founded this cab firm is still a mystery. This was such a great concept, and it was even refined such that the whole city adopted it. Because electric taxis were not adequately maintained and cared for when they were dispersed across the city, we do not have them now. Because of this failure, the firm was forced to close, and the cabs we know today took their place. This was not just a case of the drivers being untrained or being lazy.

In the 1940s, solar energy was extensively employed in Californian houses, mostly to run heaters. In the 1970s, solar energy was so widely employed that it practically replaced all other forms of energy. The business making the heaters had to relocate to a larger production facility due to the rising demand for solar energy. Unfortunately, this resulted in a price increase, which made customers shop elsewhere. After residents in southern California learned there was an abundant supply of natural gas there and converted to it to save money, gas heaters were invented. This is what put an end to the solar heating industry. The OPEC oil crisis in 1973 led to the establishment of the Solar Energy Research Institute (SERI). The mission of this institution was to enhance all solar technology, but owing to insufficient government financing, a large scope for its research, and an unsuitable director, SERI was unable to do this. There hasn't been much advancement in solar technology since SERI, which was forced to quit up for the most part. Nobody is certain as

to why most people are unaware of the background of green technology or why we do not pursue it more aggressively, particularly now that it seems to be a higher priority.

CHAPTER 3

INITIATIVES OF GREEN TECHNOLOGY

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Energy Savings

Your computers need electricity and cooling whether you run a small business with a few PCs or a huge company with a computer room or data centre. There are environmentally friendly PCs and solutions to power and cool your equipment. Web Hosting Canada, a member of the Green Business Bureau, utilises hydroelectric electricity from Canada's hydroelectric power network and other energy sources to power its servers. On their computer servers, businesses may also employ solar-powered generators as a backup power source. DSM offers a fantastic essay on the advantages of transitioning to a cloud server and data centre in terms of cost and efficiency. Since 2007, Green House Data has been at the forefront of green data centres, and they have a nice piece on how they keep their facility sustainable.

Cloud computing is another option to reduce power usage in addition to adopting a green data centre. You can operate your company apps without utilising your own computers if you use cloud computing.

Instead, large-scale data centres operated by organisations like Amazon, Microsoft, and Google can run your applications more sustainably and effectively. Additionally, there can be nearby businesses that provide data centres and cloud computing while using eco-friendly practises. Investigate a local business' website before hiring them to learn more about their business procedures. Businesses often make a lot of noise about their eco-friendly procedures and practises.

Eco-friendly laptop/computer alternatives

As a result of its reduced power requirements, mobility, and sustainability, laptops have emerged as the preferred device for both workers and corporations. A fantastic post on the top 3 most environmentally friendly laptops available in 2020 can be found at Future Proof. Although laptops are an excellent choice, there are still many desktop computers that are environmentally friendly.

Tree Hugger lists a few environmentally friendly desktops and provides guidelines for figuring out how environmentally friendly certain brands and models are. You could wish to suggest to your administrator adopting virtualization software, which allows servers to be shared and utilised more effectively, for the more advanced organisation with a small IT staff.

Device Recycling

Businesses need to improve how they get rid of outdated equipment that is no longer needed. Only 20% of the roughly 44.7 million tonnes of e-waste that was disposed of in 2016 was done so appropriately, according to the United Nations. Apple gathered more than 2,000 pounds of gold from scrapped gadgets in 2015. Companies may recycle equipment and provide other firms the opportunity to utilise the old parts and materials rather than having landfills loaded with potentially hazardous chemicals and expensive tech components.

Reduction of paper

One of the easiest measures organisations can take to become green is to use less paper and print less often. Office copy paper accounts for more than 20% of the total paper used in the US. Going paperless in your organisation has a wide range of choices. Going paperless in your company is not only more environmentally friendly, but also more practical in many ways. While you undoubtedly save money on paper, you may also save money on pricey office supplies and printer ink. Going paperless, or "going digital," may also increase the effectiveness of your company's operations and decrease the amount of time it takes to complete activities. Digital papers and information stored online, for instance, may be readily managed, shared, secured, and viewed from any location. Electronic exchange of these digital materials, which can be done in seconds rather than days, has replacing mailing physical papers.

Four Pillars of Green Technology Policy

Green technology, an environmentally friendly technology is developed and used in a way that protects the environment and conserves natural resources. A part of the renewable energy branch of the environmental technology movement, the green technology importance cannot be ignored. We have come to a point, where we need to pause and reflect on the growing green technology importance and why it is going to be important for humanity. With many reasons behind green technology importance, perhaps volumes can be written and spoken on the subject. Whether it is the growing importance of green technology in the industry or at homes, it is certain that things need to be done fast. It does not take a rocket-scientist to state that mankind has to do something about clean environment and save energy resources. Going green can only help us come out of the present tough situation. Before things turn for the worst, we should realize the green technology importance to solve this problem.

Green engineering is the process of developing design concepts, commercialising products, and utilising resources and processes in a way that minimises risks to the environment, improves the sustainability of the product, and monitors pollution caused by the product and its effects on human health without sacrificing the product's economic viability or overall effectiveness. Green technology, or "Clean Technology," is another name for "green engineering."

In an effort to accomplish the following key objectives, green engineering seeks to adapt the creative design process for the goods.

- To reduce the pollution produced by companies that process materials, as demand for their goods rises, for example, the number of automobiles, which is expanding at a fairly high pace every year.
- To reduce the operator's exposure to certain risks, i.e., to monitor workplace safety.
- To utilise energy and raw materials efficiently over the whole lifespan of the intended product, as well as during its design. When compared to the transportation, business, and residential sectors, the industrial sector uses the majority of the available energy.
- The product should be financially feasible; that is, you should consider if the product is also economically viable. In general, both quantity and quality raise a product's price.
- The product should be practical for the specific purpose or goal for which it was created or made.
- To reduce waste, increase recycling, and work toward sustainability

Due to the significant advantages it has achieved by putting the core standards and principles of Green technology and engineering into practise, the discipline of Green engineering has drawn the attention of design and production engineers to itself. Pressure has also been placed on Earth by recent innovations and developments in nearly every field. In terms of the dangerous and toxic gases that are released into the atmosphere by both these vehicles' production facilities and their vehicles, the car industry has placed pressure on the environment. The strain on our world most often manifests as greenhouse gases and global warming. It is imperative that this issue get serious consideration in addition to the introduction of certain cutting-edge strategies for efficiently utilising energy and natural resources without endangering the earth or the many species of humans that call this planet home. This procedural study may be quite beneficial since it emphasises the legal concepts and methods for making the best use of the energy and resource availability to create goods that are both affordable and sustainable. To develop high-quality goods with the aid of life-cycle processes that are efficient in terms of performance and environmentally friendly, a number of creative and new design and manufacturing approaches have been presented in the article that follows. Green engineering is the process of developing design concepts, commercialising products, and utilising resources and processes in a way that minimises risks to the environment, improves the sustainability of the product, and monitors pollution caused by the product and its effects on human health without sacrificing the product's economic viability or overall effectiveness. Green technology, or "Clean Technology," is another name for "green engineering."

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goods that are both affordable and sustainable. To develop high-quality goods with the aid of life-cycle processes that are efficient in terms of performance and environmentally friendly, a number of creative and new design and manufacturing approaches have been presented in the article that follows.

A means to combine the needs of economic development with environmental responsibility is provided by green technology. Since there is a growing need globally to tackle climate change, sustainable development and green technology must collaborate to drive the economy, generate jobs, and attract investments.

On the basis of GDP in 2005, the government promised to reduce greenhouse gas (GHG) emissions by 45% by 2030 at the 2015 Conference of Parties (COP21) of the United Nations on Climate Change in Paris. This goal was set as 35% unconditionally and 10% subject to getting funding from affluent countries for capacity building, technological transfer, and mitigation of climate change.

Green technology was recognised as a driver to strengthen the national economy and promote sustainable development in the National Green Technology Policy (NGTP), which was unveiled in 2009. It emphasises the importance of waste management, building, transportation, and energy as the four main pillars of green projects.

Provisions for an Investment Tax Allowance (ITA) for the purchase of green technology assets and an Income Tax Exemption (ITE) on the use of green technology services and systems were necessary to promote the use of green applications. By encouraging expenditures in green equipment development, the usage of green technology by service and system providers, and investments in the production of green equipment, these programmes want to encourage enterprises to buy certified green assets.

The Government continues to prioritise green adoption as part of Budget 2020 measures to encourage economic multiplier effects by extending the Green Investment Tax Allowance for the purchase of green technology assets and the Green Income Tax Exemption on the use of green technology services until 2023. The ITE has also been extended for companies who conduct solar leasing activities in an effort to increase interest in and participation in the Net Energy Metering Scheme (NEM), which was established by the Sustainable Energy Development Authority (SEDA).

Companies are urged to submit an Investment Tax Allowance application before incurring the first Qualifying Capital Expenditure (CAPEX) on the relevant project or assets. Before issuing the first invoice for a qualifying business transaction, companies are advised to submit an application to MIDA for Income Tax Exemption.

2019 saw the authorization of 12 green services projects for RM31.67 million and a total of 427 green technology projects for RM4.33 billion.

MIDA has approved 479 green technology projects with investments totalling RM2.23 billion as of January to September 2020, despite the challenging global economic climate. This is an encouraging indicator of future robust investment flows and interest in green technology in

Malaysia. Over the last five years, MIDA has seen positive outcomes from the incentive programmes, including an increase in the production of a variety of renewable energies, an increase in the number of businesses providing green technology services, and better waste management.

Due to the COVID-19 pandemic, MIDA received more than 900 applications between January and December 2020. This is a positive development for companies who are committed to reducing environmental damage, reducing greenhouse gas emissions, encouraging a healthier lifestyle, and using more renewable energy and natural resources. It unquestionably corresponds with the government's intention to achieve the Sustainable Development Goals set out by the UN (SDGs).

The goals of green technology are many. To meet the needs of society in ways without damaging or depleting natural resources on earth is the main objective of green technology. The idea is to meet present needs without making any compromises. You have reached the right destination to know all about the goals of green technology. Focus is being shifted on making products that can be fully reclaimed or re-used. By changing patterns of production and consumption, steps are being taken to reduce waste and pollution, as one of the important goals of green technology. It is essential to develop alternative technologies to prevent any further damage health and the environment. Speeding their implementation can benefit our environment and truly protect the planet. Explore the goals of green technology, introducing sustainable living, develop renewable energy and reduce waste. Figure 1 below demonstrates the four pillars of green technology.

Energy – Seek to attain energy independent and promote efficient utilization;

Environment - Conserve and minimize the impact on the environment;

Economy - Enhance the national economic development through the use of technology;

Social - Improve the quality of life for all

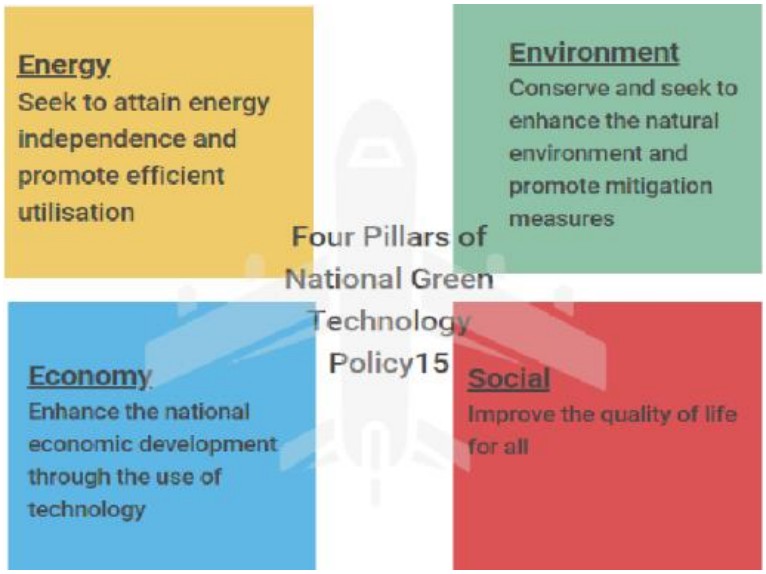

Figure 1: Illustrating the four pillars of green technology.

1. Environmental Pillar

All human activities have an impact on the environment. Conversely, the relative health of the environment will determine and will contribute to the nature and scale of activities in the other pillar areas of this plan: economic, cultural and social. Earlier in this plan, we noted some of the major global environmental challenges: climate change exhausting nonrenewable resources, shrinking natural habitats, diminishing biodiversity, ocean acidification; and increasing human population pressures. Clearly, all of these issues have economic, social and cultural element.

At its core, adaptation aims to increase resilience to climate impacts and reduce vulnerability. It is about finding ways to cope with the immediate threats – higher temperatures, rising sea levels, more frequent and intense abnormal weather events and more. But adaptation is also about making communities more robust and resourceful. About providing them with sufficient capacity and surplus to be able to implement both immediate and longer-term changes. A focus on future climate risks is of particular importance in this respect. This is due to the long-term nature of adaptation as climate impacts unfold over time. It may for example include assisting natural ecosystems in adapting not only to current but also expected future climate effects. Weather systems are highly complex and imperfectly understood. It is therefore difficult to predict how and when climate change will affect individual regions, localities and resources. One of the likely first signs of climate change disruption is highly volatile food and vital commodity prices. And it is also probable that we are already experiencing them. Disruption will be a key characteristic of climate change impacts. Disruption has many consequences hard to predict, or if predictable, hard to avoid. Therefore preparing a community, a village, a city or a whole country for climate change impacts to a large extent comes down to empowering them to be sufficiently flexible and responsive. Generally speaking, this is much easier to achieve for a wealthy and well managed society. Therefore a lot of the climate change adaptation efforts in many ways resemble the activities and strategies deployed in international development work for decades. Ensuring that local communities are healthy; that they have an adequate, sustainable, well-maintained and well-managed resource base; produce enough to generate a reliable surplus; and have the power, institutions, capability and knowledge to use that surplus to act, develop and adapt is at the core of both development and adaptation.

2. Social pillar

The Social Equity Pillar will help social agencies and residents to raise awareness about social needs and to engage both citizens and community partners to plan and act in response to these needs. The end result will be to improve the well-being of the whole community. Together, we will build social capital in the community between individuals and groups in order to enable collaborative action on projects of common interest. With this, we stress the importance of personal and group well-being and security, including full access to effective health care, housing, food, and education services-these being the essential components for full participation in cultural, environmental, and economic activities.

Social sustainability aims to preserve social capital by investing and creating services that constitute the framework of our society. The concept accommodates a larger view of the world in relation to communities, cultures and globalisation. It means to preserve future generations and to acknowledge that what we do can have an impact on others and on the world. Social sustainability focuses on maintaining and improving social quality with concepts such as cohesion, reciprocity and honesty and the importance of relationships amongst people. It can be encouraged and

supported by laws, information and shared ideas of equality and rights. Social sustainability incorporates the idea of sustainable development as defined by the United Nations sustainable development goals. The principle of sustainable development addresses social and economic improvement that protects the environment and supports equality, and therefore the economy and society and the ecological system are mutually dependent.

3. Economic Pillar

It is focused on the attraction of new businesses and people to India. This is critical to the city's growth and sustainability and assists us in building a strong and vibrant local community. The recruitment of talented people in the public, private, and non-profit sectors in India are fundamental to achieving this. Present businesses and the jobs they create are main components of a strong, sustainable economy. Together we can achieve and be the difference that makes the difference.

Critics of this model acknowledge that a great gap in modern accounting practices is not to include the cost of damage to the earth in market prices. A more recent approach to economics acknowledges the limited incorporation of the ecological and social components in this model. New economics is inclusive of natural capital (ecological systems) and social capital (relationships amongst people) and challenges the mantra of capital that continual growth is good and bigger is better, if it risks causing harm to the ecological and human system

4. Energy Harvesting

An important pillar of green technology is energy harvesting, which seeks new innovative ways to extract useful energy from otherwise useless waste by-products, as well as to develop new technologies to maximize the harnessing of energy. Energy efficiency has proven to be a cost-effective plan for building economies by minimizing the amount of energy used.

The phrase "sustainability" is a general term that refers to policies, projects, and practises meant to protect a certain resource. As the four pillars of sustainability, it truly refers to four separate areas: personal, social, economic, and environmental.

The aim of human sustainability is the preservation and development of society's human capital. Projects under the broad area of "human sustainability" include investments in the health and education systems, access to services, nutrition, knowledge, and skills. Because there are a finite number of available natural resources and areas, it's critical to achieve a balance between further growth, improvements in health care, and guaranteeing the economic security of everyone. In order to value human capital and perceive themselves as productive members of society, corporate organisations will advocate business practises that do so. Everybody involved in the creation of commodities, the provision of services, or other significant stakeholders is important, as is shown by human sustainability (the human capital of the organisation).

Business practises and the methods used to get raw resources may have a positive or negative impact on communities all over the globe. The term "human sustainability" describes the development of a person's capacity and talents to support organisational operations and sustainability as well as to enhance social and community well-being.

Social sustainability aims to safeguard social capital by making investments and creating new services that make up the framework of our society. The concept provides for a more comprehensive perspective of the world in terms of communities, cultures, and globalisation. Recognizing that our activities might impact other individuals and the whole world is necessary if we want to preserve future generations. Social sustainability is concerned with maintaining and improving social quality and emphasises concepts like cohesion, reciprocity, and honesty as well as the value of interpersonal connections. Laws, information, and the pervasive belief in equality and human rights may all assist to promote and sustain it. Social sustainability incorporates the idea of sustainable development, according to the UN's Sustainable Development Goals. The natural system, society, and economy are all interrelated as a consequence of the principle of sustainable development, which places a strong emphasis on social and economic progress that fosters equality and protects the environment.

The purpose of economic sustainability is to preserve the capital. The goal of economic sustainability is to increase living standards, but the goal of social sustainability is to increase social fairness. To maintain company profitability over the long term in the business environment, resources must be used effectively.

Maintaining strong and stable economic growth is one of the key objectives of sustainable development. Economic development cannot be stopped by choosing. But more than only economic growth is involved in sustainable development. The two aspects of growth—amount and quality—are crucial. The greatest shortcoming of modern accounting techniques, according to critics of this paradigm, is that environmental impact is not compensated for in market prices. An approach to economics that is more contemporary acknowledges the model's limited incorporation of the ecological and social factors. New economics, which incorporates natural capital (ecological systems) and social capital, challenges the tenet of capitalism that perpetual growth is beneficial and bigger is better (human interactions). Continued expansion is harmful, and greater is better if it puts ecological and societal systems in jeopardy.

CHAPTER 4

ROLE OF GREEN TECHNOLOGY FOR ENVIRONMENT PROTECTION

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Environmental sustainability aims to improve people's welfare by protecting natural resources (e.g. land, air, water, minerals etc.). The term "ecologically sustainable" refers to strategies and policies that ensure that the needs of the current generation are met without endangering those of future generations. The four pillars of sustainability are built on the idea that each pillar's difficulties must first be fixed and then maintained if complete sustainability is to be achieved. Even though there may sometimes be some overlap between the four main types of green firms, it is essential to choose which one to focus on since each has unique characteristics. Businesses must decide strategically on the approach they will use in order to properly incorporate it into their procedures and policies.

An economy with a green economy strives for sustainable growth without endangering the environment. It also tries to reduce environmental dangers and ecological scarcities. Although it has a tight relationship with ecological economics, its emphasis is more politically relevant. "For an economy to be green, it must not only be efficient, but also equitable," according to the 2011 UNEP Green Economy Report. In order to ensure a just transition to a low-carbon, resource-efficient, and socially inclusive economy, fairness involves understanding the equity components at the global and national levels.

The direct valuation of ecological services and natural capital as having economic value (see The Economics of Ecosystems and Biodiversity and Bank of Natural Capital) and a full cost accounting regime, in which costs externalised onto society via ecosystems are reliably traced back to, and accounted for as liabilities of, the entity that causes the harm or neglects an asset, are two features that set it apart from earlier economic regimes.

Indicators of environmental friendliness and sustainable development that are visible to consumers include green sticker and eco label procedures. As a means of promoting their environmental policies in a world economy that is becoming more globalised, many companies are beginning to embrace these standards. These criteria, sometimes referred to as sustainability standards, are particular requirements that ensure the items consumers purchase don't harm the environment or the people who made them. A new, greener economy may now be developed thanks to the recent increase in the number of these criteria. They concentrate on certain aspects of the manufacturing process, such as the sourcing of raw materials, the preservation of biodiversity, and the conservation of water resources. They also concentrate on economic sectors including forestry, farming, mining, and fishing.

A theory of economics that considers an economy to be a part of the environment in which it dwells is known as "green economics," however this definition is ambiguous (after *Lynn Margulis*). According to the individual theorist, a holistic approach to the topic is normal, wherein economic concepts are mixed in with a variety of other topics. The word has been used by proponents of feminism, postmodernism, the environmental movement, the peace movement, Green politics, green anarchism, and the anti-globalization movement to denote a wide variety of unconventional economic theories.

The usage of the phrase is further clouded by the political differentiation of Green parties, which are legally constituted and use the capitalised Green term as a distinctive and identifying symbol. Therefore, it is better to speak of a loose school of "green economists" who often support changes to a green economy, biomimicry, and a more thorough accounting for biodiversity. (For a presentation of these by a layman, see Bank of Natural Capital and The Economics of Ecosystems and Biodiversity, two recent authoritative international works toward these aims.)

Green economics is seen by some economists as a branch or subject of more mainstream schools. For example, it is viewed as classical economics where the conventional land is generalised to natural capital and has certain characteristics in common with labour and physical capital (since natural capital assets like rivers directly substitute for man-made ones such as canals). Or it could be seen as a branch of neoclassical economics where the cost of life for developing vs. developed countries is kept constant at a ratio reflecting a balance of power and that of non-human life is very low. Marxist economics sees nature as a form of Lumpenproletariat, an exploited base of non-human workers providing surplus value to the human economy.

The UNEP's (as well as national governments like the UK) growing commitment to the concepts of natural capital and full cost accounting under the rubric of "green economy" may obfuscate differences between the schools and redefine them all as versions of "green economics." The Bretton Woods institutions and the International Monetary Fund, which are in charge of monetary policy globally and have launched the "Green Fund" initiative, have made it clear that they intend to move toward biodiversity valuation and a more official and widespread form of biodiversity financing as of 2010. The Zero Emissions Research and Initiatives advocate for extreme zero emission and waste targets, taking these factors into consideration. [Required Citation] According to the UNEP's 2011 Green Economy Report, "the annual finance need to green the world economy was expected to be in the range US$1.05 to US$2.59 trillion. By using worldwide Gross Capital Formation as a gauge, we can see that this demand represents around one-tenth of annual global investment.

An agreement on a set of fair transition common principles between multilateral development banks and the European Investment Bank was made public at COP26. These principles also support the Paris Agreement. According to the guiding principles, policy engagement, plans for inclusion and gender equality, financing for the transition to net zero carbon economies should be prioritised while socioeconomic effects are taken into account. All of these efforts should be directed at bringing about long-term economic transformation. Multilateral development banks that have sworn to uphold the principles of climate change mitigation and a Just Transition include the African Development Bank, Asian Development Bank, Islamic Development Bank, Council

of Europe Development Bank, Asian Infrastructure Investment Bank, European Bank for Reconstruction and Development, New Development Bank, and Inter-American Development Bank. Additional support came from the World Bank Group.

The phrase "green growth" refers to a potential economic expansion that is ecologically responsible. It is founded on the knowledge that, as long as economic development remains a top priority, it is necessary to dissociate economic expansion from resource usage and negative environmental effects. Green economy, low-carbon development, and sustainable development are all closely connected ideas, as a result of which. The shift to sustainable energy systems serves as a major impetus for green development. Those who support green growth policies contend that well carried out green policies may open up job prospects in industries like renewable energy, organic agriculture, and sustainable forestry.

Many nations and international bodies, including the World Bank, United Nations, and Organisation for Economic Co-operation and Development (OECD), have created policies for green growth; even other bodies, like the Global Green Growth Institute (GGGI), are entirely devoted to the problem. The phrase "green growth" has been used to describe regional or global initiatives, such as the economic recovery from the COVID-19 recession, which is sometimes referred to as a green recovery.

Critics of green growth draw attention to the fact that green growth theories fall short of taking into consideration the fundamental changes to economic structures required to solve the climate catastrophe, the biodiversity problem, and other environmental deterioration. Instead, degrowth, doughnut economics, the circular economy, and other fundamental shifts that better take into consideration planetary limits are cited by critics as preferable models for economic progress.

A study found that 64% of enterprises are making investments in garbage reduction and recycling, 32% are making investments in new, less polluting sectors, and around 57% are making investments in energy efficiency. In 2021, almost 40% of companies made expenditures to increase energy efficiency.

Measurements of the environment

Economic index indicators are used to assess the state of the economy and its growth. Green indices were born out of the necessity to assess the ecological effect of human activity, the efficiency of various industries, including transportation, energy, construction, and tourism, as well as the investment flows into fields like clean technology and renewable energy. The sixth edition of the consulting Dual Citizen LLC's Global Green Economy IndexTM (GGEI) 2010–2018 has just been released. Along four primary dimensions leadership & climate change, efficiency sectors, markets & investment, and environment it gauges the success of the green economy and how it is seen in 130 different nations.

Green energy concerns

Energy conservation and efficient energy usage are also necessary in order to achieve green economies. Green energy production based on renewable energy must replace fossil fuels. By

2035, the use of fossil fuels for power production may be completely phased out, and by 2050, renewable energy sources like solar and wind energy may take its place.

High external expenses and high initial expenditures for the creation, research, and marketing of green energy sources and green goods may be blamed for the market's inability to react to requirements for environmental protection and climate change mitigation. For businesses to invest in and generate green goods and services, the green economy may need government subsidies as market incentives. Such market incentives are offered by the American Recovery and Reinvestment Act of 2009, the European Union's Recovery and Reinvestment Act, and the German Renewable Energy Act. Other industry experts, however, contend that businesses that comprehend the business case for sustainability and have the capacity to sell green goods and services to consumers other than the typical green consumer may benefit significantly from implementing green strategies.

By the middle of the 1990s, it seemed that the nuclear industry in the United States was on its last legs. No new nuclear power plants has been constructed from 1977 up to 2013. The dependence on energy sources based on fossil fuels for economic reasons was one of them. As a result of the Three Mile Island incident and the Chernobyl tragedy, the public also had a dread of nuclear energy.

The Bush administration signed the Energy Bill into law in 2005, giving the nuclear sector a subsidy of around $10 million to support R&D activities. Nuclear energy has been emphasised as a solution to combat climate change and reverse its effects in view of the growing danger it poses. Environmentalists and ordinary people are compelled to assess the benefits and drawbacks of utilising nuclear energy as a source of renewable energy because of its environmental impact. Nuclear power is contentious, which might cause the pro- and anti-nuclear movements in the green economy to divide.

According to a European climate poll, 60% of Chinese respondents, 59% of Britons, 50% of Americans, and 63% of EU citizens support the use of renewable energy. According to 2021 data, 18% of Americans support using natural gas as a fuel. Nuclear energy is a more preferred option to conventional energy for people in the UK and the EU. Following the COVID-19 epidemic, Eastern European and Central Asian firms lag behind their Southern European counterparts in terms of the quality of their green management practises on average, particularly with regard to set energy consumption and emissions targets.

When it comes to determining the effectiveness of green management strategies, external factors like consumer demand and energy taxes are more important than firm-level characteristics like size and age. A greater range of green activities will likely be funded by businesses with less financial constraints and better green management practises. Financial returns and the environment both benefit from investments in energy efficiency. Firms who took part in a study in 2022 predicted that the switch to greener energy and the implementation of stricter climate rules would have a 30% positive effect on businesses, mostly via new business possibilities, and a 30% negative impact. Just over 40% of the same companies don't think switching to more environmentally friendly options would change how they operate.

Criticism

A number of organisations and people have criticised various components of the "Green Economy," notably the popular ideas of it focused on utilising pricing mechanisms to conserve nature, contending that this would expand corporate domination into new sectors from forestry to water. According to the research organisation ETC Group, corporate focus on the bioeconomy "will stimulate even greater convergence of corporate power and unleash the biggest gigantic resource grab in more than 500 years." Edgardo Lander, a professor in Venezuela, claims that the UNEP's report, Towards a Green Economy, while well-intentioned, "ignores the fact that the capacity of existing political systems to establish regulations and restrictions to the free operation of the markets - even when a large majority of the population call for them - is seriously limited by the political and financial power of the corporations."

In a paper for UNCTAD, Ulrich Hoffmann also claims that the emphasis on "green growth" and the "green economy" in particular, "based on an evolutionary (and often reductionist) approach will not be sufficient to cope with the complexities of," and "may rather give much false hope and excuses to do nothing really fundamental that can bring about a U-turn of global greenhouse gas emissions." Ecological economist Clive Spash has criticised the use of economic development to solve environmental losses and stated that the UN's promotion of the "Green Economy" is not a novel idea at all but rather a distraction from the causes of the environmental issue. Additionally, he has criticised the UN's initiative on the economics of ecosystems and biodiversity (TEEB), as well as the methodology used to value ecosystem services in monetary terms.

Selection criteria for green technology

The Green technology is the knowledge for conserving natural environment and resources and reducing human involvement. It can operate in diversified areas such as bio-fuel, eco-forestry, renewable energy, and solid waste management. However, it is neither viable nor required to adopt all the available technologies at one time without considering country-specific strengths and weaknesses. The selection of tools and techniques as an appropriate technology is an important element in helping communities to decide what their future should be like. In other words, appropriate technology's search for those technologies that have beneficial effects on income distribution, human development, environmental quality, and the distribution of political power.

1. System Independence: It is the ability of the technological device to stand alone for doing the required job. Whether the technology will require relatively more capital or labour will be analysed to check system independence of the technology
2. Image of Modernity: People should perceive themselves as modern by adopting the technology. The message is people’s realization that technological device can elevate the user’s social status as well as need a basic human need. Image of modernity requires that the social status of people who adopt it either increases or remains unchanged.
3. Individual Technology vs. Collective Technology: It is the criteria to look into the societal/cultural standards in which the technology operates. In other words, it is the careful assessment of the technology that is based on group approach and becomes more systems

dependent. A society geared towards individual or single family unit will need more systems independent technology. Collective technologies are more easily adopted as collective action reduces a transaction cost

4. Cost of Technology: Affordability of the technology is an important indicator for their wider use since cost is the major factor in encouraging or discouraging the application of appropriate technology in developing economies.
5. Risk Factor: It is an important factor to find out how smoothly technology works in the local production system and system that explains to what degree is the technology system dependent or system independent. This indicates the need for understanding two types of risk- both the internal and external risk. Although analysis of risk is necessary before applying new technology, it is almost impossible to remove all risks.
6. Evolutionary Capacity of Technology: If the chosen device is static, it will relatively reflect the short-lived solutions to a much larger problem. The technology, which supports the continuation of development by enhancing capability to expand, can be expected to compete at the regional, national and international level.
7. Single-Purpose and Multi-Purpose Technology: In contrast to single purpose technology, multipurpose technologies are the ones that furnish a variety of applications (e.g. a tiller who can be used for tilling the land, powering water pump, and drying rice).

Greenhouse gases (such carbon dioxide and methane) are becoming more and more concentrated in the atmosphere due to industrialization over the last 200 years and the usage of fossil fuels like coal and petroleum. Global warming, which has increased the world's average temperature, is the main cause for worry today. Several countries have ratified the Kyoto Protocol, pledging to reduce emissions of six "greenhouse gases" in accordance with predetermined, enforceable guidelines. Buildings contribute for between 30 and 40 percent of overall energy usage. Therefore, it is crucial to investigate energy-efficient construction options to aid in attempts to lessen the consequences of global warming. All parties involved in the construction business are paying more attention to green building or environmentally sustainable building techniques. Considerations for green building designs include choosing the right location, using environmentally friendly construction materials, and using energy-saving building techniques like passive cooling. Other factors include the use of as much natural light as possible, the use of energy-efficient building materials, the appropriate use of lighting fixtures, etc., the use of water-efficient technologies, the harvesting of rainwater, the use of renewable energy sources, the recycling of waste water, the efficient management of solid waste, etc. Many rating organisations are now supporting the green building movement and benchmarking/standardizing green building technology. Use of green materials is one of the requirements, and there is a lot of ambiguity around what constitutes a green substance. For the same, several assessment criteria are required. Building materials may now be classified as green materials using a scale that is currently being developed.

There is a lot of strain on earth resources like soil, sand, stones, timber, etc. because of the building industry's amazing rise. Environmental effects from the production of construction materials are permanent. The most effective method for creating an eco-friendly structure is to use environmentally friendly construction materials. To find green materials, utilise the following criteria.

A. Materials are accessible locally
B. internal energy
C. Utilization of recycled and waste materials
D. quickly regenerative materials
E. Energy-related contribution Building effectiveness
F. Materials that are recyclable
G. Durability
H. Environmental Effects

The material may be evaluated overall by adding the scores that each piece of content received in these evaluations, using the aforementioned criteria and a rating scale ranging from R1 to R8 for each one. The material that follows discusses the standards for grading each criterion.

To reduce the amount of energy required for transporting the construction materials, it is best to use locally sourced resources wherever feasible. The entire energy used to move materials, commencing at the point of manufacture, should be taken into account when calculating transportation energy consumption. According to the following rules, points for rating R1 may be assigned to materials depending on their proximity to the location of manufacture.

The energy needed to produce any construction material is measured as embodying energy. This includes the energy needed to gather raw materials from nature, transport them to a manufacturing facility, and utilise that energy throughout the production process to create a final product. Every building is a complex assemblage of several processed components, each of which contributes to the overall embodied energy of the structure. Embodied energy is a reliable measure of how environmentally friendly building components, assemblies, or systems are overall.

Recycled or discarded resources may be used in the production of building materials. Utilizing recycled materials benefits the economy and the environment in several ways. Reducing the need to produce using virgin, non-renewable materials has considerable benefits, including cost, energy, and resource savings. Instead of ending up in landfills after their useful lives, waste materials may be processed again and used in the manufacture of new goods. Research has shown the use of numerous types of waste materials, including fly ash, blast furnace slag, red mud, waste glass, marble dust, cinder, rice husks, coconut husks, banana leaves, jute fibres, rubber from car tyres, etc.

The production of materials using renewable resources, such as wood or solar energy, as opposed to non-renewable ones, such as fossil fuels, must be favoured. Resources on Earth are being depleted at a startling pace. The ongoing removal of raw resources from the ground has an impact on the whole ecosystem. Since there is a finite supply of fossil fuel, it might run out quickly. Utilizing renewable resources such as sand, grasses, and timber (particular approved species that are fast renewable), as well as renewable energy such as wind, solar, and tidal, may reduce the effect on biodiversity and ecosystems.

The majority of the energy generated is used in the construction and operation of structures. Designers and builders may lessen the energy burdens on buildings with a few cautious steps, lowering energy needs and the demand on natural resources. The requirement for air conditioning

may be eliminated or reduced with the use of passive cooling methods, operable windows for natural cross ventilation, walling units with lower U values, roof insulation, water-saving appliances, and optimum building orientation with respect to solar radiation. It is possible to reduce dependency on conventional fossil fuel sources by taking into account the utilisation of alternative energy sources including wind, solar, and tidal power. The government of India established the Bureau of Energy Efficiency (BEE), which is responsible for developing the Energy Conservation Building Code (ECBC), which establishes a minimum level of energy efficiency for structures. The ECBC sets minimum requirements for the U-factor (thermal transmittance, measured in W/m2°C, which is the rate of heat transfer through a unit area of a structure for a unit difference in temperature across the structure) and the solar heat gain coefficient (SHGC), which is the ratio of solar heat gain that enters a space through fenestration to incident solar radiation.

After a product's or material's useful life or after a structure is demolished, the amount of materials recovered for reuse may be used to determine how recyclable a material is.

The chosen materials are those that need minimum upkeep and are long-lasting. The environment, its resources, and people are placed under stress by the replacement of material things. Manufacturers may assist in removing a costly, destructive, and time-consuming process of replacement by making materials more durable and simple to maintain. As shown in Table-8, rating R7 may be applied to this criteria.

Green materials evaluation criteria

The manufacturing process, usage, or disposal after a building's useful life must all be done in a way that does not damage the environment, pollute the air or water, or affect the planet, its population, or its ecosystems. Toxic-free materials should improve the quality of the air inside. Each year, billions of tonnes of raw materials are used in industrial production across the world. The effects of pollution on the Earth's environment may be felt for a long time after a product is excavated, manufactured, consumed, or disposed of. Poor indoor air quality resulting from VOC emission costs businesses billions annually in medical expenses and lost productivity.

Due to the extensive and strong variety of chemical emissions that PVC emits throughout its entire life cycle, its production, use, and disposal provide significant and distinctive risks to the environment and to human health. It is essentially the sole substance that calls for phthalate plasticizers, typically contains heavy metals, and produces a significant amount of VOCs. Additionally, during manufacturing, it is accountable for the creation of a significant amount of very dangerous compounds, such as vinyl chloride, ethylene dichloride, and dioxins, which are the most powerful carcinogens known to man. It releases more dioxins and hydrochloric acid when burnt at the end of its useful life, whether in an incinerator, building, or landfill fire. PVC-made products should be avoided at all costs. The following factors should be taken into account when determining the environmental effect of construction materials and assigning a grade of R8.

CHAPTER 5

FEASIBLE GREEN TECHNOLOGIES

Some of the selected renewable-energy technologies are:

A) Solar Photovoltaic: Solar photovoltaic technology converts sunlight into electricity using semi-conductor modules. Used generally for meeting lighting requirements, they can also be used for pumping water, refrigeration, communication, and charging batteries. Solar photovoltaic has application as the green agricultural energy source for pumping water, street lighting in villages, lighting in rural houses and pest management. Since the technology efficiently produces low-cost, high-power photovoltaic cells, this new generation of solar energy can be one of the most affordable and efficient energy sources in the future.

The sun will shine for as long as there are people on Earth. Therefore, from our vantage point, the supply of solar energy is almost limitless. The amount of energy the sun provides to the Earth in total is more than what humans use in a year. Furthermore, when generated or used, solar energy emits a lot less pollution than "dirty" electricity does. Global carbon emissions might be greatly decreased by increasing solar electricity and reducing dependency on fossil fuels.

Sunlight also has less of an influence on the environment since it is not harvested from the earth way fossil fuels are. The exploitation of fossil fuels may result in serious issues. 3.19 million barrels of oil were spilled into the Gulf of Mexico during the BP deep sea oil drilling accident in 2010, destroying the ecosystems of the ocean. Some of the oldest mountains on Earth have been disfigured by coal mining in Appalachia, and the region's surrounding communities have suffered negative health impacts as a result. Solar energy, in contrast, has a very little impact on the environment.

Although no energy source is completely pure, solar power is among the most eco-friendly options. Solar energy doesn't produce any toxic byproducts, in contrast to fossil fuels, which do. When the sun is used to generate energy, there are no carbon emissions, pollution, or other environmental hazards that impact the local or global ecosystem. The solar panels that turn light into power must be produced, however. Energy and raw materials are utilised in this, and some of the processes result in dangerous byproducts. The silicon tetrachloride that is produced when polysilicon is created from metallurgical-grade silicon is a significant example of these byproducts. This will combine with water if it is spilled, producing hydrochloric acid, which will acidify the earth and release toxic fumes.

Such trash may be recycled and rendered harmless with current technology, but not all firms are willing to make the expensive equipment investments. This issue can be resolved with the aid of better rules, incentives, and regulations. Despite the fact that this is the case, solar energy is still much more environmentally friendly and clean than non-renewable energy sources. Because of

this, it ranks as one of the top sources of clean, renewable energy. In the not-too-distant future, it is also quite probable that we will be able to completely green the process.

Features make Solar Energy Green

Solar energy is seen as green since it employs a non-depletable natural resource and has little to no adverse effects on the environment. Comparatively speaking, the conventional energy sources of fossil fuels like coal, natural gas, and crude oil emit enormous volumes of carbon emissions and pollutants, which significantly exacerbate climate change, respiratory issues, and pollution.

Extraction of fossil fuels and the production of electricity not only harms the environment, but these resources are depleting quickly and cannot be replenished. Solar energy is one of the solutions to our demand for green energy.

Solar energy

Solar energy is being used more often. Its scalability is a factor in its appeal. The millions of individual tiny arrays being put on homes and business property are just as important as the solar farms that are spreading throughout the globe. While all forms of electricity production have an environmental impact, solar energy has a very little one. Yes, there are flaws with manufacturing that can be fixed, but once panels are in use, they need relatively little upkeep. The recycling of solar panels also raises certain concerns, although many of them are unavoidable given how young the technology is. Old panels will become more popular to recycle as the industry develops.

Although every action taken by humanity has an impact, the growth of solar power has had very few unfavourable outcomes. It bears emphasising that fossil fuels like coal, oil, and natural gas have an enormously greater impact on the environment than solar energy.

The solar power sector may be profitable in addition to having very low environmental costs.

Reliance on imports of fossil fuels has in the past led to economic and political problems on a global scale; renewable energy might help solve this issue. Using solar panels at home may help you save money on your power bill and the environment by reducing your carbon footprint. They increase the value of your house as well, making them a wise investment.

Solar power offers a reliable and affordable "green" alternative as efforts are made to progressively reduce humankind's dependency on fossil fuels that are harmful to the environment. Solar energy is one of the cleanest accessible technologies, even among renewable energy sources.

Solar power

Solar energy will be a crucial component of the world's electrical supply in the future, and sustainable energy is the only alternative we have. The dirty and unsustainable fossil fuels on which the world has been reliant for many years must no longer be used. But no one source of energy can meet the needs of a growing population. One of the solutions is solar energy. Solar energy may help change how we live, together with wind, water, geothermal, and other sustainable energy sources. The International Energy Agency (IEA) 2 reports that solar PV is expanding more quickly than other renewable energy sources, notably among households and small- to medium-

sized businesses. By 20303, solar energy production is expected to account for 48% of all renewable energy generated in the United States, according to the Center for Climate and Energy Solutions (C2ES). In 2020, there will be more than 700 gigawatts of installed solar power worldwide, according to the International Renewable Energy Agency (IRENA). The production of photovoltaic panels and the reuse of existing ones are the only obstacles standing in the way of solar energy being the ideal energy source. Despite being widely available, silicon the primary raw material for PVs needs a lot of energy to be converted into solar panels. This energy is often produced using fossil fuels, especially in coal-fired power stations, which has a significant environmental impact. However, it is anticipated that as the sector develops and grows, the manufacturers will support the sustainable principles that underpin the switch to green energy.

What are the two primary drawbacks of solar power?

The two biggest drawbacks of solar energy generation are its high initial cost and reliance on the weather. The cost of even a modest project is considerable, and it will take a solar panel at least seven years and often longer to pay for itself. But prices will drop as the market expands, making panels more accessible. Additionally, there aren't many maintenance requirements, therefore operating expenses are very low.

At the moment, solar panels are ineffective at night and when there is cloud cover. That will inevitably result in inconsistent supplies. While they will produce the greatest electricity in such conditions, they are not dependent on crystal-clear blue sky and strong sunlight to operate. The solution to this issue is to use several renewable energy sources, although improvements in electrical storage are also helpful.

Storage is the long-term solution, and as we've previously seen, battery technology is always improving. Recent advancements in battery design and application have been fueled by the car industry's embrace of the electrification of transportation. Power storage technologies are clearly going to accelerate the uptake of renewable energy sources in the future. Many anticipate that the current generation of PVs will continue to operate at 75% efficiency much beyond the 25 years that solar panel manufacturers now promise their products would last. Even though there is often a very modest output deterioration, it is uncommon for a panel to fail or develop a problem before that period.

As the market develops and panels improve their ability to convert light into electricity, it could become economically sensible to replace panels before they have difficulties or become very inefficient.

According to estimates, household solar panel installations cost an average of $17,000, and at the present rate of return, you could not see a profit for seven to fifteen years, and perhaps even longer. This initial investment may be as little as $5,000 thanks to the tax discounts and incentives certain jurisdictions give, which would result in a substantially shorter payback period. After that, there are usually significant savings; power is almost free. Do not forget that solar panels may increase the value of your house and make it simpler to sell.

Few items you purchase maintain their worth over time. Once you drive the $40,000 automobile off the lot, it will be much less valuable. If you own your own property and wish to raise the value, solar panels are presently an exception. Purchasing solar panels for your house is a smart choice if you have the money and the right location. Once the installation expenses are covered, solar panels need very little maintenance, and you are free from concerns about rising energy prices. PVs on the roof benefit you should you decide to sell your house.

When we move to renewable energy sources, it will seem obvious; in 100 years, people will look back and wonder why we didn't do it sooner. We may have been a bit late to understand the harm that fossil fuels inflict and the precarious nature of the supply, but that is quickly changing. The particular adaptability of solar electricity to small-scale application is a significant contributor to this transformation. Many of us have vacant roof space that we may utilise to our advantage, even if we can't all have a windmill or a hydroelectric plant in the backyard. You gain electricity independence and contribute to a better world when you instal solar panels on your house. A true win-win scenario.

B) Wind Energy:

Wind energy is in a boom cycle. Its importance is increasing in the sense that comparatively with other sources; the wind energy produces fewer air pollutants or greenhouse gases. Wind turbine for electricity or mechanical power generation is a proven technology Available in 75% of the world, wind turbines of sizes ranging from 900 W to 50 kW can be applied off-grid for pumping and treating drinking water, irrigation, telecommunications, homes, schools, clinics and for supplementing larger power stations. Wind turbines used in pumping water for irrigation can increase agricultural growth without carbon emission. The primary method of generating electricity from the wind, often known as wind power, is via wind turbines. Burning fossil fuels has a considerably greater negative effect on the environment than using wind power, a well-liked, reliable, and renewable energy source. In the past, sails, windmills, and windpumps were powered by the wind, but in modern times, electricity is produced mostly by wind energy. An electric power transmission network is linked to a large number of individual wind turbines that make up wind farms. The cost of new onshore (on-land) wind farms is lower than that of new coal or gas power plants, yet subsidies for fossil fuels are impeding the growth of wind power. Compared to certain other power plants, onshore wind farms have a bigger aesthetic influence on the environment. Small onshore wind farms have the capacity to power remote off-grid sites or provide a small amount of electricity to the grid. Offshore wind farms have less of an aesthetic effect and produce more electricity per installed capacity. Offshore wind power is growing, despite the fact that it is less prevalent right now and that it costs more to build and maintain. In terms of new installations, offshore wind power now accounts for 10%.

Since wind energy is a variable renewable energy source, power-management strategies are used to balance supply and demand. These strategies include: wind hybrid power systems, hydroelectric power or other dispatchable power sources, excess capacity, geographically distributed turbines, exporting and importing power, or grid storage. It may be necessary to improve the grid when the amount of wind energy in an area rises. By using weather forecasts, the electrical grid may be prepared for production changes that are expected to happen.

Over 6% of the world's electricity and roughly 2% of the total energy used in 2021 came from wind energy, which produced over 1800 TWh. Over 800 GW of installed wind power capacity was added globally in 2021, largely in China and the US, at a rate of roughly 100 GW. Analysts claim that it should grow far more quickly, by more than 1% of power production annually, to assist achieve the Paris Agreement's aims to reduce climate change.

The best places for wind power are those located at higher latitudes in the north and south. In most places, when PV production is lower in the winter and at night, wind power generation is greater. Because of this, many nations are well-suited to using solar and wind energy in tandem.

C) Bio-fuel: Bio-fuel as bio-ethanol and bio diesel has the potential to assume an important portfolio in the future energy platter. Caution is mandatory in evaluating bio-fuel as green agricultural technology. Food security concerns and risks to environment and bio diversity are parameters that necessarily need to be accessed while analyzing sustainability linkage of agriculture and bio-fuel. Furthermore, conversion of the wasteland to farmland with some crop options can be viewed as positive impacts.

Any fuel that comes from biomass, or organic matter as it is often called, is referred to as a biofuel. Animal waste is included in this, as well as any kind of plant or algal material, including wood. These fuels are regarded as renewable sources of energy since the natural renewal process of life continuously replenishes them. Because of this, they provide a desirable alternative to fossil fuels like coal, oil, and natural gas. These materials need to be created over thousands of years and then retrieved by pricy, harmful methods from very deep down. Additionally, fossil fuel reserves on Earth will eventually run out, particularly if we keep using them at the present pace of depletion. This is because they are being used far more quickly than they are being generated.

Simply explained, biofuel is a general word that covers all fuels made from biological material. But not all biofuels are made equally. There is, in reality, a substantial difference between primary and secondary biofuels, which not only distinguishes them based on their methods of production but also affects how they are often utilised. The term "primary biofuels" refers to organic resources that are used directly as an energy source without any previous treatment or processing. Timber, wood chips, pellets, and other forms of wood that are often used for cooking and heating reasons are some examples of primary biofuels. This is particularly true in underdeveloped nations where there are no alternative fuel options. Primary biofuels may also be utilised to provide power, but less often. Any sort of biomass that is utilised to produce energy after processing is referred to as a secondary biofuel. Liquid biofuels with rising demand in the transportation sector, such bioethanol and biodiesel, are examples of secondary biofuels. Additionally, they are used in biomass power plants and industrial activities.

The great majority of biofuel is used at home, often in developing nations where there are no alternative energy options. This is done to heat water for cooking, washing, and cleaning as well as to heat the house itself. This uses 80% of the biofuels that are currently used. Only 2% of known biofuels are utilised as a feedstock for automobiles in the transportation sector, compared to 18% that are employed in industrial settings. However, this latter use is gaining popularity as more and more drivers, automakers, and national governments realise how important it is to raise the

emissions ratings of their vehicles. Primary biofuels are produced via a straightforward scientific technique. They are simply grown, picked, and burned since there is no processing required. However, secondary biofuels are a far more complicated animal. It could be beneficial to focus on the two most popular liquid biofuels used in the transportation sector to make things simpler.

It is not unexpected that bioethanol is produced in a manner similar to that of alcoholic drinks as ethanol is the same substance that is present in whisky, vodka, beer, wine, and a variety of other alcoholic beverages. To guarantee that the starch in the plants converts first into sugars, then into alcohol, the ingredients are treated to chemical reactions, fermentation, and heat. Then, in order to make sure that it is suitable for use in automobile engines, this alcohol is purified using a complex procedure. The biodiesel fuel is a bit unique. The first step of the procedure is the same: the raw ingredients are made to react with certain chemicals before being heated and fermented to produce the alcohol. At this phase, the alcohol is transformed into biodiesel by mixing it with either vegetable or animal fat. There are numerous other oils that may be utilised, including rapeseed oil, coconut oil, and many more.

Benefits and drawbacks of biofuels

It's true that biofuels offer a lot of advantages over oil, gas, and coal, but they have also been promoted by environmental organisations and business interests as a sustainable substitute for fossil fuels. There are a number of disadvantages associated with each fuel source, but no fuel source is ideal. The following is a list of the benefits and drawbacks of biofuels:

The benefits of biofuels

Renewable. As was already said, fossil fuels are a limited supply of energy that will ultimately exhaust themselves. Theoretically, biofuels are renewable since they can be readily replenished by producing additional organic matter.

Carbon. Inherently more environmentally friendly than fossil fuels, biofuels are produced from organic materials like plants, which absorb carbon dioxide from the atmosphere. When the expenses and emissions associated with fertilisation, shipping, and processing are taken into account, this argument isn't as compelling as one would anticipate given the predicted emissions reductions.

Cost-effectiveness. Considering that manufacturing bioethanol is less expensive than producing gasoline, merging the two might be a wonderful method to lower costs in the transportation sector. Diesel and biodiesel are equivalent. Additionally, the cost of fossil fuels will eventually increase as their reserves deplete. Biofuels' price is more predictable since they are sustainable.

fuel effectiveness. Bioethanol and biodiesel have lower levels of toxins like chlorine and sulphur in contrast to fossil fuels. In other words, they may diluted the amount of these pollutants in the fuel supply and provide cleaner emissions when combined with gasoline or diesel. The article Ensure Accurate Results for Sulfur and Chlorine Analysis in Biodiesels includes a lot of helpful information for anyone interested in learning more about how this procedure works.

Locality. Finally, since they may be generated close to where they will be used, biofuels can be produced at a lower cost and with less emissions because they can be transported locally.

Since far more land, water, and fertiliser are required to produce the same quantity of energy from biofuels as from burning fossil fuels, the same number of people will need much more of these resources. With relation to primary biofuels, this is particularly true.

The oils required to make biodiesel often come from places with declining biodiversity, such rainforests. This kind of land use suppresses biodiversity, displaces animal populations, and devastates ecosystems.

Suitability. Not every vehicle can use every kind of biofuel. Due to the fact that many automobile models' engines cannot handle 100% biofuel blends, this problem is especially prominent in the UK. Due to its weak oxidative stability and high freezing point, biodiesel is not suited for usage in the aviation sector. For additional information on this specific topic, see the article Analyzing Jet Fuel for Biofuel Contaminants - Safety First.

Emissions. When primary biofuels are used to generate heat (as is most often done in poor nations), they emit more local emissions than other types of heating.

Biofuels are they safe for the environment

Biofuels have environmental benefits as well as drawbacks, as was already mentioned. Although they may have a range of positive environmental effects on our globe, they can also have negative outcomes. How a particular biofuel is created, used, and consumed will all have an impact. Before deciding to utilise a certain biofuel as your primary fuel source, you should educate yourself about it. There might be a variety of advantages to switching to biofuels from fossil fuels. Biofuels are created from feedstocks that are renewable, as opposed to fossil fuels, which are finite resources. So, in principle, their manufacture and usage might continue endlessly.

EPA's (2010) study of the Renewable Fuel Standard (RFS) predicted that a variety of biofuels might produce fewer lifetime GHG emissions than gasoline over a 30-year time horizon, despite the fact that the manufacture of biofuels generates GHG emissions at various phases of the process. Academic research utilising different economic models has also shown that using biofuels instead of conventional fuels may reduce the lifetime GHG emissions. Compared to traditional fuels, second and third generation biofuels offer a substantial potential to lower GHG emissions since feedstocks may be grown on marginal land. Furthermore, if waste biomass has no other useful applications, no extra agricultural output is needed, and indirect market-mediated GHG emissions may be kept to a minimum.

Because biofuels may be generated locally, the importation of fossil fuels may decline. We may become less exposed to the negative effects of supply interruptions if biofuel development and usage decreases our demand of imported fossil fuels. Reducing our need for oil might lower its cost, benefiting American consumers economically while also perhaps boosting petroleum usage elsewhere. Some pollutant emissions may be decreased by biofuels. Particularly ethanol can guarantee full combustion, lowering carbon monoxide emissions.

It is crucial to remember that producing and using biofuels alone won't lower emissions of GHG or other conventional pollutants, cut down on petroleum imports, or relieve the strain on finite resources. For these advantages to materialise, there must be decreases in both the production and usage of fossil fuels and biofuels. These advantages would be lessened if fossil fuel emissions and resource demands increased rather than replaced by those of biofuels.

Impacts and potential costs of producing biofuel on the economy

Many crops used to make biofuels are also utilised indirectly as animal feed or directly for human consumption. If these crops are converted to biofuels, there may be an increase in the amount of land used for agriculture, the usage of polluting inputs, and the cost of food. Additionally, cellulosic feedstocks may compete for resources (such as land, water, fertiliser, etc.) that would otherwise be used for the production of food. Therefore, some study indicates that the production of biofuels may result in a number of unfavourable consequences.

Through the release of terrestrial carbon reserves to the atmosphere, changes in land use patterns may increase GHG emissions (Searchinger et al. 2008). Growing tropical biofuel feedstocks such as soybeans in the Amazon and oil palm in Southeast Asia on land stripped of tropical forests results in exceptionally significant GHG emissions (Fargione et al. 2008). Even the use of cellulosic feedstocks has the potential to increase crop prices, which promote the spread of agriculture into undeveloped area and contribute to greenhouse gas emissions and biodiversity losses.

GHGs may also be released during the manufacture and processing of biofuels. Nitrous oxide, a strong greenhouse gas, is released when fertiliser is applied. Fossil fuels are used by the majority of biorefineries. According to some study, depending on the analysis's time horizon, GHG emissions from the production and consumption of biofuels, including those coming from indirect land use change, may be greater than those produced by fossil fuels.

Regarding non-GHG effects on the environment, research indicates that the development of biofuel feedstocks, especially food crops like maize and soy, may result in an increase in water pollution from nutrients, pesticides, and silt. Aquifers may be depleted by increased irrigation and ethanol refinement. If the rise in net conventional air pollution brought on by the combination of the effects of biofuels on tailpipe emissions and the extra emissions produced at biorefineries, air quality may also deteriorate in certain areas.

Although estimates in the literature fluctuate widely, economic models demonstrate that the usage of biofuels may lead to increased agricultural prices. An analysis from 2013 indicated estimates for the impact of biofuels on maize prices in 2015 ranging from a 5 to a 53% rise. Several analyses found that the price of maize increased by 20 to 40 percent due to biofuels from 2007 to 2009, according to the National Research Council's (2011) study on the RFS. According to 19 studies in a working paper from the National Center for Environmental Economics (NCEE), long-term corn prices rose by an average of 2 to 3 percent for every billion more gallons of corn ethanol produced. Food prices rise as a result of increasing crop prices, although effects on US retail food costs are

anticipated to be minimal (NRC 2011). In underdeveloped nations, increasing agricultural prices might result in greater rates of malnutrition.

D) Biogas: Bio gas is the product of anaerobic digestion of organic matters by methanogenic bacteria. Bio gas qualifies on the merits that this technology utilizes organic agricultural waste and converts it to fuel and fertilizer. Direct impacts of bio gas are fuel-wood, agriculture residue, livestock manure, and kerosene savings. Increases in soil fertility and crop production have also been observed.

Biogas is a combination of gases made from raw materials such agricultural waste, manure, municipal trash, plant material, sewage, green waste, and food waste. The main gases in biogas are methane, carbon dioxide, and hydrogen sulphide. It is a renewable source of energy. In an anaerobic digester, biodigester, or bioreactor, methanogen or anaerobic organisms are digested to create biogas.

Methane, hydrogen, and carbon monoxide (CO) may all be burned or subjected to oxygen oxidation. Biogas may be utilised as a fuel for fuel cells and for any heating purpose, including cooking, thanks to this energy release. The energy in the gas may also be transformed into heat and power by using it in a gas engine.

Similar to how natural gas is compressed to create compressed natural gas (CNG), biogas may be compressed after the carbon dioxide and hydrogen sulphide have been removed and used to power cars. For instance, it is predicted that biogas in the UK might eventually replace 17% of the petroleum used in vehicles. In certain regions of the globe, it is eligible for subsidies for renewable energy. When biogas transforms into bio-methane, it may be cleaned and improved to natural gas standards. Due to its ongoing production and use cycle and lack of net carbon dioxide emissions, biogas is regarded as a renewable resource. The organic material is transformed and put to use as it grows. After then, it grows again in a cycle that keeps happening. From a carbon standpoint, the development of the main bioresource absorbs as much carbon dioxide from the atmosphere as is emitted when the substance is finally transformed to energy.

In order to create a clean and effective burnable gas, biogas systems depend on the organic wastes including manure, sewage, agricultural byproducts, and leftover food interacting naturally with microbes. A system of pipelines transports the gas, which is utilised for cooking and heating. Similar to how many of us get natural gas from our neighbourhood utility company, this is done. Thanks to the helpful neighbourhood microbes, a household may have a secure gas stove with only a match and a turn of a knob.

Biogas is a renewable fuel, which is the main distinction between it and natural gas. In other words, the system may keep working as long as organic waste is introduced. Natural gas, in contrast, originates from subsurface gas reserves and is completely gone once utilised. Another significant distinction is that biogas, unlike natural gas, also generates a by-product that is free and rich in methane: fertiliser. This may be either sold to generate cash or used to agricultural land to increase crop yields.

Last but not least, biogas systems may enhance family health and save lives. Biogas emits a little amount of emissions due to its efficiency. This indicates that there isn't any smoke or air pollution inside. In contrast, common fuels for heating and cooking in rural areas including firewood, kerosene, paraffin, and dried animal dung may emit very damaging pollutants. In addition to causing climate change, these pollutants have the potential to cause major health issues and family deaths before their time.

Biogas systems are suitable for rural locations without access to commercial energy sources, such as electricity or natural gas utility companies. Additionally, they might be excellent supplementary energy sources that help to reduce the quantity of industrial power used. They work best when people rely on conventional energy sources for cooking and heating, such as firewood, kerosene, paraffin, or dried animal waste. For example, in communities where farming and rearing animals are the main sources of income, biogas systems are ideally suited for places with high levels of organic waste. In order to produce electricity from municipal solid waste, biogas systems are also suitable for use in urban and semi-urban settings (i.e. sewage).

E) Micro & Small Hydropower: National convention of renewable hydropower varies across nations. Hydropower plants ranging from maximum capacity of 500 kW in Nepal to 25 MW in India are conceived renewable. Generally used in rural electrification, hydropower plants can take an equally important role in facilitating irrigation and value addition at source of agricultural products.

One of the earliest and most significant types of renewable energy, hydropower or hydroelectric power harnesses the naturally occurring flow of flowing water to produce electricity. Currently, the United States generates 6.3% of its total energy from hydropower and 31.5% of it from renewable sources.

Hydropower facilities exist in many shapes and sizes, despite the fact that the majority of people may equate the energy source with the Hoover Dam—a massive structure that captures the power of an entire river behind its wall. They might be small or quite huge, depending on the water flow in irrigation ditches or municipal water systems. With diversion facilities or run-of-river facilities, which send a portion of a stream through a powerhouse before the water rejoins the main river, they may even be "damless." Whatever the approach, hydropower is more accessible than most people know and is employed in a variety of applications. In actuality, all states—apart from Delaware and Mississippi—use hydropower in some capacity or another to generate energy. For instance, hydropower provided roughly 66% of the energy used in the state of Washington in 2020.

Water flowing in on one side and out, far below, on the other is used by hydropower technologies to produce electricity by taking advantage of the elevation difference formed by a dam or other diversion construction. A more cheap source of energy than most is hydropower. States like Idaho, Washington, and Oregon, which rely mostly on hydropower for their electricity production, have cheaper energy costs than the rest of the nation since hydropower solely uses the energy from flowing water. Hydropower also offers comparatively cheap expenses over the course of a whole project lifespan in terms of upkeep, operations, and fuel compared to other energy sources. Like any major energy source, hydropower has considerable upfront expenses that cannot be avoided,

but because of its extended lifetime, these costs are dispersed over time. Additionally, the machinery used in hydropower plants often lasts longer before needing to be replaced or repaired, saving money over time.

Large hydropower facility installation costs are mostly made up of expenditures for civil construction (such as constructing the dams, tunnels, and other related infrastructure) and electromechanical equipment (electricity-generating machinery). Hydropower is a site-specific technology, thus by carefully choosing the location and design at the planning stage, these expenses may be reduced.

Since ancient times, people have understood and used hydropower's advantages. Hydropower plants are a flexible and dependable source of backup power during significant power outages or interruptions, in addition to being a clean and economical source of energy. They may rapidly provide electricity to the system. In addition to producing energy, hydropower also has other advantages including flood control, agricultural assistance, and water supply.

Hydropower has a long history that extends back thousands of years. For instance, more than 2,000 years ago, the Greeks ground wheat into flour using water wheels. After Bernard Forest de Bélidor, a French hydraulic and military engineer, published Architecture Hydraulique in the middle of the eighteenth century, the modern hydropower turbine started to take shape. The first half of the 19th century saw a number of significant advances in hydropower technology, and more recently, the 20th century has seen a number of hydroelectric innovations that have helped hydropower become a crucial component of the renewable energy mix in the United States.

One of the oldest and most significant forms of renewable energy is hydropower, or hydroelectric power, which produces electricity using the free flow of flowing water. Currently, 6.3% of all electricity generated in the US comes from hydropower, which accounts for 31.5% of all renewable energy produced in the country.

Although the Hoover Dam, a massive structure that uses a whole river's force behind its wall to generate electricity, is what most people think of when they think of hydropower, there are other hydroelectric facilities of different shapes and sizes. While some may be extremely huge, others may be microscopic, depending on the water flow in irrigation ditches or municipal water systems. With diversion facilities or "damless" facilities that send a portion of a stream through a powerhouse before it rejoins the main river, they may even be possible. Hydropower is more accessible and prevalent than most people know, regardless of the technique. In reality, all states utilise hydropower in some capacity or another to generate energy, with Delaware and Mississippi being the exceptions. As an example, hydropower supplied over 66% of the energy used in the state of Washington in 2020.

The elevation difference that is produced by a dam or other structure that directs water into one place and out the other, far below, is used by hydropower technologies to generate electricity. Compared to other sources, hydropower is a more economical way to generate energy. States that mostly rely on hydropower, such as Idaho, Washington, and Oregon, have cheaper energy costs than the rest of the nation since hydropower solely uses the energy from flowing water.

In terms of operations, maintenance, and fuel expenses over the course of a whole project lifespan, hydropower is also quite inexpensive in comparison to other sources of energy. Although hydropower has higher upfront expenditures than other main energy sources because to its longer lifetime, these expenses are spread out over time. Additionally, hydropower plant equipment often lasts longer before requiring replacement or maintenance, which results in long-term financial savings.

The majority of the expenditures associated with installing big hydroelectric facilities are related to civil construction projects (such as constructing the dams, tunnels, and other essential infrastructure) (electricity-generating machinery). Because hydropower is a site-specific technology, these expenses may be kept to a minimum at the planning stage by making wise decisions about location and design. Hydropower has been used for thousands of years because of its advantages, which have been recognised. Hydropower plants can instantly provide electricity to the grid, making them a flexible and dependable source of backup power during significant electrical outages or disturbances. Hydropower plants are also a clean and affordable source of energy. Flood control, agricultural assistance, and water supply are just a few of the advantages that hydropower also brings about outside of the production of energy.

There have been thousands of years of hydropower development. As an example, almost 2,000 years ago, the Greeks ground wheat into flour using water wheels. When Bernard Forest de Bélidor, a French hydraulic and military engineer, published Architecture Hydraulique in the mid-1700s, the modern hydropower turbine was beginning to take shape. The first half of the 19th century saw a number of significant advances in hydropower technology, and more recently, this century has seen a number of hydroelectric innovations that have helped hydropower become a crucial component of the renewable energy mix in the United States.

The force or energy of flowing water may be used to generate power known as hydropower, hydraulic power, or water power. Hydropower was utilised for irrigation and the operation of several machinery, including watermills, textile machines, and sawmills, etc., before commercial electric power was widely accessible. People have collaborated with nature to improve lifestyles by exploiting water for power generating. Water falling is a powerful mechanical force that has been used for centuries. Over 2,000 years ago, the Greeks utilised it to power water wheels that ground wheat into flour. Mechanical hydropower was extensively used for milling and pumping in the 1700s. The development of water turbines proceeded throughout the 1700s and 1800s. Grand Rapids, Michigan, employed a brush arc light dynamo coupled to a turbine in a grain mill in 1881 to provide theatre and retail illumination.

The only renewable energy source now producing between 80 and 100 TWh/year at the larger facilities is hydropower, which was the first technology to do so (ItaipuBrazil and Three Gorges-China). Since hydropower projects are always site-specific, they are created to fit the river system in which they are located. Due to its wide range of sizes, it can satisfy both the huge, centralised metropolitan energy demands and the dispersed rural needs. Hydropower's versatility in scale offers potential to address the growing need for freshwater, particularly when reservoirs are built, in addition to reducing climate change.

Modern hydropower facilities produce range from a few kW, enough electricity for one house, to several thousand MW, enough power to feed a sizable city and area. Early hydropower plants outperformed fossil fuel-fired facilities of the time in terms of dependability and efficiency. As a consequence, small to medium-sized hydropower plants proliferated anywhere there was a sufficient quantity of flowing water and a need for energy. Power plants using coal and oil fuels expanded as the demand for energy rose. Several hydroelectric facilities used substantial dams to submerge land for water storage.

The design, location of intakes, dams, and rivers, as well as the proportion of water flow utilised for power production vs that which is left as instream flow, will all have an impact on the effects on ecosystems, rather than installed capacity or the presence or absence of a reservoir. Small vs huge hydro generates the sense that negative effects will be mild or severe. This assumption is untrue since it is feasible to build rather big power plants with only mild environmental consequences, yet the combined effects of multiple small power plants in the same region might be more harmful than those of a single larger plant. Instead of categorising hydropower based on technical units that have little to no bearing on environment or society, it is more beneficial to analyse hydropower based on its sustainability performance and the sort of service it provides.

The difference between the top water level (Intake) and the exit will be used to calculate how high the water pressure is on the turbines. The vertical height of water above the turbine is referred to as head to describe this discrepancy. The most crucial factor in selecting the appropriate hydraulic turbine is head, together with discharge. Pelton turbines are often utilised for high heads, whereas Francis turbines are used for medium heads. Turbines with low heads often use Kaplan and bulb designs. Unfortunately, there are no internationally recognised standards for how to classify anything as "High head" or "Low head," and categorization practises vary greatly across nations.

F) Biomass: Agriculture residues and wastes are converted to electric and thermal energy through processes like combustion, gasification, and cogeneration. Biomass technologies compliment mainstream crop production and reduce or completely replace consumption of traditional fuel.

Biomass has been used since humans first started heating their homes and cooking their meals by burning wood. The most common biomass energy source today is still wood. Additionally, there are food crops, grassy and woody plants, agricultural or forestry wastes, oil-rich algae, and the organic portion of municipal and industrial wastes. It is also possible to employ landfill fumes as a biomass energy source since they include methane, the primary gas in natural gas. Fuels, electricity, and other goods that would typically be produced using fossil fuels may all be manufactured using biomass.

By transforming biomass into liquid fuels to suit transportation demands, biofuels are fuels for vehicles like ethanol and biodiesel. Find out more about biofuels. Burning, bacterial decomposition, and conversion to gas/liquid fuel are the three processes that biopower systems use to transform sustainable biomass fuels into heat and electricity.

Bioproducts Biomass may be used to produce fuels and power, as well as chemicals used to make plastics and other goods that are generally manufactured from petroleum.

Several advantages may be derived by using biomass.

Emissions of greenhouse gases might be significantly reduced by using biomass energy. Comparable to burning fossil fuels, burning biomass also produces some carbon dioxide. Carbon dioxide, a greenhouse gas that is basically "new," is released by fossil fuels, despite the fact that it was collected by photosynthesis millions of years ago. When it comes to biomass, however, the carbon dioxide it releases is substantially offset by the carbon dioxide it has absorbed during its own growth (depending how much energy was used to grow, harvest, and process the fuel). However, studies have shown that destroying forests to produce biomass leads in a carbon penalty that takes decades to recover from, thus it is preferable if biomass is grown on already cleared land, such unused farmland.

Biofuels are the only sustainable liquid transportation fuels currently accessible, therefore using biomass may lessen reliance on foreign oil.

Today, soybeans and corn grain (for ethanol) are the most widely utilised feedstocks for biomass fuels (for biodiesel). Agronomic wastes like wheat straw and maize stover (the plant's stalks, leaves, and husks) may soon be used as well, thanks to technologies created by NREL. Plans for the long future include cultivating and using certain energy crops, such algae, quickly expanding trees and grasses, and fast-growing grasses. On terrain that cannot support intensive food crops, these feedstocks can grow sustainably..

Solar Thermal, Improved Water Mill, and Geothermal Energy: *These clean technologies are found to contribute in adding value to agriculture products. Food processing, animal husbandry, dairy, and aquaculture are identified sectors for application of solar water heating and researches on solar drying of agro products, including paddy, coffee beans, tobacco, groundnuts, banana, bamboo, rubber, etc. have been carried out in Malaysia*

CHAPTER 6

GREEN TECHNOLOGY IN WASTEWATER TREATMENT

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The main goal of wastewater treatment is typically to enable the disposal of industrial and human effluents without endangering public health or causing unacceptable harm to the environment. In fact, irrigation with wastewater is an efficient way to dispose of wastewater as well as use it (as in slow-rate land treatment). Raw municipal wastewater must, however, often undergo some kind of treatment before it may be utilised for aquaculture, watering of gardens or farms, or other landscaping purposes. The operation and effectiveness of the wastewater-soil-plant or aquaculture system are significantly impacted by the quality of treated effluent utilised in agriculture. In the case of irrigation, the crop or crops to be watered, the soil conditions, and the effluent distribution method chosen will all affect the needed quality of effluent. The amount of pre-application wastewater treatment may be decreased by crop limitation and the use of irrigation methods that have the fewest health risks. Aquaculture systems cannot use a comparable strategy, hence increased dependence will be required on wastewater treatment for control.

The most effective wastewater treatment to apply before effluent usage in agriculture is one which will result in effluent fulfilling the advised microbiological and chemical quality parameters both at cheap cost and with little operational and maintenance needs (Arar 1988). In underdeveloped nations, adopting the lowest level of care is highly preferred, not just from a financial standpoint but also in recognition of the challenge of managing complicated systems successfully. Instead of relying on cutting-edge treatment procedures to produce reclaimed wastewater that consistently passes a strict quality standard, it will often be preferable to design the reuse system to accept a low-grade of effluent.

However, there are certain sites where a higher-grade effluent will be required, thus it's critical that data on the effectiveness of a variety of wastewater treatment technologies be accessible. In order to prevent environmental contamination, organic and suspended particles loads are often reduced during the design of wastewater treatment facilities. Pathogen removal has seldom been a goal, but it must now be a top priority for the reuse of effluents in agriculture, and techniques should be chosen and created in accordance with this. Although theoretically conceivable, it is often not economically practicable to treat wastewater to eliminate components that may be poisonous or hazardous to fish, aquatic plants (macrophytes), fish, or crops. Unfortunately, there aren't many performance statistics on wastewater treatment facilities in underdeveloped nations, and even when there are, they often exclude crucial effluent quality indicators for agricultural use.

Municipal wastewater treatment facilities have noticed diurnal patterns in the short-term fluctuations in wastewater flows. Early in the morning, when water use is at its lowest and

infiltration-inflow and modest amounts of sanitary wastewater make up the base flow, flow is normally low. When the wastewater from the peak morning water consumption reaches the treatment facility, there is often a first peak of flow in the late morning and a second peak flow in the evening.

Depending on the size of the town and the length of the sewers, as well as the nation, both the relative magnitude of the peaks and the periods at which they occur, vary. Peak to average flow ratios are substantially greater in tiny than in big municipalities with modest sewage systems. Although the size of peaks is reduced when wastewater flows through a treatment facility, the daily changes in flow from a municipal treatment plant make it unfeasible, in most situations, to irrigate with effluent straight from the treatment plant. To provide a reasonably consistent supply of recovered water for effective irrigation, some type of flow equalisation or short-term storage of treated effluent is required, but storage has additional advantages.

Water scarcity is becoming more common as the demand for water grows. The need to devise ways to ensure its long-term viability is becoming increasingly pressing. Experts are currently looking at wastewater processing as a result of technological advancements. Wastewater treatment is a procedure for removing polluting chemicals and pollutants from water. It handles polluted waters from home and industrial locations and safely restores them to the Environment for irrigation, industrial usage, and drinking. Effective urban water management is required to attain these goals.

Water treatment facilities are intended to hasten the natural process of cleaning water. The natural process is overwhelmed by billions of humans and significantly more effluent. Without wastewater treatment, the volume of effluent would wreak havoc, as it still does in underdeveloped nations today. Over 80% of the wastewater that is released worldwide is untreated. 1 The nations that do have water treatment facilities utilise a variety of techniques to treat water with one common objective in mind: to purify water as much as possible before releasing it back into the environment to maintain the safety and well-being of people and the Earth.

Wastewater treatment safeguards both the environment and people.

There are substances in wastewater that are harmful to both people and the environment. Wastewater treatment facilities aid in water filtration and assist to prevent problems like those that are now present in developing nations. Unclean water provides serious health concerns and is responsible for 1.7 million fatalities yearly, more than 90% of which occur in underdeveloped nations. Numerous water-related illnesses, such as cholera and schistosomiasis, continue to be prevalent in many poor nations where only a very tiny portion (in some instances less than 5 percent) of residential and municipal wastewater is treated before being released into the environment.

The ecology is also safeguarded through wastewater treatment. Fresh water is necessary for fish and other aquatic life. They can't live in sewage-filled water environments. Excessive levels of chemicals, including nitrogen and phosphates, may induce excessive plant growth and the discharge of toxins into water in streams, rivers, and other large bodies of water. Dead zones, where fish and other aquatic life can no longer live, are caused by the lack of oxygen.

Role of Green technologies in wastewater treatment

Clean energies, non-toxic chemical procedures, and environmental monitoring are all part of the category of techniques known as "green energy technologies." We can reduce or delay the harmful effects of human activity by employing green energy technology. Sustainable water management may be achieved using green energy technology. Green energy technology may effectively cleanse water without producing harmful compounds or poisonous byproducts. Furthermore, these green techniques may help sewage treatment, water management technology, and trash management.

Wastewater treatment is the process of eliminating impurities and unwelcome elements from home, industrial, and contaminated waterways in order to safely release them into the environment for drinking, irrigating, industrial, and other purposes. Infrastructure for the treatment of water and wastewater using green technology may be developed in underdeveloped nations at a reasonable cost. Traditional wastewater treatment methods are costly and need complicated operations and maintenance. The most popular green technologies for sustainable water management are new wastewater treatment techniques like bioreactors and biofiltration used in sewage treatment techniques. Devices that house bacteria and other microorganisms are called bioreactors. To hasten biological processes, oxygen is given. These processes will ultimately change dangerous contaminants into non-toxic ones. In biofiltrations, wastewater is routed through the biofilm either up-flow or down-flow, continuously or intermittently. The live microorganisms that have been immobilised speed up the breakdown of the contaminants and organic debris in the wastewater during this phase.

It is vital to apply current technology to transform wastewater into useable water since over 80% of the water provided for home consumption is delivered as wastewater. Green technologies, including bioreactors and biofiltrations, merely come in handy and play a big part.Advanced green technologies (AGTs) are a set of realistic approaches and materials that use non-toxic chemical processes, clean energy sources, and environmental monitoring to reduce or eliminate the negative effects of human activities. These attempts are to improve sustainability, by securing societal demands without causing further damage to or depletion of remaining natural resources.

Traditional wastewater treatment processes are costly and hard to operate and maintain. The most popular green solutions for sustainable water management are new wastewater treatment technologies, such as bioreactors and bio-filtration used by sewage treatment technology.

Bioreactors are containers that hold bacteria and other microbes. Biochemical reactions are sped up by the addition of oxygen. As a result of these processes, dangerous contaminants will eventually be converted to non-toxic forms. Water is carried through the biofilm in bio-filtration either up-flow or down-flow, and in a continuous or discontinuous way. The immobilized live microorganisms speed up the breakdown of organic debris and contaminants in the wastewater during this phase.

This could be accomplished:

A. When manufactured goods and products are recycled;
B. By improving human production and consumption behavior to reduce waste and pollution;

C. Clean alternative technologies and energies are being developed to replace those that have been shown to harm human health and pollute the environment;
D. By establishing cost-effective approaches for implementing and commercializing related technologies, as well as supporting the creation of new employment and vocations in the industry.

Use of Green Technology in Water Recycling

The following are some of the water reclamation processes that can be used:

Membrane Bioreactor Solutions - These systems combine biological, secondary, and tertiary wastewater treatment into a single process. Its goal is to lower the carbon footprint associated with sludge sewage treatment. It employs a high amount of organic and microbial removal, as well as nutrient removal.

Reverse Osmosis Systems (ROS) - This is a supportive treatment that is applied after the water has been pre-treated to eliminate undesired particles. For safer use, the water is desalinated using a reverse osmosis system, which provides an effective barrier against microorganisms. It makes use of a semi-permeable membrane, which is a thin membrane with microscopic pores that allows only pure water to pass through.

Ultrafiltration Solutions -Ultrafiltration solutions are widely employed when water is treated for drinking purposes. It employs membrane filtration, in which particles are separated from liquid or gas mixtures by a force such as pressure. Water viruses, bacteria, protozoa, and other pathogens are effectively removed because it is used for human consumption.

Electro dialysis Reversal - This is a desalination method in which electricity is applied to electrodes to separate salt and other particles. It is self-cleaning and therefore ideal for murky wastewater. Electrodialysis reversal has one of the best recovery rates in water-scarce settings.

Applications of Advance Green Technologies or AGTs

Bioreactors

The notion of a bioreactor underpins the most widely used advanced wastewater technology for wastewater treatment. A bioreactor is, essentially, a container that contains bacteria and other microorganisms that have been added to, or immobilised on, one of the following surfaces: a packed bed, a fibrous bed, a membrane, or a moving bed biofilm reactor. In order to speed up the separation of liquid water from the biosolids, separators often found in bioreactors are connected to sequential tanks and include a mechanical separator as well. Additionally, they include oxygen supply aerators designed to hasten the metabolic processes carried out by live microorganisms.

The biochemical processes that are triggered when wastewater comes into touch with the bacteria and other microorganisms on the bioreactor's platform result in the contamination or pollution of the environment being changed into less harmful or non-toxic forms. When dealing with wastewater that contains metals, bioreactors infused with sulfate-reducing bacteria (SRB) create hydrogen sulphide, which precipitates the dissolved metals as insoluble metal sulphides that are recovered as valuable byproducts.

Biofiltration

A biofilm is created on a biofilter by growing a few specific types of bacteria and other microorganisms. Following that, either continuously or intermittently, the wastewater is fed through the biofilm in an upflow or downflow configuration. As a result, the wastewater's organic materials and contaminants are degraded more quickly by the immobilised live microorganisms. The effectiveness of the biofilm and the quality of the treated wastewater that results are strongly influenced by factors like the activity of the microorganisms, the age of the biofilm, the oxygen levels, the temperature, and the composition of the water. The removal of heavy metals from industrial wastewater is another purpose for this form of AGT, which is often employed for treating household wastewater.

Bioremediation

With the help of living microorganisms, polluted wastewater sites may be cleaned up using a bioremediation technique that produces less harmful or nontoxic materials by removing and neutralising dangerous species and pollutants. Both in-situ and ex-situ procedures are available. In-situ remediation procedures include the direct addition of living microorganisms to polluted areas, whereas ex-situ remediation involves treating contaminated locations elsewhere.

However, because not all pollutants can be removed by bioremediation or biofiltration, live microorganisms have their limitations when it comes to the treatment of contaminants and dangerous species. Heavy metals such as lead, mercury, cadmium, nickel, and other elements are examples. As a result, many cutting-edge green technologies, such as electrocoagulation and emew electrowinning, have been created for that aim.

Electrowinning

An electrolyte solution-immersed cathode and anode are used in the electrowinning process to transfer current between them. Following that, metals are electroextracted from their dissolved cation-oxidized states. The metals are then deposited on the cathode. As a result, wastewater may be electrowined to recover heavy metals including copper, nickel, silver, gold, cadmium, bismuth, cobalt, and others.

Electrowinning

The AGT's "emew electrowinning" employs a vigorous circulating flow of electrolyte as opposed to traditional electrowinning, which uses a bath where the electrolytes are gently circulated or completely left stagnant. The capacity to recover metals down to extremely low concentrations is made possible by this considerably improving the diffusion of metal species to the cathode, which increases deposition rates. Thus, the quantity of metal recovered to produce cleaner water rises when wastewater is treated using emew electrowinning technology. The chart below contrasts the differences between traditional electrowinning and emew electrowinning, as well as the effectiveness of metal removal that results as a function of time.

AGTs are now used in a variety of industries, including energy and environmental clean-up.

Energy -The development of alternative fuels is one key application field for AGTs. Wind turbines, solar cells, and bioreactors are among the clean, renewable, and efficient new energy sources being developed and implemented. These alternatives generate electricity without polluting the environment like traditional fossil fuels do.

Monitoring the environment and conserving energy -Monitoring, which includes weather forecasting, remote online monitoring of discharges using cognitive reasoning, and other applications, is another application field of AGTs.

Advanced weather forecasting is used to predict weather and its impact on infrastructure in order to reduce energy waste and greenhouse gas emissions when combined with building monitoring. Municipalities, enterprises, and environmental agencies can track effluents and discharges in real time using remote, online monitoring systems integrated with the Internet of Things (IoT), and make process or other changes as needed to ensure compliance.

Non-toxic chemical processes, clean energies, and environmental monitoring are all examples of green energy technologies. We can reduce or eliminate the harmful effects of human activities by utilizing green energy solutions. These can be used to manage water in a sustainable way. Green energy solutions may effectively purify water without generating dangerous compounds or poisonous by-products. Furthermore, these green methods can assist sewage treatment, water management technology, and waste management.

This overview demonstrates the promise and potential of modern green technologies in wastewater treatment and environmental remediation, which will become increasingly significant as the globe shifts towards clean energy and waste resource recovery.

Water is in short supply due to the rising demand for it. Finding solutions to keep it going is becoming increasingly critical. Experts are increasingly researching wastewater processing due to technological advancements. Unwanted substances and toxins that contaminate the water are taken out during the wastewater treatment procedure. With the use of green technology, it will be possible to safely reintroduce contaminated home and industrial water supplies into the environment for drinking, irrigation, and other uses. Urban water management has to be done well if these goals are to be met. More details regarding how green technology might aid in wastewater treatment will become available.

CHAPTER 7

FUNDAMENTALS OF WASTEWATER TREATMENT

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Diverse water sources are accommodated via water recycling or water reclamation. These wastewater sources include municipal wastewater, agricultural runoff, and precipitation. The goal of treating this wastewater is to make it "fit-for-purpose standards" for the subsequent usage and to guarantee that it is secure for environmental protection and public health.

Even though the treated wastewater is not meant for human consumption, it must still be clean if it will be used as irrigation since unclean water may damage plants and soil. Wastewater comes in two flavours: unplanned and planned. While the planned wastewater is the groundwater supply from bodies of water, irrigation for agriculture and landscaping, etc., the unplanned wastewater is the previously utilised water.

Wastewater as a Potential Energy Source

Energy may be produced from wastewater, depending on the water supply. Typically, anaerobic digestion is used to provide heat throughout the wastewater treatment process. Microorganism materials from the wastewater may be broken down by anaerobic digestion. Methane gas is created during this process, which results in the production of heat and power.

Wastewater energy is converted through chemical, thermal, and electrical processes. The amount of potential energy that may be produced depends on the treatment strategy.

Positive Effects of Wastewater Treatment

Even in large volumes, there is plenty supply to meet the demand for water use. The water that will be used for industrial and agricultural reasons may originate from recycled water, preventing the degradation of water quality.

In the long term, wastewater treatment improves stream and wetland ecosystems. The habitat for animals will prosper, fisheries breeding grounds will be better, and flood risk will decrease if the water quality is improved. Wastewater treatment technology are a major aid in nations where drought is a prevalent concern.

According to study, the usage of chemical fertilisers is decreased if recycled water is employed in the agricultural sector. This is due to the fact that following reclamation, nutrients like potassium, nitrogen, and phosphorus continue to be present in the water. Due to its additional advantages, water may feed the soil on its own. According to research, a location's usage of freshwater from

the main water supply is significantly reduced by roughly millions of gallons each day. Water scarcity is avoided when just a tiny portion of a region's water is used from its reserves.

In addition to other water conservation methods, water recycling is a simple way to successfully satisfy everyday industrial, home, and environmental needs. The demand on the freshwater supply is lessened by using treated water. Waterborne infections are successfully eradicated by wastewater treatment, a sanitation procedure. Protection of the public's health and safety is provided. Recycled water is purportedly pathogen-free and safe for human contact, even intimate touch. It is nevertheless crucial that it be chemical-free even if it won't be utilised for human consumption in order to prevent further environmental damage.

Use of Green Technology in Water Recycling

The following procedures may be used in water reclamation:

Membrane bioreactor solutions combine biological, secondary, and tertiary wastewater treatment processes in a single phase. It seeks to lessen the carbon footprint that may be seen in the sludge sewage treatment process. It uses sophisticated methods for removing organic material, microorganisms, and nutrients.

Ultrafiltrations Solutions - The ultrafiltration solutions are often employed when treating water for drinking. Utilizing a membrane filter, it separates particles from liquid or gas mixes using a force like pressure. Since the water is intended for human consumption, viruses, bacteria, protozoa, etc. are successfully eradicated. Through this procedure, the surplus plasma volume is decreased without affecting the electrolytes of the water.

Reverse osmosis systems: This procedure is referred to as a supportive treatment since it is used after water has undergone a pre-treatment to eliminate impurities. Reverse osmosis is used to desalinate the water, which creates a strong barrier against microorganisms for safer usage. To make sure that only clean water can flow through, it uses a semi-permeable, thin membrane with tiny holes.

With the use of electricity applied against electrodes, the desalination process known as "electrodialysis reversal" separates salt and other particles. Because it is self-cleaning, it can handle turbid wastewater. The use of electrodialysis reversal produces one of the greatest recoveries in water-scarce locations.

Systems for Thermal Evaporation and Crystallization - Evaporation and crystallisation are often used for the treatment of wastewater in brine, streams, or ocean. It collaborates with other techniques, such reverse osmosis, to create Zero Liquid Effluent Discharge systems. This disposal method is affordable, making it popular with businesses that have their own recycling system.

Examples of green energy technology include environmental monitoring, clean energies, and non-toxic chemical processes. By using green energy alternatives, we can lessen or even get rid of the negative impacts of human activity. These may be used for sustainable water management. Green energy technologies have the potential to properly cleanse water without releasing any harmful

byproducts or substances. These environmentally friendly techniques may also help with trash management, water management technologies, and sewage treatment.

This promise and potential of contemporary green technology in environmental remediation and wastewater treatment, which will become more and more important as the world moves toward clean energy and waste resource recovery.

Get in touch with us right now to learn more about our wastewater treatment options, water and wastewater technology, and environmental initiatives.

Green Technology in Agriculture

As illustrated in Figure 2, Agriculture is one of the most significant contributors to environmental degradation. The production, transportation, and consumption of food are very carbon-intensive, and it produces vast amounts of fossil fuels that end up in our atmosphere, accelerating global warming. With population numbers rising and living standards increasing, it has become more critical than ever to focus on green technology available in agriculture.

Agriculture is one of the most significant contributors to environmental degradation. The production, transportation, and consumption of food are very carbon-intensive, and it produces vast amounts of fossil fuels that end up in our atmosphere, accelerating global warming. With population numbers rising and living standards increasing, it has become more critical than ever to focus on green technology available in agriculture.

Figure 2: Green Technology in Agriculture

The leading green technologies and techniques that help make farming more environmentally sustainable are renewable energy, zero tillage, biotechnology, organic agriculture, vertical

farming, irrigation, integrated pest management, drones, fleet management, agricultural robots, and digital sensors.

Green technology works to reduce the negative impacts of humans on the environment. When implemented correctly, they will support the human population on Earth and give future generation successful agricultural methods. Green technology is vital for agriculture because they reduce environmental damage, produce less fossil fuel as by-products, and aid in sustainable agricultural development. These are the prime reasons for calling them clean technology.

Renewable Energy

Renewable energy is essential for sustainable agriculture. A renewable resource is a natural resource that can refill itself to replace what has been consumed. The renewable resource cannot run out. Most of the agricultural machinery currently runs on fossil fuels, releasing greenhouse gas emissions into the atmosphere and contributing to climate change.

Since people can harvest these natural resources forever, renewable energy and agriculture are a great combination. These can give farmers a long-term source of income.

Agriculture has a lot of potential to contribute to the creation and use of solar, wind, geothermal, and biomass energy. The United States is home to a large number of renewable resources that are geographically dispersed. To use these resources, a variety of commercial technologies are available. With the right assistance, further technologies - some with the potential to disrupt paradigms - might also be commercialised.

This is a "back to the future" scenario in many aspects, including the trend toward more self-sufficient farms and the importance of agriculture to the U.S. energy supply. Increased use of renewable energy in and by agriculture reminds one of Henry Ford's visions of cars running on alcohol and water pumps being powered by windmills. Many on-farm energy needs, from water pumping to space heating, are increasingly being met entirely or in part by renewable technology. Farmers and ranchers are selling energy in greater numbers (e.g., electricity generated from wind turbines, biofuels, and products from biomass). Through increasing energy source diversification, higher energy self-sufficiency, and less environmental effect, this is helping to boost energy security in agriculture.

There are many energy futures available to the US. One option is to continue on the current path. The "Green Revolution" of raising agricultural production has been significantly fueled by fossil fuels for automated farming. More than seventy-five percent of agricultural energy usage is now accounted for by three energy inputs: diesel fuel, fertilizer, and electricity. (2004) Miranowski When oil output and consumption reach the projected levels, America will rely more and more on foreign oil imports, increasing its vulnerability to oil interruptions and price increases (Figure 1). Even a brief interruption of the electricity supply in the agricultural sector might result in a significant decrease or full loss of a growing season. Farmers often cannot pass on price hikes for energy or fertilizer to consumers since they are price-takers for their commodities, therefore they earn a reduced return for their goods as prices rise.

Many problems caused by the usage of fossil fuels may be solved by renewable energy. It doesn't depend on foreign fuels and emits little to no pollution into the environment. Unlike fossil fuels, which have a limited supply, renewable resources are abundantly accessible nationwide. Although cost has been an issue since the first wave of interest in renewable energy in the 1970s, price competitiveness has considerably improved. These innovations now provide 6.1 quadrillion British Thermal Units (Btu) for home energy use.

The development of various renewable technologies is at varying stages. Others show promise over the long run and are either commercially available or almost so. Sadly, many of the advantages that renewable energy might provide are not monetized and cannot be understood via price signals. To advance or retard the commercialization of these novel technologies, policies are required. Solar, wind, geothermal, and biomass energy technologies are all covered in this article, along with their domestic status and future prospects.

Solar

Solar technology generates thermal or electrical energy. Semiconductors like crystalline silicon or different thin-film materials are used to create photovoltaic (PV) cells, sometimes known as "solar cells," which convert light directly into energy. Solar thermal methods capture solar energy and utilise it to either generate electricity directly via traditional steam cycles, heat engines, or other producing processes, or they may use it to directly heat water and spaces (concentrating solar systems). In the future, hydrogen might be produced from solar energy to supply power, chemicals, and transportation fuels, as well as to act as a kind of energy storage when the sun isn't out.

Technology has led to a steady decline in the price of these products, and rising power prices may close the remaining difference. Solar energy may be more cost-effective in areas with high power bills, even if solar resource availability is highest in the Southwest (approximately 25% more than the national average). For instance, the cost of power in New York may be 50% more expensive than in Arizona (U.S. Department of Energy, Solar Energy Technologies Program, 2003). Where the distance is too vast to warrant additional power lines in agriculture, PV can affordably deliver energy. Lighting, battery charging, tiny motors, water pumping, and electric fencing may all be powered by solar electric systems.

Operations involving livestock and dairy products often need to heat a lot of air and water. For instance, heating water for cleaning equipment consumes a significant amount of energy on commercial dairy farms. Up to 40% of the energy used on a dairy farm may be attributed to warming water and chilling milk. To meet all or any of these hot water needs, solar water heating devices may be employed. Sun heating for greenhouses and solar crop drying are further solar applications (National Renewable Energy Laboratory, n.d.).

As new technologies improve solar cell performance and lower prices, the number of solar energy uses is anticipated to expand. In comparison to the best currently commercially available solar cells, which have conversion efficiencies of up to 30%, new "quantum dot" materials have the potential to potentially more than quadruple efficiency, turning 65 percent of the sun's energy into power. Additionally, research is being done to find ways to lower the cost of solar water heating systems by using materials like plastics rather than metals and glass.

Wind Energy

Mechanical and electrical energy are produced by wind technology. An electric generator is driven by rotor blades that are turned by the wind, converting the kinetic energy of the wind into electrical energy. Wind power is a renewable energy source, and wind turbines don't emit any pollutants. Utility-scale turbine sizes vary from 750 kW to 5 MW, with the majority of turbines topping 1 MW. Wind farms, which provide a large amount of electricity to the electrical grid, often have groups of turbines. Minor wind turbines come in a variety of sizes, ranging from 0.4 to 1.5 kW generators for small loads like battery charging for yachts and tiny cabins to 3 to 15 kW systems for a house to those that produce up to 100 kW of power for bigger loads like small businesses.

Due to significant advancements in cost reduction for locations with consistently strong wind speeds, wind power technology is now widely used. 9,149 MW of the country's power producing capacity was provided by wind by the end of 2005. This produces the same amount of power each year that more than 2 million typical American families need, based on a capacity factor of 31% on average. In 30 states, there are wind energy plants for commercial use (American Wind Energy Association, 2006). Modern wind turbines with high wind speeds may generate energy for a few cents per kilowatt-hour (kWh), which is comparable to the price of fossil fuel-fired power plants.

Small wind systems may support agriculture in conventional ways, including by employing mechanical energy to mill grain or pump water. By eliminating the cost of putting up transmission cables, particularly in more distant applications, tiny electricity-generating units may potentially become economically effective as costs decline. When production exceeds internal needs, tiny windmills that are linked to the electrical distribution system might produce income via electricity sales. In order to produce power that is both reasonably priced and dependable, decentralised wind systems can be combined with other energy sources to create a hybrid energy system. In this system, the intermittent and expensive wind resource is supplemented by more expensive small generators like diesel generators or batteries (Bergey, 2000). According to estimates from the small wind turbine business, there are sufficient wind resources throughout 60% of the United States, and 24% of people reside in rural regions where zoning and building regulations allow for the installation of tiny wind turbines (National Renewable Energy Technology, 2004). Agricultural producers are projected to employ wind energy more often as a result of rising economic efficiency thanks to technical advancements as they seek to reduce energy costs and boost energy independence.

Geothermal

Geothermal technologies generate thermal or electrical energy. Dry steam plants, flash steam plants, and binary-cycle plants are the three kinds of geothermal power plants now in operation. Power is produced from geothermal resources with high temperatures (more than 300°F).

The size of a single power plant may range from 100 kW to 100 MW. Both national grid applications and applications for rural electric mini-grids may use the technology. Direct use of geothermal energy's heat is also possible. Geothermal fluids may be utilised for a variety of tasks, including heating buildings, pasteurising milk, drying onions and garlic, growing plants in greenhouses, and heating water for fish aquaculture. Resources that can withstand temperatures

between 70°F and 300°F are often utilised. Geothermal heat pumps are another kind of technology that may be used for room heating and cooling. The near-surface earth is used as a heat source during the heating season and as a heat sink during the cooling season, hence this technique does not need a hydrothermal (hot water) supply. The average cost of geothermal-generated electricity has been dropping, even if prices of these facilities vary depending on the resource's nature and the scope of the project. Geothermal power prices in 1980 varied from 10 to 14 cents per kWh. It currently costs between 4 and 7 cents per kWh since new technology have brought down the prices of exploration, producing fields, and power plants. Over 2,500 MWe of installed geothermal energy capacity are available in the US, with capacity factors sometimes surpassing 90%. This would be enough to meet the energy requirements of over two million homes.

More than 10,000 thermal megawatts (MWt) are produced directly or via non-electric sources, including geothermal heat pumps. In direct use systems, power is measured in megawatts of heat as opposed to megawatts of electricity in power plants (Lund, 2005). Using the same resource concurrently for multiple uses, such as heating and electricity, is referred to as "cascading" geothermal energy in certain projects. Cascades increase economics and resource use efficiency.

The low-to-medium temperature geothermal resource base is substantially more abundant and broad than the high temperature resource base. The western United States is home to low- and medium-temperature geothermal resources. In 16 western states, the Geo-Heat Center in Oregon has located more than 9,000 thermal wells and springs, more than 900 low-to-moderate temperature geothermal resource locations, and hundreds of sites that utilise this energy directly. Within five miles of settlements, 404 resource locations with a potential population of 9.2 million people are located in these states (Geo-Heat Center, n.d.).

There are several uses for geothermal energy in agriculture. 43 greenhouse businesses using geothermal energy to heat them produce vegetable, floral, ornamental, and tree seedlings. Catfish, tilapia, shrimp, alligators, tropical fish, and other aquatic species are grown at 49 geothermal aquaculture facilities. Dehydration of food, grain drying, and mushroom cultivation are all examples of agri-industrial uses. The main industrial usage of geothermal energy is for drying onions and garlic (Lund, 2005).

In the majority of rural locations, ground source heat pumps may be used. In the US, between 600,000 and 800,000 ground source heat pumps are now in operation. Midwestern, mid-Atlantic, and southern states (from North Dakota to Florida) account for the bulk of geothermal heat pump installations in the US (Lund, 2005).

Future innovations like improved geothermal systems (EGS) promise to lower the price of geothermal energy. To boost fluid movement beneath and enable heat extraction, they may be created by fracturing rock. Projects now under progress in Europe and Australia are expanding our understanding of how to employ EGS for power generation.

Bio-refineries

The term "biorefinery," which refers to a facility where innovative technologies are used to extract energy and other valuable products from biomass resources, is central to discussions about

renewable energy derived from biomass. Similar to oil refineries, biorefineries are thought of as industrial establishments that transform a stream of raw materials into a variety of products, optimising value by adjusting the output mix to suit changing market circumstances. Products from a biorefinery might include energy, steam, high-value chemicals, and liquid fuels like biodiesel and ethanol. Many of these goods have the potential to take the place of petroleum, either as a source of chemical feedstock or as a fuel for cars, which would boost energy security and lower emissions into the atmosphere.

Biorefineries are already present in certain ways. For instance, they convert trees into a range of wood products, power, and heat, or they turn maize into ethanol, corn syrup, animal feed, and other items. For the next generation of biorefineries, researchers are creating methods for using the substantial quantity of energy present in plant cellulose, a challenging but possibly fruitful endeavour. Enzymes are utilised in one biochemical process (known as the sugar platform) to split apart the molecules of cellulose, producing sugars that may then be processed further to produce industrial and consumer goods or fermented to produce ethanol. The syngas platform is a thermochemical process that includes heating biomass to create a gas made of a few basic molecules, which is subsequently transformed into fuels and other goods via chemical or biological processes. Additionally, scientists are working to generate crops specifically suited for certain biorefinery endproducts utilising breakthroughs in plant genetics and biochemistry.

Here, we have listed some of the most commonly used renewable energy sources in agriculture.

A. Solar technologies are very versatile for agricultural usage. It works by converting solar light radiation into electrical energy. Farmers can use the electricity generated from the sun for running farm machinery, lighting, and water pumping.
B. Solar thermal technologies are another green technology that is becoming more favored. It works by converting solar heat radiation into heat energy. Some of the common uses are for water heating, underground soil heating, and solar greenhouses.
C. Wind turbines are a popular choice for farmers because they don’t use up much land. Farmers can use them for pumping water for irrigation.
D. Biomass is derived from biological organisms such as plants, animal waste, and corn. This material is then converted into energy by burning. The heat is used directly for heating buildings, drying crops, and dairy operations. Additionally, it is also be used for producing steam and generating electricity.

Zero Tillage

Zero tillage, also known as no-till farming, is a method that eliminates the need to plow the soil or the usage of any heavy farm machinery. Since the soil is not disturbed as with traditional farming methods, fewer greenhouse gases are released from the ground. Consequently, there is less soil erosion and runoff. Additionally, zero tillage also improves the rate of soil carbon sequestration, which is the amount of carbon the soil absorbs and stores. It also utilizes crop residue left on the soil surface from the previous crop.

With the use of mechanical agitation, such as digging, stirring, and overturning, agricultural soil is prepared for planting. Zero tillage refers to a method of planting crops that involves drilling the

seed directly into the ground without first preparing the soil or disturbing any existing crop residue. Zero tillage is preferable to tillage since it not only lowers cultivation costs but also cuts down on weed growth, crop duration, soil erosion, and irrigation needs. Zero tillage, often known as no tillage or nil tillage, is a farming method.

No-till agriculture in India

In the 1960s, farmers in India began using the No Till method. In the Indo-Gangetic plains, where rice-wheat crops are grown, the zero-tillage method is used. Without doing any operations, wheat will be sown following rice harvest. By lowering their cultivation costs, the hundreds of farmers that use the same technology increase their yields and earnings. The ZT technique is used to cultivate rice and maize in the southern districts of Andhra Pradesh state, such as Guntur and certain areas of West Godavari.

The rice-wheat production method was made possible by the green revolution in India's north-western regions. However, as time passes, the yields of rice and wheat stagnate as a result of poor soil and water management practises and late wheat planting since rice is produced in the hot season and wheat in the winter, and both practises are incongruous. The zero tillage technique was developed in the 1990s to help solve the issue by drilling the wheat directly into the ground without any prior tillage or land preparation.

The equipment used to drill seed into uncultivated ground is essential to the achievement of zero tillage. A seed drilling prototype was unveiled by CIMMYT in the late 1980s. The GB Pant University in India created the first locally produced seed drill with a motor to lower the price, increase availability, and make it more accessible and cheap. Using a rice-wheat cropping technique, the drills are pulled by tractors.

In the kharif season, direct-seeded rice, maize, soybean, cotton, pigeonpea, mungbean, clusterbean, and pearl millet perform better when planted with zero tillage than they do in the rabi season when they are planted with wheat, barley, chickpea, mustard, and lentil. By using this method instead of traditionally tilled wheat, it is possible to advance the planting of wheat following rice by 10 to 12 days, preventing the decline of wheat yield that results from late sowing. Wheat crops may take use of ZT's possibility to avoid heat stress's terminal effects. Due to lower costs associated with soil preparation and reduced fuel consumption per hectare, zero tillage decreases cultivation costs by close to Rs 2,500–3,000/ha. The crop's need for less water and the oxidation-related loss of organic carbon are both decreased by zero tillage. Wheat's slight Phalaris issue is reduced with zero tillage. Surface soil (0–5 cm) with zero tillage, especially when crop residue is retained, considerably improves the soil's carbon status (Ref: Policy paper 31 - Doubling Strategy for Doubling Income of Farmers in India).

Benefits of Zero tillage

1. To produce larger yields, the crop length might be shortened, leading to early planting.
2. a saving of around 80% is achieved via a reduction in the cost of the inputs used in land preparation.
3. The amount of irrigations may be cut down while still using residual moisture.

4. The soil is replenished with both dry and organic particles.
5. Safe for the environment - Carbon sequestration will lessen the greenhouse impact.
6. No-tillage practises lessen soil compaction, cut down on runoff, and stop soil erosion.
7. No-Till fields feature more beneficial flora and fauna due to the intact soil and lack of disturbance.

Organic Farming

Organic farming uses environmentally friendly farming methods to improve soil and human health, simultaneously protecting the environment. It uses higher quality soils which means better crop productivity of organic food, making it a more economically competitive option. Organic farming has less need for fertilizers and pesticides, which require many fossil fuels.

Instead, Organic farming uses crop rotations and manure to control pests, disease, and weeds. Using organic technology mitigates the effects of global warming. It also uses less energy and promotes more incredible biodiversity.

Sales from organic farming in the US surpassed $45 billion in 2017 due to the industry's recent strong growth. Between 2011 and 2018, the quantity of land devoted to organic farming rose by as much as 20%. However, the sector still has a lot of growth inhibitors. Since organic farming only makes up a tiny portion of farming in the US, even with 20% additional acres, it is still a relatively new practise. The additional time and resources needed to run an organic farm are among the main contributing reasons. The key to advancing the growth of organic farming and food production will be finding solutions to issues like how to lengthen growing seasons and boost crop yields while still using organic practises.

Green technology may be useful. Some of the most prosperous organic farms have already discovered organic methods to incorporate modern green technology into their operations. Alternative energy is a natural match since it can help provide more electricity with a less environmental impact. In actuality, passive solar energy in particular has the ability to transform unoccupied or underutilised space into a source of energy.

A significant problem is lack of space. Crop yields may be enhanced using contemporary farming techniques in a limited area, and this is especially true if you're not worried about soil erosion, runoff, and other environmental problems. Therefore, the development of vertical farming techniques is one area where new technology are assisting in the support of organic ways. In addition to lowering the environmental effect of the process from farm to table, this technology may be used in combination with organic agricultural practises to help bring sustainable farming to urban areas. By offering a low-energy approach to monitor big regions, even drones are being utilised as a tool to assist organic agricultural practises. Having "eyes in the sky" helps to encourage sustainability while making it simpler to develop across wide regions since human attention is so crucial to operating a sustainable farm.

These are just a few examples of how green technology is already promoting the expansion and prosperity of organic farming. Contrary to popular belief, technology is constantly being used into the production of organic food. The use of software and other planning technology in sustaining

an organic farm is one significant area of development that sometimes gets neglected. Our capacity to sustainably manage agriculture increases as data analysis techniques advance. Every organic project involves some level of fine-tuning, therefore the use of farm management software in organic farming is only logical.

In order to boost crop yields, shorten grow periods, and make organic products more widely available, new technology, whether expressly green or not, may be beneficial supports for an organic farm. After all, the greatest way to reap the benefits of organic farming on the environment is to increase its use. One of the reasons why so many organic farmers are involved in cutting-edge environmental research is because green technology makes it simpler to achieve. We may discover even more methods for green technology to assist sustainable development and aid in the expansion of organic farming as we learn more about the environment and effective agricultural management.

The practise of "organic farming" involves avoiding or drastically reducing the use of synthetic fertilisers, pesticides, growth regulators, genetically modified organisms, and feed additives. Crop rotations, use of crop residues, animal manures, legumes, green manures, off-farm organic wastes, biofertilizers, mechanical cultivation, mineral-bearing rocks, and components of biological control are all used to the fullest extent in organic farming systems to maintain soil productivity and tilth, supply plant nutrients, and control pests like insects and weeds.

Organic farming practises may increase farm productivity, restore decades' worth of environmental damage, and link small farm families to more sustainable distribution networks, enhancing food security, provided they are organised in terms of production, certification, and marketing. As more farmers have shown little interest in farming over the last several years, many who used to crop are moving to other areas. Organic farming is one way to promote either food security or self-sufficiency. The land and water are severely contaminated by the use of dangerous pesticides and massive quantities of artificial fertilisers. This has negative effects on the ecosystem, such as soil erosion, reduced soil fertility, polluted surface and ground water, and genetic variety loss.

Organic farming, a thorough approach of production management, promotes and enhances the health of agro-ecosystems, including biodiversity, biological cycles, and soil biological activity. According to several studies, utilising organic farming methods may lead to yields that are even higher than those attained using conventional methods. Additionally, there may be a discernible difference in the indices of soil health, such as the ability to mineralize nitrogen and the variety and richness of microorganisms, which were higher in the organic farms. The occurrences of insects and illnesses were significantly reduced as a result of the increased soil health in organic farms. By focusing more on small-scale integrated agricultural systems, rural towns' economies may be revitalised.

The advantages of organic agriculture

1. It improves the health of the environment by reducing contaminants.
2. The product poses less threats to the health of people and animals since it contains fewer residues.
3. It helps to keep agricultural production at a level that can be sustained.

4. It improves the health of the soil and reduces the cost of agricultural produce.
5. It helps to ensure that natural resources are used as efficiently as possible in the near term while simultaneously preserving them for future generations.
6. It not only reduces the need for energy for both equipment and animals, but it also greatly reduces the possibility of crop failure.
7. It improves the soil's physical properties, including granulation, outstanding tilth, good aeration, simple root penetration, and increased water-holding capacity while reducing erosion.
8. It improves the chemical properties of the soil, such as nutrient availability and retention, reduces nutrient loss into the environment and water bodies, and promotes advantageous chemical interactions.

Drones

As a green technology to increase sustainability and aid in the battle against climate change, drones have become crucial in the agriculture industry. It enhances precision agriculture. It does away with the need for speculation and helps farmers operate more sustainably by increasing their productivity.

Due to their many potential uses, drones are being used in an expanding number of spheres of life. Drones are already used in research, renewable energy, geology, and agriculture, which opens the way to a prosperous future. But is it an ally or foe when it comes to sustainability?

Drones, commonly referred to as unmanned aerial vehicles, are basically flying robots that may be remotely controlled or fly on their own utilising flight plans managed by software, onboard sensors, and a global positioning system (GPS). Drone usage has grown quickly because, in contrast to human aircraft, it can hover for long periods of time, it is far less costly than other aircraft, and it poses no danger to the flight crew since it is managed remotely.

Drones' technological advancements may have a positive impact on our planet:

1. Data Collection

Perhaps drones' most obvious contribution to the battle against climate change is data collecting. Drones can access places that are hard for people to reach, which reduces research costs and increases the accuracy of data collection.

Researchers have used drones to measure surface reflectivity and keep track of how much solar energy is reflected and absorbed by a certain area. When determining where to grow trees to maximise climatic advantages, forest managers may use this measurement, which is crucial for understanding climate change. While satellites were often utilised in the past to collect this data, drones have the benefit of being more manoeuvrable.

2. Reduction in Gas Emissions

According to a research comparing the environmental effects of different "last-mile" delivery techniques, which transport packages on their last leg of travel, drones emit 84% less greenhouse gases per item than diesel vehicles do. Additionally, compared to vehicles, drones use up to 94%

less energy each package. The greatest potential for lowering carbon dioxide emissions from cars travelling to individual households from loading sites comes from the deployment of drones for the latter phases of small item distribution.

The amount of CO_2 in the atmosphere has increased by 50% as a consequence of human-caused CO_2 emissions, from around 275 parts per million (ppm) before the industrial revolution to over 410 ppm in 2020. The concentrations of greenhouse gases are increasing much too rapidly, according to the UN, to maintain global warming below the planned 1.5 degrees Celsius. They are a significant contributor to air pollutants that harm human health and safety. The findings show that drone-based autonomous applications may reduce worldwide GHG emissions by 0.9 to 2.4 gigatons of CO_2 equivalent (GtCO2e) by 2030, assisting in hastening the transition to a low-carbon society.

3. Planting Trees Due to the worsening environmental circumstances in today's world, nature is fighting to complete its job. The use of drones to disperse seeds might aid in the cooling of the planet by fast creating new forests, repairing regions that have been harvested for lumber, reseeding in fire-devastated zones more quickly, and reaching difficult-to-reach locations.

According to estimates from the FAO (Food and Agriculture Organization), between 20 and 40% of the world's agricultural yield is lost each year to pests. Plant diseases cost the world economy over $220 billion annually, while invasive insects cost the economy about $70 billion.

IoT sensors, cameras, microphones, satellite systems, control, and robots are all used in precision agriculture to provide autonomous real-time monitoring of plant health, productivity, and environmental implications. By using these technologies more often, emissions might be reduced by 4.3% on average while disease-related product loss is kept to a minimum.

The contemporary agricultural business is at a crossroads with the global supply at an all-time high and commodity prices at an all-time low as a consequence of rising demands in food production and consumption. The "farm to fork" movement has seen increasing pressure for improved product traceability as consumers become more interested in the origin of the goods they buy and how they were grown. Farmers and agronomists around the world are in more need than ever to improve resource management in response to constricting budgets.

Furthermore, the agricultural sector continues to face increasing complexity in maintaining the supply chain's security due to climate change. The most recent data indicate that the total loss to agriculture in Europe from climate change might be as high as 16% by 2050. Rapid environmental change exacerbates these problems further. Optimizing sustainability credentials will continue to be a top concern, especially in light of the possibility that improved sustainability metrics might provide extra economic gains by allowing agricultural experts to concentrate their resources and efforts more wisely.

According to a landmark report by the Intergovernmental Panel on Climate Change (IPCC), sustainable land management may be essential to reversing the effects of climate change on land degradation, a serious result of human and agricultural activity as well as extreme weather conditions and which results in the pollution or degradation of the quality of land and soil. This

might provide "cost-effective, immediate, and long-term advantages," according to the paper. With this in mind, it is essential that farms alter the way they run in order to both lessen the consequences of climate change and safeguard themselves against financial loss.

Ambitious plans have been put in place to strike a balance between feeding the globe and lowering global emissions. The National Farmers' Union (NFU) of the United Kingdom, for instance, has said that it intends to make British agriculture carbon neutral by 2040 via the implementation of a number of policies to enhance land management, promote agricultural productivity, and advance the broader bioeconomy. The NFU has argued for working "smarter" to reduce direct pollution from farming by providing the same value with fewer emissions, notwithstanding the fact that there is no one solution to the issue.

The worldwide market for precision agricultural methods, which may aid farmers in making better-informed choices, is now anticipated to reach $43.4 billion by 2025. Unmanned aerial vehicles (UAVs), also known as drones, haven't quite entered the mainstream of agriculture, but they are becoming more and more crucial to precision farming, where they are assisting farmers in setting the standard for sustainable farming practises while also protecting and boosting profitability.

Precision agriculture techniques allow for the fine-scale monitoring and mapping of yield and crop parameter data within fields thanks to the use of GPS technology and geographic information system (GIS) tools. These provide more intensive and effective farming techniques that may assist farmers in modifying fertiliser recommendations or spotting crop illnesses before they spread widely. Farmers may make choices based on economic and environmental considerations now that they have access to more data. For instance, by optimising fertiliser application and using just the correct quantity at the right time, considerable financial and environmental savings can be achieved.

Utilization of Drones

As a part of a successful strategy for sustainable agricultural management, the use of drones in the agricultural sector is steadily expanding. This strategy enables farmers, agricultural engineers, and agronomists to streamline their operations while also gaining valuable insights into their crops through the use of robust data analytics. Drone data may be used for crop monitoring, for instance, to precisely plan and implement continuous improvements like the usage of ditches and changing fertiliser applications. Instead of more typical time- and labor-intensive data collecting, products may be properly tracked from farm to fork utilising GPS positions at every stage of the trip.

UAVs are especially helpful for carefully monitoring vast tracts of agriculture, taking into account variables like slope and elevation, for example, to provide the best sowing recommendations. The technique has also been helpful in acquiring a thorough understanding of plant emergence and population, since more precise data may aid in choices on replanting, as well as thinning and pruning activities, and the refinement of crop models.

Importantly, crop fertility can be determined using high-resolution drone data, which enables agricultural experts to apply fertiliser more precisely, cut down on waste, and design - and fix - irrigation systems. In the aftermath of natural catastrophes like floods, the technology may also be

especially useful for assisting farmers in assessing damage across terrains that may not be easily accessible on foot.

Developing Drones

UAVs have enormous promise for enhancing sustainable agriculture. Already, it is estimated that the market for agricultural drones will be worth US$32.4 billion, showing that the sector is starting to see the advantages over more conventional approaches like ground mapping.

Drones are more effective than other techniques, enabling users to swiftly acquire high-resolution pictures despite the enormous territory that has to be surveyed. Estimating yearly yield may assist in directing decision-making and controlling expectations, particularly in present unstable market circumstances. Additionally, UAVs are increasingly seen as a safer alternative to terrestrial approaches, which require on-foot work, for mapping challenging locations, such as uneven or large fields, that may be dangerous for operators.

UAVs are gradually gaining acceptance as a more precise and economical alternative to the human aircraft and satellites that have traditionally been used to monitor agriculture. Even on overcast days, studies have shown that drone photography offers a greater rate of accuracy and resolution. Accurate crop health tests can be done all year round utilising UAVs, however using conventional terrestrial methods might possibly cause projects to be delayed by days.

In the past, it has been hard to get an accurate image of plants since the cameras on manned aeroplanes and satellites have not been able to map fields with adequate clarity. UAV technology, on the other hand, gives users a precise representation of the various plant sections, even enabling the early detection of pests and illnesses. The processing time has been slashed to just a few minutes owing to new software solutions, which formerly required longer than ground mapping and satellite approaches to handle these high-quality photos. This implies that it may be done while in the field, enabling prompt evidence-based choices and data entry into precision farming equipment, greatly speeding up the process.

Once farmers have made the decision to use drones for agricultural management, there are a number of things to think about before making an investment. Fixed-wing and rotary drones are two UAV kinds that each have certain benefits. Because rotary systems, such quadcopters and multicopters, can capture high-resolution pictures at closer range utilising mm per pixel, they are perfect for mapping and examining tiny regions. Smaller takeoff and landing zones are also an option, which works well in cities. A fixed-wing drone, on the other hand, is often more suited to and advantageous for agricultural applications, because mapped regions are frequently enormous and take-off and landing space is not constrained. With an object resolution of cm/inch per pixel, its endurance and high cruising speed enable a greater area of land to be mapped up to 2.6 times faster. Users also gain from its ability to withstand high wind resistance, which is crucial when mapping large areas of open land, as well as from labour cost savings.

Aside from the device they choose, agricultural experts must also think about the advantages of hiring a professional drone pilot or if it would be better to educate a team internally. Due to the long-term cost advantages and possible return on investment of using drones internally, businesses

are choosing to do so more often. UAVs may now be effortlessly linked with current farm management information systems (FMIS) to cut down on field and planning time thanks to technological advancements. Partnerships between hardware and software makers may help agricultural experts with the processing and analysis that comes after data gathering - all in one system, further streamlining processes.

A drone may be flown by agricultural specialists who can then use the included software to analyse the photographs before exporting them straight to an application map for use on farming equipment like sprayers. These precautions allow for precise application and assure reduced material waste, which may save expenses. This kind of seamless integration connects the farmer, drone manufacturer, software, ag service provider, and agronomist, enabling a full drone to tractor workflow and setting the standard for intelligent agriculture and farm management techniques.

Operators must also stay current on laws governing things like restricted airspaces surrounding airports and people's right to privacy. The world's laws are presently not unified and are constantly changing. Given that regional regulations differ significantly, having the right team in place can assist drone operators in the agriculture sector in selecting a compliant model, ensuring they have the proper certification, and flying in accordance with the most recent recommendations, safety standards, and regulatory requirements.

Taking Off

Farming practises need to alter as a result of increased agricultural emissions in order to slow down global warming and guard against its effects in the future. Drone-based agricultural mapping has become more widely available, enabling operators to gather vital information on the health of crops and make informed plans. The technology not only benefits the environment, but it also has the potential to save farmers and other agricultural experts a lot of money over time. In comparison to more conventional mapping techniques like manned planes and satellites, drones have emerged as an effective means to swiftly and efficiently survey challenging terrain. This promotes agriculture's transition to a data-driven sector. With its Microsoft Azure Farm Beats initiative, which uses data analytics from UAVs to increase agricultural production and optimise resource use, technology giant Microsoft is setting the bar in this field.

Drone technology has a bright future in enhancing sustainability. Artificial intelligence (AI) will then be used to automatically examine the collected data as the following stage. This would promote more effective operations and enable more regular health evaluations, both of which would enhance sustainability throughout the business.

Brazil Case Study: Reducing Herbicide Use

In a soybean field in Brazil, the usage of herbicides was reduced by 52% with the use of drones. The sense Fly eBee X offers high-quality photos of fields with a mapping capability of up to 500 hectares (1,200 acres) and a flying period of up to 90 minutes. To automatically identify weed infestations, precise photos of the terrain were processed and analysed using xarvio FIELD MANAGER. Within hours, the team had access to the findings and a categorization of the amount of weed infestation, along with comprehensive reports of weed thresholds, swiftly and effectively.

Herbicide application maps created by the fleet of eBee X fixed-wing drones employing xarvio FIELD MANAGER processing technology helped Brazilian farmers save an average of 52% of herbicides during the 2018–19 growing season.

CHAPTER 8

INTEGRATED PEST MANAGEMENT

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IPM, or integrated pest management, is a sustainable method of controlling pests that minimises threats to the economy, human health, and the environment by integrating biological, cultural, physical, and chemical methods.

Humans have been creating methods to safeguard their food supplies from pests throughout history. The Ancient Sumerians utilised sulphur compounds to control insects, which is one of the first documented instances of pest management.

Since then, control methods have advanced greatly because to changes in agricultural practises including block cropping, dependence on fewer varieties, travel, the expansion of global food commerce, and most recently, the effects of climate change. All of these elements have promoted pests' greater distribution and quicker colonisation. Concurrently, farmers have been able to boost yields and streamline cropping systems thanks to developments in pest management, which has helped to enhance the supply of healthy, high-quality, and reasonably priced food.

Plant protection products (PPPs) have helped the world food production, but in certain nations and with specific crops, improper usage has raised questions about human health and had detrimental effects on the environment, such as contaminating the water supply and destroying biodiversity. While there have been tremendous advancements over the last 25 years in the areas of diagnostics, threshold level comprehension, application precision, and chemical formulations with less negative environmental and non-target species effects, there is still work to be done. Maintaining plant health for effective cropping is a major and continuous issue for the agricultural and horticulture industry because of increased pest resistance, the deauthorization of pesticide products, and public concern about the use of PPPs. By integrating beneficial and varied solutions, IFM and IPM seek to solve this dilemma. 8 Integrated Farm Management (IFM)

Farm decision-making is not dependent on a single problem, and IFM helps farmers find the best choices in an integrated manner.

A total farm business model called "Integrated Farm Management" (IFM) produces more sustainably farmed crops.

IFM is focused on preserving and maximising the use of all resources on farms, including soil, water, air, workers, equipment, money, PPPs, wildlife habitats, landscape features, and archaeological elements. It also addresses legislation and welcomes innovation. A thorough

knowledge of the industry is necessary for successful adoption, as is a creative and challenging strategy. IFM implementation is based on combining useful agroecological concepts and conventional practises with knowledge and innovation. It focuses on creating a risk management strategy to foresee, evaluate, manage, and create backup plans for any unforeseen and/or natural catastrophes.

Integrated Pest Management (IPM) is a modern, sustainable approach which encourages the use of natural pest control mechanisms. It aims to grow healthy crops with the minimum possible disruption to ecosystems and risks to the environment. Crop health is essential for good productivity in agriculture which means that IPM is a vital green technology for the future.

These green technologies are leading the way in changing how the agricultural sector works. The stark reality is it won't be one single technology that can save the planet from environmental destruction. There will be a series of new green technologies sometimes mixed in to return to some more 'traditional' techniques. Research is in progress for new technologies, and people are working hard to make our Earth a more sustainable place. Agriculture will always be essential for humanity, so it is in our best interests to find the most successful way to keep it green and sustainable.

Sustainability encompasses more than just the present generation's financial security; it also considers how future generations will be able to fulfil their own requirements. Sustainability understands that, in addition to goods and services provided by the environment, such as recreation, clean drinking water, and scenery, which are not always bought and sold in markets, economic well-being also depends on the ability to buy and sell goods and services (like food and clothing) in markets that are operating efficiently. Investments in a variety of capital, such as natural and human-made capital (such as buildings and machines), are also necessary for sustainability (e.g., farmland, aquifers, lakes, rivers, estuaries, and wetlands). Sustainable development depends significantly on agriculture. The production of food via agriculture depends on natural resources. As the largest user of both land and water, agriculture also contributes significantly to the degradation of rivers, lakes, and estuary waterways. A more sustainable course of economic growth necessitates good stewardship in agricultural production since both food and natural capital are essential for both the present and the future. There isn't a single indicator that can be used to measure the sustainability of the agricultural sector, so we look at patterns in a few of the measures that are already in place.

Any IPM programme should prioritise prevention as its main method of pest management. Suppressing harmful organisms lowers the likelihood of a single species becoming dominant and having a substantial influence on a cropping system, while putting preventive measures into place naturally lowers the probability of occurrence.

You may prevent and control insect infestations in a variety of ways.

Different tactics must be used based on the season, crop, field history, and local variables since there is no "one size fits all" strategy to controlling pests. The promotion of beneficial species, crop rotation, variety selection, cleanliness, cultivation techniques, and stale seed beds are a few examples of important potential.

Rotating crops

In order to reduce pest outbreaks in annual crops, crop rotation is one of the most time-honored and reliable methods. On the same plot of land, a variety of crops may be grown, which benefits soil fertility and structure as well as the incidence of pests, weeds, and diseases. In comparable crops, illnesses may linger, weeds can grow, and insects can survive and overwinter. These lifecycles are broken up by rotations that include crops from several plant groups. To lessen the chance that pests may spread from the cover crop to the crop, it is also vital to choose cover crops from several plant families. You must be aware of the recommended intervals between crops in a rotation as well as the lifespan of the target pest.

Varietal Selection

You may choose to plant pest-resistant types by using historical facts, predictions, research, and advice from knowledgeable consultants. By doing so, you can develop a crop that will be more resilient to pest harm. To balance this, however, with market demand. Morphologic characteristics like greater leaf hair densities, improved vigour, or early maturity are among the traits that might make crops more resistant to pest assault. Choosing a cultivar does not ensure that the crop will be totally resistant to pests, but when combined with other IPM strategies, improving host-plant resistance may help with prevention.

Hygiene

It is crucial to make sure that everyone involved in the company and anybody else working on the property (such as contractors) adheres to sanitary standards.

Regular cleaning of machinery, equipment, and tyres is one hygiene precaution, particularly in locations that are known to be high risk and in agricultural storage areas. It's also crucial to perform appropriate field sanitation, which includes getting rid of sick crop trash by either reintegrating it into the soil or feeding it to animals. The transmission of diseases, weed seeds, and pests like potato cyst nematodes or black grass seeds may be minimised with the use of these techniques.

Cultivation Techniques

Early crop establishment promotes a robust, healthy crop that may be better equipped to fend off pests and illnesses. For site-specific management, it is vital to take into account known pest hazards and cultivate activities that disrupt pest lifecycles. For instance, minimal tillage farming methods may prevent the spread of green bridges while reducing aphid infestations in the fall by protecting natural predator populations. To control weed seed populations, employ rotational ploughing.

Along with lowering insect activity, seedbed preparation may enhance crop emergence and damage resistance. In order to increase establishment, decrease clods that may serve as slug habitats, and consolidate the seedbed after planting, this may include rolling.

Shorter emergence time weeds may be managed by using stale or phoney seed beds. Weed seeds that have been disturbed and brought to the soil surface during cultivation are germinated in an early seed bed so that the young weeds may be removed before the crop is drilled. When trying to maximise the yields of crops with few herbicide alternatives, this strategy is very beneficial.

Altering sowing dates, maintaining balanced fertilisation, liming, and irrigation/drainage methods are further management and establishment measures that promote the avoidance and control of pests.

Favorable species

It is possible to control pest populations and stop outbreaks by promoting beneficial species. A variety of birds and insects, including those in the lacewing (Chrisopidae), hoverfly (Syrphidae), spider (Arachnidia), and ladybird (Coccinellidae) families, can find food, shelter, and nesting sites in habitats like beetle banks, strips of tussocky grass, field margins, or hedgerows when they are established and maintained.

Among these are agricultural productivity, soil erosion, groundwater quantity, surface water quality, groundwater quality, and wetland conversion rates. Although there are overlaps in the services that these indicators reflect, one might consider agricultural production, soil erosion, and ground-water availability as indications of our capacity to feed the present and future generations at fair prices to consumers. Wetland conversion rates, the quality of the surface and ground waters, and the effects of agricultural output on these waters may all be considered of as environmental indicators.

When seen as a whole, these indicators support a perspective of agricultural production in the United States where environmental issues are present, but where many of these issues may be resolved by well-thought-out programmes and regulations. Through a number of conservation projects throughout the years, the government has attempted to address many of the environmental issues connected to agricultural output. For instance, the USDA's Conservation Reserve Program pays farmers to take extremely erodible or ecologically delicate land out of cultivation. In a similar manner, the Wetlands Reserve Program offers rewards and cost-sharing to landowners who permanently restore previously converted or farmed wetlands to their original state. These payments act as market pricing and incentives for resource conservation, although in an imperfect way.

Due to their potential to enhance agricultural production's environmental performance without affecting farm output or revenues, "green" or more sustainable technologies are gaining a lot of attention in recent years. Green technology development may be constrained, nevertheless, by the absence of markets for the environmental benefits they provide. The availability of a resource is indicated by market pricing. The so-called "induced innovation theory" states that, in general, research and development, as well as the adoption and spread of new technologies, will be focused on conserving the most expensive or limited resources. There is less of an economic incentive to develop or deploy technology that preserve such resources as the market pricing of many environmental services and natural resources are lower than their intrinsic worth to society. The mere availability of a technology does not guarantee its adoption, though. Green technology may take time to spread and become widely used. Knowledge of environmentally friendly technology, such as precision agriculture, better nutrient management, integrated pest control, and conservation tillage Agriculture shows that three important criteria impact adoption in addition to profitability.

The first factor that may discourage adoption is structural resistance, such as a lack of funding and labour supply restrictions. It is only profitable to apply these technologies in particular situations due to the diversity of the natural resource base, which includes various soil, water, and climatic resources. Third, adoption may be hampered by the financial risk associated with new technology. Further repercussions result from obstacles to the acceptance and spread of green technology. No one green technology will be sustainable for every farmer in every section of the nation since the economic and environmental effects of green technologies differ by crop and location. It is advantageous to have a decentralised strategy to research and development and technology transfer since these obstacles varied throughout the nation, placing a premium on understanding of regional adoption and diffusion limits.

Green energy technologies include things like non-toxic chemical methods, clean energies, and environmental monitoring. Green energy technologies allow us to mitigate or even reverse the negative impacts of human activity. These may be used to manage water in an environmentally friendly manner. Without producing harmful substances or deadly byproducts, green energy solutions may successfully cleanse water. These green practises may also help with trash management, water management technologies, and sewage treatment.

This shows the promise and potential of contemporary green technology for wastewater treatment and environmental remediation, which will become more important as the world transitions to clean energy and waste resource recovery.

The growth of agriculture and its related fields depends heavily on agriculture, which plays a critical role in assuring their long-term viability. In order to properly grow the agricultural sector, agriculture must provide food and rely on natural resources. Since food and natural capital are needed for both the present and future generations, moving toward a more sustainable path of economic growth needs outstanding stewardship in agricultural production. Because of the massive amounts of fossil fuels that are released into the atmosphere as a result of food production, storage, and transportation all of which contribute to environmental degradation and hasten global warming agriculture is one of the industries that contributes most significantly to environmental degradation today. It's more important than ever to concentrate on the best green agricultural technology available, given the expanding global population and improving standards of living.

According to the Asian and Pacific Centre for Agricultural Engineering and Machinery of the United Nations (APCAEM), sustainable agricultural development is essential for the elimination of poverty through ensuring environmental sustainability. "Green Technologies (GT)" refers to such agriculturally based environmentally beneficial technology. When properly implemented, green technology, which is sometimes also referred to as clean technology, can support the human population on Earth indefinitely while also giving future generations efficient agricultural systems to use for the higher production rate.

Green technology seeks to lessen humans' negative effects on the environment and, when used as a source of renewable energy, reduces the use of fossil fuels. Green agricultural technologies have a key role in protecting the environment, reducing the production of by-products related to fossil fuels, and promoting the long-term growth of agriculture. Renewable energy, zero tillage,

biotechnology, organic farming, vertical farming, irrigation, integrated pest management, drones, fleet management, and digital sensors are a few of the top green technologies and methods that are assisting in good farming. Other green technologies and methods include irrigation, integrated pest management, organic farming, vertical farming, biotechnology, and organic farming.

Agriculture's long-term survival depends on renewable energy, sometimes referred to as clean energy. Natural resources that can replenish themselves to make up for what has been used are known as renewable resources. Since they cannot run out, they are sustainable resources. Fossil fuels are now used to power the vast majority of agricultural equipment, which releases greenhouse gases into the atmosphere and adds to the dangerous effects of climate change. This damage to the environment may be reduced by using renewable energy sources. Since these natural resources can be collected, farmers may have a consistent source of income creation with the intended impact, making renewable energy as a green technology and sustainable agriculture a good matching element.

Through the use of green technology and solar technologies, electricity is produced from solar energy, which is created when solar light radiation is converted into electrical energy. This method is used in zero-tillage farming, where the sun's energy is used to power a variety of agricultural tools, including water irrigation pumps, farm lighting, and machinery for food processing. Agribusiness and all of its supporting industries benefit the most from this kind of green technology. Increasingly popular green technologies include solar thermal systems. It may be used to warm water, create solar greenhouses, and other things by converting solar heat radiation into heat energy.

Due to its low land need, wind turbines are a preferred option for farmers. For irrigation, they may be used to pump water. Plants, animals, and other living things, such as maize, make up biomass. In order to create energy, the material is then burnt. Buildings, crops, and dairy operations may all be heated by the heat as well as utilised to directly operate them. Power and steam may both be produced with it.

Zero tillage, also referred to as no-till farming, is a method of farming that doesn't require ploughing the ground or the use of large farm equipment because it disturbs the soil less than traditional farming methods do. By reducing erosion and runoff, zero tillage farming helps to reduce greenhouse gas emissions. Utilizing crop waste left on the soil surface from previous harvests, zero tillage also increases soil carbon sequestration, or the amount of carbon absorbed and retained by the soil.

Overall, this cost-effective farming technique helps farmers save money while reducing the amount of greenhouse gases discharged into the sky. This approach, which can be utilised everywhere in the globe and has been shown to be advantageous to both the environment and the economy (see Genetically Modified Organisms, or GMOs, and the Impact on Green Technology), is crucial. Before witnessing results from zero tillage, there is no need to make a big financial commitment. The agricultural industry's long-term viability may be significantly increased by educating farmers about this approach. In addition to taking into account the growing global food need, no-till farming is a sustainable practise. Although reducing greenhouse gas emissions is a

bonus advantage of this technique, which was first created with the intention of preserving water and soil, the world as a whole could profit from it.

Green Technology in Construction

Civil engineers carry a larger responsibility of building the infrastructure of a nation. The past couple of decades have been witnessing a frequent occurrence of disasters both natural and man-made. This call for developing disaster resilient communities….adoption of green and clean technologies is the need of the hour to achieve the objective of Millennium Development goals. Green Technology deals with studies and researches to reduce the impact of construction on the environment considering human health and safety of the planet Earth. Simply put, Green Technology involves constructing new buildings by incorporating a few environment-friendly aspects.

A conscious effort is to be made in resorting to clean energy production, usage of alternative fuels which are less harmful to the environment etc. Though the market is in a nascent stage, awareness creation and inclusion of the same in producing green and sustainable design has to be resorted to, with an aim to leave behind a legacy for the generations to come. Inclusion of the green building norms has to be integrated with contemporary approaches.

Green building moves beyond being a sustainable alternative to being a step in how we live our lives as industry develops and the world's supply of non-renewable resources steadily gets scarce and more costly. Fortunately, sustainable energy technology is more sophisticated than ever and may benefit you financially as well as the environment. Although green technology, such as solar power, may seem expensive at first when compared to conventional alternatives, you will ultimately save money on energy bills over the course of usage.

But what does "green building technology" really mean? It's a broad category that includes anything from geothermal heating to energy-efficient appliances. The ten items on this list strike a balance between environmentally friendly building materials that anyone can use when constructing a new home and more sophisticated green technologies that bring cool scientific advancements to the construction industry, such as glass that can be tinted on demand and biodegradable paint (did you know it's made using milk?). In the future, everyone may employ these materials and technologies, but why wait? They are currently accessible.

Increased solar reflectance and reduced thermal emittance are two features of cool roofing. In other words, they reflect more of the sun's rays than a typical shingle roof and keep the inside temperature from escaping through the building's top. Dark shingle roofs may become as hot as 150 degrees Fahrenheit under the sweltering summer sun (65.5 degrees Celsius). That may be reduced by more than 50 degrees thanks to the reflectance of a cool roof.

Naturally, it is advantageous to lower the roof's temperature, but the main savings are found within. By reflecting extreme heat or keeping the air within, a cool roof raises the temperature inside a

structure. This lessens the load on air conditioning systems and thus lowers the pollutants produced by running our heating and cooling systems. Cool roof shingles, tiles, and reflective paint are just a few of the materials that may be used to build a cool roof. There is no need to seek farther if you need an environmental justification for the cool roof: Their reflectivity may aid in reducing the heat island effect, which makes urban and suburban regions much hotter than the nearby rural areas when exposed to strong sunshine.

Anyone who has ever had fibreglass fragments pierce their flesh can witness to the fact that insulation is among of the worst materials used in building. Since the material is primarily wall filler, it doesn't need to be attractive or pleasant. Why not build insulation out of any old trash if it would remain hidden? That is the core idea of green insulation, which lines our walls with recyclable materials. A nice illustration is cotton insulation: The recycled denim, often known as used jean scraps, makes up the majority of the soft blue insulation. Have you ever considered using the fabric from your favourite pair of trousers to insulate your home?

Insulation made of cellulose recycles a substance that is equally prevalent. Any ideas as to what the mysterious substance is? The affable newspaper is it. One of the most popular types of recycled paper insulation is blow-in cellulose, which may be sprayed into walls or attics rather than being spread out in sheets. Recycled glass may even be used in fibreglass insulation, however there is a drawback: It takes a lot more energy to melt the glass and create fibreglass insulation than it does to make cellulose insulation out of paper. Compared to fibreglass insulation's 30 to 40% recycled content, cellulose insulation often ranges from 75 to 85 percent, and it is even more effective at blocking airflow than fibreglass. When it comes to green insulation, cellulose and cotton are unquestionably preferable options since neither causes as much pain or raises as many health issues as fibreglass.

We sometimes forget about the other side of the coin, which involves pulling something down and disposing of building materials, as construction is all about creating something new. Biodegradable materials may make that disposal procedure more environmentally friendly by producing items that naturally disintegrate without polluting the land, as opposed to a massive scrap heap of debris and chemicals. Biodegradable paint, which imitates the conventional method of making paint from a milk-based formula, is a great example. An organic paint combination is made by The Old Fashioned Milk Paint Co. using milk protein, lime, and mineral colours.

Utilizing recycled items, such as recycled fibreglass insulation, is a fantastic first step toward being environmentally responsible, but even better are products that naturally decompose without releasing toxins into the environment. Hemp is employed in construction outside of the US for anything from insulation to building foundations. Industrial hemp is a low-THC relative of marijuana that is illegal to produce in the United States, but at least one business is importing the hemp to make Hemcrete, a hemp and lime combination that resembles concrete. Not only is hemp a biodegradable structural material, but our next green construction technology has also been around for a very long time.

Similar to adobe, the ancient building method known as rammed earth employs the Earth's natural resources in a straightforward procedure to create robust structures. Rammed earth has been used

for construction for thousands of years; it was used to build some of the Great Wall of China. A rammed-earth building may still be constructed in much the same way as it was centuries ago. To create thick, hard walls, a wet combination of earth and hard materials, such clay or gravel, is blended with a stabilising agent, like concrete. After forming, rammed earth must mature for many months, or perhaps up to two years, in a humid environment. USC is the source.

Rammed earth is the best material for controlling a building's temperature because of its density. It will keep cool in the summer and warm in the winter, and producing rammed earth emits less emissions than the conventional construction process. Even if the technique of compacting rammed earth walls nowadays is a little simpler than it was thousands of years ago, there are still instruments available that are specifically made for manually compacting the walls.

Although rammed-earth building isn't precisely common in the twenty-first century, it is still practised, and there are builders that focus on creating houses from the minerals of the planet. Similar to our next green technology, a technique created to capture water runoff, rammed-earth construction does need extra attention to control water appropriately in order to avoid harm.

Management of Storm Water

Large tracts of land may be carved up and plant life washed away in rural regions due to water runoff from severe rain and snowfall. The strength of storm water in metropolitan places is also harmful; overflowing sewage systems may flood streets and buildings, creating unsafe driving conditions and causing millions in property damage. Erosion can be a highly detrimental phenomena. This is where storm water management comes in: it entails constructing systems and landscaping to effectively handle vast amounts of water. In order to reduce evaporation and purify storm water, the U.S. Environmental Protection Agency is committed to managing storm water using a "green infrastructure," which uses vegetation and soil in populated areas.

The advantages of the EPA's green infrastructure are many and include: The infrastructure minimises sewage overflow by absorbing water, lowers the heat island effect caused by metal and heat-absorbing pavement, and at the same time does so while also lowering storm water pollution as it goes through vegetation and soil. By absorbing carbon dioxide, plants enhance air quality and a rise in green cover lowers total runoff. The EPA uses a variety of strategies to create a green infrastructure. One of the simplest alternatives is to place plant boxes, little installations of earth and vegetation, along the pavement. Green storm water technology has a lot of promise, as seen by some of its other environmentally friendly innovations, such as fully vegetated green roofs and permeable pavements that let water drain to the sediment layer.

Geothermal heating

Geothermal heating employs the inherent energy of the Earth to produce electricity, as opposed to storm water management, which uses vegetation to manage water. Geothermal energy is an effective renewable energy source that is much more ecologically beneficial than coal-powered electricity or natural gas, much like wind or solar energy. The cold doesn't render geothermal heating useless, despite what you may believe. A few feet down, pipes are protected from the impacts of freezing temperatures. It is a warm source of energy in the winter and a cold one in the

summer since the earth there consistently hovers around 60 degrees Fahrenheit (15.5 degrees Celsius).

Pumping a water/antifreeze solution via subterranean pipes to capture thermal energy, the energy is then sent to a heat pump, which uses it to heat or cool your home. Although the heat pump does need electricity to operate, the geothermal system's efficiency implies that you'll receive far more energy out of the pump than you put into it. It takes a lot of work to dig up earth to instal the pipe that collects energy, which is one drawback of geothermal heating. Solar energy, however—our next traditional renewable resource—does not have this issue.

Solar Energy

What comes to mind when you think about solar energy? fields upon fields of enormous solar panels? It's not always necessary to have a tonne of equipment to use solar electricity. In certain cases, solar energy may be used without any apparatus at all. Active solar power, which is likely what comes to mind when you think of solar energy, differs from passive solar power, which relies on smart house design rather than cutting-edge technology. Passive solar house design simply harnesses the sun's rays to heat a home via smart positioning of windows in a residence. Large windows allow solar energy to enter the house, and a surface that absorbs heat, such as a dark wall, keeps the heat within the house to keep it warm. Air vents and fans may aid in distributing the air around the home.

Obviously, active solar systems produce more heat than passive solar architecture. Solar panels utilise the heat from the sun's rays to warm water or air, reducing the need for gas or power in the process. The amount of greenhouse gases we emit from utilising nonrenewable energy sources decreases as our reliance on solar energy increases [source: EnergySavers]. The size of the system and the local climate have an impact on how effective solar panels are. However, with the correct circumstances, a solar system will provide years of cost-free electricity, making up for the initial installation expenditures.

Windows must be open for passive solar energy to be used to generate heat. However, what happens during the summer when you want to block out all of that solar radiation? A far cooler alternative is on the horizon that promises to reduce HVAC expenses and alter how we perceive inside sunshine. Awnings, blinds, and roof overhangs may reduce that incoming light. It is known as smart glass.

Smart glass, also known as electrochromic glass, modifies the amount of light it reflects by charging ions on a window layer with a brief electrical pulse. While there are now windows with low emittance that reduce part of the sun's rays, smart glass allows you to choose how much light you wish to block. Skyscrapers might have thousands of windows tinted automatically during peak hours and restore to full transparency in the evenings thanks to smart building management systems. The dynamic windows are expected to result in a 25% decrease in HVAC expenses, according to smart glass developers. Tested is the source. Although electrochromic glass is still being refined for use in commerce, expect to see more of it in the years to come as rival inventors introduce this clever energy-saving technology to the market.

Modern appliances nowadays are more intelligent than ever. The newest appliances are made to save energy and make our lives easier. While our kitchens may not yet resemble anything from The Jetsons and Rosie isn't here to cook and clean, they are still meant to do those things. The 2011 Consumer Electronics Show's offerings from LG are the ideal example of the current trend in appliances: To be as energy-efficient as possible, its SmartGrid refrigerators, dishwashers, and washing machines all connect to a smart metre. Electrical metres that collect real-time data and can interface with gadgets to deliver valuable power statistics are fundamentally known as smart metres. With the use of such information, LG's smart appliances are able to calculate energy costs and operate on autopilot when power prices are at their lowest.

The technology we're accustomed to seeing in specialised computer systems is increasingly being incorporated into new appliances. For instance, LG's smart refrigerator employs an LCD screen to help you arrange and inventory the chilled food. Your whole grocery inventory is accessible on a mobile device like a smart phone, basically providing you an omnipresent shopping list based on what you currently have in stock. By programming in the expiry dates, you may have the fridge alert you when food is going bad. Nevertheless, the increases in energy efficiency are what really distinguish smart appliances as a great green technology. They make up a minor portion of our last green building strategy, the zero energy house, which incorporates green building principles from almost every other strategy we've discussed.

The Energy-Free House

Zero energy buildings, also known as zero net energy buildings, are built with the intention of operating effectively without a conventional electric grid. In other words, they generate their own electricity using renewable sources. A zero energy building uses zero net energy annually and emits no carbon dioxide since it is powered by renewable energy sources like solar or wind power. The "zero" refers to both energy consumption and carbon emissions.

Homes that use zero energy are specifically constructed with good insulation and energy-saving strategies like passive solar architecture. Obviously, efficient design is only the beginning; the structures still need electricity. Common options include active solar and wind collectors, and some structures utilise biofuels for heating. Construction with zero energy is most effective in small communities where numerous dwellings may share a renewable resource.

Naturally, creating a zero-energy house is no simple undertaking. Although it is expensive as well, some governments are gradually promoting zero energy building with incentives to encourage the advantages to the environment. The state of California also provides extra money back to customers that choose renewable energy, while the federal government of the United States grants a tax credit for solar investments of 30% of the entire system cost. Zero energy building is still a specialised field with significant upfront expenses, but the payoff is an ideal synthesis of technology with little environmental impact compared to the typical construction project of today.

Adoption of Green Technology in Civil Engineering

Environmental protection has to be at the forefront of the infrastructure design, this can be achieved by promotion of reuse and recycling of waste. Promotion of green technologies not only in water

reuse and recycling and increasing availability of clean drinking water for everyone is to be enforced but application of the same in all realms of Civil Engineering is to be incorporated in producing sustainable green design.

The concept of green walls having enough soil to support the growth of plants supported with monitoring and self-irrigation facility not only improves its survival but also improves the aesthetics and air purification potential. Many other facets of Civil engineering require integrated planning and design in a transition from contemporary practices to state-of-art green and clean constructions. A meticulous planning, creativity, adaptability and problem solving skills helps in achieving these objectives.

One of the trendiest topics in construction is green building technologies. Buildings with a lower carbon footprint and a less effect on the environment are made more sustainable and energy efficient by green technology. Green building is here to stay as a result of the ongoing battle between governments, corporations, and civil society to preserve the environment via a variety of strict and forceful governmental interventions.

In comparison to traditional construction materials, green technology employs industrial waste gypsum, doesn't need plastering, and consumes less cement, sand, steel, and water. In comparison to traditional structures, it offers lower built-up areas that aid in increasing the efficiency of buildings. The versatility of construction techniques, the relative rapidity of construction, and the lightness of structures make buildings more resistant to the effects of earthquakes. For builders, building owners, and renters who are increasingly aware of the effect of green technology, there are several benefits to using it in construction. Property owners gain from reduced continuing operating expenses, increased building values, improved tenant retention rates, and market advantages associated with being a "green" firm. Even before the government issued laws, several of the industry's top firms voluntarily started using green technology in building.

By effectively using energy, water, and other resources, safeguarding occupant health and enhancing employee productivity, and lowering waste, pollution, and environmental degradation, green buildings are created to minimise the overall impact of the built environment (Siting, design, construction, operation, maintenance, renovation, and deconstruction) on human health and the environment. The best use of natural resources, the reduction and recycling of waste, the purification of water and air, the treatment of sewage, environmental restoration, energy conservation, and a considerable decrease in pollutant emissions are all part of the efforts towards sustainable development. Utilizing solar panels, dams, geothermal wells, and wind turbines are some examples of green technology that attempts to actively exploit renewable resources like sunshine, water, and wind.

By using cutting-edge techniques and technology, green buildings may increase their efficiency. Around the globe, a variety of green construction techniques and technologies are in use, including biomimicry, vertical and rain gardens, glass fibre reinforced gypsum (GFRG) panels, smart glass, and green roofs.

An estimated 30% to 40% of commercial buildings are empty on average at any one moment. The occupancy status of the buildings is monitored by green building technology using motion

detectors, RFID scanners, access card readers, and other sensors. The green technology changes HVAC, cooling, heating, and ventilation choices whenever a space in a building is vacant and automatically turns off lights. Eliminating all superfluous energy usage may result in energy cost reductions of up to 30% for building owners.

There are several factors that might contribute to an unhealthy climate in business buildings, especially when ventilation problems are an issue. When HVAC systems are kept on all the time, condensation may build up, creating a hazardous atmosphere. In order to maintain a precise temperature and humidity level in the space, energy-efficient green building solutions may automatically switch off HVAC systems when not in use.

According to a report on the Net Zero Energy Building Movement in India, buildings utilise more than 50% of their energy for things like lighting and cooling that make inhabitants more comfortable. Until structures can be built that can generate enough energy to meet their increasing energy needs, the construction sector's energy consumption will continue to rise. This has given people a motivation to strive for zero energy buildings throughout the nation. This is a very new idea, where the total yearly energy used by the building equals the energy generated both on and off the site. This lessens climatic effect and aids in lowering greenhouse gas emissions.

However, there are certain difficulties in the development and long-term acceptance of green technology in the building sector. There are several long-term advantages, such as reduced operating costs, greater health, and increased productivity, even if the initial cost of erecting a green building might now be somewhat more than that of a conventional one. Other obstacles to the development of green technology in construction include poor awareness, costly equipment, the scarcity of expertise, inadequate regulation, extra permissions, and a lack of sufficient incentives.

Given the increasing number of programmes raising awareness of the value and need of green buildings, the future seems promising. India now boasts the second-largest green footprint with 3.59 billion square feet of green building development over the last several years. The number of green buildings is expected to increase by 20% in the nation by 2018 and reach 10 billion square feet by 2022. The demand from consumers, environmental regulations, and increased knowledge of the advantages of green buildings for tenants and occupants all contribute to this expansion. The lack of available energy in the nation has further pushed developers to choose "Green" alternatives.

Green building technology has become one of the hottest trends in construction. The benefits of a green technology application in construction are far-reaching and comprehensive, offering significant advantages when used in new facilities as well as existing structures. Green technology makes buildings more energy-efficient and sustainable, so they have a lower carbon footprint and a reduced impact on the environment. Builders, building owners, and tenants all realise considerable benefits from the application of green construction technology.

The primary way that green technology benefits are achieved is through greater energy efficiency. In new buildings, green building construction plays a role in every phase of development. Every aspect of the structure, including siting, design, construction materials, and the systems used to run and maintain operations are chosen to be as sustainable and energy-efficient as possible. A total of

30-40% of a commercial building is typically unoccupied at any given time. Green building technology makes use of motion detectors, RFID scanners, access card readers, and other sensors to monitor the occupancy status of building sectors. Whenever an area of a structure becomes unoccupied, green technology automatically shuts off lights and adjusts HVAC, cooling, heating, and ventilation options. Building owners can realise as much as 30% savings in their energy expenses by eliminating unnecessary energy use in this manner.

Net-zero energy building design

Green building practices typically include technology and processes that help lessen energy consumption and, in turn, reduce carbon emissions. The global net-zero energy buildings market is on the rise and is set to reach a value of $2.1 billion by 2024.

The design of zero-energy buildings combines innovative renewable energy sources with energy efficiency to consume only as much energy as it produces. Zero energy buildings often have designs that reduce the dependence on energy sources such as air conditioning and interior heating.

Civil engineers take into account the layout of a building as well as the technology involved to ensure it has net-zero energy capabilities. For example, civil engineers can strategically place the windows within a building to encourage the use of daylight and minimise the use of electric light sources. The implementation of renewable energy applications, such as solar for electricity, is a crucial aspect of a zero-energy building design and advancements in technology are helping civil engineers achieve their green goals.

Buildings that are net zero energy are those whose energy needs are met entirely by renewable resources, producing no carbon emissions in the process. A building is considered to have net zero energy if it annually generates as much energy as it uses. In order to balance their energy use, these kinds of buildings may draw power from electrical networks and return any excess power back.

Avoid being misled by contrasting phrases. Net zero energy building is referred to as NZEB. "Zero Net Energy Building" is referred to as ZNE. They all convey the same meaning. They may also be known as "green structures."

"Net zero" and "zero" are not the same thing. For instance, according to New York state law, 85% of the reductions must come from the state's own energy and industrial emissions. 15% of the total might come from carbon offsets, such as those in forestry and agriculture. Carbon offsets are effective whether a company reduces its own emissions or offsets them elsewhere. The impacts on the climate are same.

Solar electricity was first captured by residences' roof-mounted solar panels in the 1970s. In addition to saving money on electricity, this was also good for the environment. Programs to promote their usage were developed by California and other states, but they have not succeeded in moving us in the right direction. Despite their importance, solar panels cannot complete the task on their own. This is so that net zero energy buildings may take a far more comprehensive approach. Numerous elements that encourage energy saving must be included. Additionally, it need to extend much beyond single-family renewable energy dwellings and residential structures. Commercial buildings and other building kinds must be included.

Sustainable resources

The construction industry is one of the key sectors that's most dependent on natural resources, such as wood, stone, and clay for its materials. However, civil engineers are now taking steps to use sustainable resources as they have a lower carbon intensity.

Using recycled materials falls into the sustainable resourcing category and is contributing to the reduction in the extraction and processing of raw materials. Civil engineers are increasingly implementing circular environment ideas such as switching to renewable materials like timber or hemp. Additionally, the construction industry is also seeing a rapid emergence of innovative techniques, such as prefabrication. These processes help to improve the efficiency of projects, whilst decreasing costs, waste and carbon.

Distributed Energy Systems

As green building begins to rise in popularity, Distributed Energy System (DES) is a development that civil engineers are increasingly using in construction projects. By using a range of innovative sensors and meters, a DES can observe and manage a building's energy and provide data that can be used to cut costs and improve efficiency.

Many civil engineers have decided to integrate a DES into their sustainable designs to reap the benefits, which include:

- Reduced operational costs
- An improvement in energy reliability and efficiency
- Substantial reduction in carbon emissions
- Data to help improve current and future projects

CHAPTER 9

GREEN TECHNOLOGY FOR HEALTHCARE

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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 pharmaceutics 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. The healthcare sector is uniquely placed in these times of environmental crisis by contributing to climate change and pollution while bearing the brunt of its consequences. The fundamental objectives of any healthcare service are to save, prolong and enhance lives, and to ‘do no harm’. These core philosophies are very much aligned with green priorities. That is why green technology is so important in healthcare.

The impact of environmental damage on healthcare

The health impacts of environmental damage are well documented. The effects of climate change threaten to undermine gains made in public health during the past 50 years. Respiratory illness,

heart disease, stroke, some cancers and direct injuries are caused by pollution, poor air quality, waste, unsafe drinking water and events arising from climate change such as wildfires, flooding and extreme weather events.

The impact of Covid-19 has put additional strain on healthcare systems around the world and only added to the impact on the climate and on societal inequalities. Additional activity in intensive care services, mass vaccinations and the increased requirement for single-use PPE has increased energy usage, emissions and the production of waste.

The twin emergencies of the environmental emergency and a growing healthcare crisis mean that the sector must lead by example. That means health leaders, policymakers and individual facilities and staff must work together to reduce emissions, minimise waste and adopt 'green' policies to reduce people's vulnerability to future threats and therefore reduce the burden on health services. This cannot be achieved without harnessing new technology.

The utilisation and benefits of green technology in healthcare

The field of green technology in healthcare encompasses a continuously evolving group of methods and materials, from techniques for generating energy to the use of energy, direct patient care provision, lab services and ancillary activities such as cleaning, catering and waste disposal.

For example, green hospitals are increasingly being designed to utilise renewable energy such as geothermal energy for heating, cooling and hot water. Here, ground source heat pumps harness solar energy absorbed by the earth. 40% of the total energy consumption of a typical hospital comes from its Heating, Ventilating and Air Conditioning (HVAC) systems. Green HVAC systems can significantly reduce the amount of energy, and, in turn, greenhouse gas emissions.

Using technology to enhance initiatives to develop optimised workflows in the design and refurbishment of healthcare facilities reduces waste and emissions, lowering the impact on the environment.

It also contributes to the overall efficiency, improving patient outcomes through reduced waiting times, more effective procedures and treatments, and enabling providers to better track patient journeys.

Delivering care closer to home is more person-centred and also reduces transport emissions, as does implementing fleets of zero-emissions ambulances.

Furthermore, the focus on green and sustainable healthcare spaces transforms the provision from being a clinical place where people go to receive treatment into one with an additional focus on overall and long-term wellbeing. It improves patient outcomes and enables both staff and patients to feel they are contributing to goals beyond direct healthcare itself.

Green advances are also seeing healthcare providers increasingly working in partnership and collaboration with others with the expertise in technology to deliver progress to environmental targets and deliver 'greener' healthcare. This has long term benefits for the sector in utilising technology as a means to achieve positive outcomes.

Green jobs in healthcare

The Covid-19 pandemic accelerated investment in healthcare jobs. Employment opportunities are being created with a focus on promoting green principles and putting them into practice. Alongside this, what we're increasingly seeing is an element of 'green' and of 'sustainability' being built into the full spectrum of healthcare roles. We are seeing specific responsibilities, even protected time, being incorporated into role specifications to achieve environmental and sustainability outcomes. If environmental considerations and green technology are a passion of yours in delivering healthcare and positive outcomes for individual patients and wider public health, take a search through our current listed vacancies to find a role in which you can make a true difference.

FLEXBUMIN, BAZTER

A medication for critically unwell patients, albumin is made from human plasma. It replaces lost fluid and helps to keep blood volume and pressure at an appropriate level. The firm has also developed FLEXBUMIN, the first albumin available in a flexible, light, plastic container called GALAXY. This material is generally packed in glass bottles (such as Baxter's BUMINATE), but the company has also developed it in glass bottles.

Albumin quality is maintained by the four-layer GALAXY container, which is approved for usage and storage in both frozen and ambient environments. Additionally, it offers resistance to water vapour and is strong and inert.

The FLEXBUMIN container system is the first and only medical product in the world to obtain the Carbon Trust designation, which attests to its commitment to environmental sustainability. Since it uses less resources (the plastic container weighs 88–90% less than the glass bottles used for the 50ml and 100ml products), consumes less energy to produce, and emits fewer greenhouse gases during transportation, its carbon footprint is 55-77% lower than BUMINATE's. Following the albumin infusion, consumers will experience reduced waste because to the decreased bulk of FLEXBUMIN. This lowers disposal costs in the US market by up to 90%, saving 3-5 cents per unit when autoclaving and 6-9 cents per unit when burning.

Green Series Exam Lights from Welch Allyn

"Welch Allyn joined the US Environmental Protection Agency ENERGY STAR Partnership as one of the first medical device firms." Lighting that is energy efficient One of the first medical exam lights in the US to use energy-efficient, light-emitting diodes (LEDs) rather than halogen lamps is the Green Series Medical Exam Light from Welch Allyn. With a 5,500°K colour temperature and a 50,000-hour lifespan, they don't need to have their bulbs changed and generate brilliant, white light.

The line of products consists of the GS Exam Light IV, which is intended for OB/GYN offices and offers a flexible light pipe and three times the average light output; The GS 600 Minor Procedure Exam Light, with three LEDs and a broader head, is suited for minor procedures and examinations. The GS 900 Procedure Light, with six LEDs and a variety of mounting choices, combines durability, manoeuvrability, and high light output in a compact design for in-office tests.

Welch Allyn's Tracy Bennett, regional category manager for the US and CAN, said that their new line of medical exam lights is made to match any healthcare setting, including OB/GYN offices and ambulatory care centres. By employing brighter, whiter light, they improve visualisation of the exam area, and the energy efficiency of LED technology lowers the cost of ownership.

Welch Allyn recently became one of the first manufacturers of medical devices to sign up for the US Environmental Protection Agency's ENERGY STAR Partnership, demonstrating the firm's dedication to promoting energy efficiency and sustainability.

Siemens Somatom Definition Flash CT Scanner

The Somatom Definition Flash CT scanner, a dual-source CT with two X-ray tubes rotating simultaneously around the patient's body, uses a tiny fraction of the radiation dosage that earlier systems required to scan even the tiniest anatomical features.

In comparison to its predecessor, the Somatom Definition, it requires 45% less energy on average when inspecting the thorax, and 85% less energy when inspecting the heart. Comparable CT scanners now on the market cannot match the system's fast speeds and low radiation levels. In contrast to the normal effective dosage for this technique, which is typically between 8 and 20 millisieverts (mSv), a heart scan may be conducted with less than one mSv. Furthermore, the Somatom Definition Flash does not need the lead that is often used in the counterweights that balance the revolving components of CT scanners.

This is due to the fact that the device no longer requires counterweights since modern building methods have decreased the out-of-balance forces and steel as a material has been used to make up for the imbalances that are still there. The firm presently has 11 items in its environmental portfolio, and since 2006, Siemens Healthcare has managed a worldwide standardised EHS (Environment, Health & Safety) management system.

Battery-free EEG system from IMC

The Holst Centre, a non-profit open innovation R&D centre, and the imec nanoelectronics research centre collaborated in 2008 to create a battery-free, wireless, two-channel EEG device that is primarily powered by body heat and light. It has silicon solar cells and a thermoelectric generator that can utilise heat lost from the user's temples to generate electricity. It is powered by a hybrid power source. For the EEG system to function, the power source can typically give more than 1MW inside. The system, which is still on the cutting edge of green medical technology, is built into a device that resembles headphones and uses an ultra-low-power biopotential readout application-specific integrated circuit (ASIC) developed by imec to extract high-quality EEG signals while consuming very little power.

The acquired EEG data is compressed using a low-power digital signal processing block before being sent via a 2.4GHz wireless radio connection to a PC. In comparison to the power generated by the integrated hybrid power supply, the whole EEG system uses just 0.8MW.

The device may be used to track patients' brain activity after suffering a head injury and to spot certain types of brain injuries.

Philips' MammoDiagnost DR

The new MammoDiagnost DR digital radiography system is designed to enable high-volume screening and overcome workflow difficulties in hospitals and healthcare facilities, as well as mobile screening programmes in rural areas. The client uses less energy with MammoDiagnost, there is no silver contamination of the wastewater, and no toxic chemicals are used in the film processing.

Because of the device's simple design and usage of UNIQUE, UNified Image QUality Enhancement software, images are delivered with exceptional quality. Due to the digital system's compliance with DICOM and IHE standards, it may also be included into the hospital's electronic workflow, allowing for paperless patient registration and diagnosis. The generator's user interface is at the console of the Eleva acquisition work station, which has the generator built within the gantry. This streamlines the process while also saving the hospital money, resources, and space.

Digital technology has largely replaced films, which reduces energy use for the consumer, eliminates the need for drinking water for film processing, prevents silver pollution of waste water, and eliminates the need for chemicals for film processing. As a result, environmental compatibility is achieved. Environmental advantages of this product over its analogue counterpart, the MammoDiagnost, include a 46% drop in energy consumption, a 13% drop in product weight, an 11% drop in packaging, a 20% drop in radiation dosage, and a 24% rise in the product's overall environmental effect.

Cambridge Consultants' pre-filled Syreen syringe

Syreen, a cutting-edge pre-filled syringe idea created by Cambridge Consultants, was built with sustainability, patient safety, and support in mind. The design serves as both the main drug container for an injection and the supplementary packaging. Rather of glass, it is made of the amorphous polymer material cyclic olefin polymer (COP). As a result of the syringes' ability to clip together, standard syringes no longer need extra packing like cardboard or Styrofoam. The Syreen design decreases the average volume of syringe packaging by half and the weight by 30% while utilising recyclable materials, possibly saving the industry millions of pounds.

According to Phil Lever, commercial director for Cambridge Consultants' medicine delivery devices, the idea of Syreen is to provide a sustainable alternative to the status quo and induce a paradigm change in the current supply chain. Since Syreen indicates, inventive design may successfully combine economics and ecology to provide medical device firms a competitive edge. Typical glass syringes employ a variety of materials from across the globe, and shipping costs are outrageous owing to inefficiencies in the packing.

Waste management system Neptune 2 and Stryker

Since the healthcare sector has one of the highest environmental footprints, Stryker places a high focus on sustainability. Medical technology, in its view, presents a particularly good potential to

boost provider efficiency and cut waste. Consequently, the business has created a number of green healthcare programmes. The effective, independent Neptune 2 waste management system is one of Stryker's environmentally friendly products. The dual-canister architecture of the system reduces the need for extra containers and reduces the amount of trash containers that must be used and cleaned periodically.

Additionally, it cuts down on the time spent controlling trash by medical staff. The 1.6oz disposable manifold from Neptune decreases the amount of trash generated since it is made of the ecologically friendly Polypropylene #5 plastic; in a landfill, 77 manifolds are needed to make up one full 3l canister. By almost eliminating hazardous exposure to fluids and smoke in the operating area, the device also lowers hazards for medical personnel.

In addition to preventing contact with infectious fluids and surgical plume and shielding workers from splash exposure, it also collects and disposes of surgical waste as a completely closed, all-in-one device.

Green lighting programme, Fresenius

The European Commission has named Fresenius Medical Care's St. Wendel manufacturing facility a "GreenLight" Partner in recognition of the plant's environmental initiatives. St. Wendel is situated in the northeastern Saarland region of Germany. The St. Wendel site installed more energy-efficient lighting in all of its manufacturing facilities between 2006 and 2009, replacing 70% of the outdated conventional bulbs in those locations. "The 'GreenLight' campaign is a continuous, voluntary effort that supports lighting that is more ecologically friendly and saves electricity."

An annual energy savings of around €270,000 was achieved because to the modification's 42% decrease in electric power usage. Fresenius Medical Care is helping to lower atmospheric CO2 emissions by updating the lighting fixtures at its St. Wendel site. An continuing, non-profit programme called "GreenLight" promotes lighting that uses less energy and is better for the environment. It was introduced in February 2000, and as of right now, 26 European nations—including Switzerland and Norway—abide by it. Participating businesses make a commitment to update their current conventional lighting and increase energy efficiency as part of the "GreenLight" initiative, if the upgrades are financially feasible. It is necessary to reduce the amount of electricity used for lighting by at least 30% overall.

The GE Optima MR360

Ge's ecomagination programme is a cutting-edge corporate effort that attempts to assist in satisfying consumers' desires for more environmentally friendly, energy-efficient goods. The Optima MR360 ranks well among them. The system is one of the most energy-efficient 1.5T MR systems on the market, using 34% less power than the company's earlier systems.

The Optima MR360's ability to reduce annual electricity use by roughly 60,000kW/h, which can save over €5,700 a year in Europe under normal operating conditions, at an electricity rate of 0.10 euro/kW/h, is achieved by utilising efficient gradient and electronics design in conjunction with

innovative water-cooling technology. In real terms, this is equivalent to the electricity consumption of about 12 households in the European Union.

The Optima MR360, which was designed with cutting-edge magnet technology to avoid cryogen boil-off, may also assist in lowering the cost of refilling liquid helium by at least €1,300 yearly at normal cryogen costs in Europe, compared to systems without the technology.

Ozone steriliser with Ortosintese

The Ortosintese ozone steriliser is a full system for low-temperature sterilisation that was developed in cooperation with the Brasil Ozônio Industry, situated at the University of So Paulo, and the Brazilian Incubator of Technological Projects. The manufacturer classifies it as "100% environmentally friendly" and it generates no hazardous waste. Ozone is used in the unique device as a sterilising agent for a number of reasons, including its suitability for thermosensitive materials, its superior effectiveness in lowering microbial load, and its shown 100 times more efficacy than chlorine. There are no waste products involved that need special treatment, storage, or disposal since the system just requires oxygen as an input, and the only output is a little quantity of water. The machine also consumes very little energy. Manufacturing company Ortosintese, based in So Paulo, Brazil, recycles paper machine oil, plastic, acids, and batteries as part of its manufacturing processes in addition to producing medical equipment and orthopaedic implants. This demonstrates the company's dedication to sustainability.

The Green Tech Mindset

Green technology will change our lives in ways that will effect not just the environment but also the availability of jobs and food. The future of mankind is gravely threatened by climate change and global warming. Green technology, fortunately, is reducing the effects of global warming. The landscape of several industries, from the use of electric vehicles like electric scooters to clean energy sources like solar panels and hydropower, will alter as more nations incorporate green technology into their processes, materials, and production. In the end, it will improve lives and assist rehabilitate the environment. Here are just a few of the numerous changes that society may anticipate as more individuals use green technology.

Streamline Road Transportation to Cut Carbon Emissions

23% of all carbon emissions worldwide are related to transportation. These include both personal and commercial automobiles, boats, and aircraft. More cities are pushing for electric bikes, automobiles, buses, and e-scooters as a way to cut down on dangerous gas emissions. In reality, the Urban Electric Mobility Initiative (UEMI) was started by UN Habitat with the goal of reducing carbon emissions to 30% by 2050 and increasing the usage of electric vehicles by 30% by 2030.

In addition to electric cars, green fuel enhancers like Biofriendly's Green Plus® have reduced vehicle carbon emissions. 1,333,803 tonnes of carbon dioxide have been removed from the atmosphere thanks to Green Plus's treatment of 1.7 billion gallons of gasoline. By using these

green technologies, metropolitan areas' carbon emissions will be drastically reduced, enabling residents to breathe cleaner air.

Make the environment free of plastics

Due to its slow rate of degradation, plastic presents one of the biggest environmental risks. As a result, it pollutes land and water, which may endanger the creatures that live there. Many groups have created strategies to assist reduce the present plastic waste via the use of green technology. For instance, a business in Scotland binds asphalt and builds roads using plastic garbage. These roads provide longer-lasting roads while reducing plastic waste and eliminating the need for oil in road construction.

Additionally, non-toxic and biodegradable product packaging is made possible by green packaging manufactured from natural plant fibres. Innovations in environmentally friendly packaging assist different industries, particularly the commerce sector, minimise their carbon footprint. Businesses may become more environmentally friendly by doing away with the use of oil and petroleum in their packaging materials and procedures and substituting plant-based or biodegradable materials and sustainable processes in their place. The globe could eventually lead a plastic-free existence if more businesses and individuals work to eradicate plastic.

Increase the number of available jobs

In contrast to popular opinion, moving toward a greener economy does not always mean job losses. According to a research from the International Labour Organization (ILO), the green industry might provide 24 million additional employment globally by 2030. These employment, according to an OECD study, will be created by the agricultural and industries associated to biofuels, solar photovoltaic sector, and wind energy generation.

The OECD research claims that green policies will change the structure of the economy as it shifts towards sustainable economic activity. Changes in the macroeconomic environment and total income are also included in this. A transition to green policies is expected to produce more employment possibilities than it will eliminate, despite the fact that the entire implications are yet unknown.

Use vertical farming to address the food shortage

Only a third of the land that was accessible in 1970 will be remaining, according to the United Nations Food and Agricultural Organization. The topic of a food scarcity is brought up by the prediction that by 2050, there will be 9 billion people on the planet. The necessity for increased food production is also emphasised. Vertical farming is a green technology invention that offers a potentially effective remedy. Using this farming technique, farmers may grow more crops in a smaller area by stacking plants vertically.

Due to its reduced usage of land, water, fertiliser, and chemicals, vertical farming also lessens the environmental impact of the agricultural industry. Additionally, it promotes farming in or close to metropolitan areas, allowing businesses and customers to purchase fresher food. By using less area for agriculture, more trees may be planted, thus lowering carbon dioxide. Despite the fact that

vertical farming may be quite expensive, the financial and environmental advantages greatly exceed these drawbacks.

Sustainability and You

While these environmentally friendly products will support environmental restoration and enable us to lead sustainable lives, it is ultimately up to us. Are you prepared to embrace and use green technology quickly? After all, the clock is ticking. The longer we delay protecting the environment, the longer it will take for its effects to manifest.

Nowadays, sustainability is mainstream. Consumers and B2B businesses alike are increasingly seeking sustainable solutions. Sustainability is being ingrained in the ideals of more and more businesses. For many producers, this is the main reason the subject is so important. Sustainability and "good for the environment" are frequently used interchangeably. This, however, only tells half the tale. In order to be really sustainable, development must address three interrelated issues:

Economy: How can you build goods and services that are helpful, valuable, and geared toward long-term success rather than merely quick growth?

Social concerns: How do your goods and services improve the standard of living for your customers?

Ecology: What goods and services might assist conserve and replenish natural resources?

When creating goods and services, it's crucial to consider all three factors. You may do this using our 6 Rs, which are 6 principles for the sustainable design of goods and services. Traditional design methods like the human-centered design approach are not replaced by them. Instead, they need to supplement it with ethical, social, and ecological viewpoints. You may use the 6 Rs as a guide to determine how and where to include sustainability-related elements into the development process. Some of the 6 Rs are not brand-new; for instance, reuse and reduce are presumably concepts you are familiar with from the circular economy or private setting. However, we have added to and moved them to the digital world.

Reconsider: Reconsider and ponder again

Inquire about habits and depart from conventional thinking: Examine the principles that guide your business and your work in the spirit of digital ethics. Increase awareness of sustainability in yourself, the business, and society. To discover novel, sustainable strategies, for instance, use design thinking procedures in ideation and prototyping. What concepts, for instance, might you utilise to encourage people to alter their behaviour in order to lead healthier or more environmentally friendly lives? This includes displaying green alternatives for the time being or providing them by default.

The goals of green technology can be achieved by first of all changing our mindset and keeping in mind the 6 Rs of sustainability. This is so important and, unfortunately, mostly overlooked. The 6 Rs of sustainable development can also be interpreted as secondary goals of green technology, those are as illustrated in Figure 3:

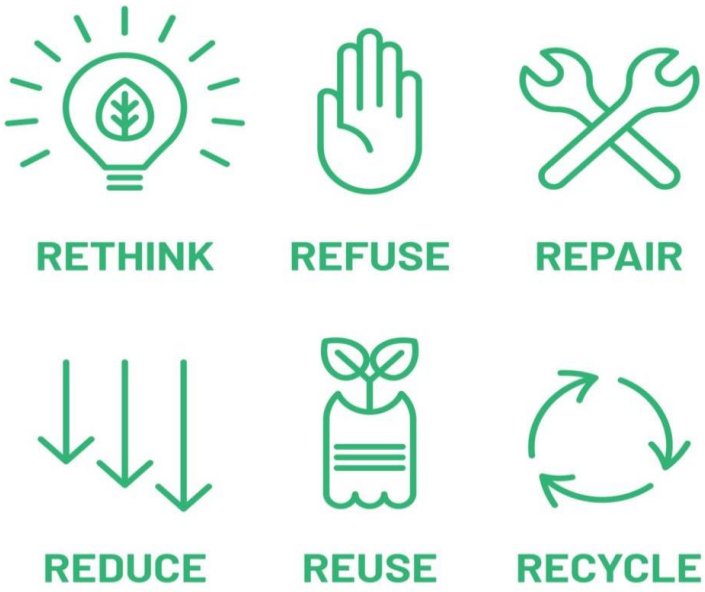

Figure 3: Illustrating the 6Rs of Green Technology.

1. Rethink – Remove the preconceptions and think: "Do we really need this?" if yes, then think "can we do this differently and in a more eco-friendly way?". This stimulates creativity, a crucial ingredient to create new green technologies. Consumers can ask the question, "Do I really need this product?" (Do you really need to replace your mobile phone every year?) Designers and manufacturers can make products that do the same job more efficiently. They can design the packaging so that it is easier to recycle (for example, by making the packaging from a single material.

2. Refuse – Refuse to use materials that are not environmentally friendly. This helps to think out of the box and for sure it will be possible to find some eco-friendly alternatives.

Consumers need to look to reduce the number of products they buy, or consider buying products that use less energy. Manufacturers are looking to design products that: have less materials in the product take less energy to manufacture need less packaging during transport. Retailers can reduce carbon emissions by transporting products straight to the consumer from the place of manufacture, instead of via warehouses and shops.

3. Reduce – Look for ways to reduce waste and the use of natural resources. Being efficient is a must for green tech.

4. Reuse / Renew – Can you reuse some old components or waste for your product? For example, it is possible to reuse some organic waste to produce eco-friendly packaging. Glass milk bottles are a classic product that is reused. A more recent product that can be reused is a printer cartridge, which can be refilled. Some products have fi lters that can be washed rather than using

disposable, single-use filters. Consumers could sell or donate products they no longer use themselves, so that someone else can use them.

5. Repair – Make sure that your green tech product is easy to repair. This helps extend the lifespan of the product and reduces waste.

6. Recycle – The benefits of recycling and very important and recycling is key to reducing waste and pollution. If possible, use recycled materials and make your product easy to recycle. Avoid rare or exotic materials and make sure that your product is easy to disassemble. Cardboard recycling is a nice example of this.

Those 6 steps are an excellent framework to help us achieve the goals of green tech by stimulating our lateral thinking and creativity.

Motivation and the right attitude towards the environmental problems we are facing are also crucial and reading some sustainability quotes can truly help to get the right mindset.

CHAPTER 10

LEVERAGING NEW AND ANCIENT TECHNOLOGIES

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When thinking about how to achieve the goals of green technology, the first thing that comes to mind is often related to advanced tech. However, it is not always necessary to reinvent the wheel. Sometimes ancient tech coupled with modern systems can offer us amazing green solutions. For example, one of the alternatives to concrete is rammed earth. This is an ancient construction methodology that can be used to reduce our use of concrete and be more eco-friendly: a perfect example of ancient green tech that is still relevant today.

On the other hand, advanced digital transformation technologies and industry 4.0 are offering incredible solutions to make our production lines much more efficient: less waste, more productivity, reduced costs, and much more. Those technologies were not available before in the history of the industrial revolution and we should leverage them to speed up our progress towards sustainable development.

Green technology or environmental technology is the activities that have minimal effects on the environment. These activities include: reducing wastage, energy generations, deploying nontoxic/harmful substances, efficiency improvements, and so on. Environment conservation became a point of concern after significant events had occurred in the world. For instance, the vast industrial accident (India 1984), oil crisis (1970 -1980), the nuclear disaster (Chernobyl 1986), ozone layer hole, and amazon rainforests clearing. These events have raised awareness about the importance of environmental health in the world. Different governments, companies, and organizations have begun the environmentalism process and enacted laws and regulations for green management.

Green managements are about the environment and sustainability. It can cause enormous changes in companies operations to green their products, operations, and facilities. It can change their sustainability business to competitive advantages. Adopting green innovation by companies and organizations keeps the environment healthy and clean. This can be done by applying service, products, and technology that do not negatively affect the natural environment resources. For instance, manufacturers and software tools keep the environment clean from harmful technological wastage.

In other words, to keep the environment clean, green technology applications must be intensive in economic expansion. The world has many natural resources that are depleted already, such as household batteries and electronics. Some of these resources contain harmful chemical that causes pollution to groundwater and soil

Green Technology in Manufacturing

Industrialization has become a burgeoning virus in today's competitive world. The companies are striving hard to sustain themselves. They tend to give better products and services and improve their manufacturing operations in today's unprecedented global competition. Because of this reason the manufacturing sector consumes lot of energy and other resources and emits large amounts of greenhouse gases which increase environmental problems like climate change - global warming, global dimming etc. and environmental degradation. And it also found a large amount of energy is also wasted in many forms. One of the possible ways to strike out these problems is Green Manufacturing. Green Manufacturing can be applied in all manufacturing sectors that minimize waste & pollution, Enables economic progress and conserve resources.

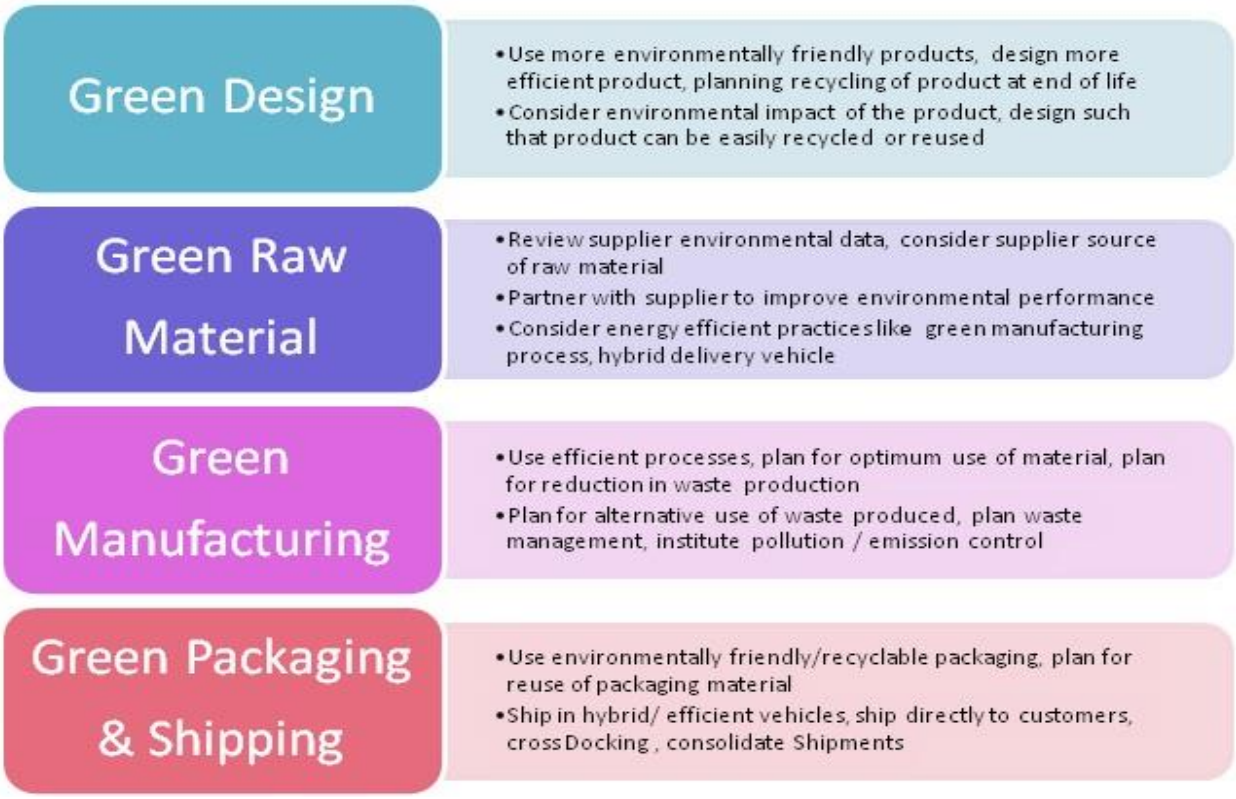

Figure 4: Illustrating the green technology pillars in contruction.

Manufacturing is the largest sector of the American economy. It stands at the center of our country's success and contributes to many job opportunities throughout the United States. From retail to construction, transportation to utilities, the manufacturing sector is closely connected with all other thriving industries across the nation today. Manufacturing, along with other industrial processes, is one of the primary industry sectors being targeted for green technology use. Traditional manufacturing methods are transforming into lean, green conserving machines that benefit the planet and the bottom line.More than that, companies need to communicate how they are dealing positively with climate change to customers who increasingly demand environmentally responsible practices. The consumer class has expanded to the point where upward price pressures are being placed on resources, including construction and industrial materials, energy, and water.

The costs of conservation and green technology are more easily justified in this financial climate It is no wonder why over 70 percent of Americans today view manufacturing as the most important industry, or why so many people are striving towards a career in this in-demand field. If you are considering a job in manufacturing and want to stand out amongst the competition, it is crucial to learn about the latest technologies, trends, and practices within the field. Figure 4 illustrates the various components.

Despite the fact that few individuals are completely aware of this, it is essential information for companies wanting to improve. In what ways is manufacturing green then? Sustainable production methods and eco-friendly business practises are established in manufacturing companies via green manufacturing. The procedures lessen the negative effects that a manufacturer has on the facility, bring about beneficial change, and inspire other companies to adopt similar practises.

What Green Manufacturing Techniques Can a Company Use?

Green manufacturing may be done in a variety of ways for businesses:

Utilization of renewable energy - Producing goods often necessitates using a significant quantity of energy. Businesses may acquire their energy from renewable sources, easing the burden on the grid and minimising their negative environmental effects.

Boost Energy Efficiency - Businesses may alter their energy source, but they can also reduce the quantity of energy used to produce goods.

Reducing pollution - A company's ability to have a significant environmental effect may be determined by how much pollution it produces. Recycling and the creation of cutting-edge technologies may help achieve this.

Conserve Natural Resources - Because large industrial facilities often have an adverse impact on the environment, businesses may do their part to conserve natural regions.

Businesses may significantly enhance these areas by investing in new technologies and doing research, but what advantages exist besides environmental ones?

The advantages of green manufacturing

It's only fair that a business should be recognised and praised if it makes an outstanding effort to practise green manufacturing. As more companies become green, the environment will benefit, and one way we can achieve this is by rewarding those companies that take the initiative.

If your company excels in environmentally friendly production, you need to promote it and let others know what you're doing. This may assist promote your brand positively and be a very helpful tool for public relations.

Making your production greener may have a significant influence on your sales since, according to a 2019 poll, 37% of respondents said that they think about the environment when making a purchase.

It can have a significant impact, as seen by APP's Crunchbase profile. All business operations at Asia Pulp & Paper are conducted sustainably. Green manufacturing is something that the top companies accomplish in one way or another, so if your company is one of them, you can expect to stand out from the competition.

It's not simply about increasing your sales when it comes to public relations. As a result of believing they are contributing to a worthwhile organisation and a favourable image, your workers may be more motivated. Even if you don't like your job all that much, it will be much simpler to feel satisfied if you know that the firm you work for is making a difference for the environment. It might be difficult to identify any benefits if you dislike your job and your employer makes no attempt to minimise their environmental effect. Recruiting new personnel falls under this as well. People are concerned about the environment, and when your company is vying for talent with other companies, your commitment to sustainability might be the deciding factor in luring the top candidates.

Tax advantages

Companies that adopt green manufacturing techniques may take advantage of incentives provided by several state and federal governments. Although making the switch to being green might be expensive up front, there are several incentives available to support your first efforts. Governments must encourage firms to employ green manufacturing techniques as they don't want major polluters operating inside their borders. You may take use of this for your company to ease the move. Discover the possibilities you have and the financial rewards that your company may get by doing your research.

Green manufacturing is unquestionably excellent for the environment, and many firms strive to implement it, but in the end, it has to benefit your financial line. Because so many people rely on your company for employment, turning green cannot afford to cost you a lot of money. Moving to green manufacturing in 2020, however, might really result in financial savings for a number of reasons. The public's purchasing habits are increasingly being impacted by sustainability, and technology has dramatically enhanced green production methods. This makes it easy to make adjustments while enhancing your business line, especially given that governments are keen to encourage industries to become green.

Although being green won't happen overnight, it is a goal that can be attained, and you can start taking the necessary measures right now.

The benefits of green manufacturing

Green manufacturing is the renewal of production processes and the establishment of environmentally-friendly operations within the manufacturing field. Essentially, it is the “greening” of manufacturing, in which workers use fewer natural resources, reduce pollution and waste, recycle and reuse materials, and moderate emissions in their processes.

Green manufacturers research, develop, or utilize technologies and practices to lessen their impact on the environment. As detailed by the Bureau of Labor Statistics, workers at green companies must have specific manufacturing training in green technologies and practices such as:

Energy from renewable sources. Workers may generate electricity, heat, or fuel from renewable sources for use within their establishment. These sources may include wind, biomass, geothermal, solar, ocean, hydropower, landfill gas and municipal solid waste.

Energy efficiency. Workers will utilize specific technologies and practices to improve energy efficiency within their establishment.

Pollution reduction and removal, greenhouse gas reduction, and recycling. Workers will use green technologies and practices to:

A. Reduce or remove the creation or release of pollutants in their operations
B. Reduce greenhouse gas emissions
C. Reduce or eliminate the creation of waste materials
D. Collect, reuse, recycle or compost waste materials

Natural resources conservation. Workers will use specific technologies and practices to conserve natural resources, such as those related to organic agriculture, land management, and soil, water, or wildlife conservation.

In Goodwin's Green Manufacturing Courses in CT, students learn about the different practices and technologies needed in a green, clean, and lean working environment. They develop the skills necessary to preserve and restore environmental quality in manufacturing, as well as create a green workplace for their companies. By studying local, state and national green/clean/lean/sustainable resources in these courses, students can truly learn how to prepare for the growing green workforce of the future.

Green manufacturing benefits employers and employees

Not only does green manufacturing benefit the environment, but growing numbers of businesses throughout the country are finding that a focus on recycling and the reduction of waste can benefit their business as a whole. Business owners are seeing improved bottom line and employees are seeing an increase in motivation, morale, and public relations

Somebody has to design and fabricate wind turbine components and solar panels, as well as transport them to where they need to go. Diesel and port fees are rising, discouraging off-shore production and transportation. Green technology could be a boon to U.S. manufacturing.

Green technology will require skills and manufacturing expertise to cost effectively produce components for solar arrays, energy storage, and other technology.

a) The number of parts to build green technology must be reduced
b) Manufacturing of green technology must orient itself to mass production and efficiency
c) EGTs must align themselves to industry standards and capabilities
d) Supply chains for glass, steel, adhesives, and controls must be built

All of these things are needed to reduce the cost to manufacture green technology to the point where it is a (pardon the pun) sustainable business in itself. The demand is there. Green technologies are available and are being integrated into the manufacturing industry every day,

making new companies eligible for government contracts and helping them attract and retain customers.

Traditional manufacturing is changing, as it always has, to incorporate new technologies that increase efficiency and decrease cost. It is now integrating green technology because it not only saves money, it saves the Earth. It's the right thing to do.

CHAPTER 11

GREEN TECHNOLOGY IN OTHER SECTORS

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Looking from the other side of this technological globe, there are certain unnecessary derivatives generated by using such technologies in abundance, which result in environmental waste, natural resource exhaustion, and harm to the earth's ecosystem. The ethical dilemma arises as a result of the impact of novel technology on values and society. To reform a society's current structure, it is common practice to equate it to a future, expected system of the kind known as "ideal systems," which refers to systems that have ideal features that are flawless in any way. It has been determined that scientists have continually developed the characteristics of realistic devices to enhance their performances by having those imaginary devices in mind. One of the features of ideal technology is the potential to be renewable and emit zero greenhouse gases into the atmosphere ideal technology is green technology.

Green Technology in Aircrafts and Space Travelling

Space exploration would provide us with a way of detecting the wellbeing of the earth, a source of energy, and a blank canvas for our creativity. Humans will be able to live more carefully in space thanks to green technologies. Impulsion oils, coverings, basic fabrics, smart costumes, sensors, and life-sustaining environments are all possible uses where green technologies can have an effect on space travel. Green nanotechnology is expected to produce constituents that are more effective, tougher, self-healing, and feather light than presently accessible ones.

Green Technology in Building Construction

Green technology opens up exciting new possibilities in the construction industry, such as the creation of energy-efficient, incredibly, extended, and incredibly lightweight construction materials. Now it is possible to monitor concrete properties, appearance, and hardness by influencing the fundamental construction of cementphases. Nano-modification also provides vital statistics for more accurately estimating the material's operating life and understandings of how to refine it even further.

Green Technology in Aircrafts and Space Travelling

Space exploration would provide us with a way of detecting the wellbeing of the earth, a source of energy, and a blank canvas for our creativity. Humans will be able to live more carefully in space thanks to green technologies. Impulsion oils, coverings, basic fabrics, smart costumes, sensors, and life-sustaining environments are all possible uses where green technologies can have an effect on space travel. Green nanotechnology is expected to produce constituents that are more effective, tougher, self-healing, and feather light than presently accessible ones.

Smart technologies will make future aviation travel more sustainable.

A large portion of an airport's supporting activities take place in the background. Additional ways Hitachi technologies may improve sustainability at airports across the globe include:

Support for the ecosystem: Data and AI used wisely may power driverless and self-driving devices for support activities, improving the effectiveness and efficiency of numerous operational procedures, including fuelling aeroplanes.

Power grids and microgrids: Smart technologies like Hitachi field-based sensors provide real-time data and analytics for enhancing power grid operations. By enabling airlines and airports to electrify their facilities and fleets of support vehicles, this increases the resilience of microgrids and lessens their dependency on fossil fuels.

Fleet electrification and management: Fleets, especially those that support airside and landside activities, are turning green. If they haven't already, passenger shuttles, belt loaders, catering trucks, and container loaders are all becoming electric. To guarantee that fleets, whether they are electric or not, are managed safely and effectively, the appropriate cars, charging infrastructure, and software are needed. Global fleet managers are addressing these issues with the use of Hitachi Process Intelligence (HPI), Asset Performance Management (APM), and other technologies.

Systems unification: By removing data silos, increasing operational efficiency, and increasing resource productivity, solutions like Hitachi Visualization Suite assist unite diverse systems. This makes it possible for many departments and organisations to collaborate more effectively and efficiently. To effectively and efficiently handle incidents, video, IoT social media data, analytics, a workflow engine, and an evidence repository may all be shown on a single pane of glass.

Greater visibility and coverage for monitoring and controlling the security of airport surroundings and airline operations are provided by Hitachi Smart Spaces and Lumada Video Insights, in addition to improving operational effectiveness. Intruder or suspicious item detection, person of interest search across video systems, and leveraging cutting-edge biometric technology like finger-vein scanners to authenticate IDs are just a few of the uses.

Airports offer unprecedented opportunity to become centres for innovation, community, and industry as we move into a new technology era. Airports may create and implement strategies to increase their impact and benefits to their local communities while expanding their business models and generating new income streams with the support of Hitachi's Social Innovation Business and consultancy services.

In order to improve everything from sustainability and passenger experience to safety and operations, airports and airlines are expected to rely more on smart technology like Hitachi Smart Spaces and Lumada Video Insights. As airports play an ever bigger role in the smart city ecosystem, new data and technologies also provide prospects for new income streams and business models. The most effective approach to simplify operations, increase profitability, and improve customer happiness is via these smart technology and solutions. More crucially, by boosting sustainability in ways that will have positive effects well beyond the confines of today's congested airports, airports, airlines, and Hitachi will be powering good.

Nanotechnology

Nanotechnology is the study of materials at the molecular, atomic, and densely complexed levels. Humans' fundamental needs and expectations are required to be fulfilled by nanotechnology as it evolves. Food, potable water, clothing, electricity, accommodations, well-being, and the climate are all requirements for humans, necessitating computerization of every ground, increased lifespan, and so on. Nanotechnology production that is planned and supervised contributes to ecological protection and can therefore be classified as green technology. Green Nanotechnology can have a major effect on nearly all sectors and fields of culture by delivering better-built, harmless, long-lasting, smarter, and healthier items for the household, electronics, pharmacy, transportation, agriculture, and businesses. Nanotechnology may thus be developed as a renewable technology for a sustainable culture if it is used in a managed manner for environmental sustainability.

Finding a sustainable balance between food quantity and ultimatum that ensures the human species' long-term survival would be one of humanity's most important challenges. Green technologies in the foodstuff and food handling industry face tasks in reducing the generation of process-induced contaminants, which necessitate the use of experts. Biological conservation, non-thermal technologies, electronic and magnetic wave warming, and electrical and magnetic fields are only a couple of the technologies available. There are potential prospects to remove process-induced poisons in foodstuffs, and also the environmental impacts of food production and storage, underneath the large category of nanotechnology and biotechnology.

Many factors contribute to the depletion of natural resources and contamination of the atmosphere, the most important of which are consumer buying habits and daily life habits. Simple changes can make a big difference; for example, if each office worker used one fewer staple per day, we'd save 120 tons of metal. Per year, over 14 billion pounds of garbage is poured into the oceans of the kingdom. The majority of it is made of plastic, which is toxic to marine organisms. The deterioration of ecological quality is a direct result of millions of decisions taken without thought to the consequences on the creation.

These statistics are unquestionably shocking, but people have the power to change the world; after all, about 75% of the waste in landfills is biodegradable. Many people underestimate the strength of the discrete, especially their dominance when it comes to matters that are significant to them. Customers are the only ones that have the ability to influence the world; even though it doesn't feel that way, customers effectively control how companies work. The lack of a widely recognized categorization scheme for green technology sometimes stymies its advancement and adoption. In 2016, China founded the Green Technology Bank (GTB), a virtual databank of green technologies, to promote and preserve sustainability improvement and speculation. This research planned a level three classification system of green technology (CSGT) using an amalgam approach that assimilates bottom-up and top-down methodologies to have a coherent metric for categorizing these skills. Green technologies are divided into five main classes, comprising ecological quality, resources use, energy consumption, safe living, and environmental protection, with 30 subordinate groups and 87 tertiary groups, according to the proposed CSGT. The CSGT allowed the investigation of 2453 specific examples of renewable energies. The outcomes provided useful

statistics for judgment makers and green stockholders to comprehend the expansion of green technology from the viewpoints of multiple bases, divisions, implementation stages, and spatial delivery.

Green nanotechnology is the use of nanotechnology to improve the sustainability of environmental processes that have negative externalities. Additionally, it alludes to the use of nanotechnology-related goods to improve sustainability. In order to assist sustainability, it involves creating green nanoproducts and utilising nanoproducts.

The goal of green nanotechnology is to create clean technologies "to minimise potential risks to the environment and human health associated with the manufacture and use of nanotechnology products, and to promote replacement of existing products with new nano-products that are more environmentally friendly throughout their lifecycle."

The creation of nanomaterials and products that do not affect the environment or people's health, as well as the creation of nanoproducts that address environmental issues, are the two main objectives of green nanotechnology. In order to create nanomaterials and nano-products without harmful components, at low temperatures, using less energy and renewable inputs where feasible, and utilising lifecycle thinking in all design and engineering phases, it leverages established concepts of green chemistry and green engineering.

Green nanotechnology refers to the use of nanotechnology to improve existing non-nano manufacturing methods for materials and products in order to reduce their environmental effect in addition to producing nanomaterials and products with less of an impact. The intended chemical reaction products, for instance, may be separated from plant waste using nanoscale membranes. Chemical processes may be improved and made to use less energy by using nanoscale catalysts. Using nano-enabled information systems, sensors at the nanoscale may be a component of process control systems. Another method for "greening" industrial processes is to use alternative energy sources, which nanotechnology has made feasible.

Creating goods that directly or indirectly assist the environment is the second purpose of green nanotechnology. Cleanup of hazardous waste sites, desalination of water, treatment of pollutants, or sensing and monitoring of environmental contaminants are all directly possible using nanomaterials or products. Indirectly, self-cleaning nanoscale surface coatings could reduce or eliminate many cleaning chemicals used in routine maintenance procedures; lightweight nanocomposites for cars and other forms of transportation could save fuel and reduce materials used for production; fuel cells and light-emitting diodes (LEDs) powered by nanotechnology could reduce pollution from energy generation and help conserve fossil fuels; and improved battery life could result in less material consumption. In order to prevent unanticipated effects and to predict affects throughout the course of a product's whole life cycle, Green Nanotechnology approaches nanomaterials and products from a wide systems perspective.

Nanomaterials are being researched for application in more effective fuel cells, ecologically friendly batteries, and more effective solar cells. The most advanced energy-related nanotechnology initiatives include energy storage, conversion, manufacturing advances via lower

material and process rates, energy conservation (for example, by improved thermal insulation), and improved renewable energy sources.

The advancement of nanotechnology in solar cells is a significant project currently under progress. Solar energy is a renewable resource, and as solar cells grow smaller, their efficiency increases. Solar energy is less than $1 per watt in cost.

Nanowires and other nanostructured materials are still being researched in the hopes of developing solar cells that are more affordable and effective than those made of ordinary planar silicon. Another example would be the usage of hydrogen-powered fuel cells, which may use a catalyst made of carbon-supported noble metal particles having a diameter of 1–5 nm. Hydrogen storage materials may be made of materials having tiny nanopores. The use of nanomaterials may allow batteries with larger energy content or supercapacitors with a better rate of recharging, where nanotechnology may potentially find uses in batteries.

For photovoltaic (PV) and solar thermal panels, nanotechnology is already employed to create coatings with increased performance. Solar panels are made to be more effective, particularly in bad weather, when they combine hydrophobic and self-cleaning qualities. For continued optimum energy efficiency, PV coated with nanotechnology is supposed to remain cleaner for longer.

Future of Green Technology

The industry of green technology is constantly growing. As shared in the "Green Technology and Sustainability Market by Technology: Global Opportunity Analysis and Industry Forecast, 2021–2030" report, in 2020, the global green technology and sustainability market size was valued at $10.32 billion and is projected to reach $74.64 billion by 2030, growing at a CAGR of 21.9% from 2021 to 2030. Environmental awareness and the growing concern of organizations and individuals about global warming will only continue to enhance the growth of the green technology market. Furthermore, governments all over the world are starting to invest in green technology businesses to decarbonise the economy and make their countries more energy efficient. An example of such an initiative is the funding announced by the Department for Business, Energy and Industrial Strategy (BEIS) in the United Kingdom. In addition to carbon capture projects, the funding will be used to strengthen energy efficiency in UK homes and businesses by finding cleaner, greener ways to heat and power them. We predict that more and more funds like this will be established in the near future.

Global investment in green technology has been increasing by almost 20% over the last few years in different sectors like energy, innovation, and manufacturing. With more pressing environmental problems across the world like energy shortages, global warming, pollution, rising urban population, and others, individuals, small and big companies, and countries are looking into the future to see how adapting to greener technologies can help change the world.

Finding a way to curb our huge reliance on fossil fuels and reduce pollution depends on how we develop new green technology and more eco-friendly solutions. We need alternative and more efficient solutions to shape the future. Below, we look at what the future of green technology looks like. The transmission of technology is not a passive, one-way process. It is necessary to take into

account both supply and demand considerations in order to encourage the transfer of green technology from developed economies to developing nations. Investors and businesspeople who take part in technology transfers look for an enabling environment in recipient developing nations, specifically the capacity and infrastructure to support production and management as well as the regulations that encourage further development of green technology, on the supply side. To effectively absorb green technology, there must be local demand (pull forces) on the supply side. In order to foster the transfer of green technology and adopt sustainable development strategies, developing nations must acquire technical capability and establish institutional frameworks that allow them to accept, modify, and advance the transferred systems and components.

Most of the transfer of green technology is now taking place in the largest growing economies, including China, Brazil, and India.

It's not fully unidirectional, however. Additionally, it occurs in a variety of ways inside, across, and between industrialised and developing nations.

The most common transfer route is simple buying and selling. Additionally, there exist contracts for in- and out-licensing of promising innovations and related know-how as well as the development of more complex platforms for the development, transfer, and use of technology, such as joint ventures, strategic alliances, and R&D services. Learning about various technologies via specialised programmes, technical support, training, and education is another method of technology transfer.

Obstacles to the use of green technologies

Since environmental costs are often externalised in traditional manufacturing processes, green technology is often more costly than the technology it seeks to replace. It may be more expensive than more established technologies because of the accompanying development and training expenditures since it is a more recent technology. The perceived advantages also rely on other characteristics including supporting infrastructure, technological preparedness, human resource skills, and geographic components. In light of this, what would be a viable green technology in one nation or area may not be in another. There may be other obstacles that prevent the adoption and dissemination of these technologies.

Others might be of a legal, technical, financial, political, or cultural character. Some can be institutional, such the absence of a suitable regulatory framework.

The following are probably obstacles to implementing green technology from the viewpoint of a company:

• Exorbitant installation fees

Lack of knowledge, lack of alternative chemical or raw material inputs, lack of alternative process technologies, uncertainty about the effects on performance, and lack of human resources and abilities are all factors.

A lot of different parties may be involved in removing these obstacles, including the government, the commercial sector, NGOs, as well as financial, scientific, and educational organisations. This

makes it a complicated process. Finding and addressing these obstacles to the widespread adoption of clean technology in emerging nations—especially those with particular requirements, including least developed nations and tiny island developing states—is necessary to promote green development. The transmission of technology is not a passive, one-way process. It is necessary to take into account both supply and demand considerations in order to encourage the transfer of green technology from developed economies to developing nations. Investors and businesspeople who take part in technology transfers look for an enabling environment in recipient developing nations, specifically the capacity and infrastructure to support production and management as well as the regulations that encourage further development of green technology, on the supply side. To effectively absorb green technology, there must be local demand (pull forces) on the supply side. In order to foster the transfer of green technology and adopt sustainable development strategies, developing nations must acquire technical capability and establish institutional frameworks that allow them to accept, modify, and advance the transferred systems and components.

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The main focus on the future of green technology

In the business world of today, the phrase "sustainable development" has expanded to include a wide range of approaches, metrics, and initiatives. Sustainability has come to be used as a catch-all phrase for a number of initiatives, including clean-tech (clean energy, clean water, and sustainable agriculture), human resource development, and social development. However, the most basic definition of sustainability is growth that satisfies current demands without jeopardising those of future generations. Today, the concept of a successful company has quickly changed to include the capacity of an organisation to go beyond profit and transform its business model into a sustainable one. The combined efforts of corporations, consumers, governments, and civil society are helping to achieve this goal, which has now become a strategic business necessity.

Reaching the 2030 Sustainable Development Goals (SDGs) and the nation's 2070 emission reduction objectives will be made possible in large part by these initiatives. Technology that supports environmental, social, and governance (ESG) objectives is being used by an increasing number of enterprises today. In order to lower their carbon footprints, businesses are focusing on a number of critical areas, including energy optimization, emissions reductions, cleaner fuels, circular plastics, and low global warming (LGW) prospective goods.

Operating a facility requires a lot of energy, with bigger facilities requiring power needs of up to tens of megawatts. For their energy requirements, the majority of these locations use natural gas or diesel. Businesses are now looking to switch from fossil fuels to sustainable renewable energy sources. In the present economic climate, it is crucial for enterprises to save operating costs while putting policies in place to fulfil rigorous greenhouse gas (GHG) emissions limits.

Businesses are keen to transition to decarbonized, decentralised, and digitalized energy sources. This transition is made easy because to the adoption of battery energy storage systems (BESS). In its most basic configuration, these systems store a significant quantity of renewable energy for use during periods of peak demand. While significantly lowering the stability of the power system and carbon emissions, energy storage enables renewable energy sources like wind and solar energy predictable and readily accessible on demand.

Moreover, enterprises may be able to switch from linear production processes to models that support efforts for emissions management and reduction thanks to technologies like artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT).

The foundation of our civilization is made up of structures and infrastructure. Unbelievably, buildings account for 39% of global carbon emissions, according to statistics from the World Green Building Council. Operational carbon from heating, ventilation, and air conditioning

accounts for the bulk (28%) of the problem. Currently, 18% of all GHG emissions are solely attributable to commercial building electricity usage.

By monitoring and reducing methane emissions, which, according to the US Environmental Protection Agency, are more than 25 times as effective as carbon dioxide at trapping heat in the atmosphere, facilities can achieve carbon neutrality. This is made possible by technology and software that supports emissions control initiatives. Facility managers can take swift action thanks to technology that makes fugitive methane emissions easier to identify early on. This technology includes real-time analytics and the specific location of any leaks.

This enterprise-level software aggregates carbon data from energy-related emission sources in a building, including gas, electricity, and fuel sources, in addition to offering a real-time dashboard of sustainability key performance indicators. It also reduces energy consumption using advanced building control capabilities and lowers carbon footprint without sacrificing occupant comfort or well-being. Importantly, it gives clients instructions on how to follow the path to achieve carbon neutrality, which helps them work toward their carbon neutral objectives.

The production of cleaner fuels via procedures that decrease emissions is equally important to sustainable development as energy optimization and storage. Alternatives like sustainable aviation fuel, which have already been created, are essential for lowering the sector's GHG emissions.

One of the key components of the energy transition is expected to be green hydrogen, which is produced by splitting water into hydrogen and oxygen in an electrolyser driven by renewable electricity. "Hard-to-decarbonize" industries like heavy industry, residential construction, and transportation may all benefit greatly from carbon capture and hydrogen technology. Building future refineries and developing cleaner fuel substitutes, such as sustainable aviation fuel, green diesel, and green and blue hydrogen, would help India build a more sustainable future.

Due to the increasing global population and the rapid industrialization, better recycling options and plastic management are necessary to support the conversion to cleaner fuels. In order to reduce carbon footprint, new solutions for managing plastic trash are essential. Modern recycling technologies for plastics may help improve a variety of polymers, including waste plastic, commercial packaging, and other discarded plastics. These new technologies may also lessen the demand for fossil fuels in the manufacture of virgin plastics, allowing the development of a circular economy for plastics.

Commercial-scale methods that transform waste plastics that can't be recycled into sustainable polymer feedstocks have the potential to replace fossil feedstocks in the manufacture of new plastics. This makes sure that used plastic is broken down so that it may be fed back into the system used to create new plastic. According to industry research, this technology has the potential to triple the quantity of plastic that can be recycled and cut CO2 equivalent emissions by up to 57% when compared to producing the same amount of virgin plastics from fossil fuels.

Petrochemical firms nowadays typically employ fossil feed materials made from crude oil. From sustainable feedstocks like recycled cooking oil and animal fats, the novel technique may create

large quantities of petroleum naphtha. When compared to petroleum feeds, this output may release up to 80% less greenhouse gases.

Clean and green operations are more important than ever. The future of industry seems to be bright given the speed with which clean technologies are being adopted and the efforts being made to develop more sustainable processes.

From small businesses, innovators, equipment manufacturers, and service providers to global manufacturing giants, investment into green technology is being considered on both small and large scale. To understand what serves as the foundation of this rapid growth, you need to look at the key areas of focus.

Energy

Energy is considered the most pressing issue in matters green technology. There is no doubt that the world today is heading into the unknown if we continue to rely on fossil fuels. Fortunately, the energy sector worldwide is focusing more on the development of alternative fuels and energy sources. The manufacturing sector will also play a significant role in producing more energy-efficient products that go a long way into adapting the green way of life into the future.

Sustainability

Companies and service providers are taking necessary steps and putting great effort into meeting social-related needs with sustainable solutions that will be used now and in the future without damaging or depleting natural resources. For instance, car wash businesses are opting for more efficient wash systems that help them recycle used water for use to reduce wastage. If you own a transit wash system, you would see how such solutions can help you save on water bills while also offering a sustainable solution to reducing water wastage.

Source Reduction

Companies in all manufacturing and industrial sectors are also creating solutions geared towards reducing waste and pollution by changing how products are manufactured and consumed by end-users and consumers in the market. Various steps are being taken to achieve this:

- Instituting practices that reduce waste.
- Recycling waste.
- Purchasing remanufactured products like equipment and parts.
- Opting for green product alternatives.
- Adopting green policies in the product and service sectors.

Innovation

Innovation is the driver of future green technology and solutions. More focus is now on the development of better alternatives to the types of technologies that have proven to pose a danger to our environment and health. Innovation will play a huge role in changing trends in the use of fossil fuels, creating solutions for urban industrial pollution and developing alternatives for chemical-intensive agriculture.

Green Chemistry and Nanotechnology

The future of green technology will largely depend on how businesses and organizations learn to invent, develop, manipulate, and apply different processes to products and materials at different levels.

Whether it's through chemical processes or nanotechnology, this will play a huge role in helping us transform the manufacturing of products and chemical processes so as to reduce and eliminate the use and generation of hazardous materials and substances.

Regenerative Design

A large percentage of the world's waste is caused by the use of products like plastics that are not recyclable or non-degradable. Ending the cycle of using manufactured products that are not eco-friendly is a great focus in green technology today. Manufacturers are now creating products that can be fully reused, recycled, or reclaimed.

Viability

In a world where implementation of green policies is still slow, especially in developing countries, the viability of green technology going into the future is of most importance. Developing centers of economic activity or green hubs that focus on creating products and innovative technologies that truly benefit the environment and ensure health safety is critical.

Green technology inspired projects, organizations, and centers—whether government funded or private—play a huge role in speeding up implementation of green solutions as well as creating awareness and careers that focus on making the planet a safer and better place.

Exciting new technologies for a green future

Transport in public by electricity. The availability of 160 electric and hybrid car types today means that not only do individual vehicle owners have more access to EVs than ever before, but governments are also taking note. Every day in China, 300,000 electric buses rumble through metropolitan streets. Their overwhelming acceptance in China—both an economic and a policy victory—will persuade European towns to do the same. Due to their independence from expensive fuel, these eBuses have reduced total costs of ownership (TCO) while having higher acquisition costs because of upfront battery charges. They also get rid of local particles like SOx, NOx, and CO2, which are important problems in most cities right now.

The European market for electric buses is advancing quickly, but how will it change?

Electric trucks

Commercial fleets could quickly follow suit as electric passenger cars quickly increase their market share. But a thorough grasp of the total cost of ownership is necessary to facilitate a smooth transition. Electric vehicles, or "eTrucks," weren't widely used back then because they were too expensive. However, thanks in part to cost-competitive electric vehicle infrastructure that is now readily accessible, the total cost of ownership may soon be comparable to diesel-powered trucks. By 2030, certain markets may see battery electric business vehicle (BECV) adoption exceed that

of electric vehicle sales in select countries, particularly in the light- and medium-duty sectors. And although though many heavy-duty BECVs will need charging in the middle of the road, our study reveals that during the early stages of adoption, a charging station every 80 to 100 kilometres on well-traveled roads will be sufficient.

Affordable energy storage

The market for lithium and cobalt batteries has grown quickly thanks to the new generation of electric cars, and their cost has dropped significantly. Nine years ago, lithium ion batteries cost $1,000 per kilowatt-hour; now, the price is $200. Beyond EVs, other industries are also impacted by the growing battery business. They are being used more widely by utilities and industry as energy storage options. With batteries' prices falling quickly, they are proving useful for lowering power costs, boosting dependability and resilience, and improving the operational flexibility of power systems. Utility companies, however, will need to make swift changes due to the mass availability of inexpensive energy storage. One approach will be to switch from a variable pricing structure to a set cost for access to the grid (like cable TV), particularly when users start producing their own energy. Another will be to increase circuit-by-circuit nodal planning when revising grid-planning strategies.

Long-term holding

Lithium-ion batteries are excellent for addressing short-term storage needs (4-5 hours) that happen frequently (20-200 times per year), but the market also wants solutions that address long-term storage needs caused by seasonal shifts and extended periods when the sun does not shine and the wind does not blow. One of the few methods to control these seasonal variations in the past was to build hydroelectric dams. In the absence of this, the system would have to construct a vast array of seasonal plants.

Fortunately, fresh inventors think they are getting close to creating long-duration storage solutions. Recently, Google X created Malta, a company that uses molten salt to store renewable energy. By creating a low-cost thermal battery for grid-scale energy storage, Antora Energy is attempting to address the same issue. And Lightsource, which is financed by BP, is integrating storage into solar systems. What is certain is that the cost of electricity will drop dramatically if long-term energy storage is successful. By substituting less expensive generators like solar and wind in the power supply, these long-term alternatives might decrease the costs associated with the underutilization of assets during.

Recyclable plastic

Globally, 260 million tonnes of plastic garbage are produced each year, yet only 16% of it is recycled. The possibility exists for the plastics industry to switch from a "take, manufacture, and discard" business model to a circular one that attempts to reduce waste across industries while generating positive effects on the economy, society, and the environment. Pyrolysis, which turns plastic waste back into liquid feedstock using heat and an oxygen-free environment, is one possible circular process. The advantages are both economic and environmental, with a recycling-based profit pool expected to reach $55 billion over the next ten years.

Effectiveness of LED lighting

By 2030, it's anticipated that 84 percent of the market will be occupied by energy-efficient LED lighting, which is swiftly replacing conventional incandescent bulbs in American homes. LED lighting will cut energy use by 40% in 2030 alone, saving $26 billion when energy costs are adjusted to today's levels. These are significant cost reductions, but the Department of Electricity claims that by increasing its investment in LED lighting, the United States could still save an extra 20% on energy.

Easy access to solar energy. 2019 will see additional advancements in renewable energy's affordability and accessibility, which has significant consequences for the almost 1 billion people worldwide who lack access to power. The majority of the world's population is still without electricity, so countries in sub-Saharan Africa and the Caribbean are looking into renewable energy options like solar energy to provide energy quickly and affordably to millions. While expanding the grid is part of the access solution, it is not the only one. Solar home systems (SHSs), which were previously out of reach for many communities without a dependable grid connection, may now be a viable option thanks to creative financing schemes. SHSs can provide electricity to 150 million homes by 2020, according to a new McKinsey analysis.

Capture and storage of carbon

We may think about securely collecting the carbon released during the production of cement and plastics, rather than only concentrating on entirely decarbonizing those two key industrial products. Industry can absorb carbon at its source, compress it, and transport it to a suitable location for long-term storing it thanks to carbon capture and storage (CCS). If CO2 can be utilised successfully to produce other goods, the technology has the potential to not only drastically cut greenhouse gas emissions but also increase revenue. Many sectors of the economy are already attempting to utilise collected carbon dioxide profitably, such as companies that produce polymers like polyurethane using captured carbon. Prior to now, it has been too expensive to adopt emerging technologies, such as direct air collection, on a large scale. However, a recent research from Stanford University suggests that the cost of direct air capture, which removes carbon dioxide from the atmosphere and transforms it into synthetic fuel, might ultimately fall from $600 per tonne of CO2 to less than $100.

The role of hydrogen in the energy transition

Without hydrogen playing a significant role in the solution, it is hard to see how we can fulfil ambitious global warming standards. By 2050, hydrogen is expected to power more than 400 million automobiles, 15 to 20 million buses, and more than 20% of passenger ships and locomotives, according to hydrogen-led routes to cleaning up the environment. However, hydrogen-powered fuel cells have the capacity to store more energy while being lighter than battery-powered electric cars. They are the perfect option for huge freight trucks that must drive great distances because of this. In Germany, California, South Korea, Japan, and other countries, hydrogen-powered fuel cell cars are currently on the road. By 2020, more than ten more models are expected to be available. In other words, the use of hydrogen fuel may enable the world to reach its target of a 60% reduction in carbon dioxide emissions. Despite the fact that the essential

technology already exists, manufacturing hydrogen still has to become much more affordable, and the infrastructure that supports it needs to be improved. By serving as a long-term transit and storage option for renewable power, hydrogen may enable the wiser use of other renewable energy sources. It may serve as a crucial catalyst for the energy transition.

Solar Power

The solar power industry is growing fast and is aiming at achieving enough solar capacity in the future. As one of the leading green technologies with implementation all over the world, a lot of innovations are coming up every day. From solar roof tiles and walls to large solar stations in deserts and smart solar innovations, car wash owners and other businesses can power their operations and cut energy costs.

Living Buildings

Planting roof gardens on flat open top buildings has been going on for some time now. However, this technology is being pushed further by architects and designers with more innovative concepts of making entire buildings and cities green. Urban jungles also help absorb heat, rainwater, and carbon dioxide, as well as provide insulation.

Vertical Farms

With global population rising fast, providing sufficient food for everyone will be a problem in the coming future, especially when arable farmland becomes progressively limited by productivity and space. The solution lies in vertical farms or indoor farming in densely populated cities.

Windmill Farms

Wind is one of most critical natural energies available, so it presents a key area of focus in green technology. Innovative wind turbines are now being created with more attractive designs, better durability in strong weather and better functionality even in low-wind environments.

Biodegradable Products

As the world comes to terms with the level of damage that non-biodegradable products are doing to the environment, biodegradable alternatives to plastics are part of the future green technology solutions expected to bring change. Efforts are currently being made by manufacturers to produce safer products using biodegradable materials.

Green Computing

Environmentally sustainable computing is another example of future green technology. With over 60% system components ending up in landfills, the focus is now shifting to more efficient and effective designing, manufacturing, testing, using and disposing of computers and other related equipment and devices to ensure minimal or no impact on the environment.

The future of green technology is bright, with innovations expected to change the way we do things, use day-to-day items and even interact with our surroundings.

Challenges Facing Green Technologies

Green technologies are technologies that are good for the environment. They reduce the harm that technology developed by humans for their convenience does to the environment. However, there have been issues with green technology that make it more difficult for them to achieve their intended purposes. The main difficulties in implementing green technology ideas, design, and production are covered here.

1. Developmental Issues
2. Market Difficulties
3. Technology Obstacles
4. Financial Difficulties
5. Regulatory Obstacles

1. **Developmental Obstacles:** Unpredictability and disruptions in fuel supply have affected green technology. Due to the absence of palm oil farms and mills in many small renewable energy initiatives, they make it impossible to have a long-lasting fuel contract. Other power suppliers cannot access energy sources produced by renewable materials because there are not enough links between them and green technology. The cost has restricted the usage of renewable energy sources. The cost of renewable energy sources is higher than that of accessible fossil fuel energy sources. Additionally, the availability of natural gas poses a serious threat to the development of green technologies. It has been difficult to examine the consequences and implications of national policy while recommending proper technological expansion. There haven't been enough developments to fully explore these consequences. Programs for the development of green technologies have been delayed as a result, since some of the national policy implications are not well recognised.

2. **Market Challenges:** The obstacles faced during trade growth are the biggest hindrance to growing the use of green technology in emerging nations. Environmentally friendly technology that are readily accessible across the globe and the related services that are available on the market are not well known.

   The production of environmentally friendly green goods is slowed down by the lack of global knowledge about providers of green technologies. Additionally, concerns and opinions from the industrial and environmental sectors are taken into account when developing international trade and environmental policy. Small and medium-sized firms are barred from joining the global markets for green technology due to the complicated rules. Consumers take a long time to move from old goods to new ones, which adds to the supply chain side of promoting a new product. This procedure may be difficult and drawn out. The green chemistry products have encountered opposition and roadblocks to complete adoption. On whether goods should be regarded as being safer for human use, there is a lack of consensus.

3. **Technology Challenges:** There aren't enough experts in the world with the knowledge and skills necessary to support green technology and the ideals they promote. For instance, not all of the features of green buildings are appreciated by experts. These include effective ways to get energy that reduce environmental harm, as well as ventilation, temperature, and lighting management. In order to fulfil requests to outgrow earlier methods of running their firms, it must stay up with the most recent innovations. Green technologies require real-time access to their data in order to communicate effectively across borders. Information and communication technology advancements are a hurdle that green technologies must continually develop to overcome in order to flourish and accomplish their intended purposes.

4. **Financial Challenges:** Finding funding for renewable energy projects has proven to be difficult. Small renewable energy project developers need to be in good financial shape to get funding for their initiatives. And rather of relying primarily on commercial loans, they should have the financial resources to do so via equity investment. The government should think about providing a soft loan to support renewable energy initiatives as national projects since the developers lack sufficient finances to finance their projects and they begin to stall. The identification of appropriate green technologies for producing revenue via sustainable agriculture, such as ecological agriculture and rural renewable energy, has proven difficult in the realm of agriculture.

5. **Regulatory Obstacles:** The management of international regulatory compliances with reference to green technology is a barrier that holds back their growth. While there are significant investments being made in the US, there are many prospects for renewable energy projects abroad. It has proven difficult to enforce green technology legislation in such nations. The identification, adherence to, and management of legislation that differ greatly from nation to country provide difficulties for organisations driven by green technology initiatives. It is challenging for medium-sized and small businesses to access the global markets for green technologies due to the complicated laws and regulations of entrance. There are considerable regional differences in each nation's ability to effectively execute energy restrictions. Some nations lack the government rules needed to push green technology ventures forward. For instance, green construction innovations are not subject to restrictions in Asia. While some nations have a green construction strategy, not all of them are supported by the right incentives or regulations to promote development. Construction and development of exceptionally strong, energy-efficient materials to offer a dependable energy supply are opportunities for the green technology market

. Environmentally friendly goods and services

Reducing the amount of resources necessary to create green goods will considerably lessen negative effects, preventing the collapse of the economy and the environment. Renewable energy, water recycling, and water treatment services have been highlighted as the most important reasons for export prospects and development in the green technology sector. Conclusion: In the modern world, green technologies are essential. Green technologies should be used to guarantee the sustainability of the eco-social environment since conventional technology poses a threat to it.

Although the use of clean technology has certain drawbacks, if we consider its long-term advantages, we and our future generations will undoubtedly gain. Technology will also enable us to preserve our finite resources. Consequently, education is the most straightforward means of ensuring social, environmental, and economic sustainability.

LOOKING AHEAD

Businesses have a wide range of ideas on how green technology will transform over the next decade. Most agree that innovations and implementation will increase. Some of the changes expected include:

1) A significant increase in efficiency levels in the next 5-10 years.
2) A whole new building approach to smart energy innovation and use.
3) Continued growth in consumer demand for highly efficient products.
4) Stricter implementation of measures to lower emissions.
5) Efficient designs that perform better and are more sustainable.

India, which has a population of 1.5 billion people and an economy of USD 3.3 trillion, has immense potential for creativity, invention, and effective application of cutting-edge technology, including green ones. The Indian economy has recently shown both strong development in numerous areas as well as covid durability. The International Monetary Fund projects that India's economy would expand by 8.2% in 2023, which is on line with the growth of the world's top countries.

The epidemic and the war between Russia and Ukraine have prompted industrialised nations to think about diversifying their energy supplies by using a variety of sources as well as various geographic locations. The earlier-than-anticipated appearance of warning indicators of climate change has compelled governments all over the world to think about lowering reliance on non-renewable energy sources and search for cleaner alternatives. India has made the ambitious commitment to achieve net-zero carbon emissions by 2070 despite the country's increasing energy needs, and it is already in the process of revamping its energy industry to embrace green energy. The installed renewable energy capacity in the nation has doubled to 100GW during the last five years, thanks to the energy industry.

India offers prospects for innovation and investment in the area of green technology due to its strong pledges to combating climate change and phasing out the use of coal and other fossil fuels for rising energy demands in the future.

Marketing strategies

In India, the adoption and promotion of green technology is a deliberate effort to achieve nationally specified contributions and decrease reliance on non-renewable energy sources as part of the climate action plan to reduce emissions. The many policies targeted towards the nation's sustainable economic growth are strongly supported by these activities.

Numerous initiatives have been made in India that both directly and indirectly aid in the adoption of green technology. The Aatma Nirbhar Bharat Abhiyan, or campaign for an independent India, is significant among such initiatives. This initiative forced the government to update the standards for the classification of micro, small, and medium-sized businesses and simplify registration by connecting various portals to provide a single point of contact for a variety of regulatory and other business requirements, such as credit facilitation, skill development, and recruitment, adoption of strict emission and waste management laws, a decrease in the use of coal for power generation, and the promotion of electrification.

Feasibility of initiation

India has long recognised the importance of implementing green technologies and has prioritised it at the national level for more than 20 years in order to address environmental problems brought on by non-green technologies, which cause irreparable environmental damage and jeopardise sustainable economic growth.

The acceptance and use of green technology are not without their growing pains, however. For instance, green technologies need a lot of labour and are often not cost-effective. A complete transition to green technology for a developing nation like India is not simple, unlike industrialised countries, which are technologically competent and have the resources to embrace them.

India presently has a significant need for green technology as a result of continuously updated legislation implemented across several industries to support sustainable growth. The labor-intensive nature of green technology presents an additional possibility for India to meet its employment needs. The size of its domestic market and the existence of a well-established low-carbon environmental products and services sector are further variables that favour India.

Questionnaires for practice

1) What is Green Technology?
2) What is the need of Green technology?
3) Give a brief about history of green technology.
4) What are the major initiatives of green technology?
5) Elaborate the role of green technology in sustainable development.
6) What are the major applications of green technology in healthcare?
7) What do you mean by Green buildings?
8) What are green materials?
9) How can green technology help aviation sector?
10) What is green manufacturing?
11) What is green nanotechnology?
12) What are other sectors which can be benefitted by green technologies?