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## Importance of Use of Green Technology in Research : An Overview

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### ABSTRACT

Green technology is a broad word that refers to the application of science and technology to generate environmentally sustainable products and services. It is connected to cleantech, which refers to goods or services that increase operational performance while lowering costs, reduce energy usage and waste, or decrease negative environmental effects.

Green technologies cover a wide range of technologies that assist in reducing human influence on the environment and fostering long-term growth. The fundamental parameters for green technology are social equitability, economic feasibility, and sustainability. India's current push for renewable energies and green technology, such as solar, wind, and nuclear power, can go a long way in aiding the country's success story.

Keywords-green,technology,clean,technology,renewable,sustainability,environment

### INTRODUCTION

The goal is to safeguard the environment, heal past environmental damage, and conserve the Earth's natural resources.

#### Advantages of Green Technology

- Energy Sector- Power generation is the field where green technology has the potential to make a difference. Green energy, such as solar PV, biogas generation, and wind power, can provide additional job possibilities and be successfully implemented to provide energy solutions to communities in remote places.
- Helps in reducing the input cost- One of the primary objectives of any company is to cut costs on the input side. Green technologies such as green buildings, energy efficiency measures, and green manufacturing, among others, have been identified as energy and resource savers. This not only assists firms in lowering their input costs, but it also allows them to fulfil their social duties.[1,2,3]
- Manufacturing sector-Green manufacturing can provide considerable benefits to manufacturing companies. Green technology in the manufacturing field can help reduce waste and pollution by modifying production and consumption habits. This not only decreases a product's environmental footprint, but it also makes production a more environmentally friendly and cost-effective activity because inputs from the source are decreased by design.
- Trickle Effect- The fact is that all green technologies take into account the demands of both people and the environment, so it's no surprise that success in one area leads to success in others. In India, for example, people have employed alternative green power production methods to not only meet their personal energy demands, but also to sell their energy to the grid, resulting in a large profit.
- Approach of Green Farming-Green farming methods have been shown to be both healthier for humans and productive for the soil. In contrast to inorganic farming approaches, which resulted in a decline in production after a given amount of time, green farming leads to increased productivity over longer periods of time.
- Helps in creating avenues-Green technology has the potential to create new industries that were previously unimagined, especially at a time when the economy is slowing. Previously, waste management was restricted

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to garbage dumping. In South Asia alone, waste management is already a \$25 billion business. As a result, the environment will be cleaned up, jobs will be created, toxic and greenhouse gas emissions will be reduced, and there will be numerous benefits.

- Benefits in rural sector-Green technology have the potential to have a significant impact on local communities. The provision of bio-gas plants to rural families has the potential to empower communities and boost production. It was seen during the distribution of solar lanterns as part of several programmes, such as the TERI's Lighting a Billion Lives Campaign. It is obvious that people have benefited from it by not just using but also trading the outputs.

## Examples of Green Technology

- LED Lighting-There is a significant increase in efficiency by avoiding incandescent lighting. Traditional incandescent light bulbs use more energy than LED light bulbs. LED lights are used outside of pure visual assistance. Moreover, they are used in vertical farming and even in the fight against malaria.[5,7,8]
- Wind Energy- Wind energy harvesting is an excellent example of green technology in action. Wind energy is frequently connected with a wind farm. Small-scale windmills, on the other hand, are a great way to incorporate green technology into a home.
- Solar Panels-Solar panels have become a viable option due to decreased pricing and monetary incentives such as tax credits in many locations. Even a single solar water heater saves a lot of energy. As solar energy is extremely efficient, any losses can be recouped very quickly.
- Programmable thermostats-A low-cost green technology solution is a programmed thermostat. With a programmable thermostat, you can set a schedule and have the temperature automatically adjust to your comings and goings, consequently saving both energy and money. The ability to monitor and modify temperature remotely is an additional benefit of a smart thermostat.
- Vertical Farming-It is the process of growing vegetables vertically rather than horizontally in stacked layers. Increased sustainability is one of the advantages of vertical farming. Some vertical farming setups don't even require soil, and they save a lot of water.
- Green Architecture-It allows buildings to be built in such a manner that they take use of available natural light while also providing enough insulation to reduce energy usage. Such construction methods will save energy in lighting and remove the need for heating by limiting the quantity of heat lost to the outside.

Huge capital expenditure is required to attain the ambitious targets set by India on the international stage by applying green technologies. However, there is a problem regarding storage of renewable energy sources. Recently, the Power Ministry has released a comprehensive framework for promoting and developing energy storage facilities. This problem can be solved by successful public-private cooperation.

Hence, experts recommend policy certainty and preparation to give investors a safe place, with equal emphasis on solar, wind, and hydrogen energy sources. As a result, an integrated approach to increasing business and possibilities while maintaining a sustainable environment would be developed.

## II. DISCUSSION

Reducing carbon emissions and leveraging a circular economy is the key focus for developers of green technologies, here are 10 solutions that could work

### 10. Biomimicry

Mimicking plants and the natural environment is a method of sustainability that is only dreamt of. Scientists are working to capture the regenerative functions of plants and animals, similar to healing a wound or sealing a cut made when pruning a plant. This technology could be used in fibres to enable cuts to patch up minor holes and tears.

### 9. Molten salt energy storage

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Heat is one way in which energy can be stored, meeting a gap in the energy sector that must be filled to reach a renewable energy future. It has been noticed that salt has particularly good characteristics for heat storage, making it a great base for capturing and holding energy.

## 8. Artificial photosynthesis

Speaking of mimicking plants, scientists and technologists are working together to mimic the effects of photosynthesis through technology. The solutions are expected to amalgamate both sunlight and carbon dioxide to create usable energy—a form of carbon capture that will provide further resources.

## 7. Smart meters

While they don't actively reduce emissions, smart meters installed in homes allowed consumers to reduce their energy consumption, which is an indirect way of reducing overall housing emissions. Individuals are able to save on their household bills while companies have more energy in the pipeline to supply to other buildings. [9,10,11]

## 6. Carbon capture and storage

One of the most innovative solutions for eliminating atmospheric carbon dioxide, carbon sequestration, is going beyond human efforts to plant more trees and reduce carbon output. New technologies will be leveraged in years to come to actively remove carbon emissions from the atmosphere. However, according to the International Energy Agency (IEA), current carbon capture alone will not be enough to deliver the 1.7 billion tonnes of activity required.

## 5. Electric vehicle propulsion

One of the most visible forms of renewable technology is electric vehicle (EV) propulsion. Range anxiety plays a role in the adoption of EVs as the current charging infrastructure and energy grids are not capable of supporting a fully-electric future, yet.

## 4. Nuclear energy technology

Although controversial based on its potential to disrupt cities (an example being the Chernobyl nuclear reactor), technology is being developed to make the most of nuclear materials to produce clean energy at scale. Current technicians are only able to utilise uranium supplies to around 1% of their full potential, making nuclear a contender for widespread green energy.

## 3. Waste-water electricity generator

The circular economy can be applied beyond recycling man-made materials. Oregon State University developed a hybrid electricity generator, which uses microbial fuel cells and reverse electrodialysis. These technologies combined enable the use of waste water to create electricity. Alongside the solutions contribution to mains grid power generation, the technology is also capable of powering the treatment of water as it comes full circle.

## 2. Recycled plastic road surfacing

In 2011, Coca-Cola announced its road surfacing project in Pakistan as it encourages a circular economy of waste materials. Plastic-based road materials have been adopted as an initiative that not only utilises recycled plastic bottles, but also develops in the community in the surrounding area.

## 1. Green architecture

Due to the sheer scale of the built environment, difficulties arise around the sustainability of urban living. As buildings are getting taller and cities more compact, innovation is taking place to ensure that new buildings meet climate

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requirements, but are also capable of generating energy, sequestering carbon, and fitting aesthetically within local landscapes. Initiatives also consist of planted roofs and walls, adding to the carbon reduction footprint. [12,13,15]

## III. RESULTS

Green and sustainable technologies, which are environmentally friendly and low-carbon, are rapidly growing and are positioned to dominate world's future. Unfortunately, as the negative environmental, health and economic impacts of non-sustainable choices become ever more abominable, there is a clear need to accelerate the penetration of green technologies to create a resilient global society.

To do this, renewable energy sources including solar, wind, hydro, tidal, geothermal, and storage concepts must be scaled up, green materials processing technologies must be expanded including recycling, industrial symbiosis and industrial ecology. Society's transportation system must be decarbonized. The world's unsustainable systems must be converted to green resilient systems en masse and new green technologies that remediate environmental desecration but be scaled up. We must anticipate challenges and global catastrophic risks and prepare for them to make a resilient society. Free and open source technological development has been proven to be one of the most potent sources of innovation and rapid technology distribution. Thus, open source green technologies are of particular interest as it couples open source rapid innovation with the much-needed acceleration of green technology deployment.

Green Technology, Resilience and Sustainability covers research in the following areas that focus on solutions to environmental issues:

- New green technologies that help improve renewable energy supply
- Solar Photovoltaic Technology
- Solar Thermal and Passive Solar Applications
- Wind Energy Technology
- Geothermal Technology
- Wave, Tide and Ocean Energy Technologies
- Hydro Power and Pumped Storage
- Renewable Hydrogen Production Technology and Fuel Cells
- Energy Storage
- Distributed Generation and Smart Grids
- Hybrid or Dual Use Concepts (e.g. agrivoltaics, floatovoltaics, BIPV etc.)
- New green materials processing technologies
- Recycling systems
- Green materials
- Green buildings and construction processes
- Efficient and sustainable industrial processes
- Green products
- Industrial symbiosis
- Industrial ecology
- Life cycle assessment and analysis
- Sustainable chemistry
- New green technologies that help improve transportation
- Electric vehicles
- Battery technology
- Green urban design and walkable cities
- Public transport
- Bicycle engineering
- New green technologies that remediate environmental desecration
- Water conservation, purification and treatment
- Rehabilitation of chemical and nuclear contaminated sites and brown fields

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Reforestation and methods to prevent illegal logging  
Green sanitation  
Pollution reduction and elimination  
Resilient technologies  
Sustainable utilization of resources such as land, water, and air  
Biodiversity preservation  
Free and open communication systems  
Education systems  
Agriculture systems and alternative foods  
Preparation for disasters: natural and manmade  
Preparations to reduce global catastrophic risks  
Technologies that reduce existential risk[17,18,19]

## IV. CONCLUSION

Green development and the digital economy are receiving increasing attention among scholars, practitioners, and policy makers, as the link between the two remains unclear, and exploring the study of the mechanisms at play between the two to achieve quality economic development is an urgent issue to be addressed. This study addresses this gap and aims to provide clarity by analyzing examples of business practices in developing countries. Using a total of 20,283 datasets from 2049 listed manufacturing firms from China from 2007 to 2012 as the study sample, the mechanism of digital transformation's impact on firms' green technological innovation capability is empirically examined and the mediating role of firms' green dynamic capabilities is verified. This study finds that: (1) Digital transformation significantly enhances the level of green technology innovation of enterprises. (2) There is a partial mediating effect of green dynamic capabilities in the process of digital transformation positively affecting enterprises' green technology innovation. (3) Digital transformation by state-owned, central and western regions and by medium-sized enterprises is more significantly effective in promoting green technology innovation than non-state-owned, eastern regions and small and large enterprises. (4) The analysis of economic consequences shows that digital transformation can mitigate the incremental costs incurred in the process of digital transformation by empowering enterprises to achieve green development and cost reduction through green technology innovation.[20,21,22] Achieving green and sustainable development has become a major global agenda. The European Union, Japan, and China have committed themselves to "carbon neutrality"; the EU has proposed a new industrial system with a greater focus on social and ecological values—Industry 5.0—which states that the manufacturing industry must respect and protect the earth and achieve sustainable development. However, the manufacturing industry is currently facing problems such as high costs and low success rates to achieve sustainable development, so it is urgent to find effective ways to develop. Green technology innovation is being initiated throughout the product manufacturing life cycle [1], emphasizing the minimization of waste of resources and energy in the entire life cycle of design, manufacturing, assembly, transportation, sales, after-sales service, and recycling of products at the end of life; striving to save energy and reduce consumption, reduce pollution and damage to the ecological environment [2]; and helping manufacturing enterprises to reduce production energy consumption, reduce waste emissions, and alleviate environmental pollution. It has become an important choice for manufacturing industries to achieve sustainable development.

Therefore, how to improve the green technology innovation of manufacturing enterprises has become a hot topic. Studies have shown that environmental laws and regulations [3,4], incentive policies such as financial subsidies [5], and green finance [6] can urge or help enterprises to engage in green technology innovation, while external stakeholders such as government support [7] and customer demand [8] can motivate enterprises to seek green technology innovation [9]. Elements such as management's green orientation [10,11], organizational capability [12,13], and organizational governance structure [14] are important factors in promoting green technology innovation.

Moreover, human society has entered the digital era and enterprises have started to apply digital technologies such as cloud computing, big data, and artificial intelligence to transform their production, operation, and business models, i.e., digital transformation [15]. While reshaping the competitiveness of enterprises, digital transformation also brings breakthroughs to enhance the green technology innovation of enterprises [16]. A study by the Global e-



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Sustainability Initiative (GeSI) suggests that digitalization will help reduce global CO<sub>2</sub> emissions by 20% by 2030 by revolutionizing smart grids and integrated energy management systems. It is thus clear that digital transformation may contribute to sustainable economic and social development by enhancing green technological innovation, but there is no clear answer to its underlying mechanisms.

One of the key outcomes of digital transformation is the enhancement of the dynamic capabilities of companies [15]. Dynamic capabilities help enterprises to achieve the absorption, reconstruction, and application of external green sustainability knowledge [17], forming green dynamic capabilities. At the same time, some studies have shown that the enhancement of enterprises' green dynamic capability helps to acquire external green knowledge of the organization, enhance the efficiency of green knowledge adoption, and promote enterprises' green technological innovation [3], as well as improve enterprises' green innovation recognition ability and promote enterprises' green technological innovation [18,19]. Therefore, this study argues that digital transformation can enhance green dynamic capabilities and promote green technological innovation, and we thus construct a model for empirical testing.

From the above, this study collects relevant data at the enterprise level and constructs an econometric model for empirical testing. We examine the impact mechanism of digital transformation on enterprises' green technology innovation capability and verify the mediating role of enterprises' green dynamic capability. In addition, to deal with the endogeneity between digital transformation and green technology innovation, this study (1) adopts the instrumental variables approach and conducts a series of robustness tests; (2) further analyzes the economic consequences of digital transformation to enhance enterprises' green technology innovation capability; and finally (3) explores the heterogeneity of the impact of digital transformation on enterprises' green technology innovation for enterprises with different characteristics, with the following main contributions: discovering the impact mechanism of digital transformation affecting green technological innovation in manufacturing industries and providing practical insights for manufacturing enterprises to achieve sustainable development.[23,25]

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