

## **GREEN TECHNOLOGY: AN EMERGING PERSPECTIVE FOR SUSTAINABLE DEVELOPMENT**

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### **Abstract**

Green Technology a recent breakthrough in the world of technology has changed the dynamics of business world by formulating new tenets of managing operations. Green technologies play an important role in the growth and development of a nation. Green technology, also known as clean technology, refers to the development and extension of processes, practices, and applications that improve or replace the existing technologies facilitating society to meet their own needs while substantially decreasing the impact of human on the planet, and reducing environmental risks and ecological scarcities. In recent years tremendous research efforts have been devoted toward finding innovative and effective ways to develop important technologies, while ensuring that the processes are 'green'. The drive toward 'green' or sustainable processes arises from several aspects not only scientifically, but rather due to the need to establish a better quality of life, improves human health, and prevents damage to the environment. The present study would throw some light on different perspectives of green technology in sectors like manufacturing, services, marketing, operations, electronics, computer science, energy, agriculture, waste management and economics and contains recent advancements made towards sustainable development in the field of Green marketing, bioenergy, nanotechnology, green chemistry, degraded land reclamation. Also, the study would offer useful insights for a large and broad readership, including practioners, researchers, scientists, academicians and readers from diverse backgrounds across various fields such as management, computer science, electronics, nanotechnology, chemistry, agriculture, environmental science, water engineering, waste management and energy and practioners in the area of green technologies.

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## Introduction

The term "technology" refers to the application of knowledge for practical purposes. The field of "green technology" encompasses a continuously evolving group of methods and materials, from techniques for generating energy to non-toxic cleaning products. The present expectation is that this field will bring innovation and changes in daily life of similar magnitude to the "information technology" explosion over the last two decades. In these early stages, it is impossible to predict what "green technology" may eventually encompass. The goals that inform developments in this rapidly growing field include: *Sustainability* - meeting the needs of society in ways that can continue indefinitely into the future without damaging or depleting natural resources. In short, meeting present needs without compromising the ability of future generations to meet their own needs. *"Cradle to cradle" design* - ending the "cradle to grave" cycle of manufactured products, by creating products that can be fully reclaimed or re-used. *Source reduction* - reducing waste and pollution by changing patterns of production and consumption. *Innovation* - developing alternatives to technologies - whether fossil fuel or chemical intensive agriculture - that have been demonstrated to damage health and the environment. *Viability* - creating a center of economic activity around technologies and products that benefit the environment, speeding their implementation and creating new careers that truly protect the planet.

Examples of green technology subject areas include *Energy*- Perhaps the most urgent issue for green technology, this includes the development of alternative fuels, new means of generating energy and energy efficiency. *Green building*- Green building encompasses everything from the choice of building materials to where a building is located. *Environmentally preferred purchasing*- This government innovation involves the search for products whose contents and methods of production have the smallest possible impact on the environment, and mandates that these be the preferred products for government purchasing. *Green chemistry*-The invention, design and application of chemical products and processes to reduce or to eliminate the use and generation of hazardous substances. *Green nanotechnology*- Nanotechnology involves the manipulation of materials at the scale of the nanometer, one billionth of a meter. Some scientists believe that mastery of this subject is forthcoming that will transform the way that everything in the world is manufactured. "Green nanotechnology" is the application of green chemistry and green engineering principles to this field (Green Technology, 2016).

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### **Green Technology Breakthroughs**

Some innovative advancement in green technology are as follows:

**Camel Train:** Camel Train is an advanced system that provides clean drinking water from any lake, river, stream, pond or flood, whether it is pulled, carried by its handles, or backpacked in. The Camel Train can be dropped right at the water's edge, and within a 1 minute, begin turning polluted water into safe, great-tasting water for drinking, cooking, or cleaning.

Camel Train is the world's first portable all-membrane water purification system, uniquely designed as a global water treatment solution. Ultra and Nanofiltration membranes produce near reverse osmosis quality water at volume, effectively free from pathogens, heavy metals, color, odor, flavor even radionuclides — without the need to frequently change filters. Camel Train is ideal for disaster relief, camping, animal hydration, and gray water purification, medical and missionary programs

**Sonic Soak:** Sonic Soak is a device that aims to revolutionize cleanliness and hygiene in our daily lives by using ultrasonic cleaning technology. Sonic Soak's modulated ultrasonic waves travel through water to clean at a microscopic level. Sonic Soak is the newest evolution in washing technology that utilizes ultrasonic technology to result in a deeper clean, saved time, water and energy, all in a compact package that can be taken anywhere. Sonic Soak can clean it all with the power of ultrasonic. Sonic Soak is greener as it uses only 10% of the energy consumption and less than 2% of the water consumption of a conventional washing machine. Also, convenient and saves more time and money no more dry cleaning and hand washing. Portable as well by being lighter and smarter than iphone.

**Batteroo:** Batteroo is the world's first micro-thin stainless steel sleeve that increases your disposable batteries' life up to 6x. Batteroo Boost is a slim sleeve that slips over your batteries to access the charge left inside after your battery stops working. Batteroo brings your perceived dead batteries back to life and increases their overall life and performance. Batteroo comes in AA, AAA, C, and D variations, and has a micro-thin design to slip over your battery and fit neatly into your device's battery compartment.

**Apollo:** Apollo, the world's first portable power pack using graphene composite battery and USB C PD technology. It supports up to charge at 60W, which means the battery with capacity of 6000mAh can be fully charged in 20 minutes or so if using the USB-C 60W Adapter. Apollo supports the Power Delivery 3 protocol. You needn't bring a separate adapter with you, because it is compatible with USB C power adapters of Nintendo Switch, Apple MacBook, Lenovo laptop, Dell laptop or HP laptop. If you have only old laptop chargers or MagSafe adapters, you can also use our Anywatt adapter to charge Apollo. Besides, Apollo supports 40W USB C PD output, which means it supports the Fast Charging of the latest iPhone 8 or iPhone X, or in an emergency, it supports emergency charge to your Apple Macbook. Graphene Composite Battery Inside Apollo realizes application of graphene composite cell to mobile power pack for the first time in the world (Graphene composite Provided by Cells X). On the basis of the same capacity and the same charging current, the cell with graphene composite material has much smaller internal resistance and better conductivity. Therefore, the temperature rise is lower during super fast charging, so it is safer, and cell swelling and burning will never happen.

**Hand Energy:** Hand Energy, portable electricity generator generate clean energy with the power of your body, helps to charge gadgets anytime and anywhere. Hand Energy is not only the energy generator which can save you any minute you need to make an important call, send sms or take a picture. Hand Energy is the device that can help people with limited access to electrical grid. Hand Energy is your pocket electricity generator. Everyone knows what low battery means: we are disconnected from the world! And sometimes there's no way to charge your battery when you urgently need it. Now you can forget about this problem, as you would always have your own generator with you. Generate your own clean energy with the power of your body; store it, always keep it with you, and charge your devices wherever you are. Forget about your battery

running out. Be independent from the electricity grid and don't waste your time looking for a socket.

**Home Biogas :** Home Biogas transform food waste into energy. Leftover food or food scraps may not be suitable for eating, but they still have calories that can be used to create energy. So don't throw them out! Put food waste or animal manure into the appliance. The bacteria in the digester will break down the organic matter and convert it into biogas and fertilizer. The gas bag holds 700 liters of biogas at all times, ready for all your cooking needs. It is a 100% off-the-grid and natural process, similar to what happens in your own stomach.

Feed your food waste to Home Biogas bag (device) and get up to 3 hours of cooking gas daily. It looks, smells, and burns just like any traditional gas would, the only difference is that this gas is made from recycling in your own backyard. The other outcome is all high-quality liquid fertilizer. No mess or work needed. The fertilizer flows from the user-friendly pouring sleeve straight into your fertilizer can. You will be proud to nourish your plants and food garden with a *natural* product, free from harmful chemicals and additives!

Choose a location in your backyard for Home Biogas bag (device). It can be up to 20 meters from the kitchen. Then assemble it by connecting a few parts and filling up the digester with water. Assembly is super easy and should only take an hour! After assembly, activate the appliance the old-fashioned way, using animal manure, or using a bacteria kit. Activation only needs to be done *one time*, and once activation is done, you will be able to feed Home Biogas bag (device) with your food scraps and produce free, renewable energy on a daily basis (Indiegogo, 2016).

**LED Technology:** Lighting has come a long way in the past few years. The U.S. government banned many energy-guzzling incandescent light bulbs at the beginning of 2014 in favor of compact fluorescents and LEDs. But it's the application of these new lighting technologies that's so exciting. LEDs have been named as a potential weapon against the mega-deadly plight of malaria in developing regions of Africa. And next-generation LED technology has helped vertical farming, mentioned above, take root.

**Lithium-ion Batteries:** Elon Musk's Tesla has said it plans to build a massive factory sometime in 2017 that would supply lithium-ion batteries for electric cars -- up to 500,000 a year. The company also announced a new line of rechargeable batteries that would store solar energy and power homes and businesses. They have been called the "iPad of stationary storage."

**Reusable Rockets:** SpaceX, another Musk company, has been trying to revamp the space exploration game and fuel our "Star Trek" fantasies with reusable rockets. Rockets are notoriously expensive, and Musk has long advocated for reusable shuttles, which he says could reduce the cost of space travel by a factor of 100. SpaceX has had some trouble with its first three test flights, but it's only a matter of time until Musk sticks the landing.

**Green Automobiles:** Yes, many of us can admire a Tesla Model S from across the street, but the \$70,000 starting price is still exorbitant. Tesla began selling used electric vehicles in May, but other companies are itching to join the fray. Tesla said it is allowing others to access its patents to help boost innovation surrounding green automobiles, and BMW has started to pump out electric vehicles that start at almost \$30,000 less than the Model S.

**Green Alarm Systems:** Green Alarm Systems driven by emergencies in Industrial wireless sensor networks. It presents a framework of emergency-driven alarm systems to balance the trade-off between reliability and timeliness of the systems and energy consumption of sensor nodes. First, to continuously and accurately monitor the emergency, an emergency tracking module is presented. Then, to efficiently transmit the emergency data and reduce energy consumption of sensor nodes, a sleeping schedule-based routing protocol is employed. Finally, the security sector, which consists of an efficient data technique, a decision-level data fusion and data query technique, is proposed to process emergency data and further evaluate emergency situations.

**Green and Reliable Software:** Green and Reliable Software- Defined Industrial Networks, a new architecture of software- defined industrial networking (SDIN) is proposed, which consists of four parts: field devices, the SDIN data plane, the SDIN control plane, and a cloud service platform. By separating the data plane and control plane, it can adaptively reconfigure and

reconstruct networks in less than one second. In addition, it can guarantee reliable and real-time data transmission. Simulation results show that a packet delivery rate of 100 percent and a maximum packet delay of less than 10 ms can be achieved. Then they show that the proposed network architecture is energy-efficient. Compared to traditional networking, energy consumption can be reduced by 18 percent (Han, et al., 2016).

**Green Roof:** Different countries are rapidly adopting idea of keeping their roofs planted with grass. It not only minimizes the heat effect but also reduce summer air conditioning usage. With this transformation in green technology it is expected that we would not only be able to generate enough energy to fulfill our needs but also keep our planet safe and healthy.

**Vertical Farms:** The future of modern agriculture could very well be found indoors. Vertical farms grow plants hydroponically (without soil) in large, multistory buildings under artificial light. Crops can be stacked on top of each other and grown far more quickly than with traditional farming methods.

Some advocates argue this new technology could become the norm as soon as 2050, while crop land grows scarce and a booming population demands more food. In the short term, vertical farms can be up to 100 times more productive than fields, and all produce is grown organically because of the nature of the contained environment (SEPCO, 2013).

**Algae-Based Biofuel:** Algae is a simple organism ranging from single-celled to multi-cellular forms, and is typically thought of as a kind of plant due to its ability to perform photosynthesis. Using chemical and mechanical methods, oil can be extracted from algae and converted into fuel that acts in the same way as traditional petroleum fuels.

**Solar Panels:** Speaking of renewables, the falling cost of solar power has made it far more affordable for the everyday homeowner to install solar panels on their roofs. The cost of solar has fallen from around \$150 per watt in 1970 to less than 60 cents a watt today. But the U.S. is still lagging behind other countries. Americans have installed solar arrays on about 600,000 homes and businesses so far. But places like Germany have far more prolific coverage. The

country reach a point one day last year when it produced nearly 75 percent of its entire energy demand from renewables.

**Wind Mills:** One of the last great hurdles for renewable energy is offshore wind -- turbines located just off the coast that can generate near-constant green power. Cape Wind was hailed as the first offshore wind array off the U.S. coast. But the multibillion-dollar project has faced a series of funding hurdles and the future of the farm is in doubt. Other countries have been more successful, with advances including a wind farm in Scotland that drew the ire of Donald Trump and floating turbines off the coast of Fukushima, near the site of Japan's 2011 nuclear disaster.

**Drought Tolerant Crops:** With the drought in California still raging, many farmers are worried about the future of their water-guzzling fields. Despite widespread water cutbacks for homeowners, agriculture hasn't been affected by the drought-fighting mandates of Gov. Jerry Brown (D). Moving crops to less-parched areas of the country isn't always feasible, but farmers can instead plant drought-tolerant crops, such as genetically modified, resilient seeds that can survive with less water ( Visser, 2015).

### **Findings**

Global greenhouse gas reduction and protecting environmental assets will require innovation and the adoption of green technologies. Without innovation, it will be very difficult and very costly to sustain current growth while addressing major environmental issues such as climate change. Consequently, governments across the globe are giving priority to R&D activities and incentives for the diffusion and adoption of green technologies. Green technology goals are becoming priority among national innovation strategies (Brazil, Canada, People's Republic of China, Finland, Germany, Japan); energy strategies (Austria, Australia, Norway, Portugal, Switzerland); water and transport strategies (Israel); strategies for small and medium-sized enterprises (SMEs) (France); or green growth strategies or action plans (Belgium, Denmark, Hungary, Ireland, Korea, Luxembourg, South Africa, Sweden). Beyond the EU, Australia and New Zealand, economy-wide carbon trading systems have had less priority. The patent system is also being adapted to encourage green inventions. This includes the accelerated examination of patent applications directed to green



technologies by national intellectual property (IP) offices in Australia (from 1 year to 4), 8 weeks Brazil (announced), Canada (within 2 months), Israel (within 3 months), Japan (from 2 years to 3 months), Korea (from 18 months to 1 month), the United Kingdom (from 2-3 years to 9 months) and the United States (terminated in February 2012).

Public support to green innovation mainly takes the form of direct R&D grants to Small and Medium scale Enterprises, even if specific sectors (water, transport, energy) and general purpose technologies (information and communication technologies-ICTs), biotechnology and nanotechnologies) are being targeted. Governments are also expanding the supply of risk capital for green technology through equity and debt finance (e.g. the United Kingdom's Green Investment Bank, capitalized with USD 4.5 billion–GBP 3 billion). The US and UK governments as well as foundations and large companies are also using prizes to induce green technological innovations. In countries such as Norway, support for late-stage development (such as pilot plants) has increased strongly for green technologies generally and for energy technologies in particular. For skills development, the focus in many countries has been mainly on supporting on-the-job training and adapting tertiary and vocational training to meet new occupational needs. Germany's Green Talents programme intends to foster international exchanges among young researchers in the field of environmental and sustainability research. Historically, regulations, together with subsidies and feed-in tariffs, have been the main policy tools for fostering market uptake of greener technologies. Recently, many countries have started to use targeted demand-side innovation policies such as public procurement, standard-setting, and consumer policy to encourage demand for green technologies.

Examples include green public procurement legislation in Finland, Italy, Japan, Korea, the Netherlands, Norway, Poland and Spain. Germany has modified its feed-in tariffs for renewable energy technologies by granting an additional premium for innovations. Because greening the economy requires scientific discovery and inventions in areas other than energy or the environment, countries continue to support public R&D in a broad range of scientific fields as well as targeted research programmes for climate change and biodiversity. Examples include the Finnish research programmes on climate change (USD 12.5 million–EUR 12 million) and on aquatic resources (USD 11.5 million–EUR 11 million). Countries are establishing institutions and agencies to co-ordinate and manage the diverse array

of green growth strategies, programmes and initiatives. Australia's Renewable Energy Agency and Multi-Party Climate Change Committee, Chile's Renewable Energy Centre, Korea's Presidential Committee on Green Growth, New Zealand's Green Growth Advisory Group, the Slovak Republic's Innovation and Energy Agency, South Africa's Energy Finance Subsidy Office, Switzerland's Federal Energy Research Commission, the United Kingdom's Technology Strategy Board and Low Carbon innovation Group are just a few of the institutions created to improve vertical and horizontal policy governance for green innovation (OECD, 2018).

### **Conclusion**

Environmental concerns such as global warming, climate change and depleting energy resources, have opened space for green technology to emerge as a significant development in the 21st century. It will lead to global, sustainable and macro-economic developments that may impact economics, societies, cultures and way of life in the future. In fact, green technological advancement have indicated prospects of intense innovation and changes in daily life. While predictions on economics and potential outlook for green technology are promising, green technology development must be sustainable, however, environmental challenges and growths need to be addressed in a mutually reinforcing manner. Its impacts should be carefully analyzed, taking into consideration both environmental effectiveness and economic efficiency. Thus, the importance of looking for win-win solutions across the entire economy where sustainability and growth can be achieved in a cost-effective manner must be emphasized. Emerging green technologies covering a wide spectrum of areas as already discussed. Green technology, besides offering opportunities for end users, solution providers, financial investors, regulators, policy-makers and other stakeholders, also, is a blend with challenges like market, technology, financing and regulatory.

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