GREEN TECHNOLOGIES AND INNOVATIONS

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Abstract

Reducing global greenhouse gas (GHG) emissions and protecting environmental assets will require innovation and the large-scale adoption of green technologies. Without innovation, it will be very difficult and very costly to sustain current growth trajectories while addressing major environmental issues such as climate change. The most vital concern for green technology is producing energy. This includes development of alternate options of fuel and new means of generating energy with efficiency. Green technology also includes building green cities which are built by eco-savvy methods. Green chemistry, a subject area of green technology focuses on invention, design and application of chemical products and processes that reduces the use of hazardous substances. Generating renewable energy, energy efficiency, pollution reduction, reusing and recycling, natural resource conservation methods, Greenhouse gas emission reduction etc. are examples of where green technology is in demand and needs further development. The paper presents rationale and objectives of the green technologies and innovations as some examples.

Keywords: Green technology, Energy saving, Low carbon

1 INTRODUCTION

Reducing global greenhouse gas (GHG) emissions and protecting environmental assets will require innovation and the large-scale adoption of green technologies. Without innovation, it will be very difficult and very costly to sustain current growth trajectories while addressing major environmental issues such as climate change. Consequently, OECD governments and emerging economies are giving priority to R&D activities and incentives for the diffusion and adoption of green technologies [1].

Green technologies can contribute to the green economy because they have the potential to create new business opportunities, markets and jobs.

Green technology development is accelerating in some areas. The number of patented inventions in renewable energy (+24%), electric and hybrid vehicles (+20%), and energy efficiency in building and lighting (+11%) increased more rapidly than total patents (+6%) between 1999 and 2008. Most of the green technology development is concentrated in a relatively small number of countries and there is a considerable specialisation across countries. For selected climate mitigation technologies, Japan's patent applications in 2008, for example, were relatively more concentrated in innovation related to energy-efficient buildings and lighting, as well as electric and hybrid vehicles, while the United States was particularly prominent in the area of renewable energy.

While some data are available on green technologies, much less information is available on the related non-technological changes and innovation, such as in the introduction of new business models, work patterns, city planning or transportation arrangements, that will also be instrumental in driving green growth. There is some evidence that the scope of green innovation is broadening, however. For example, manufacturing firms have moved from end-of-pipe solutions to approaches that minimise material and energy flows by changing products and production methods and reusing waste as a new resource for production. Advances are also being made through better management practices and integrated strategies that are contributing to a range of new business models [2].

Innovation with an environmental or "green" flavour faces additional barriers which exacerbate existing ones. When firms and households do not have to pay for environmental services or the costs of pollution, the demand for

green innovation is constrained and there are fewer incentives for companies to invest in innovation.

Boosting green innovation therefore benefits from clear and stable market signals, e.g. carbon pricing or other market instruments addressing the externalities associated with environmental challenges. Such signals will enhance the incentives for firms to adopt and develop green innovations, and help to indicate the commitment of governments to move towards greener growth. They will also enhance efficiency in allocating resources by establishing markets for green innovation, and will lower the costs of addressing environmental challenges. Taxes and other pricing instruments are included in Japan's recent "New Growth Strategy".

Recent experiences suggest that carbon pricing contributes primarily to incremental rather than disruptive innovation, however. This tends to increase efficiency but may also lead to growing consumption, as has been the case in personal transport. Given the other market failures that green innovation is facing, complementary policies are needed.

A key question in this context is: how and where governments should focus their efforts. In terms of how, there are three key ways that governments can lend their support to green innovation. One is in funding relevant research, whether public or private. Energy and environmental R&D, for example, account for a very small share of GDP relative to their centrality to economic life.

Another way to support green innovation is to target barriers to its early-stage commercial development. Access to finance is especially difficult for firms engaged in green innovation, due to the relative immaturity of the market, and thus greater perceived commercial risk. While, markets are likely to price this risk more accurately as markets mature [3], this may take time.

A third way to strengthen green innovation is to use demand-side innovation policies. Standards, well-designed regulations and public procurement, for example, can encourage green innovation in markets where price signals alone are not fully effective. For instance, following the introduction of the German packaging ordinance in 1989, there was a take-off of patents of biodegradable packaging [1].

2 MATERIAL AND METHODS

A mapping of scientific fields that influence innovation in green technologies, as measured by patenting, shows that chemistry and material sciences are at least as important as research on energy and the environment (Figure 1).

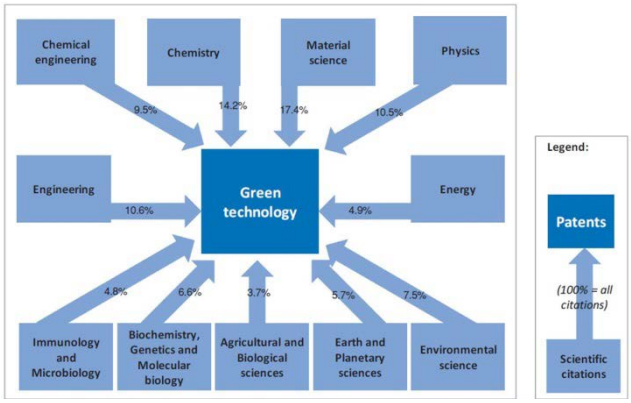

Figure 1. Scientific Fields That Implement Innovations in Green Technologies

2.1 Green technology subject areas and prospects

The most vital concern for green technology is producing energy. This includes development of alternate options of fuel and new means of generating energy with efficiency. Green technology also includes building Green cities which are built by eco-savvy methods. Green Chemistry, a subject area of Green Technology focuses on invention, design and application of chemical products and processes that reduces the use of hazardous substances. Generating renewable energy, energy efficiency, pollution reduction, reusing and recycling, natural resource conservation methods, Green house gas emission reduction etc. are examples of where Green technology is in demand and needs further development [4].

a) Energy supply sector

Green technology is particularly useful in power generation and in energy supply management areas. Potentials can include more co-generation by the industrial and commercial sectors which can lead to cost efficiencies.

b) Energy utilisation sector

Application of green technology in all areas and in demand side management programmes.

c) Building sector

Particularly in the construction, management, maintenance and demolition of buildings can provide new avenues for a greener construction industry.

d) Waste and water management sector

Potential for technology demand in the management and utilisation of water resources, waste water treatment, solid waste and sanitary landfill.

e) Transportation sector

Ability to incorporate green technology in transportation infrastructure and vehicles, particularly through development of biofuels and public road transport.

2.2 Green technology: the 10 leading countries

Report prepared by the consulting firm Cleantech Group and the WWF, shows which countries are characterized by creativity and innovation in green technology, and who also have stimulating environment for companies in the industry, either public policy or private funding [5].

Cleantech and environmental group WWF assessed 40 countries using 15 indicators related to developing of green solutions companies, such as public policies and regulations, financial incentives for private, academic incentives, private investment in the sector, and number of environment patents registered, among others.

The survey "Global Cleantech Innovation Index" shows that the renewable energy sector is the main catalyst of green investments [5].

Israel topped the 2014 index, with its relative outperformance on the measure of start-up companies per capita being a key reason that it did so. The country generates the culture, education and 'chutzpah'1 necessary to breed innovation, plus it has the survival instincts to manage a resource-constrained geography.

Finland took second place in recognition of the clear efforts the country is making to mobilize its workforce towards sustainable innovation. Finland is also developing novel innovation approaches to access larger, cleantech hungry markets in other geographies.

USA came in third place in the 2014 index, with its clean technology start-ups clearly attracting the most venture capital on an absolute basis. However, in the past few years, there have been more cleantech funds set up to invest in China than for any other part of the world, with capital inflows expecting to rival that of the U.S. in the years to come.

All of the top 10 countries in the index are relatively good at early stage cleantech development but share a common challenge in increasing commercialisation rates. Denmark, however, stands out for producing a large number of mature, publicly-listed cleantech companies relative to the size of its economy.

While China, India and Brazil currently fall outside of the top bracket of start-up generators in the index, their rank is likely to rise in the years to come as they possess a strong climate for growth and development, high levels of pollution, or resource drivers to commercialise cleantech innovation [5].

Even the so called 'laggards' in the index (e.g. Russia, Saudi Arabia) are beginning to implement supporting structures for sustainable innovation – in order to hedge against the realities of limited conventional energy sources in the long-term.

Overall, this index demonstrates that countries will get ahead if they 1) are able to adapt to growing demand for renewables (at home and abroad); 2) are connecting start-ups with multiple channels to increase their success rates and; 3) are increasing international engagement to spur widespread adoption of clean technologies.

Overall the index shows countries that put significant resources into supporting cleantech innovation are rewarded with more emerging and commercialised cleantech companies, validating the approach many governments have taken to actively promote cleantech innovation nationally.

3 RESULTS

3.1 Inspiring examples of green technology

Green technology isn't just about wind turbines, solar panels and alternative fuel anymore. A few inspiring individuals out there are breaking new ground with innovative ideas that no one's ever explored before. From a printer that can spit out whole buildings made of stone to an entire city that flips the discomfort of the summer heat into an energy-saving advantage for the wintertime to a company that decided solar panels don't have to be ugly, heavy or even rectangular [6].

Yuka Yoneda published 6 Inspiring Examples of Groundbreaking Green Technology [6] presented in the following.

- 3-D Printer Creates Entire Buildings From Solid Rock

3D printers are nothing new – but how about a printer that can whip up entire life-size stone buildings?! That's exactly what designer Enrico

Dini's prototype D-Shape printer does. Instead of ink, the device uses layers of sand, and Dini reports that the process is four times faster than conventional building, costs about one-third to one-half the price of Portland cement, and creates much less waste.

Figure 2. 3-D Printer

- Transparent Solar Spray Transforms Windows Into Watts

Photovoltaic panels transform the sun's rays into energy we can use, but they're bulky and not the most attractive in terms of design. Well one Norwegian company called EnSol AS has cast aside the notion that PVs need to take up extra space — or even be in a solid state. They've developed a remarkable new spray-on solar film consisting of metal nanoparticles embedded in a transparent composite matrix that allows you to turn ordinary windows into solar panels. The best part? The spray is clear so you can still see right through your windows!

Figure 3. Transparent Solar Spray

- POWERleap Harnesses Energy From Foot Steps!

While other green tech companies look to outside sources like the sun and wind when they think about alternative power, POWERleap decided to completely flip the script by tapping the energy inside – of ourselves! Their piezoelectric floor tiling system that converts the energy from human foot traffic into electricity could be applied to train stations, sidewalks or even inside homes to harness the wasted energy from our footsteps into power for the grid.

Figure 4. POWERleap Harnesses Energy From Foot Steps

- Solar Ivy' Photovoltaic Leaves Climb to New Heights

Who says photovoltaic panels have to be an eyesore? After all, if they could somehow be integrated as a decorative element on homes and buildings, more people might be willing to install them on more surface area. Well, that's exactly the approach that Brooklyn-based SMIT (Sustainably Minded Interactive Technology) took with their "Solar Ivy", a system of paper-thin, leaf-shaped solar panels that generate energy by sparkling in the sunlight. These pretty PVs consist of layers of thin-film material on top of polyethylene with a piezoelectric generator attached to each one, and are definitely miles away from the big, boxy panels we're used to seeing.

Figure 5. Solar Ivy' Photovoltaic Leaves

- Shoe Generator Harvests Power from Walking

Walking is already one of the greenest forms of transportation but one researcher at Louisiana Tech University thought it could be made even more eco-friendly - so he designed a shoe that converts the wearer's footsteps into electricity. The piezo power shoe contains a small generator in its sole that can charge batteries or power small electronics. Bet your Nikes can't do that.

Figure 6. Shoe Generator

- Science city stores warm air from summer to heat buildings in winter

Isn't it sad that in many parts of the world people use a ton of energy cooling buildings in the summer and then use almost as much power heating up the same spaces just a few months later? It may sound crazy but what if there was a way to save the summer's hot air and use it to warm buildings throughout the winter? Well some smart thinkers at Honggerberg Campus in Switzerland are doing just that. Their campus, called Science City is installing systems that will allow it to harness natural heat during the warmer months, pump it underground and store it until the winter when it be pushed back up into buildings and act as a heating system. The system is the first of its kind.

Figure 7. Science City

For more information on the latest trends in the field of green technologies it can be found for example at WIPO Roster Green (https://webaccess.wipo.int/green/), which is an interactive tool enabling technology experts, patent attorneys, experts in finance, engineering and environmental free to register their services and thus visibility in the Community global Green technologies.

4 CONCLUSION

Emerging markets for greener products and services on the one hand and the rise of sustainability and green growth agendas in corporate management on the other are increasingly leading firms to integrate non-financial metrics into their decision-making processes, to revisit the concepts of value and profitability that drive their business models, and to reconsider the balance between the dual objectives of short-term profitability and long-term sustainability [7].

Looking into how business opportunities will be developed in the long-term future, the World Business Council for Sustainable Development (WBCSD) developed the Vision 2050 jointly with member multinational companies (Figure 8) [8]. The expected economic transformations represent opportunities in a broad range of business segments as the challenges of growth, urbanisation, resource scarcity and environmental change become key strategic drivers for business in the coming decades. Opportunities range from developing and maintaining low-carbon, zero-waste cities and infrastructure to improving and managing ecosystems and lifestyles. Enabling these changes is also considered to be creating opportunities for the finance and ICTs sectors.

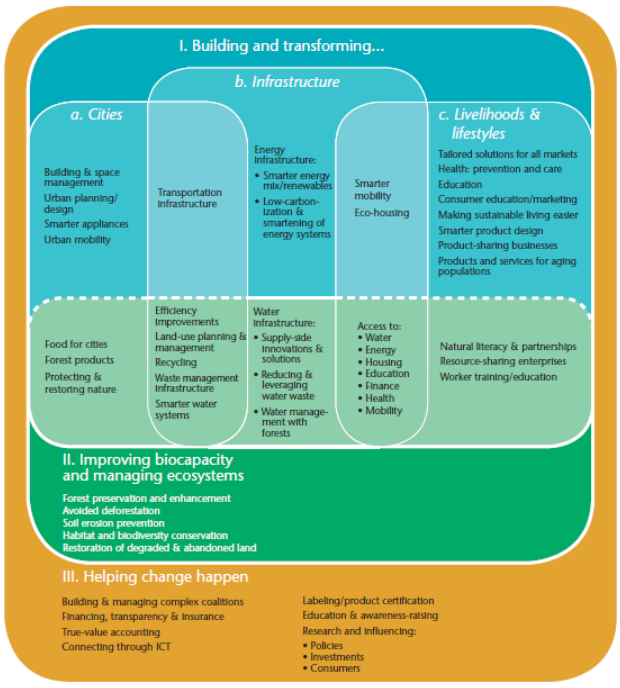

Figure 8. Vision 2050

The business model approach offers a comprehensive way to understand how value is created and distributed. Eco-innovation aims to create both economic and environmental value,

and business models act as a value driver and enabler of green technologies and solutions.

Green innovation goals are increasingly part of 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) [1].

Many OECD and non-OECD countries have established green growth strategies or prioritised activities within their national S&T strategies to create critical mass and accelerate the transition to green innovation and technology. Indeed, most countries continue to place environmental issues, climate change and energy high on the list of priorities for innovation policy in general. However, specific policy priorities for green innovation and technology differ markedly, depending on countries' scientific and economic specialisation, competiveness goals and social objectives [3].

ACKNOWLEDGEMENTS

The Centre was supported by the Slovak Research and Development Agency under the contract No. SUSPP-0007-09.

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