INNOVATION, LOW CARBON DEVELOPMENT AND GREEN GROWTH

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Developed and developing countries are increasingly being threatened by global imbalance, food crisis, water scarcity, energy crisis, and global warming. Given the present scenario, there is an increasing need for building innovation and entrepreneurial ecosystems in new technology and product areas. Three 'drivers of change' need to be harnessed to overcome market, policy and institutional barriers to low carbon growth - raising resource efficiency; increasing investment in infrastructure; and stimulating innovation in technologies, business models and social practices. The key factor in innovation ecosystem for low carbon development is government policy to incentivize new product and technology development.

Keywords*: Green Growth, Carbon Civilization, Innovation Ecosystem*

JEL classification: Q54, Q55, Q56, Q58

1. Introduction

Developed and developing countries in the last few decades are facing several crises one after another. Some of the latest crises faced by the global economy are financial crisis, global imbalance, food crisis, water scarcity, energy crisis and global warming. In addition, the acute problems of poverty, illiteracy and malnutrition continue to exist in large parts of the world. These crises can be attributed to a host of reasons viz. over-exploitation of natural resources; excessive dependence on fossil fuel; illiteracy; governance problems stemming from rapid industrialization, urbanization and globalization of finance; competitive race for export-led growth; global warming and climate change.

The solution to these problems lies partly in strengthening and improving institutional and governance system at the individual country levels; as well as through enhanced cooperation and collaboration amongst leading countries of the world that possess resources, knowledge and technology. All these solutions are being incorporated in the overarching concept of green growth. Green growth is defined as simultaneously targeting key aspects of economic performance such as poverty reduction, job creation and social inclusion and those of environmental sustainability such as mitigation of climate and bio-diversity loss, security of access to clean energy and water (Kaul, 2012). The present paper aims at examining the role

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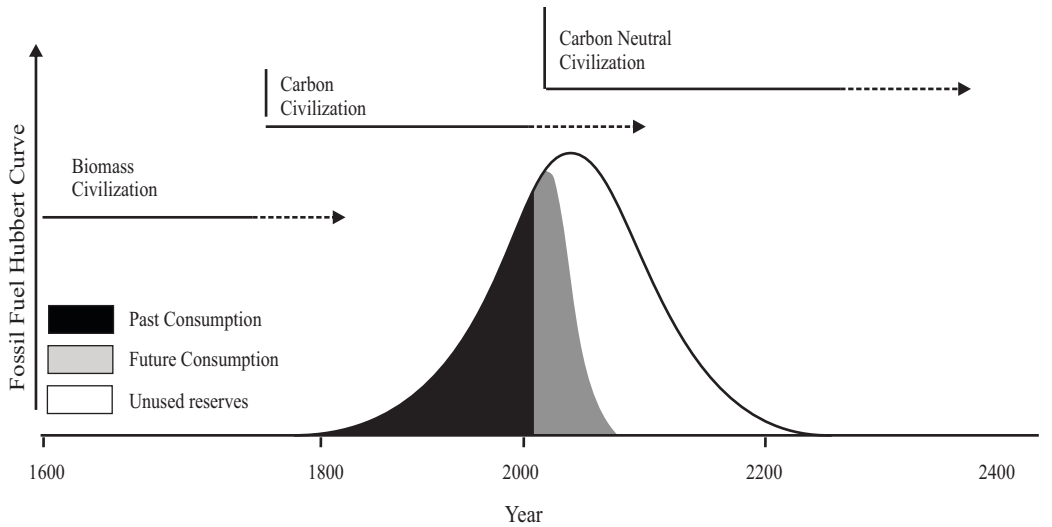
of innovation ecosystem framework to have low carbon development and green growth.

The paper is divided in five sections. The following section outlines the rise and fall of carbon civilization and its solution in terms of green growth or low carbon development. Section 3 discusses growing war of the ecosystem in the corporate world and examines the framework of innovation ecosystem. Section 4 discusses the examples of transformative innovations to have low carbon development. Finally, the concluding observations are presented.

2. **Rise and Fall of Carbon Civilization**

Figure 1 presents the rise and fall of carbon civilization in the world over time. Before 1800, our civilization was powered by energy almost entirely supplied by carbon neutral sources, mainly biomass. The growth in fossil fuel use occurred at an unprecedented rate in the 20th century as indicated by the black area, but the decline in its use will have to occur even more rapidly in the 21st century (grey area) if we are to avoid the worst effects of climate change, leaving much of our fossil fuel reserves unused (white area).

Figure 1: Rise and Fall of Carbon Civilization: Schematic Diagram

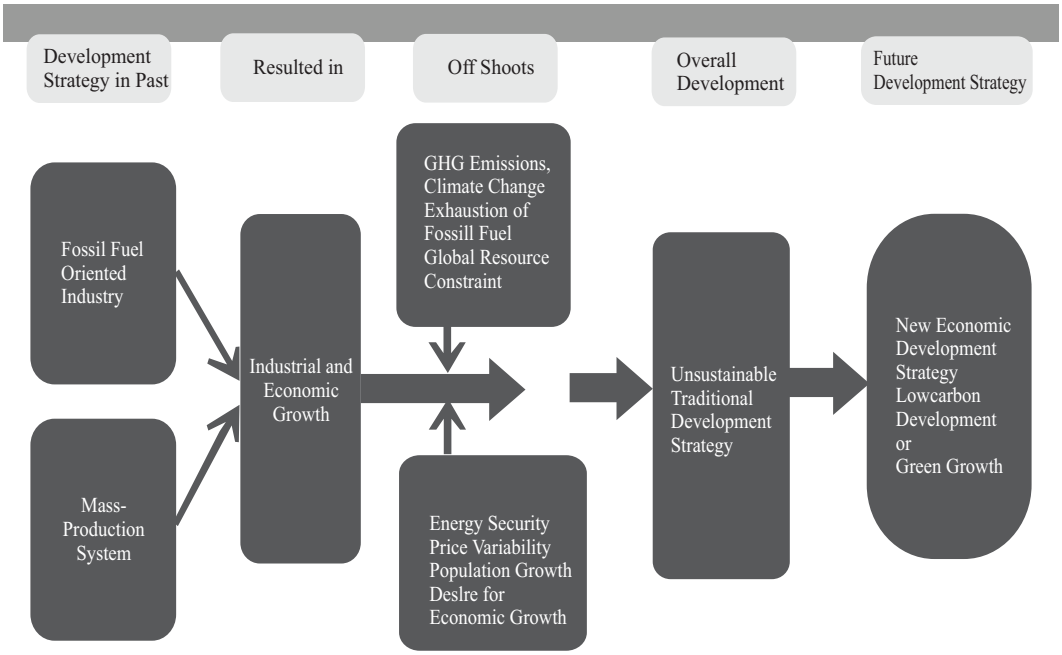


Source: Adapted from Moriarty, P. and Honnery, D. (2010).

Figure 2 further clarifies the rise of carbon economy and its impact. It explains the development of industrial policy in the developed countries of the world. Though this strategy of industrial development based on fossil fuel and mass production system has helped in industrial and economic growth, it has also resulted in the problem of climate

change and global warming. Such a development policy is unsustainable. There is a need for alternative strategy and low-carbon intensive growth or green growth.

Figure 2: Carbon-intensive Development of World and its Outcome



This requires renewing and redirecting the old innovation and entrepreneurial ecosystems, and building innovation and entrepreneurial ecosystems in new technology and product areas. The concept of ecosystem in this respect is helpful in understanding the gaps to be filled and barriers to overcome.

3. War of Ecosystems - A New Competitive Scenario

What is ecosystem and innovation ecosystem? In the global corporate world, a new competitive scenario has emerged. It is not the individual company that is competing in the fast changing technology industries; rather there is a war of ecosystems. Few years back, Nokia, a leading mobile phone company in the world sold out its business to Microsoft. Nokia has been a classic case of corporate transformation from the wood-based products industry to the telecom sector. It is also a case study on the corporate world and its competitive environment. What makes its case interesting is that Nokia became a world leader in the mobile technology and subsequently lost to the fast changing innovation war.

The CEO of Nokia Mr. Stephen Elop has elaborated the changing nature of competitive war

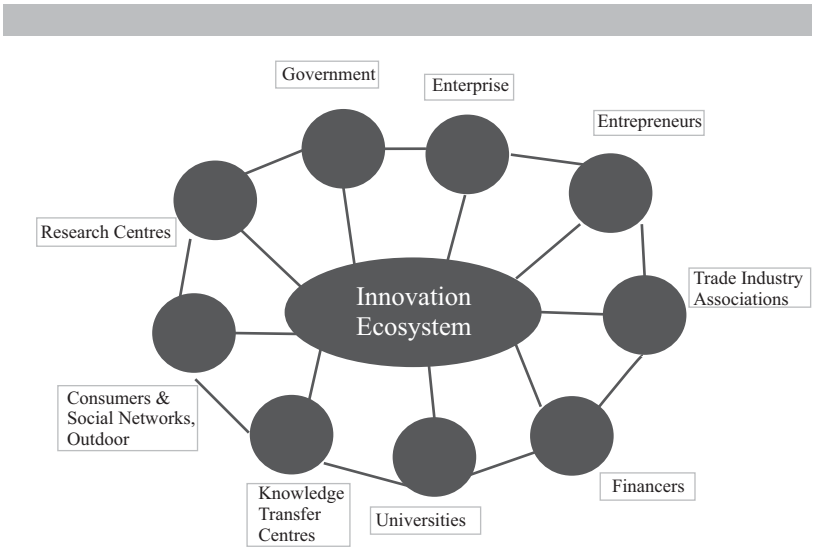
in the world: “the battle of devices has now become a war of ecosystems, where ecosystems include not only the hardware and software of the device, but developers, applications, e-commerce, advertising, search, social applications, location-based services, unified communications and many other things. Our competitors are not taking our market share with devices; they are taking our market share with an entire ecosystem. This means ……have to decide how we either build, catalyze or join an ecosystem” (February11, 2011,'Burning Platform' Memorandum). Elop's solution to his company was to form an alliance with Microsoft and transition to the Window's phone operating system.

What is Ecosystem? Campbell et al. (2009) have explained an ecosystem as a biological environment that consists of living or biotic components (e.g. animals and plants) as well as nonliving or abiotic physical components (e.g. air, soil, water and sunlight) with which the living organisms interact. For an entrepreneur or business firm, an ecosystem involves complex relationships of entrepreneurial firms with key players, contexts and ingredients such as government agencies, industry and trade associations, consumers, investors, financial institutions, capital markets, national culture, natural and geographical factors. Each of these components influences and is influenced by the entrepreneurial ecosystem. Entrepreneurs need a conducive business environment with a supporting entrepreneurial ecosystem to contribute to the well-being of the society. A success of an entrepreneur also depends on the entrepreneurial ecosystem he/she is a part of. A good entrepreneurial ecosystem values creativity, innovation and excellence, facilitates partnerships among key players and enables the development of good ideas and technologies that reach and succeed in the market. Such an ecosystem will attract latent high-tech entrepreneurs because people see a chance to build successful companies quickly (Kshetri, 2014).

A good entrepreneurial ecosystem also attracts local and foreign investments that lead to economic and social development at the local, regional and national levels. A vibrant entrepreneurial ecosystem also enables technology development and innovation. This is known as innovation ecosystem.

Science, technology and innovation have played an important role in the economic growth of all the countries of the world. Joseph Schumpeter was the first to draw the connection between innovation in the form of 'creative destruction' and economic growth. Later economists incorporated technology and innovation formally in their growth models. It is true that individuals and enterprises play a crucial role in the development of specific innovations but the process which nurtures and disseminates technological change involves a complex web of interactions among a range of different subjects and institutions. This has led to the study of national innovation ecosystem.

Figure 3: National Innovation Ecosystem



National Innovation Ecosystem

There are different ways to characterize innovation. In this paper, we treat innovation as causing significant improvements to goods and services as well as to operational processes and business models. Further, we can describe innovation in terms of both innovation activities and the innovation ecosystem that supports those activities. An innovation ecosystem (see Figure 3) models the economic rather than the energy dynamics of the complex relationships that are formed between actors or entities whose functional goal is to enable technology development and innovation.

In this context, the actors would include the material resources (funds, equipment, facilities, etc.) and the human capital (students, faculty, staff, industry researchers, industry representatives, etc.) that make up the institutional entities participating in the ecosystem (e.g. the universities, colleges of engineering, business schools, business firms, venture capitalists , industry-university research institutes; federal or industrial supported centers of excellence; state and/or local economic development and business assistance organizations; funding agencies; policy makers; etc.).

The innovation ecosystem comprises two distinct but largely separated economies, the knowledge economy, which is driven by fundamental research, and the commercial economy, which is driven by the marketplace. Of necessity, however, the two economies are weakly coupled because the resources invested in the knowledge economy are derived from the commercial sector; this includes government research and development (R&D)

investments which are ultimately derived from tax revenues.

Why do we care about developing the innovation ecosystem? There are two ways to increase economic output within an economy: (i) increase the number of inputs in the productive process; or (ii) think of new ways to get more output from the same number of inputs. The latter is the essence of what is broadly meant by innovation, which is defined as the introduction of new or significantly improved products (goods or services), processes, organizational methods, and marketing methods in internal business practices or the marketplace.

4. Green Growth, Low Carbon Development and Innovation

Green growth means focusing on environmentally sustainable economic progress to foster low carbon and socially inclusive development. It involves reducing or avoiding the human activities that are seen as causing climate change. That means, primarily, trying to reduce or eliminate emission of greenhouse gases from the combustion of fossil fuels in vehicles, houses and power stations.

'The low carbon' concept in developing countries has recognized climate change mitigation as an important aspect but is being (and still has to be) understood in the context of development and the complexity of issues that arise when examining low carbon in a development context. India's development issues and challenges are intimately linked with climate issues. Achievement of sustainable development requires linking and integrating a comprehensive and long-term low carbon development program into the local social and political agenda. This requires revisiting the current development paradigm in the light of the visible and likely future impacts of climate change. This means pulling different elements of the economic policies; regional, national and sectoral investments; and moderating and strengthening it in the local climate and people furnace, as it were, and then, building a new structure to meet the genuine needs and aspirations of the people.

The basic assumption in the use of innovation ecosystem is that by shaping the major processes of structural and technological change now occurring in global economy, we can create lasting economic growth while also tackling the immense risks of climate change.

There is now potential in investing greater efficiency, structural transformation and technological change in three key systems of the economy: a) cities; b) land use; c) energy systems; and other areas such as transportation systems, production processes, etc. Across all these systems, three 'drivers of change' need to be harnessed to overcome market, policy and institutional barriers to low carbon growth: (1) raising resource efficiency; (2) increasing investment in infrastructure; and (3) stimulating innovation in technologies, business models and social practices.

Innovation systems vary among different countries of the world because of diversity in resources, policies and governance systems. As open systems, these systems evolve over time as the circumstances changes. Neo-Schumpeterian economists are attempting to integrate: innovations system studies, Schumpeter' innovation, and Amartya Sen's capability approach. In case of developing countries, there is a need to have a simultaneous focus on fostering the system of innovation creating opportunities and competence building.

In this paper, we have focused on innovation system. That is what type of transformative innovation opportunities are there which can help in low carbon growth. Four areas have large potential to drive systemic change with particular significance for a low carbon economy: material science, digitization, life sciences and production processes (New Climate Economy, 2014).

Innovation in materials and digitization are making an impact across the global economy. Their main contribution is in terms of increasing productivity, reshaping entire industrial structures and creating opportunities for leapfrogging, by skipping less efficient and more polluting stages of development. Digitization and big data have also revolutionized the whole business and service industry. As more and more devices in our homes, businesses and public infrastructure are connected to data networks, they have potential to dramatically increase efficiency, reducing consumption of energy and other resources. As steam power was for 18th century, electricity for 19th century and hydrocarbons for 20th century, big data is a new natural resource for 21st century.

Material breakthroughs are transforming products all around us. New materials have created new possibilities in practically every sector, from pharmaceuticals to aerospace. Nanomaterials formed by particles a billionth of a metre or five orders of magnitude smaller than the width of a human hair, are being used in computer chips, medical implants, flat-panel displays and satellites. More broadly, biologists can now create entirely new life forms that can be designed for a certain application such as biofuels with high energy density characteristics targeted for aviation. Digitization and materials science in tandem with innovative business models are driving economic growth, both through incremental improvements and dramatic disruption of existing industries.

Adoption of digital technologies has substantial impact on low carbon growth through a range of new business models that reduce capital- and energy- intensity across the economy. This makes it possible to share assets such as "cloud" storage and online servers or dispense with them altogether by working remotely and digitizing information. Even in mature manufacturing industries, traditional process controls are intersecting with system automation to transform factor efficiency. Ten years ago, energy was too cheap and data too

expensive for this to be feasible. Today, the shift in relative prices is changing the picture.

Cloud computing is particularly promising, as research shows it can increase efficiency and reduce companies' overhead costs, energy usage and related emissions. Digital technologies are also changing behaviours at the individual level, in ways that could dramatically reduce green house gas emissions. Digital apps facilitate car- and ride- sharing schemes, guide riders through public transit and help motorists avoid congested roads and find parking more quickly; services such as shopping and banking have moved online, reducing the need to travel. In our homes, data-rich systems are increasingly able to control heating and lighting on a much more reliable basis.

5. Conclusion

The key factor in innovation ecosystem for low carbon development is the state (government policy). Government policy is required to incentivize new product and technology development. This may be in the form of R&D encouragement through tax incentives. It is also needed to direct and drive the use of a particular type of technology. In addition to these policy guidelines, there is a need to support the development of a vibrant financial sector for funding such products and technology. Further, a flow of continuous talent pool requires education ecosystem which focuses on excellence and creativity. Finally, there is need to create a market for such products. Here also, government policy has a substantial contribution to make.

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