

1-2-2018

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R. Ragapriya Ph.D.

Gulbarga Electric Supply Company

D. Rudrappan

Ethiopian Civil Service University

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Recommended Citation

Ragapriya, R. Ph.D. and Rudrappan, D. (2018) "Climate Resilient Green Economy: Prospects," *International Review of Business and Economics*: Vol. 1: Iss. 3, Article 2.

Available at: <https://digitalcommons.du.edu/irbe/vol1/iss3/2>

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1. CLIMATE RESILIENT GREEN ECONOMY: PROSPECTS

Dr.R.RAGAPRIYA, I.A.S., Managing Director, Gulbarga Electric Supply Company, Government of Karnataka.

Prof.D.RUDRAPPAN, President, AMECA, Former Joint Director of Collegiate Education, Govt. of Tamil Nadu, Professor, Department of Development Economics, Ethiopian Civil Service University, Ethiopia.

“The size and extent of the climate change threats are new. It is arguably the biggest challenge humanity faces today. This means that we must act urgently and seize opportunities quickly. One such opportunity is renewable energy,” – President of the 72nd UN General Assembly.

ABSTRACT

A new political climate has grown in many countries around the world, thanks to the strong base in science and widening public awareness of climate change and its risks. Clean energy revolution has been taking place all over the developed countries, underscored by the steady expansion of the renewable energy sector. The adoption of Renewable Energy Technologies (RETs) constituted a win-win situation, as renewable is not only green and job-generating, but also sustainable with a higher environmental benefit. Renewable fuels such as wind, solar, biomass, tides, and geothermal are inexhaustible, indigenous and are often free as a resource. They just need to be captured efficiently and transformed into electricity, hydrogen or clean transportation fuels. The renewable energy sources have hardly any carbon footprint and are environment-friendly and do not require environmentally-damaging mining and transport. The paper highlights various sources of clean energy in the context of sustainable economic, environmental, and social development besides focusing on the importance of renewable energy in the modern world.

INTRODUCTION

The prevailing economic growth model is focused on increasing GDP above all other goals. While this economic system has improved income and reduced poverty for hundreds of millions, it comes with significant jobless growth and potentially irreversible social, environmental and economic costs (Rudrappan, 2004). Poverty persists for as many as 2.5 billion people even today; the natural wealth of the planet is rapidly being drawn down. World Bank has estimated that approximately 60 percent of the world's

ecosystem services were found to be degraded or used unsustainably. The gap between the rich and poor has also been increasing-between 1990 and 2005, income disparity (measured by the gap between the highest and lowest income earners) rose in more than two-thirds of countries.

The persistence of poverty and degradation of the environment can be traced to a series of market and institutional failures that make the prevailing economic theory far less effective than it otherwise would be in advancing sustainable development ambitions. These market and institutional failures are well known to economists, but little progress has been made to address them. For example, there are not sufficient mechanisms to ensure that polluters pay the full cost of their pollution. Likewise, there are “missing markets” – meaning that markets do not systematically account for the inherent value of services provided by nature, like water filtration or coastal protection. A “market economy” alone cannot provide public goods, like efficient electricity grids, sanitation or public transportation. And economic policy is often shaped by those who wield power, with strong vested interests and rarely captures the voice and perspectives of those most at risk. Environmental devastations and climate challenges take place as a result of present-day non-suitable economic policies based on non-renewable energy which makes it clear the need to change the present economic model. Energy, though consisting of positive and negative features, is a vital basis of livelihood. Despite the fact that non-renewable energy is cheaper and easier to produce, the reserves of fossil fuels would be exhausted soon. Therefore, importance need to be given to green energy sources which are non-polluting, dependable and labor intensive which will propel the economy to a stronger and a higher level. The latest one among clean energy sources is fuel cells. They offer a highly efficient and fuel flexible technology that produces power with zero emission. Moreover, hydrogen fuel cells emit water only

with no CO₂ emissions and air pollutants that create haze and cause health complications as in the case of fossil fuels. Hence, the paper explores how to achieve climate compatible development path through green energy sources with the objectives listed below.

OBJECTIVES

The objectives of the paper have been listed below

To find out sources of clean energy, importance, and impact on the economy; and

To suggest remedial measures for raising the contribution of green energy and for efficient use of renewable energy sources..

Methodology

Descriptive study is adopted and secondary sources of information were collated and used for the present study.

GREEN ECONOMY INITIATIVES OF UNEP

Energy is deposited in a range of energy sources, which can be described as non-renewable or renewable. Renewable sources of energy are those that can be refilled in a short period of time, as opposed to non-renewable sources of energy. Renewable fuels such as wind, solar, biomass, tides, and geothermal are inexhaustible, indigenous and are often free as a resource. The use of renewable sources of energy is less polluting, compared to that of non-renewable sources. Specifically, increased dependence on renewable sources of energy is a key element of efforts to avert climate change. Renewable sources of energy today make a small contribution to total energy use, compared to that of non-renewable sources. A range of barriers including the high cost of production hampers the widespread deployment of renewable energy technologies. Green Economy attempts to remedy these problems through a variety of institutional reforms and regulatory measures, tax, and expenditure-based economic policies and tools. The concept of green economy has been strongly recommended by the United Nations Conference on Sustainable Development held in Rio in 2012.

ELEMENTS OF SUSTAINABLE DEVELOPMENT ARE ENVIRONMENT, SOCIETY, AND ECONOMY

A key feature of the sustainable development is that it comprises three elements: Environment, Society, and Economy. Or, the three Ps: Planet, People, and Profit. All the three, in no particular order, are balanced so that one doesn't destroy another. The greater sustainability movement, however, is guided by these three E's, commonly referred to as the "three pillars" of sustainability: environment, equity, and economics. The environmental pillar is the

most talked-about aspect of sustainability along with economic efficiency. Economic efficiency implies an economic state in which every resource is optimally allocated to serve each individual or entity in the best way while minimizing waste and inefficiency. When an economy is economically efficient, any changes made to assist one entity would harm another.

MAJOR CAUSES OF GLOBAL CLIMATE CHANGE

Global climate changes seen above have occurred as a result of an increase in greenhouse gases, aerosols and land use changes in the context of urbanization wave witnessed in the world. Global warming is caused mainly by three factors such as radiation from the sun, earth's natural temperature cycle as a result of changes in earth magnetic field and the accumulation of carbon dioxide (CO₂) in the atmosphere. Climate change refers to an increase in average temperature on account of a rise in the emission of greenhouse gases; while emission of carbon dioxide is weighed in tonnes and gigatonnes (Gt=10⁹ tonnes), green house gas concentration in the atmosphere is monitored in parts per million (ppm) molecules of dry air. In the baseline scenario i.e., business as usual scenario, the CO₂ concentration would rise from 27 Gt in 2005 to 62 Gt in the year 2050, corresponding to an increase from 379 ppm to 550 ppm of CO₂ in the same period as against the natural range of 180 ppm to 330 ppm. (Aswathanarayana,2010). Similarly the atmospheric concentration of methane gas has increased from 775 parts per billion (ppb) molecules of dry air in the 1990s to 1732 ppb in 2005 as against the normal range of methane between 320 ppb and 790 ppb. (IPCC, 2007) This phenomenon of global warming takes place in the atmosphere between earth surface and the ozone layer which is about 50 km up in the atmosphere ((Nakicenovic, 2001). Further, it is pointed out that temperature tends to decline with distance from the surface of the earth.

To avert the catastrophes of global warming, green economy is needed because it is low carbon, resource efficient, and socially inclusive, focusing on sustainable development and poverty reduction. The green economy is defined as an economy that aims at reducing environmental risks and ecological scarcities, and that aims for equity and sustainable development without degrading the environment. To implement this concept, the United Nations Environment Programme (UNEP)'s Green Economy Initiative (GEI) has been designed to assist governments in "greening" their economies by reshaping and

refocusing policies, investments and spending towards a range of sectors, such as clean technologies, and renewable energies. Ban Ki-moon, Secretary General of UN has rightly said “the clear and present danger of climate change means we cannot burn our way to prosperity. We already rely heavily on fossil fuels. We need to find a new, sustainable path to the future we want. We need a clean industrial revolution”. Thus, as seen above, while the prevailing economic growth model focuses on increasing GDP above all other goals, a Green Economy promotes a triple bottom line: sustaining and advancing economic, environmental and social well-being. The energy sector is accountable for about 25 percent of worldwide greenhouse gas emissions. Improving energy effectiveness and raising the share of renewable power in the global energy mix is significant to reducing carbon dioxide emissions and achieving the central goal of the Paris Climate Change Agreement, 2017 which has stipulated to limit the global average temperature rise to well below two degrees and as close as possible to 1.5 degrees Celsius above the pre-industrial levels.

A low-carbon economy (LCE), low-fossil-fuel economy (LFFE), or a decarbonized economy is an economy based on low carbon power sources and therefore has a minimal output of greenhouse gas (GHG) emissions into the biosphere, but specifically refers to the greenhouse gas carbon dioxide. Implementing green economy practices can help reduce waste, conserve natural resources, improve both air and water quality, and protect ecosystems biodiversity and usher in sustainability. Sustainability broadly means balancing economic, social and environmental systems so that one ‘system’ does not adversely impact the other two. Long term changes in the average weather patterns / temperature has been often used interchangeably with ‘Global Warming’ or “Green House Gas Effect” phrases and have been linked to manmade acceleration of the quantity of CO₂ produced globally. Going green helps the environment by reducing the amount of pollution that enters the soil, water, and air. By using alternative energy sources and avoiding the burning of fossil fuels, recycling and reducing waste and driving more efficiently, fewer pollutants are released into the environment in order to protect planet, Earth (Rudrappan, 2010).

TRANSITION TO A GREEN ECONOMY

The transition to a Green Economy has a long way to go, but several countries are demonstrating leadership by adopting national “green growth” or “low carbon” economic

strategies. And there are many examples of successful, large-scale programs that increase growth or productivity and do so in a sustainable manner such as in the case of Republic of Korea and China. In many ways, Green Economy objectives simply support those already articulated for the broader goal of sustainable development. But this new framing responds to following two recent developments.

First, there is a deeper appreciation today by many governments, corporate bodies, and the civil society that we are reaching planetary limits, not just in terms of greenhouse gas emissions but also in our use of water, land, forests and other natural resources. The environmental and social costs of our current unviable economic model are becoming more and more apparent. Already, the Club of Rome has cautioned the world governments about the dangers of crossing the limits to growth way back in 1972 through its publication Limits to Growth. Efforts of economists have not been focused so far on fixing the failures of economics in addressing these problems so far. Second, and perhaps even more important, the global recession has led to a reconsideration of key tenets of the current economic model—such as the primacy of growth and the belief in light-touch regulation. Many leaders in the public and private sector have questioned the existing economic policies and seek:

- Policies and regulations that can identify and manage financial and other risks more effectively
- New markets and industries that can create good and long-term jobs
- Public support for innovation to position a country to compete in tomorrow’s international markets

These developments point to the need for a new source of growth that is environmentally sustainable—for example, employment in high-growth sectors such as clean energy. Past sustainability efforts have not focused sufficiently on fixing the failures of economic policies such as pricing the problem of pollution. But now, the policy makers have a chance to tackle these challenging problems, given the policy openings created by the response to the global financial crisis. A good example is Republic of Korea’s adoption of a national green growth strategy.

However, in the wake of global financial problems, people have their own doubt about the affordability of green economy solutions which are perceived to be expensive. The USA as well as most other developing countries are much concerned that transitioning to a Green Economy will hinder economic growth and the

ability to reduce poverty. Moreover, there will be short-term, non-trivial losses associated with the changes in industry and market structure (e.g., a decline of the coal industry and related job losses.) Supporting those actors who will bear the brunt of the transition to the green energy will be critical for building a Green Economy.

Some countries feel that they are lagging behind in green technology know-how and its implementation and therefore will be at a competitive disadvantage in the race for future markets. Others feel that the Green Economy is the pretence for rich countries to erect “green” trade barriers on the exports of developing countries.. These are all legitimate concerns that deserve attention and solution by the developed countries.

Finally, economic analysts should inform policy decision makers on what policies and investments should be promoted. When the full costs and benefits over time are taken into account, many Green Economy solutions will be seen as more attractive. Nevertheless, there will still be difficult choices and trade-offs. Is it reasonable to promote and invest in expensive, grid connected solar power, when hundreds of millions in India still have no access to electricity in remote villages? And even where Green Economy solutions make economic sense, they may be politically challenging. The transition to a Green Economy will not be that easy. The principal challenge is how to move towards an economic system that will benefit more people over the long run. Transitioning to a Green Economy will require a fundamental shift in thinking about growth and development, production of goods and services, and consumer habits. This transition will not happen solely because of better information on impacts, risks or good economic analysis; ultimately, it is based upon the decision of policy makers at the top. Moreover, the problem is vested interests. Those who benefits from the status quo are either over represented or have greater access to institutions that manage natural resources and protect the environment. U.S. climate legislation, for example, was defeated in no small part by resistance from fossil-fuel based energy advocates.

The following steps would help to formulate decisions in favour of green energy solutions.

- Increase public awareness and the case for change. Greater visibility on the need for this transition can motivate voters and consumers - not just because of the costs but also the economic benefits generated by a Green Economy, such as new job generation and new markets. People will not adopt policies

because they are green. They will do so when they believe it is in their interest in the long run (Rudrappan, 2011).

- Promote new indicators that complement GDP: Planning agencies and finance ministries should adopt a more diverse and representative set of economic indicators that focus less exclusively on growth and track the composition, pace, and progress of development.

- Open up government decision-making processes to the public and civil society so as to ensure policies are accountable to the public and not to vested and well-connected interests. Timing is everything and important when it comes to big policy reforms. Green Economy advocates will need to be ready when that window of opportunity presents itself.

Ultimately, the widespread transition to a Green Economy will depend on whether or not the long-term public interest is reflected in today's economic policies.

RENEWABLE ENERGY SOURCES

“Green energy” is a term used to describe the energy that is generated from the sources that are known to be non-polluting. For these reasons, “green” energy should be considered as the energy of the future. Most are related to the sun in some way. Sunlight produces solar energy directly. It indirectly produces hydropower (through the movement of rainwater), biomass (through photosynthesis) and tidal power (through tides caused by moon and sun). It is estimated that the share of total renewable sources in the world primary energy supply in the year 2005 was 12.7%, the share of coal 25.3%, oil 35.0% and natural gas 20.6% and hydro 2.6%.

Algae can also be used productively to produce not only several kinds of fuel end products but also by-products which have wide-ranging applications in chemical and pharmaceutical industries. They can be mass produced using land and water which are unsuitable for raising plant and food crops. They are energy-efficient and consume carbon dioxide; thereby reducing the level of global warming considerably.

“Bloom Box”, recently unveiled by K.R. Sridhar, an Indian American has the potential to revolutionize electricity production. It is a fuel cell device consisting of a stack of ceramic disks coated with secret green and black “inks”. It can convert any renewable and fossil fuel such as natural gas, biogas, coal, and gas into electricity round the clock. Since no combustion is involved, there would be no noise, smell or emissions. (Fells, 1990)

Renewable technology favors decentralization and more importantly attempts to seek local solutions to local problems, independent of the

national network. This process enhances the flexibility of the system thereby spreading the economic benefits to the scattered population, who are often small in number. Several studies have pointed out that seventy-five percent of the world's energy supply is used by only 25 percent of the people living in wealthy and industrialized economies. (OECD, 1995) However, it is usually the under-developed or developing countries that face the maximum risk from climate-related threats. Therefore, the investment in green energy supply and progress should be encouraged by governments of all countries and other authorities for green energy replacement of fossil fuels which are far more environmentally benign for a sustainable future. One of the initiatives that gained political support from various countries at the Copenhagen Summit (2009) was the Reduced Emissions from Deforestation and Forest Degradation (REDD) programme. REDD involves supporting developing countries financially to conserve rather than clear tropical forests. Twenty-five years ago, methanol was vigorously promoted. Then came the phase of electric vehicles, the hybrid-electrics, the fuel cells, and the ethanol and finally to plug-in hybrids today.

In December 2015, representatives of 196 governments have met in Paris on the need to limit to global warming to 1.50 c above the pre-industrial levels, a good goal that holds the promise of delivering transformational change, if the aim is translated into action. Due to political challenges from some countries on the need to control co2, some have suggested to focusing on the need to develop large-scale technological interventions to control the global thermostat. Advocates of geo-engineering technologies put forth that conventional adaptation and mitigation measures are not reducing emissions fast enough to prevent alarming warming. "carbon capture and storage" (CCS) technology is needed to suck the excess carbon dioxide out of the atmosphere and to limit global warming and human sufferings as per the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. CCS is a process of capturing waste co2 from huge sources like fossil-fuel based power plants and depositing it in an underground geological formation, leading to prevention of co2 from entering into the atmosphere. However, the problem is depositing co2 in an underground formation also enables increased oil recovery, thereby leading to a more co2 formation in the near future.

Another technology, bio-energy with carbon

capture and storage (BECCS) is the process of planting fast-growing trees which naturally capture co2. After some time, these plants have been converted into fuel via burning for power plants and the resulting carbon emissions are captured and sequestered. However, the demand for biomass has led to land grabs and rising food commodity prices.

The third proposal related to geo-engineering is known as Solar Radiation Management (SRM) which aims to control the sun light from reaching Earth. SRM may be achieved by pumping sulphates into the stratosphere which would cause clouds to reflect more sunlight back into space. It merely delays the impact and not reduces co2 concentrations; hence scientists do not favor SRM as it changes climatic conditions such as drought and flood in some areas damaging the livelihoods of millions of people.

Besides the above climate control technologies, there are simple and politically challenging methods such as a moratorium on new coal mines and new coal-power plants. The investments in coal-fired plants could be diverted to decentralized renewable energy production. A mere 10 percent of the global population in developed countries is responsible for almost 50 percent global co2 emissions.

The fifth powerful measure would be to protect and restore natural ecosystems such as wetlands which would result in the storage of 220-330 gigatons of co2 all over the world. Other remedial measures for reducing co2 include strengthening public transportation, encouraging the use of railways for freight traffic, building bike paths and subsidizing delivery of bicycles.

All the above solutions put together could change the world for better but none of the above solutions is a silver bullet. As world leaders convene for the 22nd United Nations Framework Convention on climate change to bring the Paris Agreement into force, the planetary thermostat should be under the control of all the nations and not a handful of powerful states.

GLOBAL CLIMATE CHANGE

As a result of radioactive forcing, climates have been subjected to global changes like all other planetary surfaces. The components of global climate system such as atmosphere, biosphere, hydrosphere, cryosphere, and lithosphere interact with each other to determine Earth's climate. Moreover, the climate is influenced by the long-term balance between incoming solar or "short-wave" radiation and outgoing terrestrial "long-wave" radiation. The changes

in climate have been documented by the Intergovernmental Panel on Climate Change (IPCC). Main findings as summarized in Horton et al.,(2010) have been listed below:

- global warming temperatures have been due to human activities (IPCC, 2007);
- carbon dioxide (CO₂) have been found to be more than one-third higher than pre-industrial levels;
- other gases such as methane (CH₄) has increased by 100% and nitrous oxide (N₂O) has risen by 20 % over the above period;
- subsequent increases in greenhouse gas concentrations are projected to lead to higher level of temperatures and climate changes;
- in this 21st century, the global average temperature is expected to raise between 1.8 and 4.00 c

By 2100, warming has been expected to increase by more than 8.0C over land, northern hemisphere, and Arctic region. Precipitation has been expected to increase in high altitude cities and decrease in sub-tropical cities. Ocean acidification will increase due to the absorption of CO₂ by oceans which would lead to large implications on the marine ecosystem. In coastal cities, marine ecosystem provides livelihood and sustenance to billions of people and this would be affected by ocean acidification.

CONCLUSION

Thus, green energy is more labor-intensive than fossil fuel, creates more jobs benefiting poor countries. It diversifies energy supply, reducing nation's dependence on foreign oil. Pollution reduction improves public health as well as lowers health cost. Not only, it provides individual energy independence, but also saves a lot of money for the country. After the construction of renewable energy power source, one can draw it free of cost since the input is free. Green energy has less service disruption and can take the economy to a stronger level through the ripple effect that benefits other related industries. In view of the above, it is reemphasized once again that climate change, social equity, and sustainable economic development are compatible if the country uses green energy sources. To conclude " we have a choice: between energy-efficient low carbon path and an energy-intensive high carbon path, which at an unknown point of time ends catastrophically. This doesn't seem like a very hard choice" –Michael Spence, Professor of Economics, NYU Stern School, Italy.

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