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Integrating renewable energy solutions for climate mitigation: Challenges and opportunities

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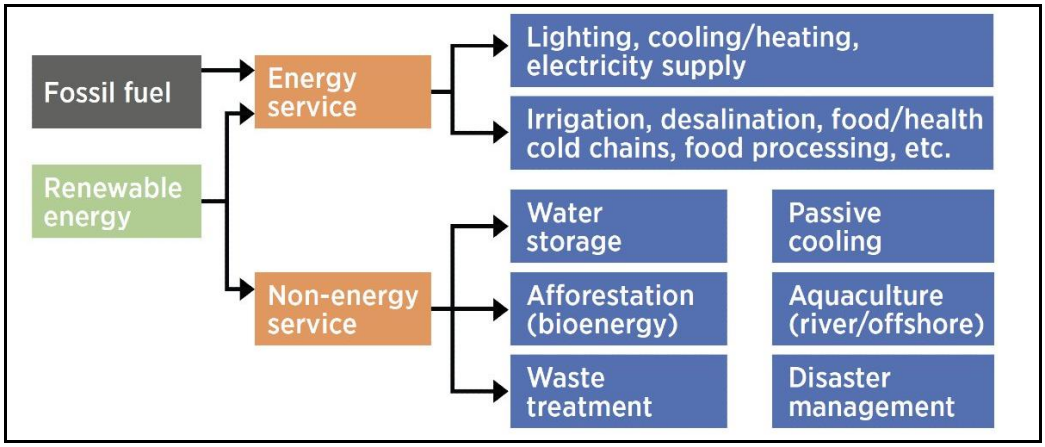
Abstract
Climate change is currently one of the most important issues facing humanity. Combustion of fossil fuel has been believed to be the main cause of global warming and its aftereffects. This calls for the necessity of shifting to renewable sources of energy so as to reduce the impacts of climate change. This broad approach aims at studying many facets of renewable energy sources and their contribution to halting climate change. Aside from preventing climate change, adaptation-comprehending the identification and implementation of pragmatic approaches to deal with the adverse consequences of climate change-is increasingly a high priority as past and present greenhouse gas emissions start to exact their inevitable impact on the climate. Increased levels of greenhouse gases in the atmosphere due to human activities. Combustion of fossil fuel, including coal, oil, and natural gas, is the major source of greenhouse gases. These gases are responsible for inducing the greenhouse effect by trapping the Earth's atmosphere with heat energy. Besides agriculture, industrial production, and deserts, human activities result in the release of greenhouse gases. These might be subjected to future environmental change, however. We quantify this effect here for key renewables using integrated assessment and climate modeling. We estimate the future potentials and associated costs of eight technologies-utility-scale and rooftop photovoltaic, concentrated solar power, onshore and offshore wind energy, first generation and lignocellulosic bioenergy, hydropower-under two warming scenarios.

Keywords: Renewable energy, GHGs, climate change, carbon dioxide, mitigation

Introductions
Climate change affects both natural and human systems, and is likely to have significant effects on the way resources are produced and consumed and on the level of economic activity. The impacts and potential impacts of climate change have generated and will continue to generate a range of climate change mitigation activities that focus on stabilizing the concentration of greenhouse gases in the Earth's atmosphere through plans and actions at the global, regional, national, and local levels. Energy policy makers are showing more emphasis on renewable sources of energy in the wake of global concern over climate change and sustainable development. These sources generate electricity devoid of GHGs emissions and are resources that will last long. The impacts of climate change on populations take place through habitat loss and fragmentation but also through changes in fundamental living conditions such as food availability. Many impacts of global climate change already have been realized, and they include increased frequency and intensity in storms, heat waves, wildfires, flooding, and tsunamis; furthermore, snowstorms and tornadoes, in addition to the spread of infectious pests and viruses, could result in more human illness and premature death. It is also inextricably linked to the alarming rate of species extinction and decline in biodiversity that could conceivably result in the sixth most catastrophic extinction event in the history of the Earth. Policies that support clean air, energy efficiency, and renewable energy will go a long way in mitigating these negative impacts.
Although most climate change adaptation measures involve substantial energy use, policy makers and practitioners seldom recognize that contemporary, reliable and affordable renewable energy services are needed for climate adaptation.
Renewable energy provides routes to "greener infrastructure" for the most climate-vulnerable countries or sectors, hence an opportunity for adaptation that can support and reduce adaptation efforts in other sectors concurrently. Consequently, renewable energy sources must fall under consideration when decisions are taken and adaptation initiatives planned.



Impact of Climate Change

Climate change esoterically affects all aspects of the world. With a rise in global temperatures, there is a melting of glaciers and polar ice caps, which results in the rise in sea levels. This increases the flooding and destruction risk, with much threat to the people living at low-lying areas and coasts. Other extreme weather conditions include changes in the pattern of rainfall, which have made droughts and heat waves more frequent and severe along with hurricanes and cyclones.

Impacts on Ecosystems and Biodiversity: Nowadays, ecosystems and biodiversity are among the most seriously affected elements in the whole world as a consequence of climate change. One of the most significant estimated impacts of climate change on ecosystems is the shift in species distribution and abundance.

Many species have already started moving poleward or to higher elevations in search of cooler climates. This can have the effect of novel ecosystem formation in the areas to which colonization is occurring and loss of biodiversity in the areas being vacated. For example, one study published in the journal Nature estimated that as temperatures rise, the range of bird species in North America is shifting northward at a rate of 4.5 miles per decade.

Another effect climate change has on ecosystems is the phenology shift. Most species have their life cycles and migration patterns based on certain seasonal cues, such as the appearance of insects or the flowering of plants. With rising temperatures, these cues are much less predictive, and this results in changes in the timing of seasonal events. A research published in the journal Science estimates that in the last three decades alone, spring flowering timing has moved forward by 3.5 days on average in the northern hemisphere. This can have a cascading impact on the overall ecosystem.

Increased temperatures, rising frequencies of natural disasters, and changing patterns of weather are some of the contributory factors for climate change negatively affecting human health. Some of the major ways in which human health is being affected as a result of changed weather include:

1. Heat-related illnesses may encompass diseases such as dehydration, heat exhaustion, and heat stroke, conditions most likely to occur when the temperature rises. This is particularly the case in the most susceptible individuals, especially children, older adults, and persons with previous or chronic medical diseases.
2. Respiratory problems: Asthma and other respiratory allergies are some of the respiratory problems that are more common due to climate change. This is caused by the higher output of pollen and spreading of air pollutants.
3. Vector-borne diseases: Due to climate change, mosquitoes and other vectors find ideal places for growth, increasing the burden of diseases such as dengue fever, malaria, and Zika virus.
4. Mental health: loss of homes and livelihoods; increased levels of stress, anxiety, and trauma are caused by natural disasters that are the other major implications of climate change on mental health.
5. Nutritional deficiencies: Due to the changes in climate, food security is impacted negatively, which consequently results in malnutrition and nutritional deficiencies, especially in the most vulnerable sections of society.
6. Water-borne diseases: There is also an association between climate change and increased water-borne diseases such as cholera and typhoid fever due to increased flooding, leading to contamination of water supplies.
7. Cardiovascular diseases: With the increased thermal stress and increased air pollution as a result of climate change, there is also an increase in cardiovascular illness.
8. Infectious diseases: With increased exposure to ticks, mosquitoes, and other vectors, climate change is also linked with an increased incidence of infectious diseases, including West Nile virus, hantavirus, and Lyme disease.
9. Cancer: Also, it is linked to the increase in the cases of cancer, since climate change is disrupting immune systems and increasing exposures to toxic substances.
10. Climate change is worsening one factor: health inequity.

Solutions to Global Warming

Now is the very moment when urgent action is required if we are to soften the impact of climate change and guarantee a secure future for our planet. "Climate change" refers to long-term variations in weather and temperature patterns, which are to a great extent caused by human activities that include burning fossil fuels, deforestation, and industrial processes. Climate change results in rising temperatures, ice caps, and glacier melting, rising sea levels, increased intensities of extreme weather events, extinction of species, and disruption to ecosystems.

What is required for effective mitigation of climate change is a multi-model approach-a multi-level, multi-aspect inclusion of society. The following few important interventions will help retard climate change:

1. Energy Efficiency Improvements: Increasing energy efficiency at all levels is another prudent strategy. It calls for optimization in energy use in buildings, transportation networks, industry, and appliances. These energy-efficient solutions can go a long way in reducing GHG emissions, besides having cost-saving benefits for businesses and individual economies. This includes the enactment of building regulations that call for energy efficiency in designs, promote the use of energy-efficient products by means of labeling programs, and provide financial incentives for energy-saving renovations.
2. Sustainable Land Use: Unsustainable farming methods, urbanization, and deforestation show high impact on climate change. Preservation of forests and afforestation/replanting projects may result in the sequestration of carbon dioxide from the atmosphere. Precision farming, agroforestry, and organic farming are other forms of sustainable agriculture that can reduce agricultural emissions. Energy consumption and transportation emissions, therefore, can be reduced with effective urban planning focused a great deal on compact and sustainable cities.
3. Transition to Low-Carbon Transportation: The transportation sector contributes the most to greenhouse gas emissions. In order to slow down climate change, transportation has to be low-carbon. The ways this can be done are by increasing the number of electric vehicles, enhancing public transport, funding infrastructure for walkers and bikers, and incentivizing ride-sharing and carpool initiatives. Governments' powers are extended to set laws that ban fossil fuel-powered vehicles, develop supportive infrastructures for EV adoptions, and provide incentives for EV adoptions.
4. Carbon Pricing and Market Mechanisms: Providing an economic incentive to reduce greenhouse gas emissions could be established through carbon pricing mechanisms, such as carbon taxes or cap-and-trade schemes. These policies will attach a price to carbon, thereby providing financial motivation for organizations and people to move towards greener practices and technologies. The funds raised through the carbon price can also finance projects relating to energy efficiency and renewables, among other initiatives toward climate change mitigation.
5. International cooperation and various policy frameworks become necessary as climate change is a global issue that requires constant coordination at the level of global response. The United Nations Framework Convention on Climate Change enables nations to debate and implement climate policies, more popularly known as UNFCCC. The Paris Agreement is one of these agreements intended to hold global warming to well below 2 degrees Celsius above pre-industrial levels. Since it is truly an international issue, no country can successfully combat climate change in complete isolation.
6. Public Education and Awareness: There is, in addition, a need for changing people's behaviour and mass action; this requires greater public understanding of climate change. Education programs would help improve public awareness about the causes of climate change, consequences, and available remedies. Encouragement of sustainable lifestyle, ethical consumerism, and environmental conservation contributes to reducing greenhouse gas emission in daily life.
7. Research and Development: To find solutions to tackle climate change, research and development must be continually financed. This includes the development of pioneering technology, the advancement of renewable energy sources to become even more efficient, capturing and storing carbon dioxide, and determining suitable ecological alternatives that could apply to high-emitting companies. Collaboration by the public, private, and academic sectors can allow new ideas to be rapidly implemented.
8. Abandoning fossil fuels for renewable resources like solar, wind, hydro, and geothermal power is one of the most important considerations to be taken into account for the reduction of climate change. These forms of energy are relatively much cleaner and more abundant and produce a minimal amount of carbon emission compared to fossil fuels.

One way the government could encourage the development and use of renewable energy is through offering feed-in tariffs, tax credits, and subsidies. It also requires investment in research and development to scale up the cost and efficiency of various renewable technologies.

Indian Renewable Energy Program -IREP

In terms of wind, the Indian wind power program is the largest in the world. Second largest biogas and improved stove program; largest decentralized solar energy program in the world. The energy policy also aims to establish decentralized system of energy generation.

that are specifically designed to serve primarily the rural needs and based on renewable resources. There is considerable unrealized energy potential in the country; IREP is the largest and most pervasive amongst the world emerging economies. Present demand-supply gap Environmental imperatives; need for strengthening India's energy security; Shareholder pressure and a rural electrification solution to high-emission enterprises.

The Indian program for renewable energy, in particular, was initiated in the 1970s under the stimulus of what was perceived as an energy crisis, especially in rural areas. At the beginning of the program, a target-oriented supply push approach was applied. Its main objective was the creation of specialized applications, such as those for remote locations without grid electricity. In India, financial subsidies have been and are given to promote renewable energy technologies (RET). After the Commission to Advise on Additional Sources of Energy was set up in 1980, the Department of Non conventional Energy Sources was established in September 1982. During the early phases, there were immature technologies and lack of experience in worldwide implementation of such programs.

In this respect, the government has proposed a draft renewable energy policy and program interventions under the Renewable Energy Plan, 2012, which are necessary to meet the following objectives: meeting the minimum energy

needs of rural communities; 10% share for renewables to set up approximately 12,000 MW of generation capacity; installing solar water heating systems in 1 million homes; electrifying at least 25% of the 18,000 non-electrified villages with renewable energy; installing 5 million solar lanterns and 2 million solar home lighting systems; covering 30 million households with improved Chullhas (wood stoves); and establishing an additional 3 million family-sized biogas plants. While 56 per cent households are without electricity, the remaining census villages are 1.25 lakh. The government will cover all these non-electrified census villages by 2009 with 100 per cent household participation.

Emerging developments in renewables

These wastes are pyrolyzed or plasma gasified at a high energy extraction potential of 1,700 MW, of which 1,000 MW is recoverable from urban and municipal wastes, and about 700 MW from industrial wastes. Gasification of waste produces essentially syngas comprising mainly of CO and hydrogen, which can be combusted in appropriate equipment installed in both reciprocating engines and gas turbines.

Emphasis has also shifted to energy originating from chemical sources such as hydrogen energy, fuel cells, geothermal energy, biofuels, ocean and tide energy, alternative fuels for surface transportation.

Besides these safety-related issues, at least two major challenges that would have to be met in the case of hydrogen concern system cost and efficiency: whereas, in principle, fuel cells are not Carnot cycle-limited and can therefore reach 83 percent efficiency levels for combined heat and electricity applications, practical fuel cells can only achieve 60–70 percent of the theoretical maximum. The path, however, from electricity produced by electrolysis to hydrogen and back to electricity via a fuel cell is only 40 percent efficient for combined heat and power applications, and even lower for pure electricity applications.

Hydrogen from electrolysis is three times more expensive than hydrogen coming from fossil fuel.

Other sources of non-conventional energy include the rising piles of garbage in the urban areas due to rapid industrialization and urbanization in India. As much as an average of 450 grams of solid trash is produced by each person in a day in India. A fair prospect of producing roughly 15,000 MW of electricity from municipal and urban garbage and about 100 MW from industrial wastes exists in India. Estimates put the equivalent power from municipal and urban garbage alone at about 70 MW. This potential should increase as our economy continues to grow. Energy from waste can be produced in the form of biogas, steam, fuel pallets, or directly as electricity. Examples of wastes are animal waste, agricultural residue.

The best geothermal resources are contained in well-defined belts of geologic activity.

The geothermal power generation facilities can be used for base-load electricity generation and already have an installed capacity of over 8,000 MW worldwide. Geothermal energy conversion systems can deliver electricity at an annual capacity load factor of over 90%. Seven geothermal provinces of India have 400 thermal springs with surface temperatures between 47 and 98 °C and low- to medium-temperature geothermal resources.

Ocean energy is broadly classified into two sections: Mechanical energy sources consisting of wave and tidal energies and thermal energy source, derived from the heat of the sun. Being a vast body covering an area of 361,132,000 sq km, or 70.8% of the Earth's surface, the oceans are the world's largest solar catchers. The Indian water area is approximately 314,400 square kilometres. The ocean's surface water receives much more heat from the sun than its deep water; this temperature differential, in effect stores thermal energy. There are many uses for thermal energy of which the generation of electricity is one. Three types of electricity conversion systems are available: closed-cycle, open-cycle, and hybrid.

Climate change mitigation initiatives

Among the benefits that could be counted when speaking about renewable energy supplies are that they are never running out of their power, reduce dependence on fossil fuels, and help the environment to decrease carbon dioxide emissions.

Technological advancement in efficient combustion of coal and renewable energy sources efficiently reduces CO2 emission. Since the generation mix is dominated by fossil fuels, the relevance of producing energy from renewable sources is gaining importance amidst the large negative environmental externalities associated with the production of electricity. Energy emissions in India are trending fast upward with increased energy consumption. But despite the fact that current Indian carbon emissions per capita stand 20 times lower than those of the US, India still emits over 200 million tons of carbon annually. It is part of a cooperative tool presently something like the Clean Development Mechanism that enables any responsible developing nation like India to participate in the global framework for emission restrictions. The CDM is a voluntary tool designed to incentivize projects that reduce greenhouse gas emissions.

Conclusion

The impacts of climate change on ecosystems and biodiversity do not spare any particular areas or species. This is a global phenomenon that has repercussions on the ecosystems everywhere. Renewable energy is obtained from sources replenished naturally and causes minimal harm to the environment. Despite all the challenges, renewable energy has a number of important advantages which solve many economic, environmental, and social concerns. Among them are solar, wind, hydroelectric, geothermal, and biomass energy sources. Investments in renewable energy rise as a consequence of the supply-side change in the energy mix induced by the tighter regulations on carbon emissions. The current energy landscape puts India at a juncture whereby the window of opportunity for diversification and increase in energy supply could be taken further to accentuate the pros in the direction of greater sustainability and social and environmental responsibility. And this window of opportunity takes the shape of renewable sources of energy. We conclude by saying that there is a need for us to act directly in the direction of discouraging and putting an end to climate change through using renewable sources of energy. Not acting on it does have very dreadful consequences that can easily lead to irreparable damage on our world and generations to come. By using renewable energy, we help lessen some of the

impacts of climate change, build a sustainable future, and ensure people and environmental security. Let's come together and make a more sustainable world by going greener.

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