A Review on Low Carbon Development and Innovation

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ABSTRACT: ***Low-carbon production (LCD) is a buzzword in today's development world. As a result, policymakers are aggressively investigating ways to meet their development goals by taking a low-carbon or even a "carbon-neutral" route. This is a new area that questions how architecture has been achieved in the past, requiring not only a thorough reconsidering of old practices but also a challenge to current value systems. We look at some of the fundamental problems that are shaping the mechanism of mainstreaming climate change into growth in this article. Recognizing that LCD can take many forms, we map out the various meanings and understandings in order to set out the variety of options that countries can explore. We conclude that, while countries should definitely learn from other countries' experiences in mainstreaming climate change through their policies and activities, each country's version of LCD must arise from its own national reality, rooted in its growth opportunities, ambitions, and capacities. The paper illustrates various phases related to flow of carbon-development so that in future, this study can be referred in order to create appropriate policies related to low-carbon development, growth and innovation.***

KEYWORDS: Climate Change, Carbon Dioxide (CO2), Development, Low Carbon Development (LDC), Innovation.

INTRODUCTION

Because of thermal energy related carbon dioxide (CO2) pollution, global climate shift has become a growing point of concern. Different nations have begun to explore alternate development strategies in order to effectively reduce emissions of co2 while sustaining economic development, with minimal carbon development being a common option. Different countries/organizations can view things differently. A diversity of ideas related to minimal-carbon growth have appeared in the literature, including low-carbon electricity, low-carbon culture, low carbon environment, low-carbon town, low carbon culture, low carbon tourism, and low-carbon planet. Both ideas are related to one another, but they still have certain basic distinctions, and there is no way to compare them. The aim of this research is to conduct a thorough review of different principles related to low carbon growth, not just to illustrate their interactions but also to provide a theoretical base for low carbon development research.

In the past decade or so, weather change policy has been a hotly debated issue in the United States. Simultaneously, it is generally acknowledged that mitigation must be matched with socioeconomic and societal development in developing countries. Renewable sources like solar wind, hydropower and geothermal are plentiful in many developed countries, creating new horizons for socio - economic development while also supplying energy. In this discussion regarding climate change and wider policy agendas, the ‘innovation and progress' science group has been prominent. While there are many opportunities for achieving "co-benefits," or socioeconomic development benefits as a consequence of mitigating climate change, it is widely understood that these developments are not imminent and that developing countries face particular challenges.

Intended for access towards funding, public & private collaborations, and global cooperation, they depend on transformative interventions, such as new policies and models[1]. Furthermore, the obstacles to slower productivity (LCD) in emerging countries differ from others in developed nations due to their diverse social, political, and economic environments. This particular topic aims to add to the discourse by exploring how the innovation, learning, and expertise lens relates to the analysis of growth outcomes from mitigating climate variation; special consideration is compensated to the development of new zones of LCD research. Climate change mitigation is increasingly being combined with industrial expansion and innovation procedure by policymakers in developing countries. This special issue would also look at perspectives from cases in various developed countries and technical fields in order to set a research and policy agenda[2].

1. *A New Development Opportunity through Mitigation:*

It is no secret that developed countries need increased access to reasonable and present energy supplies to face a variety of growth challenges. According to an analysis, approximately three billion people worldwide rely on conventional biomass for heating, cooking, and approximately 15E10 billion people currently lack contact to electricity. A further 1 billion people have only inadequate energy networks or are subjected to repeated blackouts owing to a lack of sufficient generation capability or merely due to aging power generation infrastructure. According to a report via a World Bank provided in 2009, nations with underachieving energy structures could drop up to 12% of their annual growth capacity due to blackouts and the haphazard measures needed to prevent total grid failure.

The UN Secretary-Advisory General's Group on Energy and Climate Change recently emphasized the importance of improving the situation. There was a call for engagement and action on two objectives by 2030: equal access to modern energy resources and a reduction in global energy intensity. The need to increase energy grid efficiency while reacting to the need to extend energy access while becoming more responsive to global and local environments are at the central of the paper[3]. Universal energy connectivity is a prerequisite for achieving the MDGs. It's also a lofty target that would necessitate a massive mobilization of technological, administrative, and financial capital that hasn't been attempted before. To achieve basic universal access by 2030, an annual investment of $35–40 billion will be expected in finance alone. Reduced energy intensity is another field of growth. Most of the rise in energy mandate is projected to originate from developing economies like India and China, where quick industrialization is occurring alongside a strong increase in household consumption habits of energy-intensive goods.

If these economies strive to decouple growth from energy demand, there is plenty of space to introduce energy intensity programs. Both India and China proposed reasonably optimistic energy power reduction plans of forty and twenty five percent by 2018, respectively, at the Copenhagen climate talks in December 2009. Energy conservation is one way to do this. While the costs of abatement for a variety of low-carbon infrastructure choices differ significantly, the authors conclude that engaging in energy efficient programs has the lowest costs, as well as additional GHG mitigation benefits[4].

2. *LCD and Innovation:*

Emerging nations are playing an increasingly significant part in climate change discussions. Any response to climate variation would necessitate the swift and wide-ranging "diffusion" of low-carbon technologies during the production period. According to the economics of innovation, the pace and direction of information formation and dissemination are extremely heterogeneous and reliant on national and sectorial innovation structures. The development mechanism will be influenced by and dependent on the various socioeconomic, cultural, and political conditions of developed countries in mandate for extra or less viable low carbon resolutions to materialize. Each nation has its own unique set of "original requirements." The interplay of natural resources, human capital, technical skills, governments, tradition, and history in developing countries is much more dynamic than commonly thought. Concentrating on 'diffusion' of common technical and institutional options would not have reliable and long-term funding for LCD. LCD, in a nutshell, is the procedure of transitioning the present fossil fuel based economic structure, especially the energy scheme, to achieve CO2 neutrality. This description is somewhat similar to the idea of minimal carbon rise. It is grounded on the aim of sustainable growth, but it does not solve the many planetary challenges that occur in accumulation to climate variation (e.g., habitat depletion and water scarcity), nor their interconnections..

The links between the alteration of the vestige fuel based economy and multiple global boundaries, such as Low Carbon Development and environmental preservation, are taken into account in a detailed viewpoint. However, the idea of Low Carbon Development (LCD) is being used in the particular issue to bring attention to one of the world's most serious potential hazards: climate change. More specifically, a wider perspective varies from a narrow perspective in several ways. First, unlike growth focused principles (minimal carbon growth as well as balanced growth), the wide-ranging view specifically combines two goals: climate change reduction and low and middle-income countries' long-term progress. LCD encompasses both the social as well as political aspects of sustainability in its widest sense, it entails more than just lower carbon growth rates, as it seeks to encourage international development, especially inclusive development.

Not only does the LCD concept imagine climate variation mitigation and worldwide development, but it also foresees climate change action and global advancement. There is also a presumption that there would be efficiencies between both the two[6]. The push to build green energy solutions in nations, for example, would aim to provide energy connectivity to the poor until brown power sources take over. LCD is described as policies that reduce pollution in order to prevent dangerous climate change while still achieving social and economic growth in this special issue. Participating in LCD needs creativity to follow a different path that facilitates the transition to a "green techno-economic model." The trajectory of innovation is more important than the pace of innovation. Across a variety of technical realms, the green revolution would necessitate significant improvements in productivity and use. It will be a method of ‘creative destruction' in the traditional sense: old economic institutions will be destroyed, and modern, more environmentally friendly ones will be built in their place.

This means that further studies will need to look at new facets of LCD as well as new performers. Systemic challenges in developing countries include a lack of capacity, technology, and structural structures. In such circumstances, new players emerge, such as unions, municipal governments, and non-governmental organizations (NGOs), to name a few. Furthermore, it is becoming abundantly clear that the term "developing countries" now refers to a large group of countries stretching from unstable states to low income countries to emerging economies. In other lyrics, when attempting to comprehend the LCD process for ‘developing countries,' we must concentrate on new challenges and opportunities. Over the past ten years, the academic group focused on learning, creativity, and competence development has had a significant impact on the LCD discussion.

There are three major fields where the way we learn of climate change reduction has changed. From 'tech' and 'learning' and 'innovation,' there's a lot to take in. The policy community has long highlighted the role with technology in mitigating climate change, particularly in developing nations' lots of low innovations. However, there is growing consensus that the policy establishment was led from the start by a very limited understanding of technology and the machinery creation process. Furthermore, it’s often suggested that the subsequent emphasis on technological hardware access has effectively failed. Conceptual development was aided by the distinction amongst programs, complete apparatus, and assembly facilities and skills, expertise, and skill for short term service and maintenance as well as long term improvement. The most successful way to encourage local low carbon innovation is to achieve skills (learning) within the ‘software' dimensions.

As a result, it's increasingly apparent that innovation is a multi-faceted and inclusive phenomenon that isn't exclusively, or even mostly, about ground-breaking "high tech" equipment developing from Research & Development laboratories. The current research challenge in this field is to better comprehend how knowledge and skill development occur in a variety of environments in developing countries. From 'shift' to collective engagement on a global scale: In debates of how to do it, the subject of technological transfer has traditionally been viewed as simply getting access to hardware technologies, as discussed above. The development of local technological expertise and infrastructure construction, as well as the facilitation of knowledge exchange, gained little consideration.This method controlled trade and IPR debates for many decades in the twentieth century, the goal was to upturn foreign commitments to infrastructure development reasonably than to design institutional frameworks that suited local requirements to ensure innovation adoption, implementation, and contextualization.

Despite the limited monetary and social development benefits of technology transmission in traditional segments, the United Nations Agenda of Resolution on Climate Variation structured its negotiations in a traditional, restricted way. As a result, efforts to foster climate sociable technology transition have been restricted to hardware & financial assistance, which has been widely viewed as a disappointment. Though, this policy has progressed: recognizing the value of green house gas decrease technology placement in developing nations recognizes not just the collective good in relations of the climate variation crisis, but it likewise considers the flaws in the traditional approach to technology handover. Instead of debating technology transition, there is a general agreement that global cooperation to harness technology for environmental protection and overall growth inside the universal South should concentration on innovation partnership, or joint act to promote the progress, adaptation, and placement of relevant technologies. This invention cum cooperation will go beyond technological aspects of the innovation mechanism and incorporate other aspects of the innovation mechanism that aid in technology deployment.

The new research task is to recognize collaborative themes for improved LCD information production and dissemination. While globalization has expanded the number of structural outlets for knowledge transfer (e.g., IPR, licensing, increased FDI, and exports), it may have also widened the knowledge divide between those with absorbent capabilities, technology (ICT), and organizational architecture and those without. From 'diffusion' to' systems construction': The implementation – adoption or rise – of low carbon innovations, such as clean energy technologies or energy conservation programs, has been widely referred to as technological diffusion in the climate change debate. Although this is clearly important, there has been a growing focus on the complexities of the underlying mechanism, which involves not only the deployment of technology but also the transformation of the related socio-technical environment. Organizational and structural reform, as well as improvements in the realms, tools, and strategies of policymaking, are all needed for effective LCD. This necessitates a systems level approach to An examination of the LCD. We respond to learning, creativity, and competence building procedures rather than merely innovation schemes, which developed as a perception from research in developed nations. When it comes to LCD, the problem isn't limited to a North-to-South diffusion and adaptation phase. It is largely a process of enhancing structural sustainability so that energy generation and consumption processes can become greener as well as more capable of serving local needs over time. To put it another way, developed nations are moving further into uncharted territory in search of their own solutions.

The necessity for extra context specific and engaging approaches to the LCD transformation cuts through all three points listed above. Globalization has provided knowledge networks like the Intellectual Property Right scheme and Information and Communication Technology (ICT) to increase access to frontline technologies if a country has absorptive volume. About the fact that information and technology do not originate in developed countries, these populated and rapidly rising economies offer an intriguing seedbed for LCD-related technologies. Active teamwork in unorthodox modes is needed for learning and system development in order to achieve this. For successful deployment, information and technology transition is insufficient[5]. A complementary mechanism should be in place in the country to allow such gained information to be disseminated and adapted locally. If the transition is to be well-rooted and meaningful in each region, international cooperation should go further than a technology emphasis to a capacity and system building attention.

3. *Phases of Low-Carbon Development:*

South African countries have a wide range of technical capabilities for coping with the low-carbon problem. The world is developing quickly and becoming more dynamic, making it difficult to differentiate between countries at these stages of capability. We have multiple emerging country growth poles: BRICS (Brazil, Russia, India, China, and South Africa) and large developing countries that shadow BRICS (such as Indonesia, Turkey, and Mexico); fast rising African nations (such as Ethiopia, Botswana, Nigeria, and Kenya); and Southeast Asian nations (such as Indonesia, Turkey, and Mexico). In the other side, there are nations with unstable states (such as Central African countries) and others stuck in the "middle" (Malaysia, Thailand, etc.). The trajectories for low-carbon innovation are heavily influenced by the diverse and complex development trends and conditions that exist within developing countries.

These circumstances form the paths that lead to distinct ‘innovation paths.' Low carbon transition technology paths are likely to vary dramatically among nations due to the heterogeneity of policies, trust funds, and technical prowess; this has consequences for the efficacy of reducing greenhouse gas productions and resolving related domestic oil problems, and also the degree with which carbon free technologies and explanations can become a source of resident.The ability to form certain pathways is highly dependent on current capabilities. A small number of scientists have shown that some newly industrializing countries are developing significant technologies and have the ability to become technology suppliers. In the other hand, certain recently industrializing countries are still a long way from being there. A new analysis of the results, which emphases on minimal carbon technology, shows that there is a broad range of capabilities.

Furthermore, there is a greater need to develop skills in different middle income countries, particularly in minimal income nations. We generated the subsequent three stage diagram of low carbon development by summarizing and merging many low carbon linked philosophies from literature (see Figure 1). Low-carbon growth can be divided into three stages, as seen in Figure 1, viz. low carbon economy, low carbon

environment, and low carbon earth. The low carbon economy is the first stage of low carbon growth, where the key aim is to reduce CO2 productions in economic expansion. A nation must create a concrete strategy to encourage low carbonization in its economic growth in order to achieve this aim. The proposal outlines financial, tax, and legal incentives for low-carbon infrastructure research and growth, as well as the development and use of low carbon resources and the transformation of the economy to a low carbon economy. Low carbon tourism and manufacturing are inextricably linked to a low carbon economy.

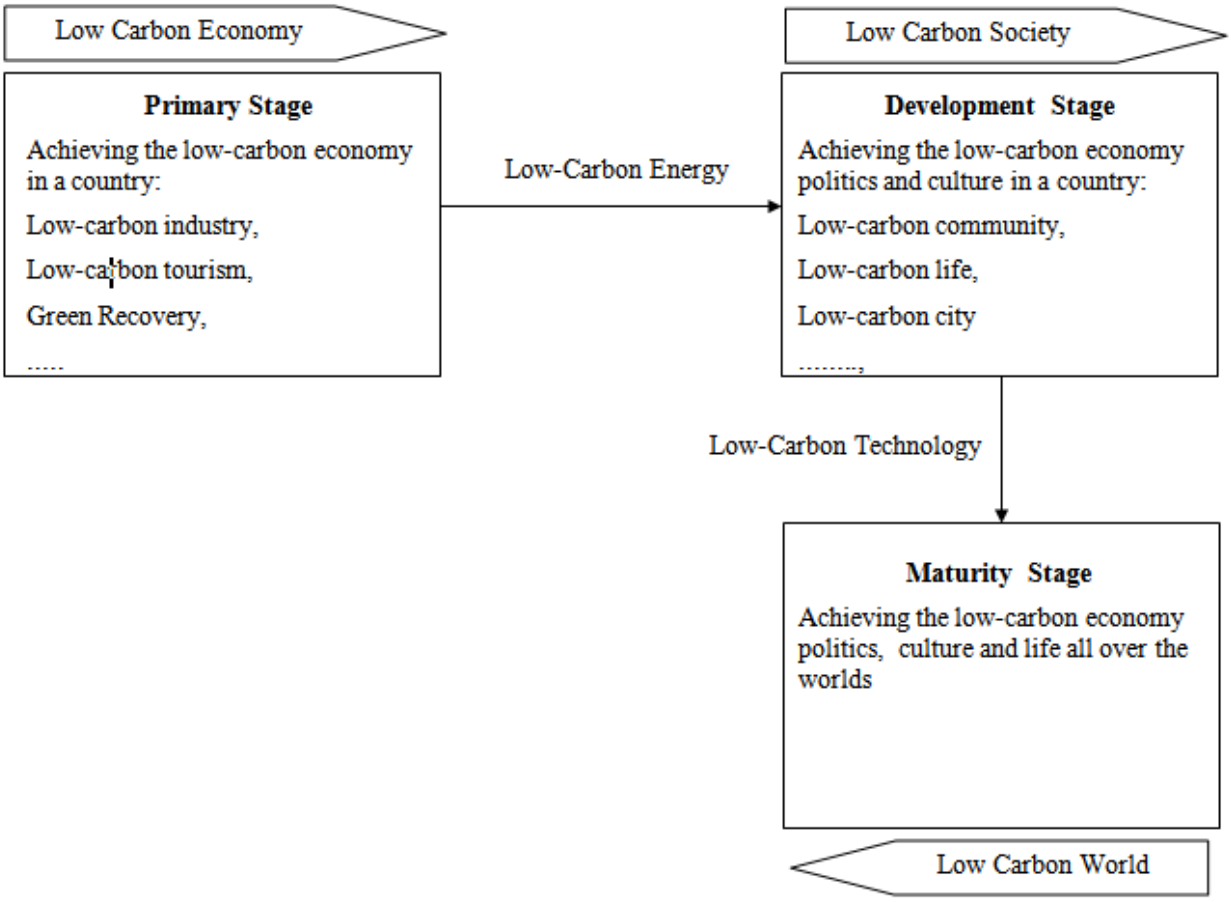

Figure 1: Flow Chart Representing Different Levels/Phases of Low Carbon Development

Green recovery refers to a series of policies and programs aimed at achieving a minimal carbon economy. After the low carbon economy stage is finished, low-carbon growth moves on to the second level, low carbon civilization, which encompasses low-carbon living, low carbon society, low carbon policies, and so on. At this point, the government must continue to encourage people to adopt low carbon existences and practice habits, such as urging them to use low carbon modes of transportation. A city is described as low-carbon until it achieves low-carbon in all facets of its economy, everyday culture, life, and politics. A low carbon neighborhood is the essence of a low carbon urban. Similarly, a country will develop a low carbon civilization if the economy, everyday life, and community are all carbon-free. Low-carbon growth matures as several countries across the world become low-carbon economies, and the stage "low carbon world" begins. Many gadgets are required to monitor production output in the low-carbon development phase. Carbon footprint, carbon sticker, and carbon certification are examples of principles that can be useful. The cumulative CO2 emissions generated by an organization, a substance, or an individual are referred to as a carbon footprint. Carbon labeling and registration are an automated method for measuring and displaying a product's or service's CO2 emissions over the course of its entire lifecycle.

DISCUSSION

1. *Policy Issues:*

The desire for a low carbon economy has raised to the forefront of the sustainability agenda. A big amount of administrations and expansion agencies has since adopted LCD into their strategies and selections. Policymakers and practitioners are excited about the possibility of consuming the LCD schedule to encourage associated benefits like increased business and employment creation, reduced localized contamination, and better energy availability. The key accomplishment factors that transform opportunities into certainties are more relevant to policymakers. We highlight the importance of a differentiated policy approach method to low carbon revolution in this presentation. As discussed in the previous section, it's particularly necessary to distinguish between countries with varying technical capacities.

As the UNFCCC's (United Nations Framework Convention on Climate Change) definitions of Annex 1 and Non-Annex 1 countries show, such distinctions provide a greater foundation for policy advancement than the symbolizations of developing and emerging countries that underpin most policy debate. In contexts where urgencies and preexisting proficiencies differ greatly, more finely grained categorizations aid in the formulation of policy plans. In countries with current institutional infrastructure, the challenge is to develop national low-carbon programs to ensure self-engaged and wide scale transformation, broadcasting, and utilization of new low carbon technology [1]. As the technological environment changes, the challenge for "specialist" nations is to build on current proportional advantages while still developing dynamic capacities to avoid being "central rigidities."

It's possible that generalist countries will want to improve systemic engagement. While several of these countries have been able to establish innovation, learning, and competence building systems (e.g. universities, R&D regulations, research institutes, and so on), stimulating interactions among components has proven to be much more difficult due to a lack of demand for expertise. The direct supply of clean vitality and the unintended provision of manufacturing and economic growth should be the subject of new ties. Securing energy access is the ultimate target in many supporter countries, counting some "early supporters" like India, and it involves both the development of new rural energy networks and the conversion of prevailing urban ones. According to Figure 1, over one billion people in Sub Saharan Africa and emerging Asia, especially in rural zones, do not obligate right to use to electricity. For the introduction of alternative energy sources, existing rural energy grids require the development of modern energy routines, institutions, and skills.

Policies must focus on creating new energy technologies viable and encouraging market formation through microcredit financing, allowing for energy technology reform and the creation of publicly open learning spaces. Governments and donor organizations could be able to assist in the growth of new decentralized energy business models by bringing together infrastructure actors including energy service suppliers, financial institutions, device suppliers, and operators and repair service providers. This assistance could mix clean energy initiatives with infrastructure financing, such as mini-grids. In order to democratize infrastructure opportunities and improve job growth, this would also include consultations bringing together municipal authorities and energy companies to merge service level specifications and social norms. It's important to involve and assist system operators with oversight capabilities in relevant application fields in order to provide guidance and link stakeholders.

Plan replication and scaling can be aided by the coordination of device operators. Working with local councils to create the "meta capabilities" needed for fetching collected and arranging the different actors is one of the most critical activities. It should be a top priority to bring system-level perspectives and expertise to the table. Numerous of the opinions listed instantly above, including those concerning "early followers," may be classified as strategic deliberations for "late followers." However, in these situations, there are further strategic considerations that need special focus[4]. Figure 2 represents rate of electricity consumption in rural, urban and in general arena by Asian under development countries.

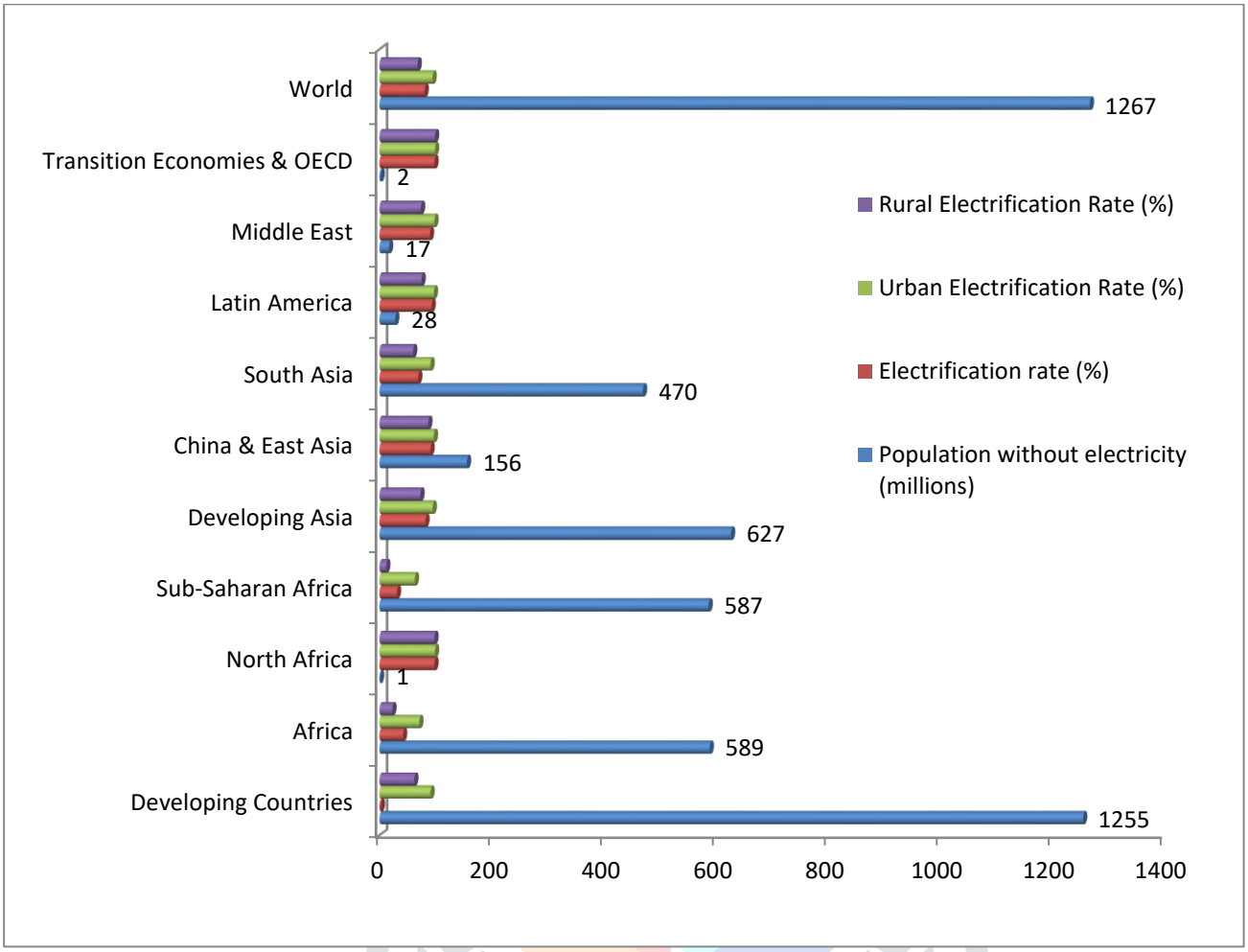

Figure 2: Graphical Representation of Electricity Access of Developing Country

Absorptive capability is clearly small, and learning mechanisms must be developed to increase it. The advancement of low carbon modernization pathways necessitates a sophisticated level of government supremacy capacity than occurs now. As a consequence, in these countries, developing governance capabilities may be a central precondition for LCD[3][11]. Furthermore, the economic interests of these nations are often disturbed with more crucial social issues. Active LCD should have a diverse policy with poverty, socio-political, and inclusiveness traits to create such a evolution more realistic for emerging countries. Another thing to keep in mind is that innovation in these countries is often small-scale, driven by the desire to fulfill "needs" that have never been fulfilled by systemic means. Examples of these technologies include group mobility schemes, climate variation mitigation housing with modest roof improvements, cultivating processes, agricultural production strategies, electricity formation from off-grid renewable energies, and so on. Supporting "off the beaten path" or "informal" green initiatives may be a step toward a more inclusive environmental transition. These variations would ultimately complement present "technology transmission" driven policies and aid to accelerate the transition procedure toward sustainability.

CONCLUSION

While low-carbon design models have gotten a lot of attention, there hasn't been a comprehensive examination of their likenesses and variances. This paper plugs an opening via providing a philosophical examination of low carbon expansion. In general, low carbon growth is a fresh political and monetary expansion pattern aimed at decreasing carbon dioxide emissions and accomplishing long-term environmental, economic, and social development. A new economic model aimed at increasing energy demand, fostering regional renewable growth, lowering CO2 emissions, and preserving global ecological equilibrium is referred to as a "low carbon economy." The word "low carbon environment" refers to a

decrease in carbon emissions across all aspects of society, such as the culture, economy, and everyday life. A low carbon urban city is described as a region that has achieved carbon neutrality in all aspects. As the essence of low carbon town, low carbon communal is an essential part of low carbon town. Low carbon living often aims to reduce CO2 emissions by conserving energy in our daily lives. The thesis depicts different phases of carbon-development flow in order to use the findings to implement suitable policies for potential low-carbon development, extension, and innovation.

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