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Review on integrated strategies for energy policy planning and evaluation of GHG mitigation alternatives

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ABSTRACT

This review paper is devoted to elaborating the status of different energy policy planning studies and the evaluation of various GHG mitigation studies. It includes, some of the major developments in global energy scenario, status of Green House Gas (GHG) emissions, issues in the implementation of Kyoto protocol and GHG mitigation, Clean Development Mechanism (CDM) and energy scenario especially pertaining to the residential, industrial and commercial energy sector in the initial sections. The later part of this paper highlights the salient contributions in various literatures pertaining to energy demand forecasting in residential, commercial and industrial sector, GHG estimation methodologies, and GHG mitigation studies in various sectors. The success and difficulties in implementing various policy planning practices were also discussed in the paper. Most of the prominent literature in the area of energy demand and consumption analysis towards effective implementation of GHG mitigation is described. In the end, a comprehensive comments and recommendations based on the study were furnished.

Contents

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1. Introduction - energy planning studies

Ever since the industrial revolution, energy has become an inevitable part of everyday life of each one of us. At macro level, energy occupies a central part of all economic activities in terms of generation, consumption and conservation and manifests itself as economic development measured in GDP growth of any region. However, energy usage has its negative sides in the form of depletion of available energy resources and contribution to environmental pollution leading to disastrous climatic changes. Naturally available energy resources are draining fast demanding focus on developing alternative energy resources as well as measures for effective energy utilization. Planning for energy generation, distribution and consumption is undoubtedly the most vital component in achieving effective energy utilization. Thus ensuring prolonged energy availability combined with minimized ill effects on the environment, forms the nucleus of strategies for sustained development of any region or nation. For proper and efficient energy policy planning, a comprehensive and up to date knowledge about the various policy planning activities, methodologies and tools is vital.

The literature on energy planning presents diversified international and national studies that were undertaken, particularly, with respect to demand side analysis in various sectors of utilization such as the industrial sector, residential or domestic sector, and transportation sector. Most of the investigations in the area have been directed toward the industrial sector owing to them being the largest energy consumers and due to easiness in accessibility of data, when compared to the studies with respect to the residential sector and transportation sector having received reduced importance. In this study, an initial investigation on the literature on energy demand analysis and corresponding GHG mitigation activities has been reviewed to identify the relevant areas for contribution in consideration of the present global energy scenario.

1.1. Objectives

While most nations across the globe agree upon the need for conservation of energy resources combined with minimizing the ill effects on environment, most attempts in this direction have not been reported to be successful in their implementation. The major objective of this study is to make a comprehensive review of different studies on energy policy planning in any sector and examine its impact of possible GHG alternatives. The other objectives of this study are (i) to investigate and assess the studies on energy consumption pattern and economic viability of GHG mitigation options (ii) to understand the present research status in the field of energy demand forecasting and GHG mitigation and identify the areas that need further and enhanced research.

1.2. Methodology

Notable contributions pertaining to the world energy scenario, energy demand and consumption pattern analysis, forecasting, greenhouse gases mitigation in various sectors along with regional level energy surveys and studies are highlighted in this study. In addition, salient aspects of studies undertaken on energy scenario prevalent in developing countries are presented, drawing up the need and importance of this study. This review work is augmented with studies on greenhouse gases estimation and mitigation methodologies along with Clean Development Mechanism and its implementation attempts. The organization of this review paper is as follows.

The first section presents the review on the status of global energy scenarios. The subsequent section commences with the categorization of energy studies undertaken so far followed by review of major studies on energy demand and consumption pattern analysis in the international level. The following section presents notable contributions on energy demand forecasting at the international level. Research on Green House Gas mitigation strategies in the international level reported is presented in the following section. The literature on investigations undertaken at the national level on energy demand and consumption pattern analysis, energy demand forecasting and GHG mitigation strategies are presented subsequently, followed by studies on CDM and its implementation at the international and national levels. The outcome and comments based on the study are listed which is followed by concluding remarks in the last section.

1.3. Global energy scenario

The United Nations has asserted that climate change is an inevitable and urgent global challenge with long-term implications for the sustainable development of all countries. Climate change has been defined as the change in modern climate caused by a variety of natural and human-related activities. However, the concentration of GHG in the planet's atmosphere caused by human behavior is considered to be the most significant contributor to a changing and warming climate [51]. GHG are gases that absorb and emit radiation within the thermal infrared range. They include water vapor, ozone, methane, nitrous oxide and most importantly carbon dioxide. Carbon dioxide is mostly associated with the combustion of fossil fuels, which is today, heavily utilized in the production of energy.

While climate change and GHG emissions know no boundaries, poor and developing communities will be among those most adversely affected and having the least ability to cope with the anticipated shocks to their social, economic and natural systems. In a global scale, the Intergovernmental Panel on Climate Change (IPCC) projects that, by 2080, millions of people will be displaced due to sea-level rise, with densely populated and low-lying countries facing the greatest threat from storm surges and rising seas. Sea-level rise of just one meter will affect the world in a devastating way: based on today's situation, approximately 150 million people in Asia alone and $1 trillion of economic assets would be threatened. For example, India, as a vast country and home to numerous fragile and unique ecosystems, will inevitably have to deal with population displacement, health impacts caused by a warmer climate, and an increasing influx of climate refugees, just to mention a few consequences.

Global green house gases emission due to human activities have increased since pre-industrial times, with an increase of 70% between 1970 and 2005. Carbon dioxide as one of the most important anthropogenic greenhouse gas has registered a growth in annual emission by about 80% between 1970 and 2005, from 21 to 38 gigatonne (Gt) and represented 77% of total anthropogenic GHG emissions in 2005. The rate of increase of carbon dioxide equivalent