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Forecasting of Carbon Emissions and Development of Renewable Energy in India

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Abstract: With the continuous growth in industrialisation, India is experiencing high demand of energy that leads to huge quantity of carbon emissions. The present work focuses to forecast the future carbon emissions, consumption of energy and predict the amount of Renewable energy requirement in the coming years in India. It will further provide insights how to optimize the production and consumption of energy, ways to bring down the future carbon emissions and to achieve sustainable cleaner production.

Keywords: Energy, Forecasting, Carbon Emissions, Renewable, Sustainable, Cleaner Production

1. Introduction

Carbon emissions reduction and renewable energy initiatives have taken center stage in India's ongoing efforts to address the global climate crisis [1]. As one of the world's most populous and rapidly developing countries, India faces the dual challenge of sustaining economic growth while mitigating its environmental impact [2]. In recent years, India has demonstrated a growing commitment to reducing its carbon emissions and transitioning to renewable energy sources as part of its broader sustainability agenda [4,5,6]. These initiatives are crucial not only for India's own environmental well-being but also for contributing to the global fight against climate change. This introduction provides an overview of India's efforts to reduce carbon emissions and promote renewable energy solutions, highlighting the key factors driving this transition and the impact it has on the nation's sustainable future.

2. Methods and Materials

Forecasting carbon emissions is a crucial component of environmental and climate change planning [1, 4]. Accurate predictions enable governments, organizations, and researchers to develop strategies for reducing emissions and mitigating climate change. Several forecasting methods are used for carbon emissions:

Time Series Analysis: This method analyzes historical carbon emissions data over time to identify trends and patterns. Time series models, such as autoregressive integrated moving average (ARIMA) and seasonal decomposition of time series (STL), can be applied to make short- and long-term forecasts.

Regression Analysis: Regression models are used to assess the relationship between carbon emissions and various predictors like economic indicators, population, energy consumption, and policy changes. Multiple regression, panel data regression, and logistic regression can be employed for different aspects of emissions forecasting.

Scenario Analysis: Scenario analysis involves constructing multiple hypothetical scenarios to predict emissions under different conditions. This method is particularly useful when considering the impact of different policy interventions or technological advancements.

Econometric Models: Econometric models, like the Environmental Kuznets Curve (EKC), explore the relationship between economic development and environmental pollution. These models can help forecast emissions based on economic growth

projections.

Machine Learning and Artificial Intelligence: Machine learning techniques, including neural networks, decision trees, and random forests, can be applied to model complex relationships in emissions data. They can be used to make forecasts based on historical emissions, economic data, and other relevant factors.

Integrated Assessment Models (IAMs): IAMs combine economic, energy, and environmental models to project future emissions under various scenarios. These models are often used to inform policy decisions and are crucial for long-term climate planning.

Carbon Budget Models: Carbon budget models estimate the remaining carbon emissions allowable to meet specific climate goals, such as limiting global warming to 1.5°C. They help track progress and determine how much carbon can be emitted in the future to stay within these limits.

Energy and Emission Inventories: National and regional emission inventories provide real-time data on emissions from various sources, which can be used to make short-term forecasts. These inventories are based on data collection and analysis from various sectors.

Environmental Impact Assessments: For specific projects or initiatives, environmental impact assessments can be used to forecast the emissions impact. These assessments consider the emissions associated with a proposed action, such as building a new power plant or implementing a transportation project.

Policy Analysis: Forecasting can also involve assessing the potential impact of various policy measures, such as carbon taxes, cap-and-trade systems, and renewable energy incentives, on future emissions.

Satellite and Remote Sensing Data: Remote sensing technologies and satellite data provide real-time monitoring of emissions, especially in sectors like deforestation, land use changes, and wildfires. These data sources can be used for near-term forecasting and trend analysis.

Stakeholder Input and Expert Judgment: In some cases, forecasting carbon emissions may also involve gathering input and insights from stakeholders, experts, and policymakers who have domain knowledge and expertise in specific sectors.

The choice of method often depends on the specific context and the time horizon of interest, as well as the availability and quality of data. In practice, a combination of these methods is often used to provide a more comprehensive and accurate picture of future carbon emissions. The below trend forecasting shows the CO2 emissions India is going to experience and generation of renewable energy in the coming decades.

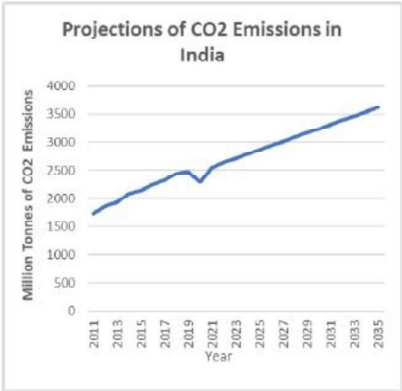

Fig.1 Projection of CO_2 emissions in India

3. Results and Discussion

The below results show the emissions of CO2 are though increasing but the generation rate of Renewable Energy is rapidly increasing year by year. The inferences can be drawn from the study is that India is focusing on more Renewable Energy generation and using biofuels, CNG, spending heavily on electrification of vehicles and making efforts for decarbonisation.

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The scope of this conference encompasses latest research outcomes pertaining to the "Energy" domain in the form of theoretical models, environmental impact, security and defense technology, innovative designs, enhancements and improvements in existing frameworks, sustainable technological advancement, societal welfare etc. Thus the conference intends to bring together the best minds from around the world to cover literally all aspects of energy technology from a multi-disciplinary perspective.

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