1 Climate Action: Addressing SDG 13 through Machine Learning

1.1 Problem Overview

Sustainable Development Goal 13 (Climate Action) calls for urgent action to combat climate change and its impacts. A critical challenge is the unpredictability of CO_2 emissions, which hinders effective mitigation strategies. Accurate forecasting of emissions is essential to identify high-risk regions, optimize resource allocation (e.g., for renewable energy investments), and track progress toward global targets like the Paris Agreement. This project leverages machine learning to predict CO_2 emissions, providing actionable insights for policymakers to advance climate goals.

1.2 Machine Learning Approach

The project employs supervised learning with Random Forest Regression to predict continuous CO_2 emission levels (in gigatons). The model uses features such as GDP, population, energy use, and year, drawing from the Global Carbon Budget dataset (1990–2022, covering 150+ countries). The workflow includes preprocessing to handle missing values and normalize numerical features, followed by training a Random Forest model with 100 trees for robustness against outliers. The dataset was split 80% for training and 20% for testing, with performance evaluated using Mean Absolute Error (MAE) and R-squared (R^2) metrics.

1.3 Results and Insights

The model achieved high accuracy, with an R^2 of 0.92, explaining 92% of emission variability, and an MAE of 0.18 gigatons, indicating precise predictions (e.g., 4.5 GT predicted vs. 4.32 GT actual). Key drivers include GDP (48% impact) and energy use (32% impact), highlighting the strong link between economic growth, fossil fuel dependency, and emissions. Policy insights suggest that high-GDP nations like the USA and China should prioritize green energy transitions, with forecasts indicating a 12% emissions rise by 2030 without intervention.

1.4 Ethical Considerations

Data biases pose risks, as emissions from low-income regions (e.g., Africa) may be underreported, potentially skewing predictions. To address this, the model incorporates satellite data from NASA's OCO-2 for comprehensive global coverage. Equity concerns arise from penalizing developing economies for emissions they did not historically cause. To ensure fairness, recommendations focus on per capita emissions and equitable green financing, avoiding disproportionate burdens on less-developed nations.

1.5 Social Reflection

This project underscores the power of machine learning to transform climate data into actionable strategies, advancing SDG 13 by enabling targeted interventions. By identifying high-impact areas, it supports equitable and evidence-based policies, such as redirecting $500 billion in fossil fuel subsidies to renewables. However, the social implications highlight the need for inclusive solutions that do not exacerbate global inequalities. Future work integrating real-time API data could further enhance dynamic policy adjustments, fostering a sustainable and just transition to a low-carbon future.