Introducing Advanced Comparative Life Cycle Assessment for Evaluating Environmental Conditions and Carbon Opportunity Costs of Energy Production Facilities

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Academics

- Bachelor of Science (BS), Columbia University
- Master of Science (MS), Stanford University

Recent Research

- Smart Toilet
- Thermal Storage & Energy Efficiency on Microgrid
- NewYork City Energy Management Project

Recent Achievements

- 2023 Smart Toilet Research: Ignoble Prize
- Patent on Smart Toilet System with Automatic Stool Collection

Research of Interest

[1] Transitioning from fossil fuels to renewable energy

[2] Development of new energy forms

[3] Comparative life-cycle assessment in energy production

Introduction / Motivation

Global Climate Concerns

The United Nations Framework Convention on Climate Change (UNFCC) has been instrumental in addressing global climate concerns. The consensus set ambitious goals to triple the global renewable energy supply and double energy use efficiency, propelling the world towards a carbon net-zero future by 2050.

Traditional LCA Limitations

Traditional LCA methodologies often miss regional environmental variations like solar irradiance and wind speed, which can lead to inaccurate emission assessments.

Enhanced Approach

The Advanced Comparative Life Cycle Assessment model incorporates distinct environmental factors to provide more precise quantification of impacts. it is essential to consider both the resources expended and the external environmental factors.

Background Information / Related works

Wind Power

Carbon emission of wind power to be 5 – 9g of CO_2/kWh; yet, no differentiations were given either onshore or offshore. wind power suggests a carbon emission rate of approximately 6 g of CO_2/kWh. However, even such studies seldom consider variables such as water depth and wind speed within their life cycle assessment.

Solar Power

Solar power installations, the variability in radiation leads to uncertainty on the unit price and power production per unit of carbon emission.

The absence of comprehensive data will result in substantial inaccuracies in the quantification of such actual carbon emissions

Proposed Method

Python-Based LCA Model for Environmental Impact

Model Foundation

The Python-based LCA model processes inputs such as the location of renewable energy facilities and their specific characteristics.

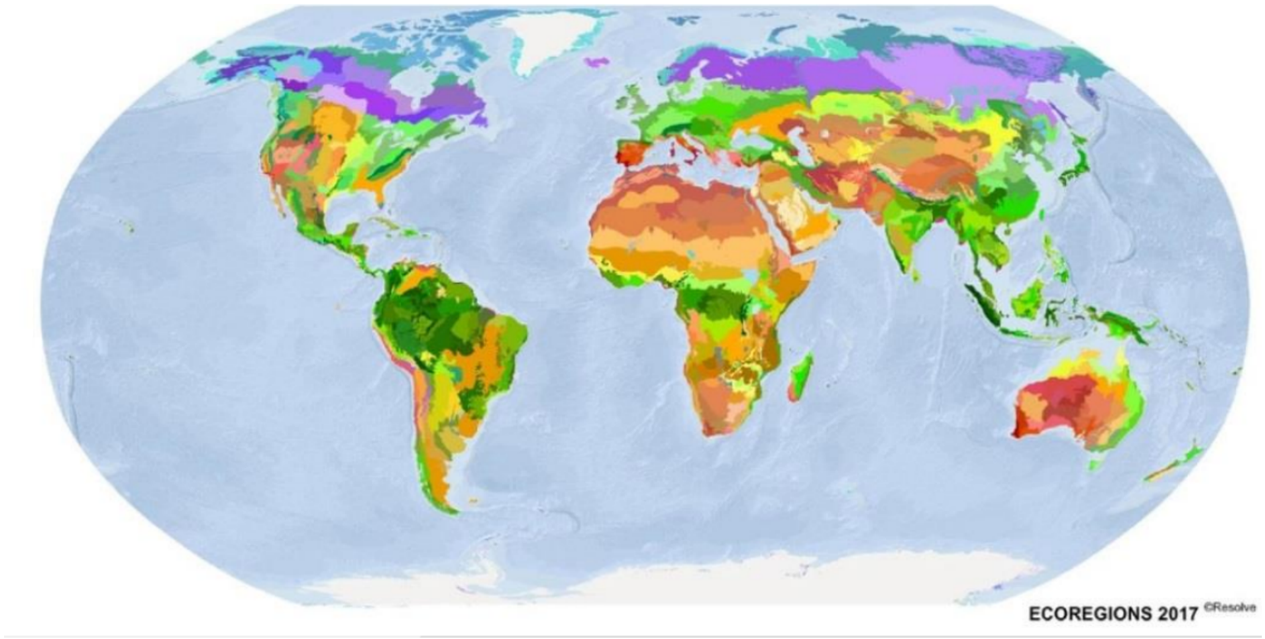
Data-Driven Analysis

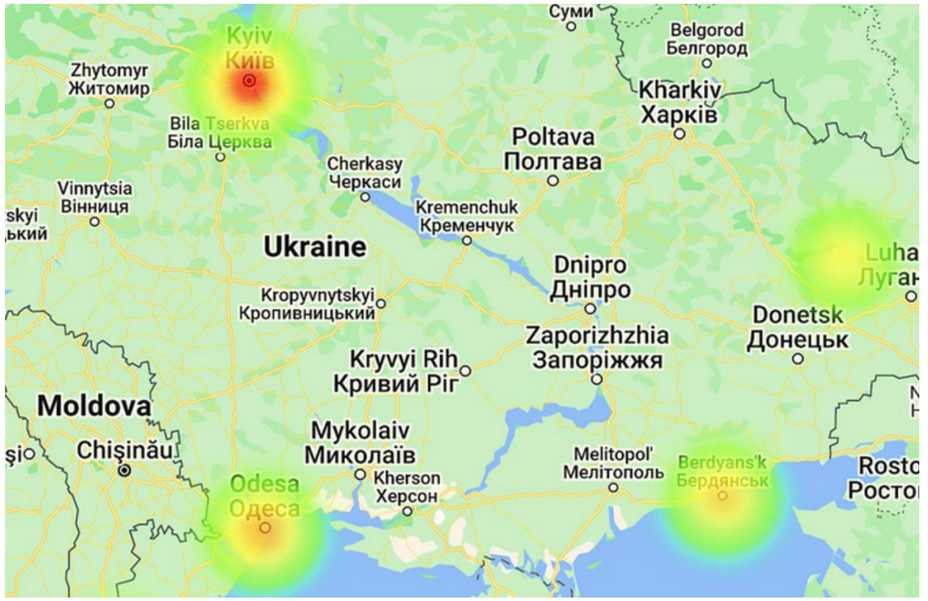
Utilizing Korean public datasets, the model updates environmental factors like wind speed and solar irradiance based on location.

Comprehensive Assessment

Considering a 20-year lifespan, the model provides a detailed environmental impact analysis of renewable energy projects.

Proposed Method





(Ku et al, 2022)

Collect regional environmental variations to calculate the LCA factors

ex) Solar irradiance-average, water depth, and wind speed

Expected Results

1

Accessible Information

The model aims to make environmental impact data accessible to a broader audience, facilitating informed decision-making.

2

Business Sector Benefits

Companies in the renewable energy sector can use the model to improve the efficiency and carbon emissions of their energy production processes.

3

Empowering P2P power transaction

General users gain the ability to select electricity generators based on simple carbon emission values, promoting sustainable development.

Future Work

1. **Expansion of the comparative life cycle assessment model**

   Expanding and enhancing AI models for global application and integration with emerging technologies.

2. **Educational initiatives and stakeholder engagement**

   Promoting clean energy policies and educational awareness through research outcomes.

3. **Comprehensive environmental impact studies**

   Investigate the environmental impact of facility installations, focusing on biodiversity, water, and land use.

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