# Prototype Overview – Energy Development Index (EDI)

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## Overview

This prototype was developed as an early-stage model to explore how satellite-derived indicators and socioeconomic data can assess relative electrification performance across geographies. The current version is a simplified proof of concept, laying a conceptual and technical foundation for a more advanced tool. Future extensions could integrate higher-resolution data and predictive modeling to support actionable insights for energy planning and investment.

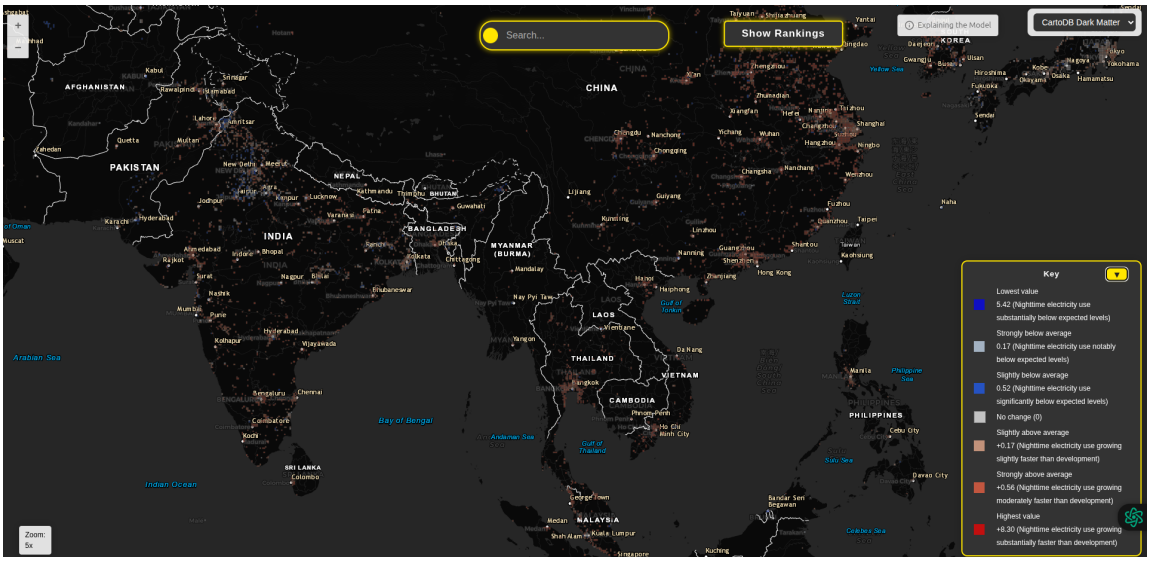


Figure 1: Prototype map interface showing $\Delta EDI$ across South and East Asia. Color scale indicates nighttime electricity use relative to expected levels based on population and GDP per capita.

**View Interactive Prototype Here**

## Potential Applications

The Energy Development Index provides a geospatial decision-support layer that can drive sustainable growth and energy transition efforts. Three primary applications are outlined below:

### 1. Target Emerging Markets for New Energies

The EDI highlights regions where energy access remains limited but economic indicators suggest latent demand. This enables organizations to:

- Prioritize countries or subnational regions for renewable energy investments (solar, wind).
- Support site selection for decentralized microgrids in off-grid communities.
- Quantify potential market size for energy access products and services, aiding planning and stakeholder engagement.

### 2. Support LNG and Energy Infrastructure Strategy

The EDI can inform downstream energy strategies by:

- Identifying high-growth regions where LNG imports could displace coal and bridge energy gaps.
- Supporting strategic decisions on infrastructure placement and investment in emerging economies.
- Guiding targeted B2B marketing efforts towards governments and utilities in countries with rising energy demand but underdeveloped grid infrastructure.

### 3. Enable Energy Transition Planning

The EDI acts as a geo-socioeconomic tool for strategy and policy teams by:

- Prioritizing geographic regions where clean energy investments would achieve the highest socio-economic impact.
- Supporting alignment with sustainability goals (Net Zero targets, UN SDG 7).
- Providing an evidence base for ESG reporting and enhancing narratives on delivering energy equity.

## Conceptual Foundation

The Energy Development Index (EDI) estimates the relative intensity of energy development in a geographic unit by combining:

- **Nighttime light intensity** ($L_t$) – proxy for aggregate electricity use.
- **Population count** ($P_t$) – proxy for number of potential energy consumers.
- **GDP per capita** ($G_t$) – proxy for economic capacity to demand energy.

The core insight is that electricity consumption depends not only on population but also on the economic capacity of inhabitants.

## Mathematical Formulation

For a given tile $t$ at time $t$:

$$EDI_t = \frac{\log(L_t)}{\log(P_t)} \cdot \log(G_t)$$

Where:

- $\log(L_t)/\log(P_t)$: Aggregate electricity use relative to population size.
- $\log(G_t)$: Amplifies demand potential based on economic capacity.

This formulation highlights zones where economic growth could unlock latent demand versus where demand is already saturated.

## Temporal Dynamics: $\Delta EDI$

Change in EDI over time ($\Delta EDI$) provides insight into how electrification evolves:

- **Positive** $\Delta EDI$: Electricity use outpaces population and GDP growth $\rightarrow$ rapid electrification.
- **Negative** $\Delta EDI$: Electricity use lags $\rightarrow$ possible infrastructure gaps or persistent energy poverty.

## Map Interpretation and Key

The prototype map visualizes $\Delta EDI$ using a color-coded scale:

- **Blues**: Nighttime electricity use below expected levels.
- **Reds**: Nighttime electricity use growing faster than expected.
- **Grey**: Areas showing minimal change.

This contextual representation supports identification of regions for:

- Grid-scale investment and electrification initiatives.
- Decentralized energy solutions in persistently underdeveloped areas.
- Demand-side management in high-income zones showing negative $\Delta EDI$.