Prototype Overview – Energy Development Index (EDI)

David Clements 23/07/2025

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.

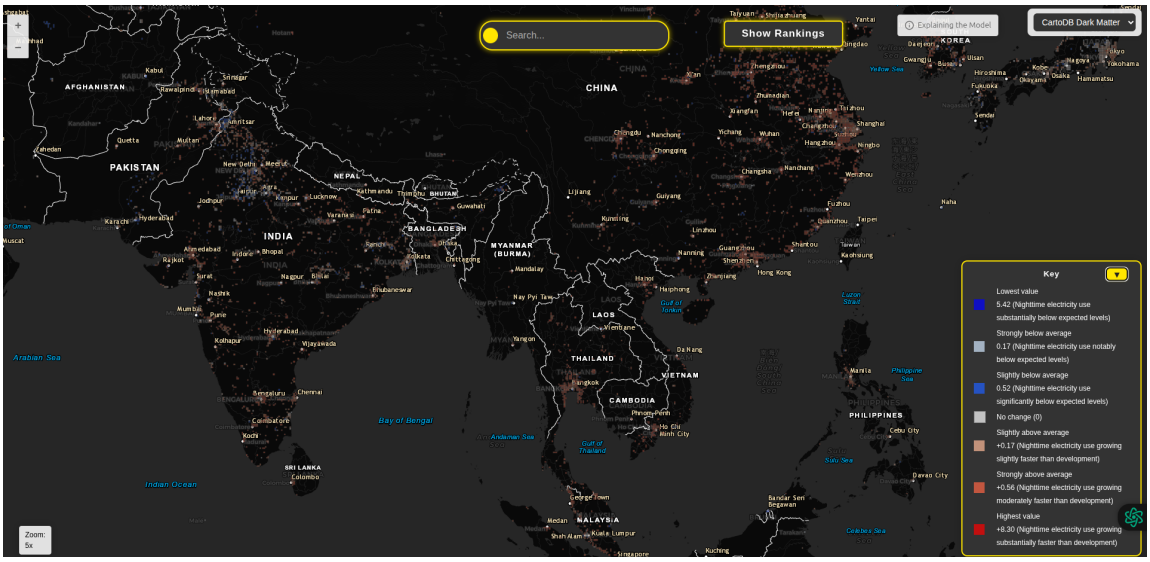

Figure 1: Prototype map interface showing ΔEDI across South and East Asia. Color scale indicates nighttime electricity use relative to expected levels based on population and GDP per capita.

View Interactive Prototype Here

Potential Applications in Shell

The Energy Development Index provides a geospatial decision-support layer that aligns with Shell's strategy to drive sustainable growth and energy transition. 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 Shell New Energies to:

- Prioritise countries or subnational regions for renewable energy investments (solar, wind).
- Support site selection for decentralized microgrids in off-grid communities, aligning with Shell's initiatives in Sub-Saharan Africa and South Asia.
- Quantify potential market size for energy access products and services, aiding commercial planning and stakeholder engagement.

2. Support LNG Growth Strategy

With Shell as a global leader in LNG marketing and trading, the EDI can inform downstream strategy by:

- Identifying high-growth regions where LNG imports could displace coal and bridge energy gaps.
- Supporting strategic decisions on regasification terminal 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 Shell's Projects Technology and corporate strategy teams by:

- Prioritising geographic regions where Shell's clean energy investments would achieve the highest socio-economic impact.
- Supporting alignment with corporate sustainability goals (Net Zero by 2050, UN SDG 7).
- Providing an evidence base for ESG reporting and enhancing Shell's stakeholder narrative 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: ΔEDI

Change in EDI over time (ΔEDI) provides insight into how electrification evolves:

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

Map Interpretation and Key

The prototype map visualizes ΔEDI 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 ΔEDI.