TransitionZero

TransitionZero

FOSS4G - 4FEO

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Empowering our partners with open data products to shape a clean energy future

We are a climate analytics not-for-profit established in 2021. We build **open** energy transition products without usability barriers and **partner** with mission-aligned organisations and initiatives to help **scale** a global standard for energy transition planning data.

What is energy systems modeling?

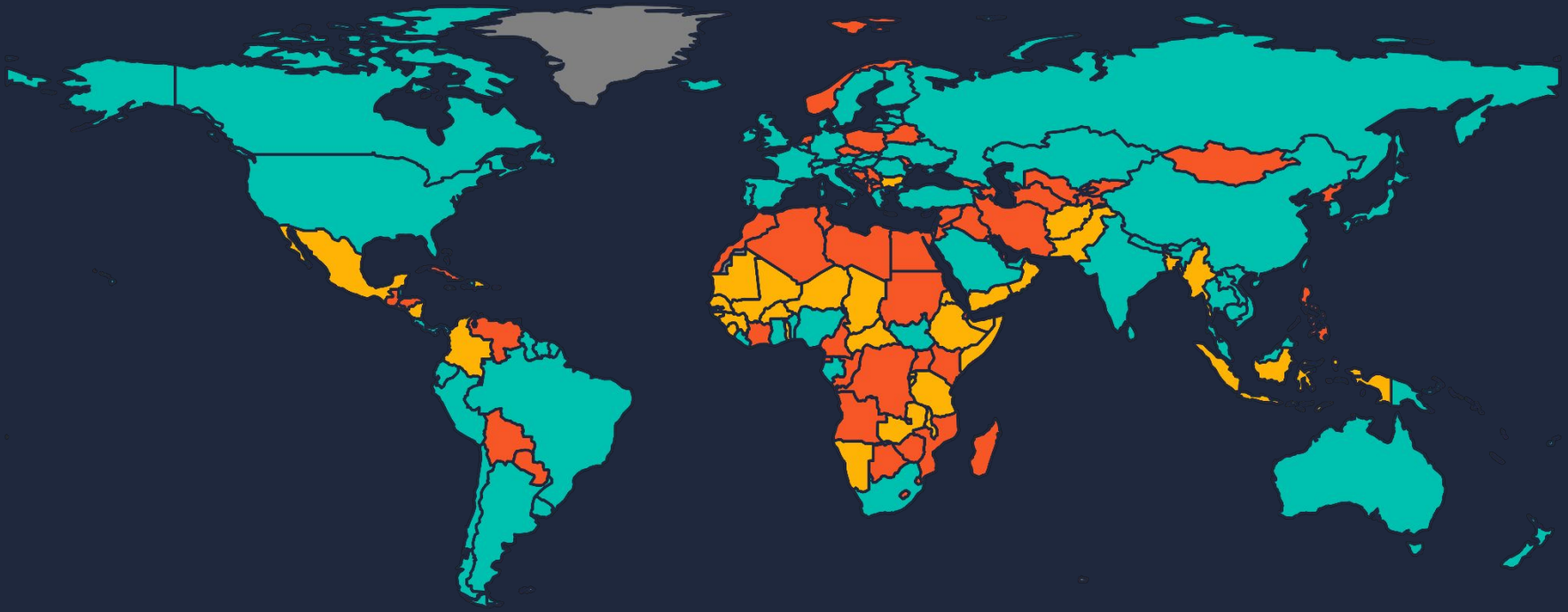
Energy Systems Modelling relates to the overall **design** and **operation** of the energy system.

- What are our **energy needs**?
- What **infrastructure** do they require?
- **Where** should it go?
- How much will it **cost**?

The answers to these questions affect **trillions of dollars** of spending per year around the world.

Net zero ambition

Most of the world now has pledged to be net zero



Coverage of Global Emissions: 75% 80%

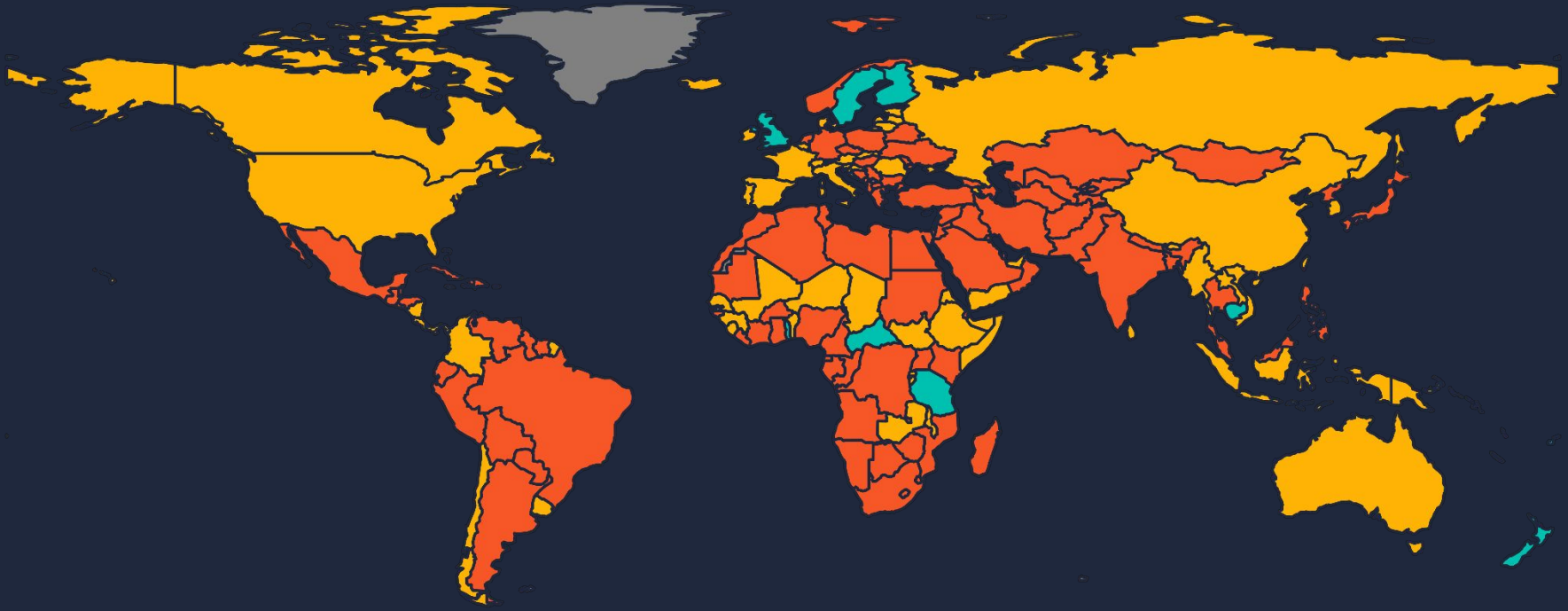
Coverage of Global Population: 66% 84%

Implemented Policy[1] Proposed Policy[2] No Ambition[3]

Data from Net Zero Scorecard (2023) Energy & Climate Intelligence Unit:
[1]: "Declaration/pledge", "In Policy Document", and "In Law" categories; [2]: "Proposed/In Discussion" category; [3]: No data

Ambition-to-action gap

Most countries do not have a credible net zero plan



Data from Net Zero Scorecard (2023) Energy & Climate Intelligence Unit

Growing need for transparency

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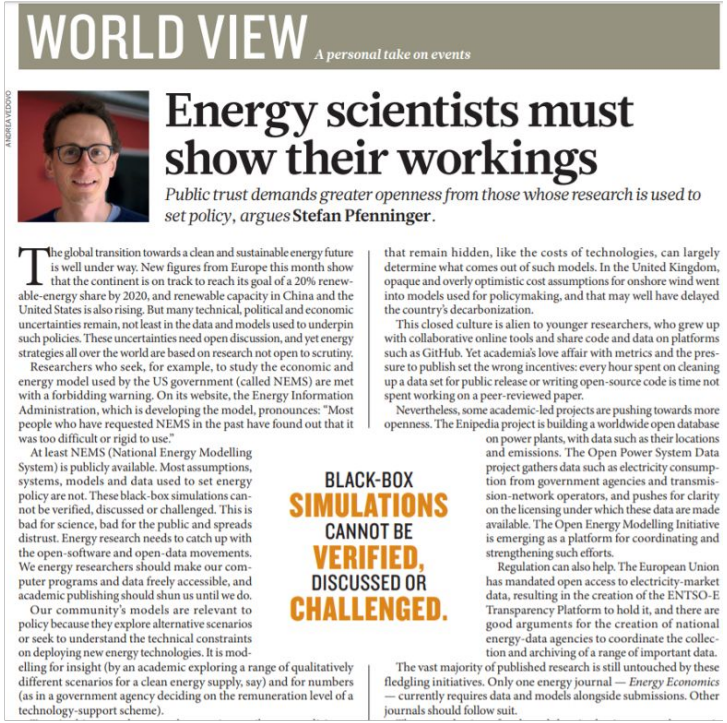
Credibility of EU energy review questioned

Pilita Clark NOVEMBER 6 2011 2

The credibility of a European energy review has been cast into doubt by experts who point out that long-term plans to cut carbon emissions are based on an economic model owned by a single Greek university that cannot be independently scrutinised.

Experts have "raised a host of questions" about how the European Commission's use of a non-transparent model could affect the energy review, according to a leaked report by energy specialists chosen by Brussels to advise on the forthcoming "Energy Roadmap to 2050".



WORLD VIEW *A personal take on events*

ANGELA VEDOVO

Energy scientists must show their workings

Public trust demands greater openness from those whose research is used to set policy, argues **Stefan Pfenninger**.

The global transition towards a clean and sustainable energy future is well under way. New figures from Europe this month show that the continent is on track to reach its goal of a 20% renewable-energy share by 2020, and renewable capacity in China and the United States is also rising. But many technical, political and economic uncertainties remain, not least in the data and models used to underpin such policies. These uncertainties need open discussion, and yet energy strategies all over the world are based on research not open to scrutiny.

Researchers who seek, for example, to study the economic and energy model used by the US government (called NEMS) are met with a forbidding warning. On its website, the Energy Information Administration, which is developing the model, pronounces: "Most people who have requested NEMS in the past have found out that it was too difficult or rigid to use."

At least NEMS (National Energy Modelling System) is publicly available. Most assumptions, systems, models and data used to set energy policy are not. These black-box simulations cannot be verified, discussed or challenged. This is bad for science, bad for the public and spreads distrust. Energy research needs to catch up with the open-software and open-data movements. We energy researchers should make our computer programs and data freely accessible, and academic publishing should shun us until we do.

Our community's models are relevant to policy because they explore alternative scenarios or seek to understand the technical constraints on deploying new energy technologies. It is modelling for insight (by an academic exploring a range of qualitatively different scenarios for a clean energy supply, say) and for numbers (as in a government agency deciding on the remuneration level of a technology-support scheme).

BLACK-BOX SIMULATIONS CANNOT BE VERIFIED, DISCUSSED OR CHALLENGED.

that remain hidden, like the costs of technologies, can largely determine what comes out of such models. In the United Kingdom, opaque and overly optimistic cost assumptions for onshore wind went into models used for policymaking, and that may well have delayed the country's decarbonization.

This closed culture is alien to younger researchers, who grew up with collaborative online tools and share code and data on platforms such as GitHub. Yet academia's love affair with metrics and the pressure to publish set the wrong incentives: every hour spent on cleaning up a data set for public release or writing open-source code is time not spent working on a peer-reviewed paper.

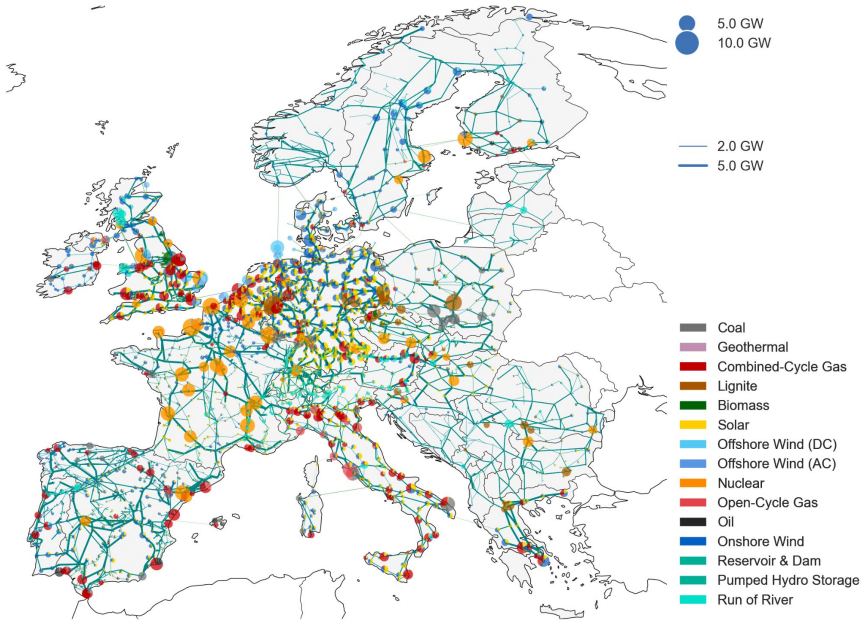
Nevertheless, some academic-led projects are pushing towards more openness. The Enipedia project is building a worldwide open database on power plants, with data such as their locations and emissions. The Open Power System Data project gathers data such as electricity consumption from government agencies and transmission-network operators, and pushes for clarity on the licensing under which these data are made available. The Open Energy Modelling Initiative is emerging as a platform for coordinating and strengthening such efforts.

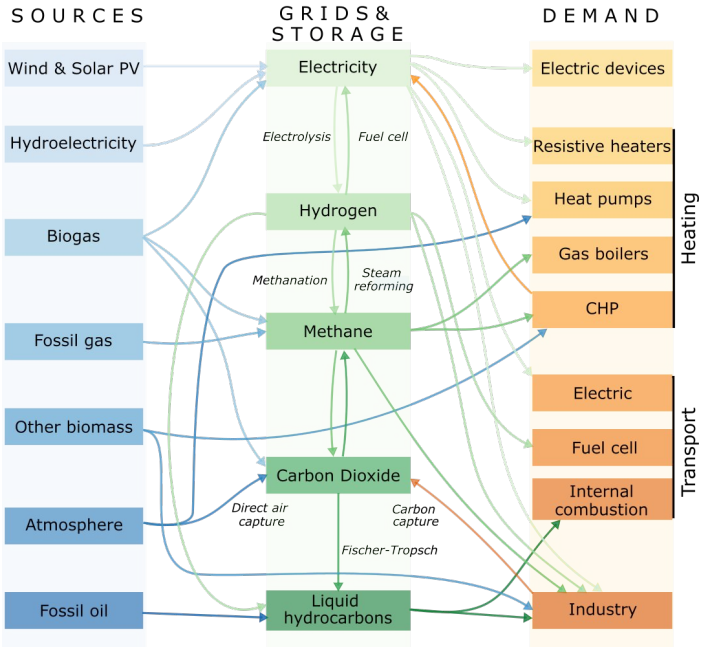
Regulation can also help. The European Union has mandated open access to electricity-market data, resulting in the creation of the ENTSO-E Transparency Platform to hold it, and there are good arguments for the creation of national energy-data agencies to coordinate the collection and archiving of a range of important data.

The vast majority of published research is still untouched by these fledgling initiatives. Only one energy journal — *Energy Economics* — currently requires data and models alongside submissions. Other journals should follow suit.

Data: many components and interactions

Need to model (at least): enough spatial and temporal detail to capture all important effects; all interactions between energy sectors; correct physics.





Source: PyPSA-Eur: A Sector-Coupled Open Optimisation Model of the European Energy System, https://pypsa-eur.readthedocs.io/en/latest/

Capacity not dependency

Future Energy Outlook (FEO) is an accessible and auditable data, model and tool platform

Data Sources

Web-scraping market and generation data

Satellite data & machine learning for asset properties and activity

Local partners & TZ analysts for data quality and completeness

Modelling Suite

Capacity expansion for planning and investment

Grid dispatch for pricing and operations

Materials and impacts of the energy transition

Platform Layer

Federated access to numerical solvers

API Backbone for scalability

Single-entrypoint authentication

Interfaces

Web app for exploring, sharing, and creating analysis

Blogs & reports with TZ flagship analysis

Python client for programmatic access

Indonesia MVP

We published a MVP for Indonesia in June, which supports an unparalleled spatial and temporal capacity expansion model in an accessible UI

34 nodes modelled for Indonesia

Hourly temporal resolution

Auditable and **replicable** model environment

Source: TransitionZero (2023) https://feo.transitionzero.org/

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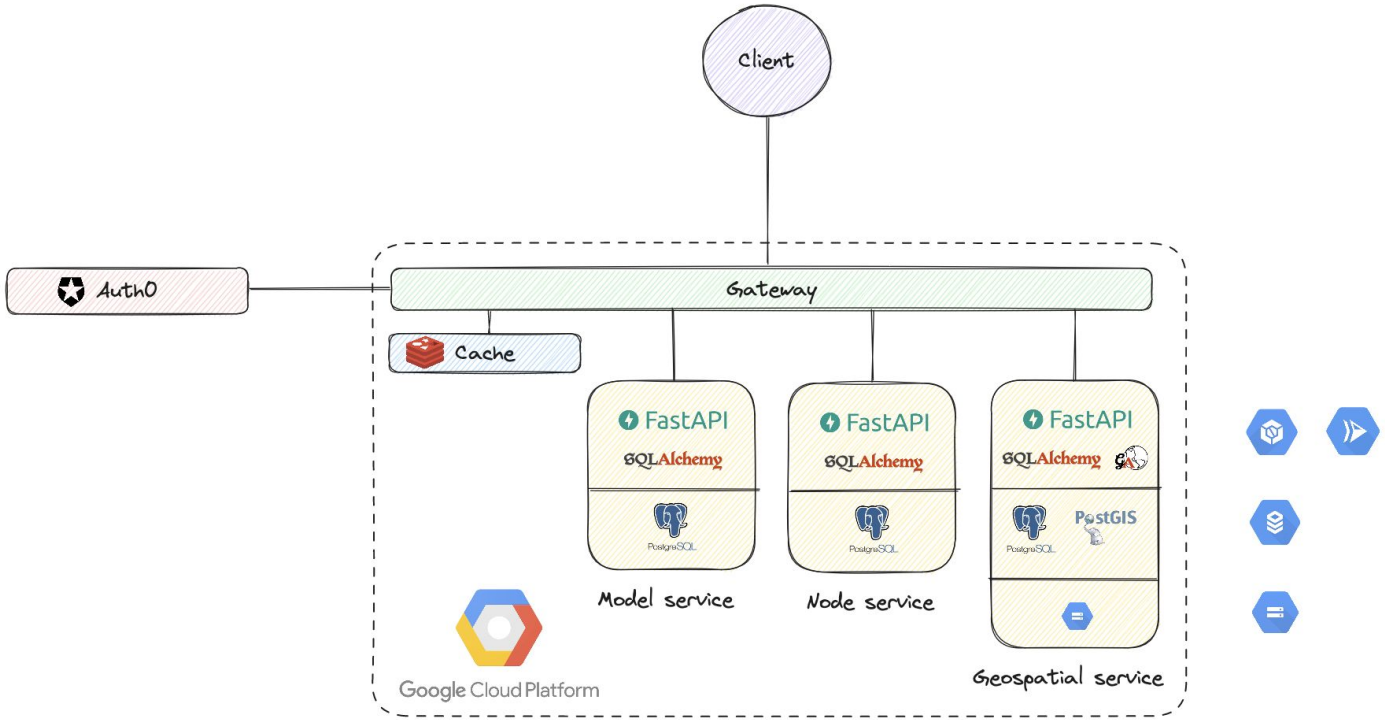
FEO Microservice Architecture

Service Overview



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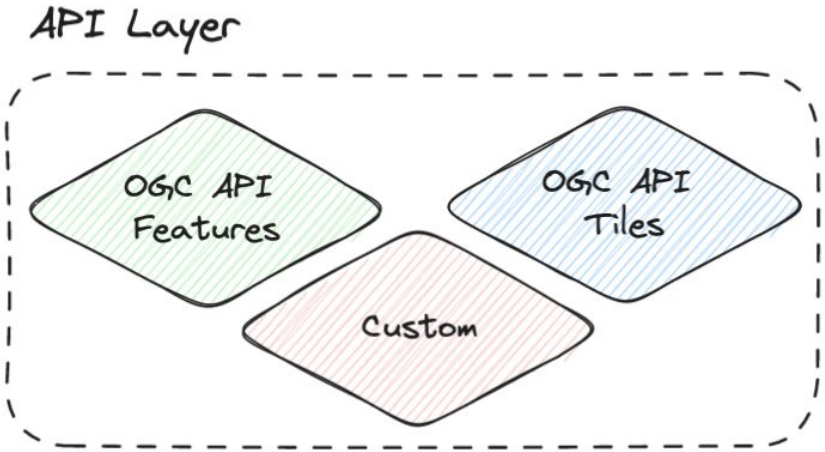
FEO Microservice Architecture

Geospatial API

- MVP: CRUD operations for vector and raster data
    - Custom code, custom spec
- Implementing OGC API - Features and Tiles
    - RESTful so integrate seamlessly with our current APIs!
- FastAPI + OGC APIs
    - Shoutout to DevelopmentSeed's excellent TiPG project!
- We need to work on fine-grained auth for some resources
- We require all CRUD operations (OGC API - Features - Part 4), not just GET



TransitionZero STAC

- Uses our COGs in cloud storage
- Uses STAC Spec so accessible via the pystac-client.
- Collections of Earth Observation, Meteorological, ML output data
- Front end (currently internal facing) created using RadientEarth's stac-browser project
    - Easy for team to search and browse our raster data
- Aiming to provide our open data via public STAC

TransitionZero ML

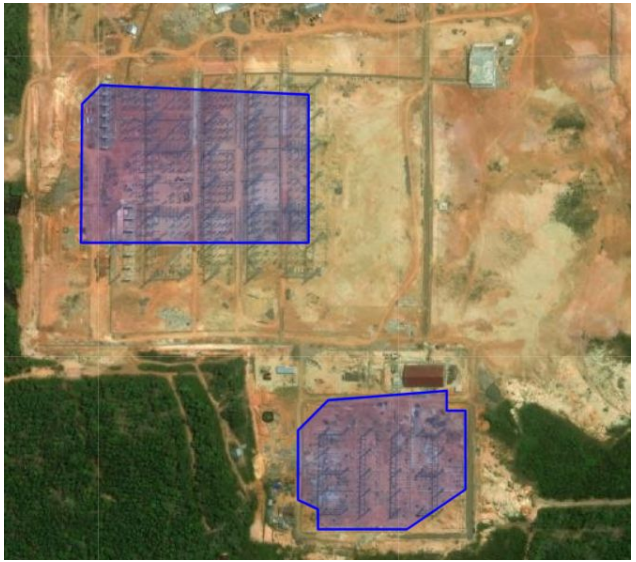
Solar Plant Detection

- Existing asset-level databases of solar plants are incomplete.
- Installations of 1MW and above are distinguishable in free, global satellite datasets.
- Automatic detection of plants gives FEO access to solar capacity data that is
    - More up-to-date
    - More spatially accurate
    - More complete
- More accurate capacity data → more accurate systems modelling

TransitionZero ML

Power Grid Enhancement

- Existing energy systems models rely on OpenStreetMap for grid line and substation data.
- This data is often incomplete, especially in Asia.
- Errors in the data are common and standard data cleaning leads to data loss.
- Our suite of grid data enhancement tools can be used to
    - Discover new high-voltage substations
    - Infer missing or broken power lines
- More accurate grid data → more accurate systems models



Large transmission substations are also visible in satellite data. We find 22 not currently mapped in OpenStreetMap.

The Future

- Monthly tech blogs (https://transitionzero.medium.com)
- Aiming to launch platform at COP28 (November 30th)
- Open source python client (WIP)
  - Access to our data
  - Ability to run models
  - Ability to interrogate model results
  - Open data available
- Other open source offerings (https://github.com/transition-zero)
- More FEO! (https://feo.transitionzero.org)

Summary

- FEO is FOSS all the way down!
- Built upon incredible work from the FOSS4G community
- OGC APIs have enabled us to seamlessly integrate FOSS4G in our RESTful microservice architecture.
- We are users of our product too! Eating our own dog food!
- We are building FOSS
    - Open platform
    - Open data
- Excited to be part of the FOSS and FOSS4G communities
- Eager to collaborate and contribute!

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