Framework for an Open-Source Life Cycle Baseline for Electricity Consumption in the United States

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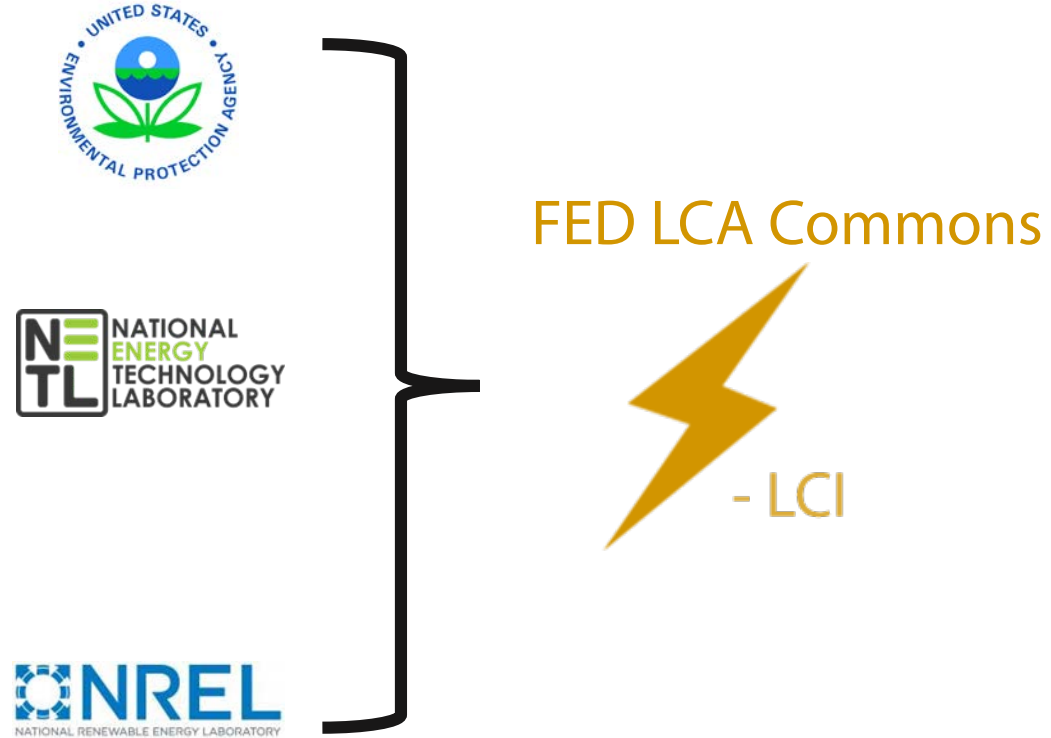
Attribution

Background
From independent to collaborative
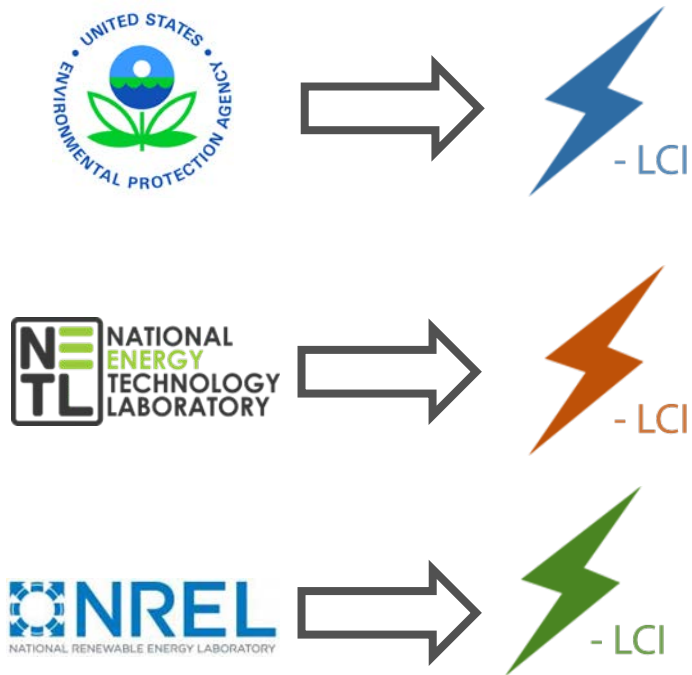
The way of the past….

The way of the present and future.

Development of Electricity LCI Data
## for the Federal LCA Commons

- **Goal**
  - provide regionalized LCI datasets for US electricity production and distribution based on collaborative input from EPA, NREL, NETL and other federal agencies
- **Strategy**
  - Combine EPA data with data for power generation and associated upstream activities prepared by the NETL and others.

  - Use only publicly available data sources

  - Use data science methods to automate data source processing and LCI creation

  - Maintain clear connections to original data sources

  - Use Federal LCA Commons standards to format the LCI and platform to distribute the LCI

Electricity LCI Model
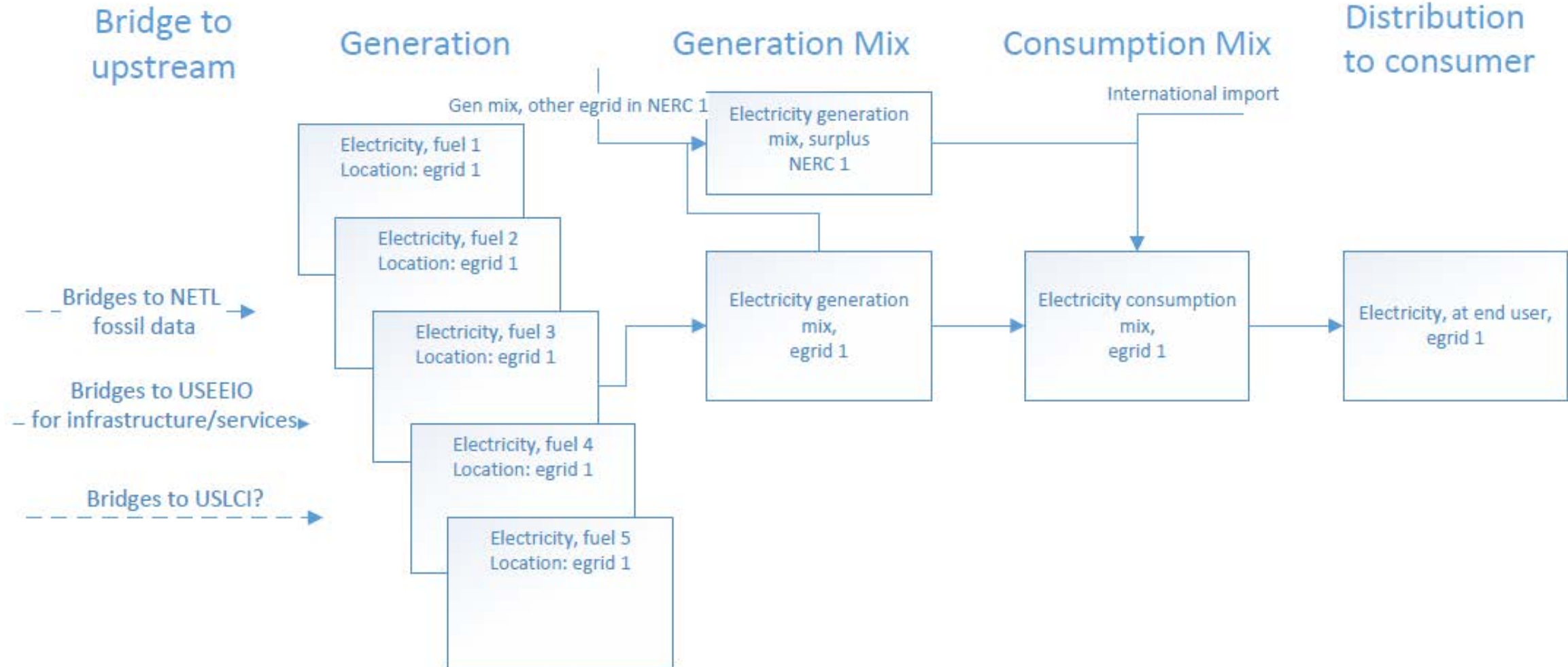
Electricity Consumption

- Data-driven consumption inventories based on FERC Form 714 data
- Included imports and exports for Canada and Mexico and surplus and deficits within eGRID regions
- Three main steps
  - determining which eGRID regions generate surplus electricity and which regions have a deficit
  - creating NERC region surplus supply pools to contribute to eGRID region consumption regions with electricity deficit
  - Generating OpenLCA formatted datasets

- **Open Source Framework**
  - OpenLCA

- **Multifunctional Platform**
  - Comprehensive Environmental Coverage
  - Disaggregation by Feedstock, Technology, and Performance
  - Scenario Analysis

- **Multiple Spatiotemporal Scales**
  - Geographic Resolution
    - NERC/eGRID Subregions
    - Aggregate U.S.
  - Temporal Resolution
    - Historical coverage
    - Forecasting

Source: https://www.openlca.org

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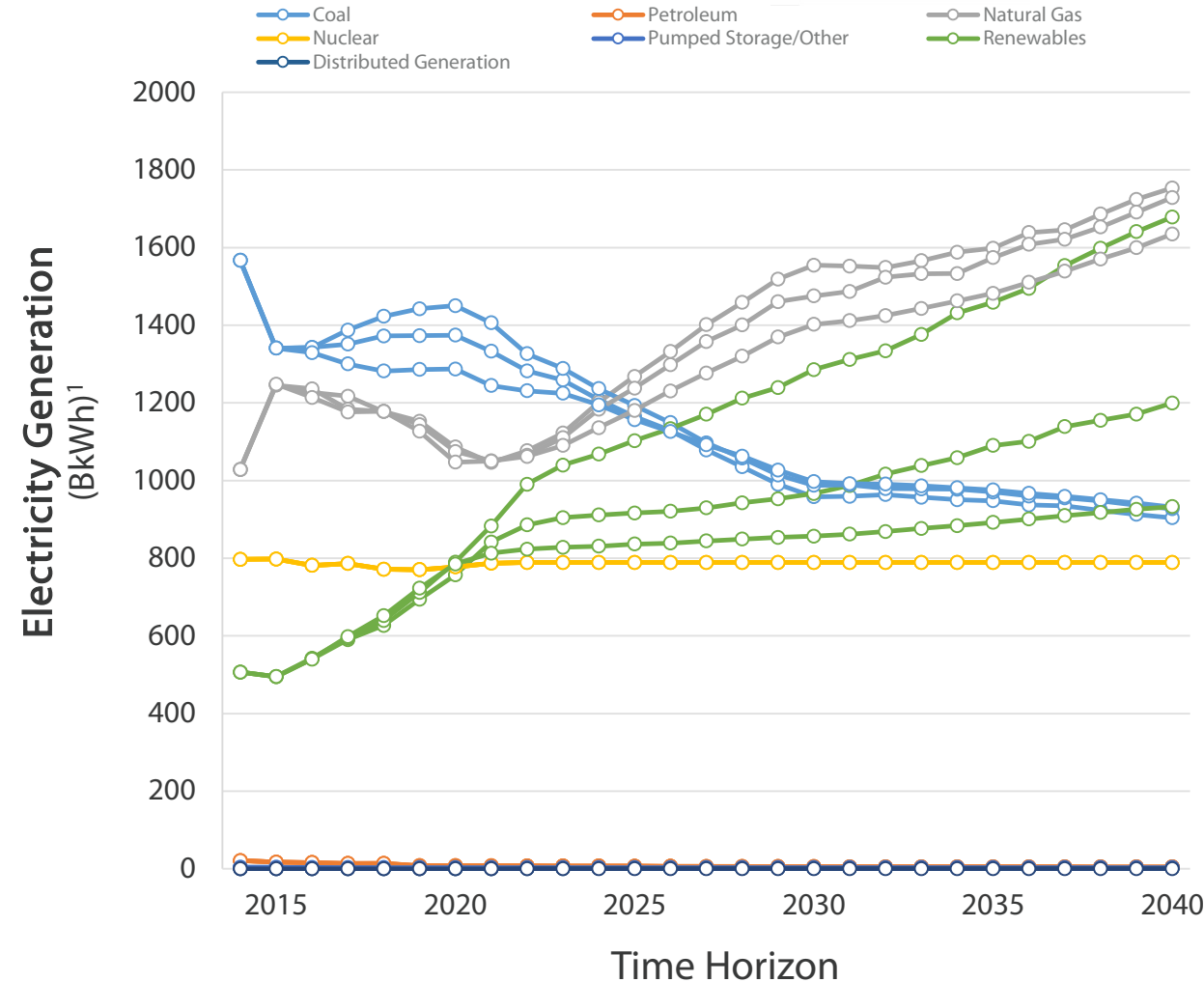 - Temporal Resolution
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[1]Source: Energy Information Administration (EIA) Annual Energy Outlook

Introduction

- Open Source Framework
  - OpenLCA
- Multifunctional Platform
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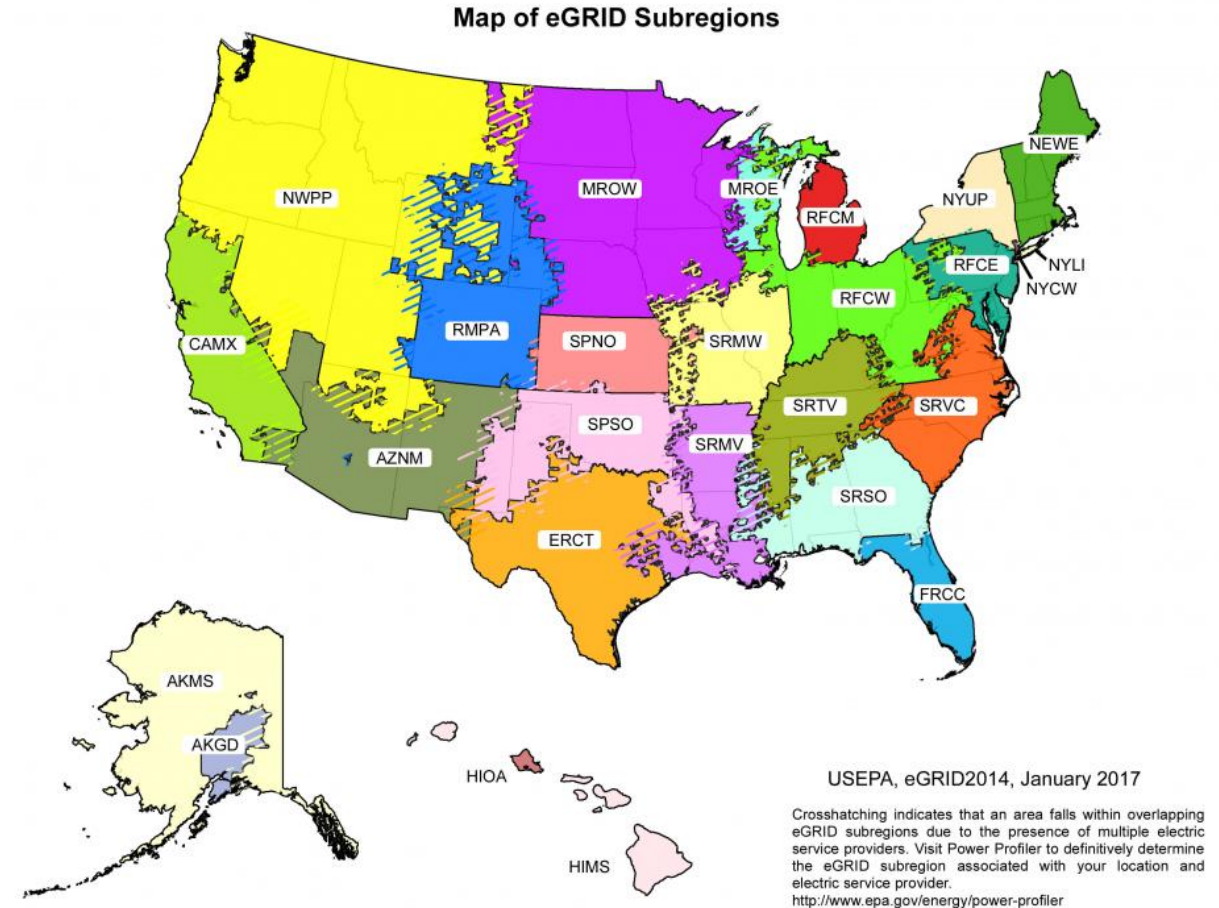 - Temporal Resolution
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Map of eGRID Subregions

USEPA, eGRID2014, January 2017

Crosshatching indicates that an area falls within overlapping eGRID subregions due to the presence of multiple electric service providers. Visit Power Profiler to definitively determine the eGRID subregion associated with your location and electric service provider.
http://www.epa.gov/energy/power-profiler

Phase 2
Introduction

- Open Source Framework
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Legend

1. eGRID subregions are encoded by color
2. Ribbon size indicates magnitude of flow
3. Ribbon ends are colored by trade origin
4. White gap between ribbon ends represent *exporter*
5. Tabulates magnitude and relative percentage of flows
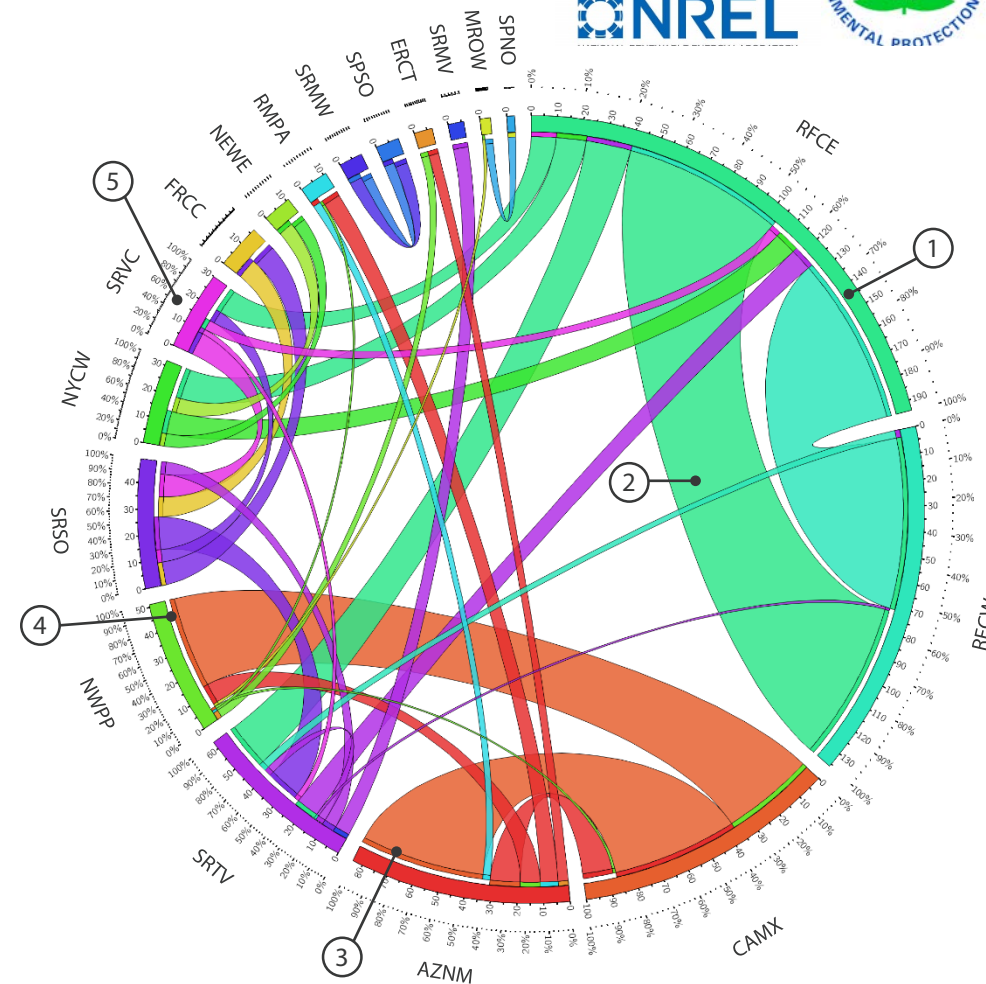
Estimated 2014 U.S. Electricity Trade by eGRID Subregion (TWh)
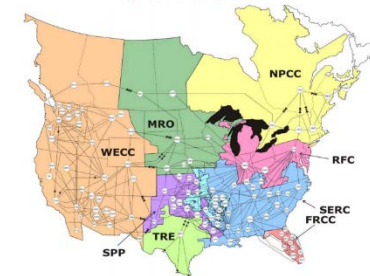
Model Framework

- **U.S. Electricity Baseline**
  - **Historical:** Time series analysis of the environmental footprint of U.S. electricity
  - **Current:** A static description of the environmental footprint of the U.S. electricity mix in the current year.
  - **Projections:** Anticipated environmental profile of U.S. electricity

Power plant Scale

Balancing Authority Area
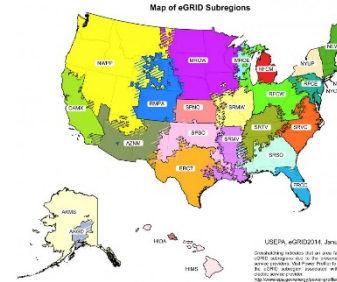
NERC / eGRID Subregion

Aggregate U.S. Scale
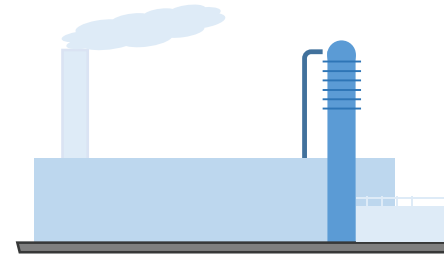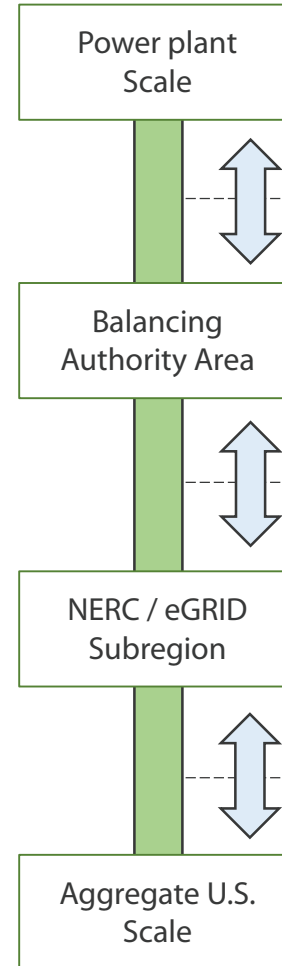
**Category:** Petroleum, Natural Gas, Coal, Nuclear, Hydro, Wind, Solar, Geothermal, Biomass
Function: Baseload, Cycling, Load Following, Peaking

Interregional Electricity Trade: Mapping of electricity imports/exports, accounting for international trade with Mexico and Canada, as well as transmissions losses.

NERC & eGRID Subregion: Environmental impacts of electricity generation and consumption for North American Electricity Reliabiltiy Corporation (NERC) and eGRID subregions
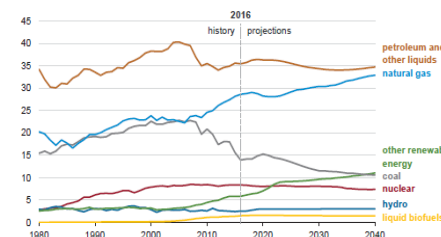
U.S. Electricity Baseline: A static description of the environmental footprint of U.S. electricity in the current year.

Future Work

Phase 3

- **Spatial Mapping**
  - Geographic Information Systems (GIS)
- **Sustainability Indicators**
  - Thermodynamic Metrics
  - Water Indicators
    - Water Scarcity
- **Consequential Effects**

Multiphase Interagency Collaboration
Project Timeline and Outcomes

- **Phase I**
  - Develop an open-access framework capable of quantifying the life cycle environmental impacts and resource intensity of U.S. electricity
    - Outcomes:
      - Transfer of existing energy generation profiles into a multifunctional open-access framework
      - Development of a U.S. Electricity trade model
      - National environmental profile of U.S. consumptive electricity mix
    - Timeline: Spring 2018

- **Phase II**
  - Expand the functionality and modularity of Phase I
    - Outcomes
      - Comprehensive environmental coverage of U.S. electricity consumption
      - Environmental profile of electricity at multiple geospatial scales
      - Capacity to drill down into modeled supply chains
      - Scenario analysis (e.g. changes to feedstock, technology, performance characteristics, etc.)
      - Forecast the environmental footprint of electricity generation
    - Timeline: Fall 2019

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https://www.nrel.gov/analysis/sustainability_analysis.html

https://www.epa.gov/saferchoice/design-environment-life-cycle-assessments