# Alaskan Community Ontology

**Describing elements of the Alaska Energy Data Gateway (AEDG)**

Liz Dobbins

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# 1 Alaskan Community Ontology

Describing elements of the Alaska Energy Data Gateway (AEDG)

## 1.1 Welcome

This repository aims to support needed conversations regarding a foundational element of Alaska Energy Data Gateway (AEDG): the creation of derived aggregates of socio-economic and energy data at upper levels such as administrative regions and grids.

To accomplish the computation of these aggregates in a reproducible way, a cross-walk between conceptual groupings of communities is required. This conceptual model will be applicable to diverse types of data. It will also guide the development of the algorythms that compute the aggregations and convert between them.

If possible, this cross-walk will be machine readable/actionable. But to establish with consensus between our various subject matter experts, we need to start with a single set of definitions and axioms (rules) expressed in a human readable form. This could happen in a wiki, but we should maintain a record of revisions so we can document discussions and final recommendations. The best format for this process is a GitHub repo.

## 1.2 Goal

To provide a basis for tranformation of data provided at different scales so that multiple groupings can be displayed on AEDG dashboards.

This is required because data will provided at different scales. For instance:

- Because of interties, electricity is not always reported by individual communities.
- Some ways of avoiding personally identifiable information (such as for building footprints) involve reporting by zip code.
- Existing analysis such as [somebody's] energy burden data is reported at census tract level.

Also, different audiences need data reported at different scales:

- Communities want a summary of their own data.
- Legislative Aides want summaries by legislative district.
- Agency leads might want to compare PCE communities with railbelt communities.

## 1.3 Format

Development will begin with a series of web pages oriented around ontological concepts. The concepts are:

- **Classes**: Types of entities. Most are defined according to existing legal structures as described in the linked references. The main exception is Community, which is the organizational principle of previous versions of AEDG; we will define that one ourselves.

  - Classes could be translated to tables in a relational database, if that makes sense for development.
  - Instances of a Class are nodes in a graph, if you think about things that way.

- **Properties**: These are attributes of the Classes.

  - Properties could take the form of columns in tables in a relational database.

- **Relations**: These can be heirarchical (taxonomy) or could form a network or graph (semantic web) of the various entities. If they are based on domain specific rules (Axioms), then that is what distinguishs an ontology. Relations enable AI to infer new information without people having to explicitly define everything.

  - Relations are the edges in a graph.
  - In a relational database, Relations can be encoded using a lookup table with a combination of foreign keys.

- **Axioms**: Domain-specific rules that encapsulate what we know about the Classes.

  - Axioms could form the basis of quality checks to entered data or the definition of the ontology. For instance, if the axioms include $x = y$ and $y = z$, trying to enter an $x$ that isn't equal to $z$ would fail a test.

## 1.4 Possibly Applicable Standards

Whenever possible, we will rely on existing resources and resist defining our own ontology from scratch. Hopeful candidates are:

Schema.org is a widely used classification scheme built around web semantics - so more applicable to internet based services, of which AEDG is one.

Dublin Core Metadata Terms (DCMT) are limited to only the most necessary terms. For instance, dc:Location is defined to include both spatial regions and named places, and puts no qualifications on the type or context. Similarly, an dc:Agent is merely "a resource that acts or has the power to act". Wikipedia says: "Initially developed as fifteen terms in 1998 the set of elements has grown over time and in 2008 was redefined as a Resource Description Framework (RDF) vocabulary."

Open Energy Ontology (OEO), which you access via this Terminology Service.

The Census Glossary describes the terms associated with the census.

Terms describing Alaska Native representation are complex. The definitions here are based on ANCSA Regional Association's Overview, is a description of the different tribal entities in Alaska that includes links to more information.



Figure 1.1: Initial Brainstorming.

# 2 Regional Classes

Types of entities in the Alaska Community Ontology

## 2.1 Classes

Classes are types of entities. Most are defined according to existing legal structures as described in the linked references. The main exception is Community, which is the organizational principle of previous versions of AEDG; we will define that one ourselves. It is likely we can use established standard vocabularies to define all Classes. Which standard we use will depend on the level of specificity we want.

- Classes could be translated to tables in a relational database, if that makes sense for development.
- Instances of a Class are nodes in a graph, if you think about things that way.
- Classes are typically capitolized to differentiate them from instances or objects of that class, which are lower case.

This page also includes Properties, which are attributes of the Classes.

- Properties could take the form of columns in tables in a relational database.

### 2.1.1 Common Properties

We've adopted some common properties that are used by multiple tables (but are not mandatory). These are based on Rails conventions:

- id (int): the row number generated when the table is ingested into the database
- name (string): human readable label. We don't use these as indices or unique identifiers, because they are never the same between data sets.
- date (string): time
- geometry (): geometry(Point, OGC:CRS84), geometry(Polygon, OGC:CRS84), geometry(MultiPolygon, OGC:CRS84) for locations and boundaries

- – The ELT process generates GeoJSON with a coordinate reference system denoted as `"crs": { "type": "name", "properties": { "name": "urn:ogc:def:crs:OGC:1.3:CRS84" } }`. This is equivalent to EPSG:4326 (WGS84) with the order changed from Lat-Long to Long-Lat.

- as_of_date (string): when the source data was published.

# 3 List of Classes

## 3.1 AEDG Context Only

### 3.1.1 Communities

- **Definition**: Construct of AEDG that is the fundamental unit of displays and dashboards.
- **SpatialRelationships**:
- **Analogous Standards**:

    - https://schema.org/Place
    - dc:Location

- **Properties**:

    - fipps_code (integer): Federal Information Processing Standard, identifying geographic locations. unique identifier.
    - geometry (WKT Point): longitude, latitude of the Community for convenience of display. Perhaps the centroid of the Municipality or a commonly accepted "place".
    - geometry (WKT Polygon): boundary of the administrative bounds of a Community available from a DRCA PCE dataset.

## 3.2 ANCSA or Indigenous Context

### 3.2.1 FedRecognizedTribes

- **Definition**: For the purposes of tracking energy in Alaska, the definition [should|will|could] be restricted to the 229 Federally recognized Tribes - sovereign governments. The 1975 Indian Self-Determination and Education Assistance Act allows tribes to contract with the federal government to provide services in place of federal agencies.
- **SpatialRelationships**:
- **Analogous Standards**:

    - https://schema.org/GovernmentOrganization
    - dc:Agent

- – OEO:provider - A provider is an agent (organization) that transfers commodities or a OEO:Service to other agents.

- **References**:

  - – https://biamaps.geoplatform.gov/BIA-Opendata/Data/ - terrible. no way to link to dataset.
  - – https://www.fws.gov/sites/default/files/documents/Map-Federally-Recognized-Tribes-In-Alaska.pdf
  - – https://www.scotusblog.com/2021/04/are-alaska-native-corporations-indian-tribes-a-multimillion-dollar-question
  - – https://biamaps.geoplatform.gov/Tribal-Leaders-Directory/

- **Properties**:

  - – geometry (WKT Polygon): boundary of Tribe
  - – Additional properties should be determined by what is important to the people. i.e. language?

### 3.2.2 VillageCorps

- **Definition**: Alaska Native village corporations were created by the Alaska Native Claims Settlement Act (ANCSA) and are organized around small communities in Alaska that typically stemmed from traditional Alaska Native land. Village corporations were intended to select lands on which any part of the village was located. Their importance in the energy context is that they might operate as Independent Power Producers that sell power to the Communities' utilities.
- **SpatialRelationships**:

  - – WITHIN Alaska

- **Analogous Standards**:

  - – https://schema.org/Corporation
  - – dc:Agent
  - – OEO:provider - A provider is an agent (organization) that transfers commodities or a OEO:Service to other agents.
  - – Is an foaf:Organization that is foaf:based_near a Community - "A location that something is based near, for some broadly human notion of near."

- **References**:

  - – https://dcra-cdo-dcced.opendata.arcgis.com/datasets/DCCED::native-village-corporations/ (215 records)
  - – https://ancsa.lbblawyers.com/1602.htm (definition)
  - – https://ancsa.lbblawyers.com/native-corporations.htm (list of 179)

– https://ancsaregional.com/about-ancsa/#mandates

- **Properties**:

    – geometry (WKT Point): longitude, latitude of tribal leadership location
    – related to Communities via the `is_based_near` lookup table.
    – Additional properties should be determined by what is important to the people.

### 3.2.3 RegionalCorps

- **Definition**: Alaska Native regional corporations were created by the Alaska Native Claims Settlement Act (ANCSA) and are organized around geographic areas defined by the common heritage and shared interests of the indigenous peoples. The boundaries of these areas do not directly represent land ownership, but instread define the areas in which each regional corporation could select lands to be conveyed under the provisions of ANCSA.
- **SpatialRelationships**:

    – WITHIN Alaska

- **Analogous Standards**:

    – https://schema.org/Corporation
    – dc:Agent
    – OEO:provider - A provider is an agent (organization) that transfers commodities or a OEO:Service to other agents.

- **References**:

    – https://www.arcgis.com/home/item.html?id=c78df0004ab845a9a32697d9c20d09e0
    – https://catalog.data.gov/dataset/tiger-line-shapefile-2017-state-alaska-current-alaska-native-regional-corporation-anrc-state-ba
    – https://ancsa.lbblawyers.com/native-corporations.htm (list of 13)
    – https://ancsaregional.com/about-ancsa/#mandates
    – https://maps.commerce.alaska.gov/server/rest/services/ANCSA/ANCSA_Corporations/MapServer

- **Properties**:

    – geometry (WKT Polygon): boundary of the RegionalCorp.
    – Additional properties should be determined by what is important to the people.

## 3.3 Administrative Context

### 3.3.1 IncorporatedPlaces

- **Definition**: Incorporated places are legally incorporated under state law, have a legally defined boundary, and an active functioning governmental structure. Examples of incorporated places include cities, towns, villages, etc. (Not boroughs in Alaska)
- **SpatialRelationships**:

  – WITHIN Boroughs
  – WITHIN Precincts
  – WITHIN HouseDistricts
  – WITHIN SenateDistricts

- **Analogous Standards**:

  – https://schema.org/GovernmentOrganization
  – has an https://schema.org/AdministrativeArea
  – dc:Location for the place
  – dc:Agent for the government
  – OEO:provider - A provider is an agent (organization) that transfers commodities or a OEO:Service to other agents. Governmental ok?

- **References**:

  – https://www.census.gov/programs-surveys/bas/information/cdp.html
  – https://www2.census.gov/programs-surveys/popest/tables/2020-2023/cities/totals/SUB-IP-EST2023-POP-02.xlsx 2023 populations for Alaska incorporated places

- **Properties**:

  – geometry (WKT Polygon): boundary

### 3.3.2 CensusDesignatedPlaces

- **Definition**: CDPs are statistical equivalents of incorporated places and represent unincorporated communities that do not have a legally defined boundary or an active, functioning governmental structure. They are locally recognized and identified by name. Examples of CDPs include unincorporated communities, planned communities, military installments, university towns, resort towns, etc.
- **SpatialRelationships**:

  – WITHIN Boroughs
  – WITHIN Precincts
  – WITHIN HouseDistricts

– WITHIN SenateDistricts

- **Analogous Standards**:

    – https://schema.org/Place
    – dc:Location

- **References**:

    – https://www.census.gov/programs-surveys/bas/information/cdp.html

- **Properties**:

    – location (WKT Point): longitude, latitude points of whereever the census says it is (does not have legal boundary, therefore not a polygon?)

### 3.3.3 Boroughs

- **Definition**: Boroughs are analagous to a county in other places. Organized boroughs were formed in those areas where economies were better developed. The remaining areas are the unorganized borough, which is divided into census areas; these areas exist for statistical analysis and do not have a government of their own. There are also consolidated city-borough governments.
- **SpatialRelationships**:

    – CONTAINS IncorporatedPlaces
    – CONTAINS CensusDesignatedPlaces
    – OVERLAPS Precincts
    – OVERLAPS HouseDistricts
    – OVERLAPS SenateDistricts

- **Analogous Standards**:

    – https://schema.org/GovernmentOrganization
    – has an https://schema.org/AdministrativeArea
    – dc:Location for the place
    – dc:Agent for the government
    – OEO:subregion - a region of relevance that is in every respect a component of a region of relevance, but never encompasses the entire extent of a region of relevance. (of Alaska)
    – OEO:provider (an organization with a role) provides a governmental OEO:service

- **References**:

    – https://gis.data.alaska.gov/datasets/DCCED::alaska-borough-and-census-area-boundaries/about
    – https://www.commerce.alaska.gov/web/dcra/LocalBoundaryCommission

- https://en.wikipedia.org/wiki/List_of_boroughs_and_census_areas_in_Alaska
- https://live.laborstats.alaska.gov/cen/maps/state/current/AlaskaBorCA.pdf
- https://live.laborstats.alaska.gov/cen/maps/bor/current/090.pdf map of FNSB with cities and census

- **Properties**:

  - type (string): "Unified Home Rule", "Non-unified Home Rule", "First Class", "Second Class"
  - geometry (WKT MultiPolygon): boundary of the Borough

### 3.3.4 HouseDistricts

- **Definition**: The Alaska State House is the lower house in the Alaska State Legislature. Its districts are determined on the basis of population and shall be "contiguous and compact territory containing nearly as possible a relatively integrated socioeconomic area"
- **SpatialRelationships**:

  - CONTAINS IncorporatedPlaces
  - CONTAINS CensusDesignatedPlaces
  - CONTAINS Precincts
  - WITHIN SenateDistricts

- **Analogous Standards**:

  - https://schema.org/AdministrativeArea
  - dc:Location
  - OEO:subregion - a region of relevance that is in every respect a component of a region of relevance, but never encompasses the entire extent of a region of relevance. (of Alaska and of SenateDistrict)

- **References**:

  - https://maps.commerce.alaska.gov/server/rest/services/Govt_Related/Govt_House_and_Senate_
  - https://www.elections.alaska.gov/doc/forms/H07.pdf list of senate and house districts
  - https://www.elections.alaska.gov/doc/forms/H32COM.pdf community/district lists
  - https://akleg.gov/pages/legbranch.php

- **Properties**:

  - district (int): digit that denotes the district
  - geometry (WKT MultiPolygon): boundary of the district.

### 3.3.5 SenateDistricts

- **Definition**: Alaska State Senate is the upper house in the Alaska State Legislature. Its districts are composed of two contiguous house districts, if possible.
- **SpatialRelationships**:

  – CONTAINS IncorporatedPlaces
  – CONTAINS CensusDesignatedPlaces
  – CONTAINS Precincts
  – CONTAINS HouseDistricts

- **Analogous Standards**:

  – https://schema.org/AdministrativeArea
  – dc:Location
  – OEO:subregion - a region of relevance that is in every respect a component of a region of relevance, but never encompasses the entire extent of a region of relevance. (of Alaska)

- **References**:

  – https://maps.commerce.alaska.gov/server/rest/services/Govt_Related/Govt_House_and_Senate_

- https://www.elections.alaska.gov/doc/forms/H07.pdf list of senate and house districts
- https://www.elections.alaska.gov/doc/forms/H32COM.pdf community/district lists
- https://akleg.gov/pages/legbranch.php
- **Properties**:

  – district (character): Capitol letter that denotes the district
  – geometry (WKT MultiPolygon): boundary of the district.

## 3.4 Statistical or Research Context

### 3.4.1 CensusBlocks

- **Definition**: Census blocks are the smallest level of geography you can get basic census demographic data for, such as total population by age, sex, and race.
- **SpatialRelationships**:

  – WITHIN CensusTracts

- **Analogous Standards**:

  – https://schema.org/DefinedRegion - Arbitrary! haha
  – dc:Location
  – OEO:study subregion (of CensusTract)

- **References**:
  - https://www.census.gov/newsroom/blogs/random-samplings/2011/07/what-are-census-blocks.html
  - https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-geopackage-file.html
  - https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html
  - https://live.laborstats.alaska.gov/article/maps-gis-data

- **Properties**:
  - geometry (WKT Polygon): boundary of the census block.

### 3.4.2 CensusTracts

- **Definition**: Census tracts are small, relatively permanent statistical subdivisions of a county or statistically equivalent entity that provide a stable set of geographic units for the presentation of statistical data.
- **SpatialRelationships**:
  - CONTAINS CensusBlocks

- **Analogous Standards**:
  - https://schema.org/DefinedRegion - Arbitrary! haha
  - dc:Location
  - OEO:study region - "A study region is a region of relevance that has the study region role and consists entirely of one or more subregions."

- **References**:
  - https://www.census.gov/programs-surveys/geography/about/glossary.html#par_textimage_13
  - https://esri.maps.arcgis.com/home/item.html?id=20f5d275113e4066bf311236d9dcc3d4
  - https://live.laborstats.alaska.gov/article/maps-gis-data

- **Properties**:
  - geometry (WKT Polygon): boundary of the census tract.

### 3.4.3 AeaEnergyRegions

- **Definition**: Energy Regions as defined by Alaska Energy Authority for Regional Energy Planning. These were also used in the Alaska Energy Statistics Reports.
- **SpatialRelationships**:
  - CONTAINS Communities

- **Analogous Standards**:

    - https://schema.org/DefinedRegion - Arbitrary! haha
    - OEO:study region - "A study region is a region of relevance that has the study region role and consists entirely of one or more subregions."

- **References**:

    - https://dcra-cdo-dcced.opendata.arcgis.com/datasets/DCCED::alaska-energy-authority-regions/about
    - https://gis.data.alaska.gov/datasets/DCCED::energy-development-regions/explore?location=0.9342

- **Properties**:

    - geometry (WKT Polygon): borders of the study regions

### 3.4.4 AcepEnergyRegions

- **Definition**: Communities were been grouped into 3 regions in order to summarize energy trends in the 2024 Alaska Electricity Trends Report. Was intended to group communities by generation mix, but we grouped in contiguous areas: railbelt, coastal, and rural remote.
- **SpatialRelationships**:

    - CONTAINS Communities

- **Analogous Standards**:

    - https://schema.org/DefinedRegion - Arbitrary! haha
    - OEO:study region - "A study region is a region of relevance that has the study region role and consists entirely of one or more subregions."

- **Properties**:

    - geometry (WKT MultiPolygon) or (WKT Polygon): boundaries

## 3.5 Optional

### 3.5.1 CensusArea

- **Definition**: Census areas are subdivisions of the unorganized borough that are only used for statistical analysis and do not have a government of their own. These are typically undeveloped areas, so I'm not sure how relevant they are for AEDG.
- **SpatialRelationships**:
- **Analogous Standards**:

- https://schema.org/DefinedRegion - Arbitrary! haha
- dc:Location
- OEO:subregion - a region of relevance that is in every respect a component of a region of relevance, but never encompasses the entire extent of a region of relevance. (of the unincorporated Borough)

- **References**:

  - https://gis.data.alaska.gov/datasets/DCCED::alaska-borough-and-census-area-boundaries/about

- **Properties**:

  - boundary (WKT Polygon): longitude, latitude points that denote the boundary of the census area.

### 3.5.2 ZipCode

- **Definition**: Postal zip codes as available from [link] (ZCTA)
- **SpatialRelationships**:
- **Analogous Standards**:

  - https://schema.org/DefinedRegion - properties of which were designed for zip codes
  - dc:Location
  - OEO:subregion - a region of relevance that is in every respect a component of a region of relevance, but never encompasses the entire extent of a region of relevance. (of the United States and of Alaska)

- **References**:

  - https://www.geonames.org/postal-codes/US/AK/alaska.html (place = town, Admin2 = borough?)

- **Properties**:

  - boundary (WKT Polygon): longitude, latitude points that denote the boundary of the house district.

### 3.5.3 SchoolDistrict

- **Definition**: Community based school districts. This might be out of scope or better handled as research.
- **SpatialRelationships**:
- **Analogous Standards**:

  - dc:Agent for the governmental organization.

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- – OEO:subregion - a region of relevance that is in every respect a component of a region of relevance, but never encompasses the entire extent of a region of relevance. (of what?)

- **Properties**:

  - – boundary (WKT Polygon): longitude, latitude points that denote the boundary of the school district. This is too much to expect, probably.

# 4 Electricity Classes

Descriptions of Electricity-related entities in the Alaska Community Ontology

## 4.1 Classes

Classes are types of entities. Most are defined according to existing legal structures as described in the linked references. The main exception is Community, which is the organizational principle of previous versions of AEDG; we will define that one ourselves. It is likely we can use established standard vocabularies to define all Classes. Which standard we use will depend on the level of specificity we want.

- Classes could be translated to tables in a relational database, if that makes sense for development.
- Instances of a Class are nodes in a graph, if you think about things that way.
- Classes are typically capitolized to differentiate them from instances or objects of that class, which are lower case.

This page also includes Properties, which are attributes of the Classes.

- Properties could take the form of columns in tables in a relational database.

### 4.1.1 Common Properties

We've adopted some common properties that are used by multiple tables (but are not mandatory). These are based on Rails conventions:

- id (int): the row number generated when the table is ingested into the database
- name (string): human readable label. We don't use these as indices or unique identifiers, because they are never the same between data sets.
- date (string): time
- geometry (): geometry(Point, OGC:CRS84), geometry(Polygon, OGC:CRS84), geometry(MultiPolygon, OGC:CRS84) for locations and boundaries

– The ELT process generates GeoJSON with a coordinate reference system denoted as `"crs": { "type": "name", "properties": { "name": "urn:ogc:def:crs:OGC:1.3:CRS84" } }`. This is equivalent to EPSG:4326 (WGS84) with the order changed from Lat-Long to Long-Lat.

- as_of_date (string): when the source data was published.

## 4.2 List of Classes in the Electricity Context

### 4.2.1 Operators

- **Definition**: Because so many types of entities generate power in Alaska, an overarching category is required to avoid classification conflicts. So operators are any entity that operates power generation facilities.
- **SpatialRelationships**:

  – Corporate entity, not spatial

- **Analogous Standards**:

  – OEO:power plant operator - "an agent that operates an electric utility generation station."

- **References**:

  – Neil McMahon, creator of the Alaska Energy Statistics Workbooks

- **Properties**:

  – ak_operator (string): assigned by Neil to integrate EIA and PCE information
  – pce_utility_code (string): assigned by AEA for accounting
  – eia_operator_id (integer): assigned by EIA
  – cpcn integer (integer): assigned by RCA
  – operator_name (string): EIA, PCE, RCA or other
  – sector_name (string): EIA's internal consolidated NAICS
  – sector_number (integer): unknown
  – operator_rca_regulatory_status_name (string): Enum = regulated, etc (see below)
  – operator_utility_type_name (string): Enum = public, private, etc (see below)
  – operator_cpcn_status (string): Enum = active, inactive
  – pce_eligible (boolean)
  – power_generation_end_use (string): Enum = retail, wholesale. source uncertain
  – notes (string)

#### 4.2.1.1 Operator Regulatory Status

- **Definition**: values of operator_rca_regulatory_status_name
- **References**:
  - Neil McMahon, creator of the [Alaska Energy Statistics Workbooks](#)

- **Values**:
  - Regulated: by the RCA
  - Not regulated
  - Regulated, rate exemption: Exempted from rate cases because of nature of ownership is municiple or co-op or very small private or the customers waived it
  - N/A

#### 4.2.1.2 Operator Utility Type Name

- **Definition**: values of operator_utility_type_name
- **References**:
  - Neil McMahon, creator of the [Alaska Energy Statistics Workbooks](#)

- **Values**:
  - Public Electric Utility: includes Electric Co-op
  - Private Electric Utility
  - Subsidiary
  - Independent Power Producer
  - Military
  - Industrial
  - State Government: as Joint Action Agency of the State of Alaska i.e. Southeast Alaska Power Agency or Alaska Industrial Development & Export Authority
  - Political Subdivision of the State: Not used?

### 4.2.2 Plant

- **Definition**: Entities that generate electricity for grids. (or power station)
- **SpatialRelationships**:
  - TOUCHES PowerLines
  - WITHIN Grids

- **Analogous Standards**:

- dc:PhysicalResource
    - OEO:power plant - "an energy transformation unit consisting of power generating units and a grid component that feeds electric energy into an electric grid."

- **Properties**:

    - ak_plant_id (string): assigned by Neil to integrate EIA and PCE information
    - eia_plant_id (integer): assigned by EIA
    - pce_preporting_id (integer): assigned by AEA
    - operator_ak_operator_id (string): assigned by Neil in operator table
    - eia_operator_id (integer): assigned by EIA
    - operator_operator_name (string): defined by Neil in operator table
    - intertie_current_intertie_id (string): assigned by Neil in intertie table
    - intertie_current_intertie_name (string): assigned by Neil in intertie table
    - combined_heat_power (boolean)
    - primary_voltage (float): grid voltage (kV) at point of interconnection
    - primary_voltage2 (float): grid voltage (kV) at point of interconnection, often null
    - phases (integer): from AEA powerhouse survey, single or three phase
    - latitude (float): of the plant
    - longitude (float): of the plant
    - notes (string)
    - geometry (WKT Point): from latitude and longitude

### 4.2.3 Grids

- **Definition**: An Electric power grid is "A system of synchronized power providers and consumers connected by transmission and distribution lines and operated by one or more control centers. ... In Alaska and Hawaii, several systems encompass areas smaller than the State (e.g., the interconnect serving Anchorage, Fairbanks, and the Kenai Peninsula)" (EIA)
- **SpatialRelationships**:

    - CONTAINS PowerLines (transmission and distribution lines)
    - CONTAINS PowerStations (power providers)
    - CONTAINS Communities (consumers) demand, load ?

- **Analogous Standards**:

    - dc:PhysicalResource
    - OEO:electricity grid - "An electricity grid is a supply grid that distributes electrical energy / electricity." It is an aggregate of material entities that have parts: power stations and power lines.

- **References**:

- https://www.eia.gov/tools/glossary/index.php?id=electric_power_grid
- https://en.wikipedia.org/wiki/Electrical_grid
- https://www.nrel.gov/grid/microgrids.html
- https://en.wikipedia.org/wiki/Microgrid
- Neil McMahon, creator of the Alaska Energy Statistics Workbooks calls these interties
- Section B.1.1 ("interconnected electric energy transmission network")

- **Properties**:

  - grid_id (string): assigned by Neil as combo of id with the year removed (see Interties below)
  - grid_name (string): primary community name + "_id"
  - communities_fips_code (integer): Federal Information Processing Standard, identifying geographic locations uniquely
  - connection_year (integer): when the community was connected to the grid. Months are often unknown
  - final_year (integer): when the community was connected to a different grid, ending its previously independent grid
  - source (string): where info came from. most often empty
  - geometry (WKT ?): All grids are continuous. Could this be a shape that includes all the PowerPlants and PowerLines?

### 4.2.4 LoadServingEntity

- **Definition**: "an electric utility that has a service obligation to distribute power to more than 10 customers that receive invoices directly from the entity;" AS 42.05.760 - 42.05.790 or FERC says "Any entity, including a load aggregator or power marketer, that serves end-users within a control area and has been granted the authority or has an obligation pursuant to state or local law, regulation, or franchise to sell electric energy to end-users located within the control area."
- **SpatialRelationships**:

  - Corporate entity, not spatial

- **Analogous Standards**:

  - OEO:provider - A provider is an agent (organization) that transfers commodities or a OEO:Service to other agents.

- **References**:

  - Alaska Statute
  - https://en.wikipedia.org/wiki/Load_serving_entity - focuses on deregulated energy market (which is not Alaska's situation)

- – [FERC Glossary](#)
- – Section [B.1.1](#)

- **Properties**:

  - – service_area: the control area that FERC mentioned, or the locations of the customers

### 4.2.5 ServiceArea

- **Definition**: The RCA associates every regulated electric utitlity with a service area.
- **SpatialRelationships**:

  - – A LoadServingEntity has a ServiceArea
  - – ServiceAreas cannot intersect (probably)

- **Analogous Standards**:

  - – https://schema.org/AdministrativeArea
  - – [OEO:subregion](#) - a region of relevance that is in every respect a component of a region of relevance, but never encompasses the entire extent of a region of relevance. (of Alaska)

- **References**:

  - – See the KML files linked to on [CPCN 17: Kotzebue Electric Association, Inc.](#) for example.

- **Properties**:

  - – as_of_date: because they can be revised
  - – geometry (WKT Polygon): service area (guessing from FERC definition)

### 4.2.6 PowerLines

- **Definition**: The transmission and distribution lines that create a Grid that includes multiple Communities. In Electric North, there was a distinction between the voltages of transmission and distribution lines, but that was arbitrarily defined and changed as needed.
- **SpatialRelationships**:

  - – WITHIN Grids
  - – TOUCHES PowerStations
  - – TOUCHES Loads

- **Analogous Standards**:

– OEO:electricity grid component (a material entity that includes power plants)
– or more specifically OEO:power line
– dc:PhysicalResource

- **Properties**:

  – owner (string): Who owns it?
  – maintainer (string): Who maintains it? Is this the same as Owner?
  – voltage (int): voltage of line in kV (by definition above 69 kV for transmission lines, but not always in Alaska)
  – type (string): buried, underwater, overhead
  – geometry (WKT MultiLineString): polyline that traces an acceptible, if not accurate, route of the lines.

### 4.2.7 FuelTypes

### 4.2.8 PrimeMover

## 4.3 Other (unused?)

### 4.3.1 Electric Utilities

- **Definition**: "A corporation, person, agency, authority, or other legal entity or instrumentality aligned with distribution facilities for delivery of electric energy for use primarily by the public. Included are investor-owned electric utilities, municipal and State utilities, Federal electric utilities, and rural electric cooperatives." (EIA) Certified utilities in Alaska have a certificate of operation issued by the RCA.
- **Analogous Standards**:

  – https://schema.org/Corporation
  – dc:Agent
  – OEO:provider - A provider is an agent (organization) that transfers commodities or a OEO:Service to other agents.
  – OEO:power plant operator - "an agent that operates an electric utility generation station."

- **References**:

  – https://www.eia.gov/tools/glossary/index.php?id=Electric%20utility
  – {Section B.1.2}

- **Properties**:

  – coop (boolean): True/False is it organized as a member owned co-operative?

– private (boolean): True/False is it a private company? Public owned utility (POU)?
– certificate_number: RCA Certificate of Public Convenience and Necessity (CPCN) number
– certificate_name: RCA's name for the utility
– geom: could be determined by the look-up table `provides_electricity_to`. For instance, AVEC and Alaska Power and Telephone serve isolated communities so their sevice regions are discontinuous. However, RCA does certify service areas for certified utilities - we need to find out if these are available as a spatial data set.

### 4.3.2 IPP

- **Definition**: An independent power producer (IPP) is a private entity that owns or operates facilities to generate electricity. It could be a person, agency, authority, corporate, cooperative, or tribal. It could sell power to a utility or generate power for a privately held facility. "means a corporation, person, agency, authority, or other legal entity or instrumentality, that is not a utility and that owns or operates a facility for the generation or production of electric or thermal energy for use by the residents, local government, or businesses of one or more municipalities or unincorporated communities recognized by the Department of Commerce, Community, and Economic Development for community revenue sharing under AS 29.60.850 - 29.60.879 and 3 AAC 180." from Alaska Statute 3 AAC 106.900.
- **SpatialRelationships**:
- **Analogous Standards**:
- **References**:

  – https://www.eia.gov/tools/glossary/index.php?id=Independent%20power%20producer
  – Alaska Statute 3 AAC 106.900. Definition for Load Programs
  – Section B.1.3

- **Properties**:

### 4.3.3 PceEntities

- https://gis.data.alaska.gov/datasets/DCCED::power-cost-equalization-pce-program-eligible-entities-1/about says "Communities served by entities that are eligible for the Alaska Energy Authority's Power Cost Equalization program."

- PCE authorizes payment to the electric utility (not the community). CSV is a link between communites and the utilities that serve them.
- Also includes ineligible like Fairbanks and Barrow. Wha?
- Map shows points but CSV is an X,Y projection?
- Data Year - points with different times. Maybe

### 4.3.4 PceCommunities

- https://gis.data.alaska.gov/datasets/DCCED::power-cost-equalization-pce-program/about says "Alaska Energy Authority Power Cost Equalization (PCE) program by community."
- CSV links PCECommunity + CommunityName + EntityName where Entity is maybe the utility?
- Single PCECommunity can link to multiple communities, i.e. "Tok; Tanacross PCE"
- This is the big CSV from AEA with columns for population and rates.

### 4.3.5 Interties

- **Definition**: This is the lookup table in the Energy Stats Workbooks used to describe grids. Interies connect new communities to existing grids and they become active in a defined year.
- **SpatialRelationships**:
  - CONTAINS PowerLines (transmission and distribution lines)
  - CONTAINS PowerStations (power providers)
  - CONTAINS Communities (consumers) demand, load ?

- **Analogous Standards**:
  - dc:PhysicalResource
  - OEO:electricity grid - "An electricity grid is a supply grid that distributes electrical energy / electricity." It is an aggregate of material entities that has parts: power stations and power lines.

- **References**:
  - Alaska Energy Statistics Workbooks

- **Properties**:
  - ak_intertie_id (string): assigned by Neil as combo of id and year
  - intertie_unique_id_name (string): primary community name
  - current (boolean): is this the most recent version?
  - communities_intertied (string): community names separated by some puctuation
  - month_of_intertie (integer): most often empty
  - year_of_intertie (integer): repeated in id, often empty
  - aea_energy_region (string): assigned by AEA
  - source (string): where info came from. most often empty
  - geometry (WKT Polygon): All grids are continuous. Could this be a shape that includes all the PowerPlants and PowerLines?

# 5 Relations

Domain-defined ways that entities relate to each other in the Alaska Community Ontology

Relations can be hierarchical (taxonomy) or could form a network or graph (semantic web) of the various entities. These are based on domain specific rules (Axioms), and that defines an ontology. Relations enable AI to infer new information without people having to explicitly define everything.

- Relations are the edges in a graph.
- In a relational database, Relations can be encoded using a lookup table with a combination of foreign keys.

## 5.1 Applicable Standards

ArcMap spatial relations

- ST_Contains
- ST_Crosses
- ST_Disjoint
- ST_Equals
- ST_Intersects
- ST_Overlaps
- ST_Relate
- ST_Touches
- ST_Within

GeoSPARQL - same except for Relate

- geor:sfContains
- geor:sfCrosses
- geor:sfDisjoint
- geor:sfEquals
- geor:sfIntersects
- geor:sfOverlaps

- geor:sfTouches
- geor:sfWithin

OBO Relations Ontology "is a collection of OWL relations (ObjectProperties) intended for use across a wide variety of biological ontologies." It is a foundational element of the Open Energy Ontology.

On the other hand, in the OEO Terminology Service, I could only find one instance of a straight-up `RO` usage: is homeomorphic for (which I don't even understand).

## 5.2 Relations

### 5.2.1 Spatial Relations

Most relationships can be established dynamically through spatial relations. We do not need to have a lookup table of Communities in Boroughs, say, because we can select all the Community points that the Borough CONTAINS. The primary relationships are sketched out on the Classes pages, but the combinations are really unlimited.

### 5.2.2 Lookup Tables

Some classes are legal or corporate entities and so do not have an intrinsic spatial component. But they serve other entities that *do* have a spatial component, so we will use look-up tables to attach spatial info to them.

Table names are very specific so that they describe the exact relationship between the entities. This will self-document the queries when those are written.

### 5.2.3 Early ideas for lookup tables

Before we established the ELT pipeline or the application database, Liz theorized about potentially required tables. These have not been developed, but they do illustrate some interesting points so they have not been removed.

### 5.2.3.1 provides_electricity_to

Utilities provide electricity to Communities. Liz added some columns that might be useful, but she doesn't know where these data will come from, so the table schema will change. This is just an example of what *could* be.

- **Analogous Standards**:
- OEO:Service - "A service is a process that is an intangible activity performed by some agent for the benefit of another agent."
- Schema.org:Service - "A service provided by an organization, e.g. delivery service, print services, etc."

| id_provides | id_utility | id_community | year_established |
|-------------|------------|--------------|------------------|
| integer | integer | integer | integer |

### 5.2.3.2 is_intertied_with

Grids are connected to each other with interties. Interties are the physical power lines (transmission or distribution) that make the connection, but "intertie" is also the action of making two separate Grids into a new Grid. An intertie can be multiple lines going on different routes so if a geometry was defined, the line might be quite complex; for our purposes, we will start by representing interties with lines that join the Community points. Interties have a start date that could be defined in multiple ways - date of construction or date when billing changed. (This needs clarification.)

- **Analogous Standards**:
    - OEO:electricity grid component (a material entity that includes power plants)
    - or maybe more specifically OEO:power line
    - dc:PhysicalResource

- **Properties**:
    - owner (string): Who owns it?
    - maintainer (string): Who maintains it? Is this the same as Owner?

This is just an example of what *could* be. Schema should be based on Neil's work?

| id_intertie | id_grid1 | id_grid2 | new_grid_id | year_established | owner | maintainer |
|-------------|----------|----------|-------------|------------------|-------|------------|
| integer | integer | integer | integer | integer | string | string |

### 5.2.3.3 is_based_near

Alaska Native village corporations are organized around small communities in Alaska that typically originated as traditional Alaska Native land. Village corporations were intended to select lands on which any part of the village was located. Therefore, they aren't the same as a Community but manage lands in possibly disjointed parcels inside and around the Community.

The DCRA dataset explicitly links these two with the columns `EntityName` and `CommunityName`. The addresses are for the corporate headquarters, which might be in Anchorage or somewhere, so those aren't reliable links.

- **Analogous Standards**:
  - The VillageCorp is an foaf:Organization that is foaf:based_near a Community - "A location that something is based near, for some broadly human notion of near."

- **References**:
  - https://dcra-cdo-dcced.opendata.arcgis.com/datasets/DCCED::native-village-corporations/ (215 records)

| id_near | id_village_corp | id_community |
|---------|-----------------|--------------|
| integer | integer         | integer      |

# 6 Axioms

Domain-specific rules that describe entity relations in the Alaska Community Ontology

Axioms are domain-specific rules that encapsulate what we know about the Classes.

- Axioms could form the basis of quality checks to entered data or the definition of the ontology. For instance, if the axioms include `x = y` and `y = z`, trying to enter an `x` that isn't equal to `z` would fail a test.
- An Axiom should describe only one quality because it will eventually have a code-based test, and we want to keep those independent of each other.

## 6.1 Regions

### 6.1.1 State

- The State is defined to be Alaska
- All Communities are in the State

### 6.1.2 Community

- Communities are primarily determined by the expectations of the AEDG audience.
- Communities should be equal to a single entity (preferred)
- Communities could be collections of entities (example: Fairbanks should include College and Farmers Loop, which are separate Community Designated Places in the census)

### 6.1.3 Indigenous

- Tribes are nations and should be federally recognized (but sometimes are not)
- Native corporations are not nations, they are corporations that are a uniquely Alaskan entity.

- Gregory Ablavsky, Are Alaska Native corporations Indian tribes? A multimillion-dollar question, SCOTUSblog (Apr. 16, 2021, 8:18 PM), https://www.scotusblog.com/2021/04/are-alaska-native-corporations-indian-tribes-a-multimillion-dollar-question/ descibes an area where the distinction between tribe and corporation is murky.

- Native Village Corporations are not a subset of the Native Regional Corporations. They are a separate type of entity.

### 6.1.4 Legislative Districts

- A Senate election district is composed of two contiguous house districts, if possible.
- Districts are redefined every 10 years after the federal census, and may change intermittently due to court challenges.
- HouseDistricts can contain multiple Communities.
- A single Community might intersect several HouseDistricts (example: Fairbanks)

  - Therefore: HouseDistrict population cannot be determined from a sum of Community populations.

### 6.1.5 Boroughs

- Communities can be unincorporated, meaning they are not in a Borough.
- If incorporated, a Community can only be in a single Borough
- There is one unincorporated Borough

  - The unincorporated Borough is split into CensusAreas for statistical purposes (not administrative)

### 6.1.6 Census

- Census blocks are not permanent through the decades. If a block is split, a suffix is added to the block number.
- Census blocks are not required to have population. They could be water-only.
- Census blocks nest within a census tract.
- Census tracks nest within state
- Census tracks nest within county, or the statistical equivalents of counties
- The optimum population of a census track is 4000 and the size is adjusted to accomplish that
- Census tracts occasionally are split due to population growth or merged as a result of substantial population decline.
- A Census Designated Place (CDP) can be located in more than one county (does that mean they might be in multiple census tracts?)

- A CDP cannot cross state boundaries.
- A CDP has a name that is different from adjacent places, but is not unique and can change.

### 6.1.7 Zip Codes (Optional)

- A ZipCode can contain multiple Communities, especially in rural areas.
- A single Community can contain multiple ZipCodes, especially in urban areas.

## 6.2 Energy-Related

- A Community can be served by multiple Energy Utilities

### 6.2.1 Grid

- Is a physical structure that supplies electricity to Communities

  - A Grid has the physical entities of PowerStations and PowerLines

- If isolated, is called a microgrid (check this)
- Can be composed of multiple Grids connected by interties

  - Interties are established on particular dates, so Grid definition can change over time

- Power Stations connected to a Grid generate power to supply a load.

### 6.2.2 Electric Utility

- An Electric Utility can operate a single Grid (KEA)
- An Electric Utility can operate multiple Grids (AVEC or AP&T)
- An Electric Utility can operate a subset of a Grid. In other words, a Grid could be operated by multiple Utilities

  - The Railbelt is serviced by 5 different Electric Utilities: Golden Valley Electric Association (GVEA), Matanuska Electric Association (MEA), Chugach Electric Association (CEA), Homer Electric Association (HEA), and the City of Seward Electric System (SES).

- Anchorage Municipal Light & Power (ML&P) used to make that 6, but they were absorbed by CEA
- Electric Utility service areas are regulated by the RCA

  - In general, Electric Utilities cannot compete against each other (Section B.2)

- – Electric Utility service areas do not overlap
- – Utility service areas are measured in the Public Land Survey System (PLSS) - township, range, and section.
- – Utility service areas are documented by the RCA with PDF maps. KML also?
  - ∗ See CPCN 17: Kotzebue Electric Association, Inc.

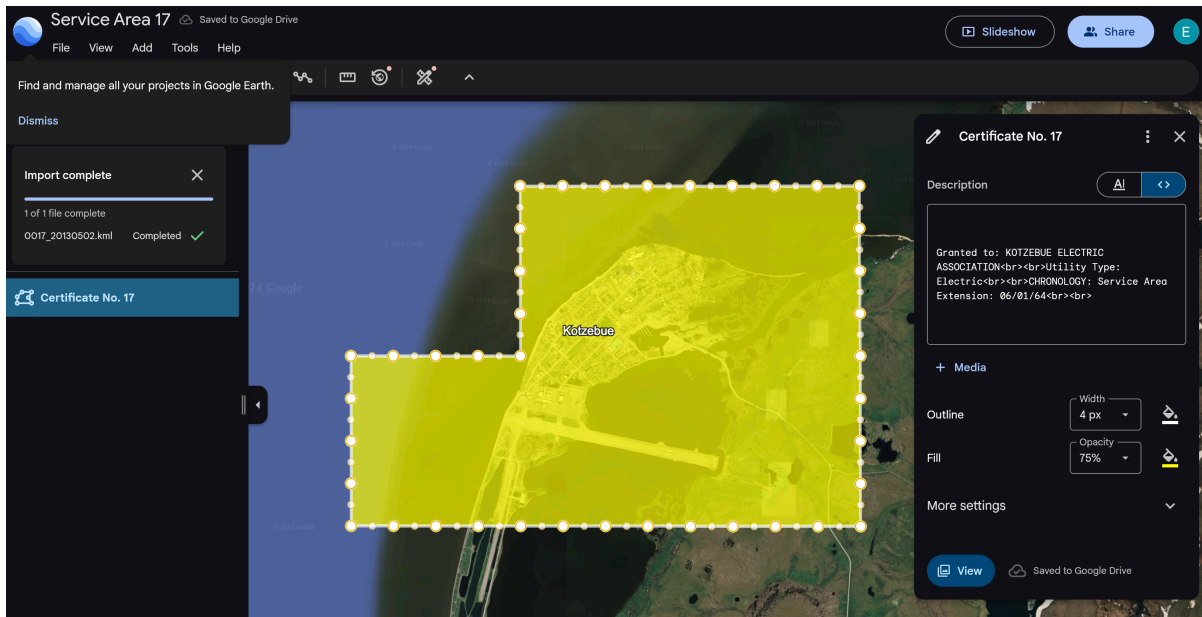

Figure 6.1: Kotzebue Electric's Service Area in Google Earth

### 6.2.3 IPP

- A Tribal Independent Power Producer (IPP) can develop and own renewable energy assets
- A local utility can buy renewable energy power from the Tribal IPP
- The cost of that power becomes a fuel cost that is an eligible PCE expense

## 6.3 Regarding Time

The assumption is that this needs to function **for the current time only**. Of course, boundaries change over time, and that these changes are of interest to researchers. However, the main users of AEDG have been defined as requiring current data to support future projects or to determine the success of existing projects. Researchers can download data and work out time-dependent issues for themselves.

# A About

## A.1 Purpose

This respository exists to support development of the Alaska Energy Data Gateway by the Alaska Center for Energy and Power (ACEP), UAF, and the Institute for Social and Economic Research (ISER), UAA. It does not exist to be its own thing. If it ceases to be applicable to the AEDG project, it should be archived.

## A.2 Funding

## A.3 Workflow

1. Liz drafted an initial versions based on discussions at the Nov 11, 2024, meeting of AEDG personnel. The intention was to track issues in this repo.
2. These were translated into a data model that serves as a translation layer between Ian who is creating the data tables and Nicole and Will who are building the Rails database.
3. As consensus is reached (often in direct messages or conversations during meetings), the resolution migrates to the data model and then to this ontology.

The original idea was to encode the ontology in OWL. However, as of Nov. 2024, it is unclear how to make use of an OWL formated ontology with code.

The second idea was a separate realational (or graph) database that would be queried during the table development. Instead, Ian built a self-contained ELT workflow as a way to experiment with different relations. His findings then feed back into the data model.

Ontology specific work will be delayed to future development cycles, if it happens at all.

## A.4 Additional Information

Learn more about the Alaska Center for Energy and Power.

# B  Energy-Related Laws

Quotes from Alaska Statute

Much of the language for the various Classes was derived from Alaska statutes so the relevant sections have been copied here for convenience. The Regulatory Commission of Alaska (RCA) also has a page on Alaska Administrative Code that describes regulations that apply to their authority.

## B.1  Definitions

### B.1.1  Electricity Definitions

Sec. 42.05.790. Definitions. In AS 42.05.760 — 42.05.790,

(1) "cybersecurity incident" means a malicious act or suspicious event that disrupts o

(2) "electric reliability organization" means an organization that is certificated by t

(3) "electric utility" means a public utility that provides electricity service;

(4) "interconnected bulk-electric system" means an interconnected electric energy trans

(5) "interconnected electric energy transmission network" means a network of interconne

(6) "load-serving entity" means an electric utility that has a service obligation to di

(7) "reliable operation" means operating the elements of the interconnected electric en

## B.1.2 Utility Definitions

State of Alaska [Statute AS 42.05.990] (https://www.akleg.gov/basis/statutes.asp#42.05.990)
includes the definition of utilities, several of which (but not all) are related to energy:

```
(6) "public utility" or "utility"  includes every corporation whether public, cooperative, o
          (A) furnishing, by generation, transmission, or distribution, electrical service t

          (B) furnishing telecommunications service to the public for compensation;

          (C) furnishing water, steam, or sewer service to the public for compensation;

          (D) furnishing by transmission or distribution of natural or manufactured gas to t

          (E) furnishing for distribution or by distribution petroleum or petroleum products

          (F) furnishing collection and disposal service of garbage, refuse, trash, or othe

          (G) furnishing the service of natural gas storage to the public for compensation;

          (H) furnishing the service of liquefied natural gas storage to the public for comp
```

## B.1.3 Definitions for Loan Programs

3 AAC 106.900.

```
 3 AAC 106.900.  Definitions.
(a) In this chapter, unless the context requires otherwise,
    (1) deleted;
    (2) Repealed 4/8/2015;
    (3) deleted;
    (4) "regional corporation" means an Alaska Native regional corporation established under
(b) In AS 42.45, unless the context requires otherwise, "nonprofit marketing cooperative" mea
(c) In AS 42.45 and this chapter, unless the context requires otherwise,
    (1) "economically viable" means
        (A) a project for which the long term benefits exceed the long term costs; or
        (B) the project is financially feasible in the absence of a government grant for the
    (2) "extension of electric service" means the point when at least three new customers beg
    (3) "immediate service" means electric service provided within 30 days after completion
    (4) "village corporation" means an Alaska Native Village Corporation organized under the
    (5) "village council" means the duly elected governing body of an unincorporated communit
```

(6) "authority" means the Alaska Energy Authority created in AS 44.83.020.

(d) In AS 42.45.010, "independent power producer" means a corporation, person, agency, author

(e) In AS 42.45.010 and this chapter,

    (1) "alternative energy"

        (A) means energy or fuel that is used for production of electricity, heat, or mechani

        (B) includes,

            (i) wind, solar, geothermal, hydroelectric, and biomass power sources; and

            (ii) local sources of coal and natural gas;

    (2) "alternative energy facility" means a facility that generates or produces alternative

    (3) "electric utility" has the meaning given the term "public utility" in AS 42.05.990(6)

## B.2 Allocation of Facilities and Services Between Competing Electric Utilities

3 AAC 52.110.  Purpose.

The purpose of 3 AAC 52.110 - 3 AAC 52.150 is to prevent duplication of electric facilities a

3 AAC 52.120.  Authority to construct facilities or serve customers.

(a) No electric utility operating in direct competition with one or more electric utilities u

(b) The commission will grant approval to provide a service connection for a customer located

    (1) the utility requesting approval receives the concurrence of the competing utility and

    (2) a determination is made by the commission, after hearing, that one or the other of th

# C Aurora Energy LLC Example

To illustrate the questions that arise with utilities that serve multiple parts of the energy market and the relationships between Independent Power Producers (IPPs) and the Load Serving Entities that distribute power to customers, this page considers the case of Aurora Energy LLC in Fairbanks. It also illustrates the development of plants and operators in Fairbanks over time because knowing that history is important.

These questions were not addressed adequately by the previous version of AEDG. In the AEDG dashboard for Fairbanks, Aurora Energy is categorized as one of many electrical utilities and no mention is made of the other utilities that serve Fairbanks. Here is a screenshot of that display:

# Electricity

## Utility

| | |
|---|---|
| **Utilities** | University of Alaska, Golden Valley Elec Assn Inc, Aurora Energy LLC Chena, Alaska Environmental Power LLC, Doyon Utilities Fort Greely, Doyon Utilities Fort Wainwright, US Air Force Eielson AFB |
| **PCE status** | PCE Ineligible |
| **Service area** | Anderson, Badger, Big Delta, Cantwell, Chena Ridge, College, Delta Junction, Deltana, Ester, Fairbanks, Farmers Loop, Four Mile Road, Fox, Goldstream, Harding-Birch Lakes, Healy, McKinley Park, Moose Creek, Nenana, North Pole, Pleasant Valley, Salcha, South Van Horn, Steele Creek, Two Rivers, Whitestone |

*Note: The data in the Electricity section are for the entire service area.*

Figure C.1: Screenshot of Fairbanks electricity section in AEDG v2.

This is inaccurate in many ways. To clarify, this page draws upon legal definitions and information from the Regulatory Commission of Alaska (RCA). Additional information came from subject matter experts Steve Colt and Mark Foster; their responses in an email exchange in Feb. 2025 have been edited here for clarity.

## C.1 What is Aurora Power LLC?

Aurora Power is a company that owns and operates the coal fired power plant in downtown Fairbanks; it is also called Aurora Energy. This plant generates electricity, and it also generates heat which is distributed to customers in the downtown area.

Aurora Energy is regulated by the RCA (CPCN 520), which gives it "Authority to operate as an electric utility to furnish electric energy to Golden Valley Electric Association, Inc.,". But there is another certificate (CPCN 119) that describes it as a public utility providing steam heat with a service area of "The corporate limits of the City of Fairbanks, Alaska, as of July 1, 1970."

Therefore, Aurora Power is both:

1. a certificated utility selling heat in a service territory defined by the network of steam [and hot water] pipes; and
2. an IPP selling electricity to Golden Valley Electric Association (GVEA)

Aurora Power is one of the successor entities to the Fairbanks Municipal Utilities System (FMUS) that served downtown Fairbanks for decades. FMUS also provided district heat through pipes, as steam. Coal fired power plants that generated heat and electricity were common across small campuses around the Northern United States. A similar entity was Anchorage Municipal Light and Power which served downtown Anchorage.

## C.2 What is Golden Valley Electric Association (GVEA)?

The Golden Valley Electric Association (GVEA) is a non-profit electric cooperative membership corporation whose mission is to "safely provide its member-owners with reliable electric service, quality customer service, and innovative energy solutions at fair and reasonable prices." GVEA incorporated in 1946, and in about 1997, GVEA acquired the electricity transmission and distribution assets from FMUS and some of its generation assets.

GVEA acquired the Frame 5 diesel fired generating units that were stationed adjacent to the FMUS Chena Power Plant from FMUS. But GVEA did not acquire the big coal plant on the Chena river; instead Aurora Energy came into being as an IPP, acquired that coal plant, and operates it now.

GVEA is the final seller of electricity, or "Load-Serving Entity" ("LSE"), serving all of Fairbanks with some exceptions. GVEA only covers customers who have or pay for electric line extensions to their property/facilities. A number of customers within GVEA's service territory continue to self-generate electricity in view of the expense of line extension costs. And for historic reasons, UAF and the military bases generate their own power (see below). GVEA's role is convoluted: sometimes selling some electricity to the bases, sometimes buying electricity from UAF, and probably some other interesting behaviors.

GVEA is regulated by the RCA (CPCN 13) and has a service area that covers Fairbanks and beyond.

Additional info:

- Henri Dale, retired from GVEA, will have details on GVEA's acquisitions.
- Wight, P. (2025). Electrifying Alaska's Railbelt: A Generation and Transmission History, 1904-2024. Zenodo. https://doi.org/10.5281/zenodo.14908275

## C.3 Are there other relevant utilities?

Fairbanks has more distributed generation than other communities in part because of the evolution of the distribution of the power plants at UAF, FMUS, Ft. Wainwright, Eielson and later additional GVEA operated power plants using diesel, HAGO, and naphtha generation resources at the North Pole refinery associated with TAPS completion in 1977.

Additionally:

- The Fairbanks Interior Gas Utility is certificated to sell natural gas outside the Fairbanks city limit but within the borough (CPCN 753)
- Fairbanks Natural Gas LLC (CPCN 514) is the gas utility in the city of Fairbanks
- The University of Alaska Fairbanks operates its own coal plant that makes electricity and heat
- Doyon Utilities provides electric utility service for Fort Wainwright in Fairbanks (CPCN 726)
- Doyon Utilities also serves as a heat utility for Fort Wainwright (CPCN 725)
- Fairbanks is connected to the Railbelt and so purchases power from other connected utilities.

### C.3.1 Aurora Energy relation to Usibelli Coal?

Aurora Energy is listed as a customer of Usibelli Coal. Their 2011 Financial Statement filed at the RCA says that "The Company has similar ownership as Usibelli Coal Mine, Inc. (UCM), sole supplier of coal to the plant." The GEM wiki says "It is a private company, owned by Joseph E. Usibelli, Sr., Joseph E. Usibelli, Jr., and Rosalie Whyel."

### C.3.2 A note on technology

For decades, Fairbanks used smaller scale wood and nascent oil/diesel. These were replaced with combined heat-power plants that imported stoker fired traveling grate coal feeds into a

boiler technology adapted from the shipping industry that later converted to oil. Fairbanks imported this relatively efficient form of heat-power energy production roughly contemporaneous with WWII and the influx of federal Department of Defense money. The steam distribution systems also provided humidification in the dry winter months. Over the years there has been some effort to replace/complement steam distribution loops with hot water distribution loops.

Additional info:

- The Royal Navy's conversion to oil is attributed to Winston Churchill.
- Otto Diesel's first big marketing gig was the 1924 World's Fair
- Mark Foster's paternal grandfather came to Alaska in the 1940s following work on hydro projects on the Columbia River in WA and worked on building coal fired power plants with steam heat distribution systems at UAF, FMUS, and Ft. Wainwright.
- See: Davis, T. N., 1984, Energy/Alaska: Fairbanks, AK, University of Alaska Press, 530 p.

## C.4  Categories

Types of utilities in Alaska are listed in Section B.1.2. For his update to the Alaska Energy Statistics Workbooks, Neil McMahon uses an overarching category called "Operator", of which utilities are one type. The types of operators are:

- Public Electric Utility
- Private Electric Utility
- Electric Co-op
- Subsidiary
- Independent Power Producer
- Military
- Industrial
- Joint Action Agency of the State of Alaska
- Political Subdivision of the State

# D  AEDG Grids

## D.1  Complexity

The Open Energy Ontology OEO defines an electrical grid as a supply grid that is an aggregate of material entities such as power stations and power lines. Some data can only be reported at the grid level, meaning that once a power station inputs electricity into a grid, we cannot know which community finally consumes that power and all communities must be reported together. Clarifying these relationships for the AEDG display and correctly accounting for it in the data tables is tricky.

In Alaska's environment of small isolated grids, multiple communities can be connected to the same grid or a community can be isolated on its own grid. The composition of a grid can change over time when, for instance, a community builds an intertie to an existing grid. In that case, a community could belong to multiple grids over time.

The relationship between grids and electrical utilities is also complex. In small communities, the grid and utility are essentially the same. However, some utilities (such as AVEC) have separate grids in each of the separate communities they serve. However, the Railbelt grid includes multiple electrical utilities serving communities in different portions of the grid.

## D.2  Treatment

For his update to the Alaska Energy Statistics Workbooks, Neil McMahon has an intertie lookup table to link communities with grids. In that table, interties are identified with a unique identifier paired with a year that represents the last time a community was newly added to the grid. He then queried by that code to return a list of the communities.

The aim of AEDG is somewhat different, in that AEDG queries the data by community - probably for the current year but also maybe shifting to other years as well. Therefore, the format of our Grids table must have the community as the primary key. The example of the community of Mountain Village is used to describe how our tables work. Mountain Village had an isolated grid until 2020 when an intertie was built to connect it to an existing multi-community grid.

In this case, generation (with imaginary values) is reported by the grid id:

| year | grid | generation |
|------|------|------------|
| 2019 | 64 | 30 |
| 2019 | 75 | 100 |
| 2020 | 75 | 130 |

And the Mountain Village is described and switching from one grid to another. 9999 for `final_year` means the grid is still active in its present form. The `connection_year` 1985 is the earliest year for which we have information.

| community (FIPS instead) | connection_year | final_year | grid_id |
|--------------------------|-----------------|------------|---------|
| Mountain Village | 1985 | 2020 | 64 |
| St Mary's | 1985 | 9999 | 75 |
| Andreafsky | 1985 | 9999 | 75 |
| Pitkas Point | 1985 | 9999 | 75 |
| Mountain Village | 2020 | 9999 | 75 |

If we are querying for generation with `community = "St Mary's" & year = 2020`, then the evolution of the grid is irrelevant. We just need to know if `connection_year <= year < final_year` so we know whether to grab generation for `grid = 75`. For `community = "Mountain Village"` we would get `grid = 75` in 2020, but `grid = 64` in 2019.

If we want to show all the communities associated with this generation value, then that query would be like: find all communities where `grid_id = 75 & connection_year <= year < final_year`. In 2019, this would return 3 communities and in 2020, it would return all 4.