

Alaskan Community Ontology

Describing elements of the Alaska Energy Data Gateway (AEDG)

Alaska Center for Energy and Power (ACEP) at the University of Alaska Fairbanks

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1 Alaskan Community Ontology

Describing elements of the Alaska Energy Data Gateway (AEDG)

1.1 Welcome

This repository was founded to support a foundational element of Alaska Energy Data Gateway (AEDG): the need to crosswalk between the different spatial scales at which socio-economic and energy data are recorded. AEDG has historically displayed data for individual communities. However, some datasets, such as electrical grids and service areas, are only available for groups of communities. Eventually, AEDG will also display data for boroughs and legislative districts so community data itself will need to be aggregated.

To accomplish the computation of these aggregates in a reproducible way, a crosswalk 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 algorithms that compute the aggregations and convert between them. As the development of AEDG continued, descriptions of energy concepts and spatial definitions were added.

1.2 Goal

The goal of this document is to provide a basis for transformation of data provided at different scales so that groupings at multiple scales can be accessed via AEDG dashboards.

This document addresses data that is provided at different scales:

- Interties and grids connect individual communities, pooling electrical generation among them.
- Electricity sales reporting is done by utilities for their services areas, which can be a different group of communities than grids connect.
- Reporting by zip code or census tract obfuscates data collected at the household level, protecting personally identifiable information such as for building footprints.

- Analysis products such as the [Spatial Energy Burden Analysis of the Fairbanks North Star Borough](#) report at census tract level.

It also attempts to plan for serving different audiences which 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.

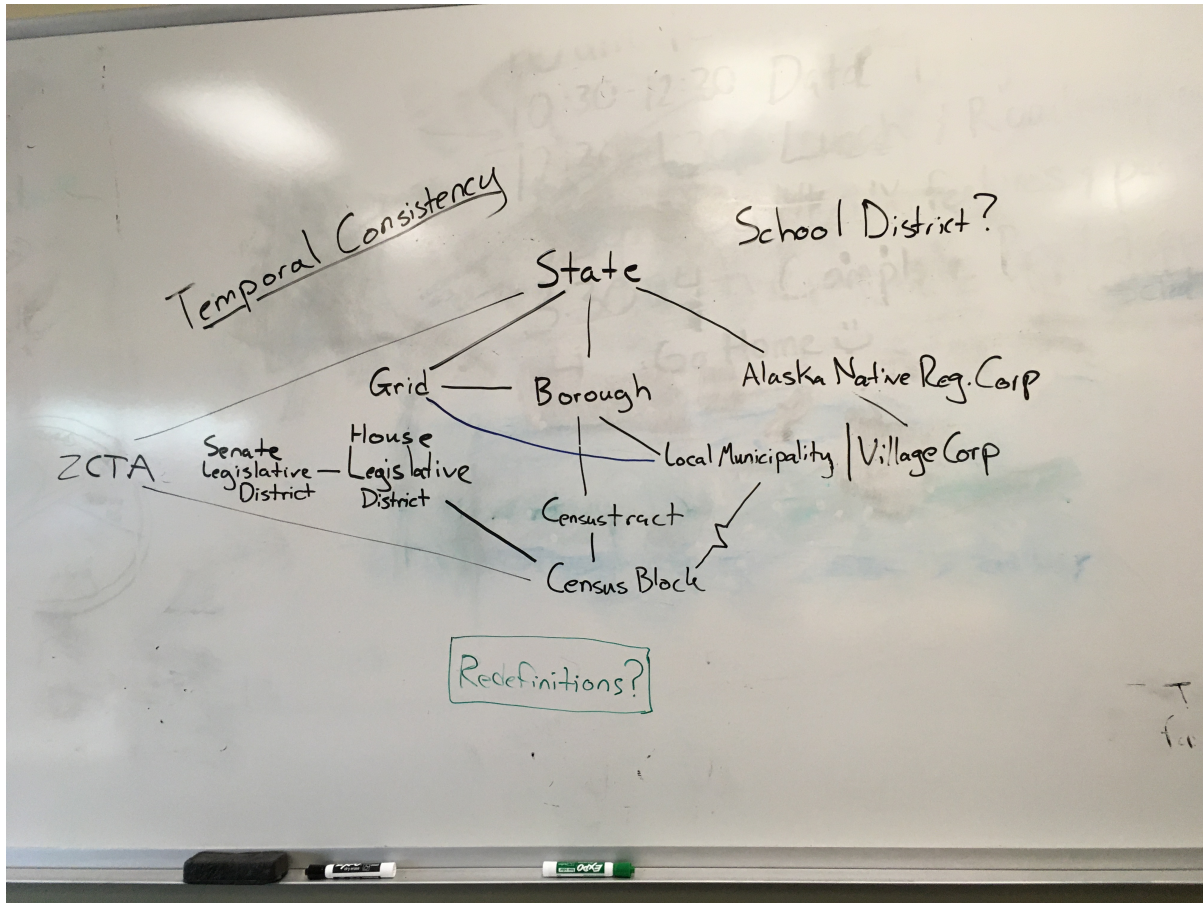


Figure 1.1: Initial Brainstorming by Jesse Kaczmariski (ACEP, UAF), Brett Watson (ISER, UAA), and Mike Jones (ISER, UAA) on 11/11/2024.

1.3 Format

This document consists of 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.
 - Classes are typically capitalized to differentiate them from instances or objects of that class, which are lower case.
- **Properties:** These are attributes of the Classes.
 - Properties could take the form of columns in tables in a relational database.
- **Relations:** These can be hierarchical (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 distinguishes 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.

If possible, this crosswalk will be machine readable/actionable. But to establish with consensus between our various subject matter experts, we needed to start with a single set of definitions and axioms (rules) expressed in a human readable form. The format of a Quarto web book tracked with `git` and published via `GitHub` was chosen so changes could be tracked with documentation of issue resolutions.

1.3.1 Common Properties

Some common properties are used by multiple classes. These are mostly based on the requirements of AEDG's backend Rails database, and few are mandatory. Common properties include:

- `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 rarely 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.

1.4 Possibly Applicable Standards

Whenever possible, existing resources are referenced to resist defining our own ontology from scratch. Example ontologies are:

- [Schema.org](http://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 \(DCMT\)](http://dublincore.org/) are limited to only the most necessary terms. For instance, [dc:Location](http://dublincore.org/terms/property/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](http://dublincore.org/terms/property/dc:Agent) is merely “a resource that acts or has the power to act”. [Wikipedia says](http://en.wikipedia.org/wiki/Dublin_Core_Metadata_Term): “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 \(OEO\)](http://www.openenergyontology.org/), which can be accessed via this [Terminology Service](http://www.openenergyontology.org/terminology/).
- The [Census Glossary](http://www.census.gov/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](http://www.alaska.gov/ancsa/regional-association/), which is a description of the different tribal entities in Alaska with links to more information.

2 Regional Classes

Types of entities in the Alaska Community Ontology

2.1 AEDG Context Only

2.1.1 Communities

- **Definition:** Construct of AEDG that is the fundamental unit of displays and dashboards.
- **SpatialRelationships:**
- **Analogous Standards:**
 - <https://schema.org/Place>
 - [dc:Location](#)
- **Properties:**
 - `fips_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.

2.2 ANCSA or Indigenous Context

2.2.1 FedRecognizedTribes

- **Definition:** For the purposes of tracking energy in Alaska, the definition 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/> has several relevant layers
 - <https://www.fws.gov/sites/default/files/documents/Map-Federally-Recognized-Tribes-In-Alaska.pdf>
 - <https://biamaps.geoplatform.gov/Tribal-Leaders-Directory/>
- **Properties:**
 - geometry (WKT Polygon): boundary of Tribe

2.2.2 VillageCorps

- **Definition:** Alaska Native Village Corporations were created by the Alaska Native Claims Settlement Act (ANCSA) and are organized around small communities. There is not a one to one correspondence between place and Village Corporations. For instance, The Kuskokwim Corporation (TKC) is merger of ten (Lower Kalskag, Kalskag, Aniak, Chuathbaluk, Napaimute, Crooked Creek, Georgetown, Red Devil, Sleetmute, and Stony River) and the headquarters of some are in Anchorage. In the energy context, Village Corporations 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://ancsa.lbblawyers.com/1602.htm> (definition)
 - <https://ancsaregional.com/about-ancsa/#mandates>
 - <https://ancsa.lbblawyers.com/native-corporations.htm> (list of 179)

- <https://dcra-cdo-dcced.opendata.arcgis.com/datasets/DCCED::native-village-corporations/> (215 records)
- <https://dnr.alaska.gov/mlw/paad/17b-easements/search/> (list of 245)
- <https://kuskokwim.com/>
- **Properties:**
 - geometry (WKT Point): longitude, latitude of place or of headquarters

2.2.3 RegionalCorps

- **Definition:** Alaska Native regional corporations were created by the Alaska Native Claims Settlement Act (ANCSA). The boundaries of these areas do not directly represent land ownership, but instead 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.

2.3 Administrative Context

2.3.1 IncorporatedPlaces

- **Definition:** Incorporated places are legally incorporated under state law, have a legally defined boundary, and an active functioning governmental structure. Examples of incor-

porated 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. It is unclear if a government can be a provider.
- **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

2.3.2 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

2.3.3 Boroughs

- **Definition:** Boroughs are analogous to counties in other states with several Alaska-specific qualities. First, boroughs were initially formed in areas whose economies were better developed at the time; the remaining areas were consolidated as the Unorganized Borough. Second, for statistical purposes the Unorganized Borough is divided into Census Areas; these do not have governments of their own. Third, there are also areas where city and borough governments have been consolidated.

- **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

2.3.4 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.

2.3.5 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.

2.3.6 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.
 - [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.
- **Properties:**
 - boundary (WKT Polygon): longitude, latitude points that denote the boundary of the school district.

2.4 Statistical or Research Context

2.4.1 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> as a broad definition
 - [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.

2.4.2 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> as a broad definition
 - [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.

2.4.3 CensusArea

see Boroughs

2.4.4 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> as a broad definition
 - [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

2.4.5 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> as a broad definition
 - [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

2.4.6 DrcaEconomicRegions

- **Definition:** The Alaska Division of Community and Regional Affairs (DCRA) distributes some data grouped by Alaska economic regions, which are based on 2013 borough and census area geography with boundaries determined by the Alaska Department of Labor & Workforce Development.
- **SpatialRelationships:**
 - CONTAINS Communities
- **Analogous Standards:**
 - <https://schema.org/DefinedRegion> as a broad definition
 - [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://maps.commerce.alaska.gov/server/rest/services/Boundaries/CDO_Economic_Regions/Map
 - <https://gis.data.alaska.gov/datasets/DCCED::economic-regions-2/about>
- **Properties:**
 - CommunityName: 6 regional names like Anchorage, Interior, and Southeast
 - DataYear:
 - LocalLaborMarketInfoURL: link to <http://live.laborstats.alaska.gov/alari/> (which is 404)
 - geometry (WKT Polygon): boundaries

2.4.7 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 Electricity Classes

Descriptions of Electricity-related entities in the Alaska Community Ontology

3.1 Infrastructure

3.1.1 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_reporting_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

3.1.2 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 acceptable, if not accurate, route of the lines.

3.1.3 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 [A.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`: Grids are identified with community names so do not have a spatial definition. However, all grids are continuous so could be a combination of lines (PowerLines) and points (PowerPlants) or a shape that encloses all the elements.

3.1.4 Interties

- **Definition:** This is the lookup table in the Energy Stats Workbooks used to describe grids. Interties connect new communities to existing grids and they become active in a defined year.
- **SpatialRelationships:**
 - like Grids
- **Analogous Standards:**
 - like Grids

- **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 punctuation
 - 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: see Grids

3.2 Organizations

3.2.1 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)

3.2.1.1 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 municipal or co-op or very small private or the customers waived it
 - N/A

3.2.1.2 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 in most the recent version of table)

3.2.2 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 [A.1.1](#)
- **Properties:**
 - `service_area`: the control area that FERC mentioned, or the locations of the customers

3.2.3 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 [A.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 service 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.

3.2.4 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 [A.1.3](#)

- **Properties:**

3.3 Reporting

3.3.1 ServiceArea

- **Definition:** The RCA associates every regulated electric utility 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)

3.3.2 PceEntities

- **Definition:** <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) so data in this layer is a link between communities and the utilities that serve them.
- **SpatialRelationships:**
- **Analogous Standards:**
- **References:**
- **Properties:**
 - Year: Entities can drop in and out of the program in time

3.3.3 PceCommunities

- **Definition:** These were defined at the beginning of the PCE program and in some cases are not now equivalent to a single AEDG Community. This is because a grids evolve over time as new communities are added, such as Tok and Tanacross.
- **SpatialRelationships:**
- **Analogous Standards:**
- **References:**

- <https://gis.data.alaska.gov/datasets/DCCED::power-cost-equalization-pce-program/about>: “Alaska Energy Authority Power Cost Equalization (PCE) program by community.”

- **Properties:**

- PCECommunity
- CommunityName
- EntityName: PceEntity such as the utility
- many such as population and rates

4 Fuel, Heating, Thermal, and Transportation Classes

Descriptions of Energy-related entities (besides Electricity) in the Alaska Community Ontology

Unfortunately, without specific data sources to provide and constrain attributes, some classes and relationships cannot yet be defined within the context of AEDG. As data sources are identified, this page will evolve. For now, it is incomplete.

4.1 Fuel (not natural gas)

4.1.1 DCRA's Heating and Gasoline Surveys

- **Definition:** In 2005, the Division of Community and Regional Affairs (DCRA) began collecting prices of heating fuel and unleaded gasoline in 100 select communities. The prices for heating fuel in these 100 communities are collected via a telephone survey of each fuel retailer. The communities have remained constant since the project's inception and the reported prices should be considered representative of what a community resident would have paid for a gallon of heating fuel (including tax) on the day of contact. Values are also presented as averages for DCRA Economic Regions.
- **SpatialRelationships:**
 - INTERSECTS Communities (as in only includes some)
 - Averaged into DrcaEconomicRegions
- **Analogous Standards:**
 - [OEO:gasoline](#)
 - [OEO:heating oil](#)
 - [OEO:monetary price](#)
 - [OEO:provider](#) - A provider is an agent (organization) that transfers commodities, in this case fuel

- **References:**

- <https://storymaps.arcgis.com/stories/6d6a33a3d9a74723a2f476c26ecfdf21>
- https://maps.commerce.alaska.gov/server/rest/services/Services/CDO__Utilities/MapServer/61
- https://maps.commerce.alaska.gov/server/rest/services/Services/CDO__Utilities/MapServer/45
- <https://gis.data.alaska.gov/datasets/DCCED::heating-fuel-price-all-years/about>
- <https://gis.data.alaska.gov/datasets/DCCED::gas-prices-all-years/about>
- <https://gis.data.alaska.gov/maps/DCCED::fuel-delivery-method>

- **Properties:**

- Community (100) or Economic Region
- Heating Fuel Retail Price Per Gallon
- Heating Fuel Vendor
- Gas Retail Price Per Gallon
- Gas Vendor
- Reporting Year: survey year (since 2005)
- Reporting Season: summer or winter
- geometry (WKT Point) or (WKT Polygon): 100 points for communities and boundaries for economic regions

4.1.2 DCRA Fuel Distribution from the Community Surveys

- **Definition:** The process of delivering heating oil and gasoline to 100 surveyed Communities

- **SpatialRelationships:**

- **Analogous Standards:**

- <https://gis.data.alaska.gov/datasets/DCCED::fuel-delivery-method/about>
- **OEO: distribution:** “Distribution is the process of delivering goods and services to agents”
- **OEO: fuel**

- **References:**

- <https://gis.data.alaska.gov/datasets/DCCED::fuel-delivery-method/about> is “Primary method by which a community receives its fuel shipments according to the biannual DCRA Alaska Fuel Survey.”

- **Properties:**

- CommunityName
- Fuel Delivery Method: Barge, Plane, Road, Ice Road (not Rail?)
- AsOfDate: when the survey was performed
- geometry (WKT Point) : 100 points for communities

4.1.3 Propane

- [OEO: liquefied petroleum gas](#): “Liquefied petroleum gas (LPG) is gas mixture of hydrocarbon gases, mainly propane and butane.”

4.1.4 Bulk Fuel Storage

- [OEO: fuel tank](#)

4.2 Natural Gas

4.2.1 RCA Regulated Natural Gas Utilities

- **Definition:** A corporation, person, agency, authority, or other legal entity or instrumentality aligned with distribution facilities for furnishing by transmission or distribution of natural or manufactured gas to the public for compensation;
- **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: natural gas](#)
- **References:**
 - [RCA search](#)
 - Section [A.1.2](#)
- **Properties:**
 - `certificate_number`: RCA Certificate of Public Convenience and Necessity (CPCN) number
 - `certificate_name`: RCA’s name for the utility
 - `geom`: service area

4.2.2 RCA Regulated Natural Gas Storage

- [RCA search](#)

4.2.3 Liquefied Natural Gas Storage

- [OEO: liquefied natural gas](#): “Liquefied natural gas (LNG) is natural gas that has a liquid state of matter.”

4.3 Pipelines and Infrastructure

- [OEO: distribution](#): “Distribution is the process of delivering goods and services to agents”
?

4.4 Heating

4.4.1 Residential Space Heating

- See costs of heating oil as Section 4.1
- [OEO: heating and cooling sector](#)

4.4.2 Wind to Heat

4.5 Thermal (Steam and Hot Water Utilities, Waste Heat, Heat Recovery)

4.5.1 RCA Regulated Steam Heat Utilities

- **Definition:** A corporation, person, agency, authority, or other legal entity or instrumentality aligned with distribution facilities for furnishing water, steam, or sewer service to the public for compensation.
- **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: heating and cooling sector](#)
 - [OEO: district heating](#)
 - [OEO: heating grid component](#)
- **References:**
 - [RCA search](#)

- Section [A.1.2](#)

- **Properties:**

- certificate_number: RCA Certificate of Public Convenience and Necessity (CPCN) number
- certificate_name: RCA’s name for the utility
- geom: service area

4.5.2 Combined Heat and Power (CHP)

- **Definition:** From OEO, “A combined heat and power plant (CHPP) is an energy transformation unit that consists of combined heat and power generating units, a grid component feeding electric energy into an electricity grid, and a grid component feeding thermal energy into a heating grid.”
- **SpatialRelationships:**
 - CHP plants provide heat to nearby buildings (Touches?)
 - CHP plants are Within Communities
 - TOUCHES PowerLines
 - WITHIN Grids
- **Analogous Standards:**
 - [OEO: combined heat and power plant](#)
 - [OEO: heating and cooling sector](#)
 - [OEO: district heating](#)
 - [OEO: heating grid component](#)
- **References:**
 - DOE’s [Combined Heat and Power Installations in Alaska](#)
 - There is a boolean column for this in the [Alaska Energy Statistics Workbooks](#) Generation Plants table
- **Properties:** based on DoE’s database
 - City: Community
 - Organization Name: operator
 - Facility Name: system name (like “Baxter Senior Living Center” or “Angoon”)
 - Application: like “Remote Community”, “Nursing Homes”, or “Hospitals/Healthcare”
 - SIC4: Standard Industrial Classification is a system for classifying industries (from OHSA)
 - NAICS: North American Industry Classification System (NAICS) for classifying business (from census)

- OpYear
- Latest Install Year
- Capacity (kW)
- Prime Mover: like “Reciprocating Engine” or “Organic Rankine Cycle”
- Fuel Class Prim Fuel: coal, oil, propane, natural gas, etc
- Last Verified Project Profile Link
- Microgrid: is it part of a microgrid?
- Critical Infrastructure: does it provide essential services and functions?

4.5.3 Waste Heat to Power (WHP)

- **Definition:** EPA’s definition is “Waste heat to power (WHP) is the process of capturing heat discarded by an existing thermal process and using that heat to generate power”
- **SpatialRelationships:**
 - TOUCHES PowerLines
 - WITHIN Grids
- **Analogous Standards:**
 - [OEO: power plant](#) - “an energy transformation unit consisting of power generating units and a grid component that feeds electric energy into an electric grid.”
 - [OEO: waste power plant](#) may be this, or it might be from refuse (i.e. garbage)
- **References:**
 - EPA’s definition [Waste Heat to Power Systems](#)
 - Unalaska 2015c announced [Rankin Cycle \(ORC\) heat recovery generators](#) at the Dutch Harbor Power Plant.
 - * Unalaska’s WHP does not seem to be in the [Alaska Energy Statistics Workbooks](#) Generation Plants table
- **Properties:**
 - unknown

4.6 Geothermal and Community-scale Ground Source Heat Pumps

- [OEO: geothermal heat plant](#)
- [OEO: geothermal power plant](#)
- [OEO: heat pump](#)

4.7 Transportation

4.7.1 DCRA's Transportation Overview

- **Definition:**
- **SpatialRelationships:**
 - Transportation joins communities
 - Transportation joins communities to services
- **Analogous Standards:**
 - **OEO: transport network:** “A transport network is a supply system of transport network components that enables the transport of people and/or goods.”
- **References:**
 - https://maps.commerce.alaska.gov/server/rest/services/Transportation/Transportation_Overview/
 - [DCCED Transportation dashboard](#)
 - <https://gis.data.alaska.gov/datasets/DCCED::community-transportation-overview/about>
- **Properties:**
 - **airport:** Answers the question: Does the Community have an airport?
 - **cargo_barge:** Answers the question: Is the Community served by a cargo barge?
 - **coastal:** Answers the question: Is the Community located on the coast?
 - **harbor_dock:** Answers the question: Does the Community have a harbor with a dock?
 - **road_connection:** Answers the question: Is the Community connected to a road system to other communities?
 - **state_ferry:** Answers the question: Is the Community served by a state ferry?
 - **description:** a narrative summary of transportation options

4.7.2 Electric Vehicles

- **OEO: electric vehicle**
- **OEO: vehicle charging station**

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](#). In the OEO [Terminology Service](#), only one instance of RO usage could be found: [is homeomorphic for](#) which has a mathematical definition involving sets.

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.

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)
- Transportation joins Communities
 - Transportation joins Communities to services such as fuel distribution
- A Community has a measured population
 - The DCRA uses Census Designated Places as Communities
 - * A city could be separated into multiple Communities. For example, parts of Fairbanks such as College and Farmers Loop are listed separately in AEDG.

6.1.3 Indigenous

- Tribes are nations and should be federally recognized (but sometimes are not)
- 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 Unorganized Borough
 - The Unorganized 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 tracts nest within state
- Census tracts nest within county, or the statistical equivalents of counties
- The optimum population of a census tract 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
- 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

- A Grid is a physical structure that supplies electricity within a single Community or to multiple Communities
 - A Grid consists of physical entities: PowerStations and PowerLines
- A Grid can be subdivided into multiple Grids connected by Interties
 - An Interties is established on particular dates, so a Grid's definition can evolve over time.
- [NREL defines a microgrid](#) as “a group of interconnected loads and distributed energy resources that acts as a single controllable entity with respect to the grid”.

6.2.2 Plant or PowerStation

- A Plant generates power and is connected to a Grid
- A Plant can also generate heat for distribution (Combined Heat and Power, CHP)
- A plant can generate power from waste heat (Waste Heat to Power, WHP)
- Plants report to the EIA with Form 923
- In the Energy Statistics Workbooks, a Plant has a single Operator
 - An Operator can have multiple Plants
- A Plant runs on a reported fuel type such as coal or solar power.
- A Plant has generating units that are driven by a prime mover such as an internal combustion engine or photovoltaic cell.

6.2.3 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
- Some Electric Utilities are eligible to report to the Power Cost Equalization program
- Some Electric Utilities are required to report to FERC
- An Electric Utility can operate its own power generation (Plants) or purchase power from other Electric Utilities or Independent Power Producers
 - Not every Operator is a Electric Utility
- Electric Utility service areas are regulated by the RCA
 - In general, Electric Utilities cannot compete against each other (Section [A.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 and KML maps
 - * See [CPCN 17: Kotzebue Electric Association, Inc.](#)

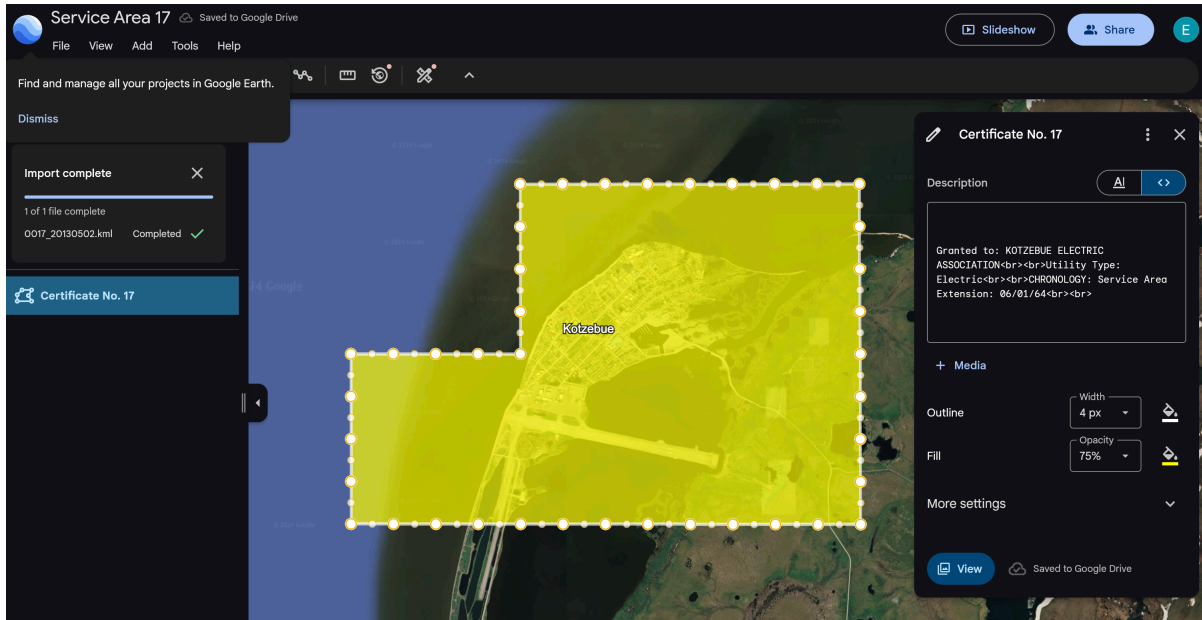


Figure 6.1: Kotzebue Electric's Service Area in Google Earth

6.2.4 IPP

- Many kinds of organizations can act as an Independent Power Producer (IPP), developing, owning, and operating renewable and other types of energy assets.
 - One such entity is a [Tribal Independent Power Producer \(IPP\)](#)
- A local load serving entity can buy power from an IPP and distribute it to customers.

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.

7 About and CRediT

Funding and Authors

7.1 Purpose

This repository exists to support development of the Alaska Energy Data Gateway by the Alaska Center for Energy and Power (ACEP) at the University of Alaska Fairbanks (UAF) and the Institute for Social and Economic Research (ISER) at the University of Alaska Anchorage (UAA).

7.2 Funding

This project was created with support from State of Alaska capital appropriations for the Alaska Energy Data Gateway.

7.3 Authors

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7.4 Additional Information

Learn more about the [Alaska Center for Energy and Power](#).

A Energy-Related Laws

Quotes from Alaska Statute

Some language for the various Classes was derived from Alaska legal code so some 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.

A.1 Definitions

A.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 or
- (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 interconn
- (6) "load-serving entity" means an electric utility that has a service obligation to d
- (7) "reliable operation" means operating the elements of the interconnected electric e

A.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, or
 - (A) furnishing, by generation, transmission, or distribution, electrical service to the public for compensation;
 - (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 the public for compensation;
 - (E) furnishing for distribution or by distribution petroleum or petroleum products to the public for compensation;
 - (F) furnishing collection and disposal service of garbage, refuse, trash, or other waste to the public for compensation;
 - (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 compensation;

A.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 AS 31.05.010.
- (b) In AS 42.45, unless the context requires otherwise, "nonprofit marketing cooperative" means a nonprofit corporation organized under AS 42.45.
- (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 project.
 - (2) "extension of electric service" means the point when at least three new customers begin receiving electric service.
 - (3) "immediate service" means electric service provided within 30 days after completion of construction.
 - (4) "village corporation" means an Alaska Native Village Corporation organized under the Alaska Native Village Allotment Act.
 - (5) "village council" means the duly elected governing body of an unincorporated community.

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

A.2 Allocation of Facilities and Services Between Competing Electric Utilities

[3 AAC 52 article2](#)

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 v
- (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

B Aurora Energy LLC Example

Single community, multiple utilities

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 B.1: Screenshot of Fairbanks electricity section in AEDG v2.

To add more context that can be applied to AEDG v3, 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.

B.1 What is Aurora Energy LLC?

Aurora Energy is a company that owns and operates the coal fired power plant in downtown Fairbanks; it has also been called [Aurora Power](#). 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 Energy is both:

1. a certificated utility that directly serves commercial and consumers rate payers in Fairbanks and receives payments from them, 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 Energy 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.

B.1.1 What is Aurora Energy’s relationship 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.”

B.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>
- [Sources of Power](#), a published list of where GVEA purchased power from. As of April 2025, the list includes 25 MW of power from Aurora Energy, but nothing from UAF and no natural gas generation from other railbelt utilities since February 2024.
- [2023 Annual Report CPCN 13 for Golden Valley Electric Association, Inc.](#) which includes FERC Form 1 on purchased and sold power

B.3 Are there other relevant utilities?

Fairbanks has more distributed power generation than other communities in part because of the evolution of the distribution of the power plants developed at University of Alaska Fairbanks, Ft. Wainwright, Eielson Air Force Base, and later additional GVEA operated power plants using diesel, HAGO, and naphtha generation resources at the North Pole refinery associated with completion of the Trans-Alaska Pipeline System (TAPS) in 1977. In addition, there are, or have been, other energy utilities besides electrical utilities:

- The Fairbanks Interior Gas Utility (IGU) is certificated to sell natural gas (CPCN 753)
- Fairbanks Natural Gas LLC (CPCN 514) used to be the gas utility in the city of Fairbanks, but it is inactive now.
- The University of Alaska Fairbanks’s coal plant that makes both 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.

B.3.1 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.

B.4 Categories

Types of utilities in Alaska are listed in Section [A.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

C AEDG Grids

Transitioning the definition of interties used in the Alaska Energy Statistics Workbooks

C.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.

C.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.