

Appendix D: Emerging Sectors

Energy Innovation

- Installed solar capacity on the Railbelt grew by nearly 600% from 2016-2021 to more than 11 MW. A further 8.5 MW is currently under construction.ⁱ
- The state has more than 150 islanded microgrids in rural villages, several of which have pioneered the integration of diesel generators with wind turbines and other renewable energy systems.ⁱⁱ
- The *Renewable Energy Atlas of Alaska* testifies to rich biomass, geothermal, hydroelectric, ocean and river hydrokinetic, solar, and wind resources across the state.
- Federal legislation in 2021 and 2022, along with public concerns about climate change and rising fuel prices, are driving a push toward decarbonization, adoption of low-cost renewable energy resources, and electrification of transportation.

Alaska's high energy costs are a longstanding barrier to economic development in much of the state. However, the state's unique energy landscape also contributes to widespread experimentation and the early adoption of renewable energy systems and other innovations in an attempt to reduce costs or solve challenges related to remoteness and distance. Historically, this has included hydroelectric dams, the deployment of wind-diesel systems in rural communities, and the pioneering application of solar panels in the Arctic.

As an Emerging Sector, energy innovation is a broad category that includes renewable energy and other technologies related to low-emissions energy sources and decarbonization, including (but not limited to):

- Renewable energy systems such as wind, solar, geothermal, hydroelectric, biomass, and tidal;
- No- or low-emissions power sources such as microreactors and next-generation nuclear power;
- Electrification of vehicles, aircraft, and marine vessels;
- Carbon capture, utilization, and storage (CCUS); and,
- Decarbonizing industrial processes such as those involved in resource development.

Globally, concerns about climate change are fueling public and private investment in the transition to low carbon energy. The federal Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) provide funding and incentives for the adoption of low-carbon energy sources, electric transportation, CCUS, electric grid improvements, R&D, and other energy-related elements. Globally, private investment in low-carbon energy transition was \$755 billion in 2021 and is increasing rapidly.ⁱⁱⁱ

Alaska's size and varied geography mean the state is rich in renewable assets as well as conventional natural resources. The state has been hailed as a proving ground for energy technologies, yielding success stories like Kodiak Electric Association producing nearly 100% of its electricity from renewable sources starting in 2014, through a combination of wind and hydroelectricity.^{iv} The Alaska Village Electric Cooperative boasts wind turbines in 23 of the 58 remote rural communities it serves.^v Perhaps surprisingly for a far northern state, solar power production is growing rapidly, with a 600% increase in installed capacity between 2016 and 2021.^{vi} Additionally, Eielson Air Force Base was selected in 2021 to host one of the first microreactors to operate on any Air Force installation.^{vii}

Alaska's landmass also holds promise for CCUS. From a geological perspective, depleted oil and gas reservoirs and unmined coal beds have potential to store emitted carbon dioxide and the state has an abundance of both. Another carbon capture strategy aligns with efforts to develop the mariculture industry: farming kelp and aquatic plants to absorb carbon dioxide in the oceans.^{viii}

The electrification of transportation systems will also have important implications for Alaska, with its complex transportation needs. IIJA includes funding for electric vehicle charging stations, as well as an electric ferry pilot project. Innovations in electric aircraft have potential to reduce the operating costs of small aircraft for passenger service, like those used to access remote communities in Alaska.

Critical Issues for Energy Innovation

- Lack of public charging infrastructure for electric vehicles outside of urban areas.
- Access to funding programs which understand the nuance of Alaska's unique environment.
- Renewable resources are often isolated in relation to population centers.
- Lack of economies of scale.

Opportunities for Energy Innovation

- Alaska as a proving ground and first market for climate technology.
- Capitalizing on in-state expertise in integration of renewables into microgrids.
- Expansion of renewable energy production.
- Establishing CCUS business models.
- R&D opportunities for private corporations and the University of Alaska.
- Testing of energy systems in cold weather conditions.

Mariculture

Mariculture at a Glance:

- In 2021, there were 49 applications for mariculture operations in Alaska, 31 operations with production, and one hatchery/nursery.^{ix}
- Seaweed production in Alaska grew by 232% in 2021, to 536,390 lbs sold.^x
- Oyster production declined for the third year in a row in 2021, with 4.6 million oysters sold.^{xi}

Mariculture—production of food products from the ocean—is not new in Alaska. Oysters, mussels, and clams have been farmed in Alaskan waters for decades. However, activity in the industry has grown in recent years, specifically in the cultivation of aquatic plants like kelp.

Aquatic farms are scattered across Southeast, Southcentral, and Southwestern Alaska. The industry is challenged by high energy costs and logistical hurdles, both linked to the remoteness of most mariculture operations. Both factors create challenges for processing products and getting them to market.

Mariculture in the Gulf of Alaska

Permitted mariculture operations in Alaska, January 2022.

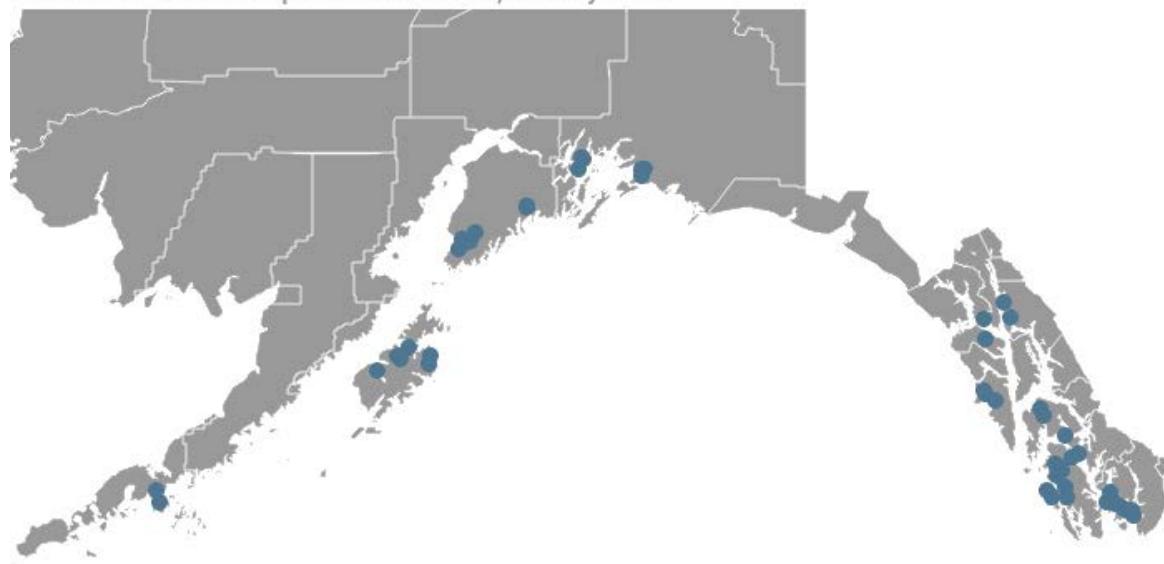


Figure 1: Permitted mariculture operations in Alaska, January 2022.

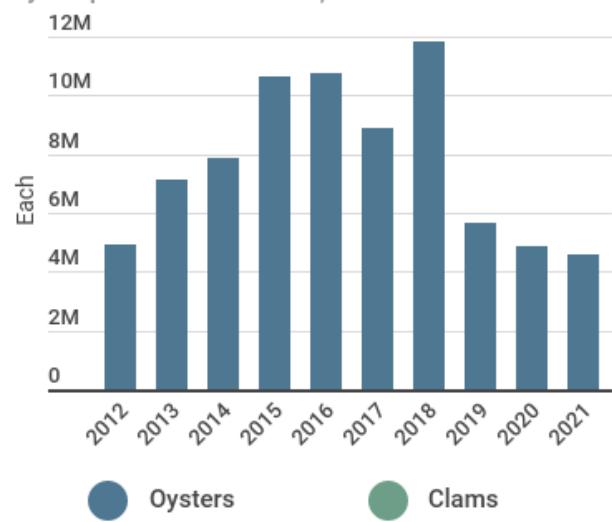
Source: Alaska Department of Fish and Game.

Bivalve production in Alaska has remained variable over the years with oyster production peaking in 2018 at 11.8 million oysters sold by commercial growers.^{xii} Sales decreased in 2019, 2020, and 2021. This was not expected to be a long-term trend; however, the lockdowns and business closures, specifically restaurant closures, associated with the COVID-19 pandemic dramatically disrupted Alaska oyster production.^{xiii} The three-year trend is likely driven by reduced sales from hatcheries and nurseries.^{xiv}

Aquatic plant production—seaweed—has boomed over the last four years, reaching 536,390 lbs sold in 2021 from essentially nothing just five years earlier.^{xv} As recently permitted mariculture operations mature, and new applications are approved, mariculture production could continue to grow rapidly.

Statewide Mariculture Production

Oyster production in Alaska, 2012 to 2021.



Other mariculture production by type, 2012 to 2021.

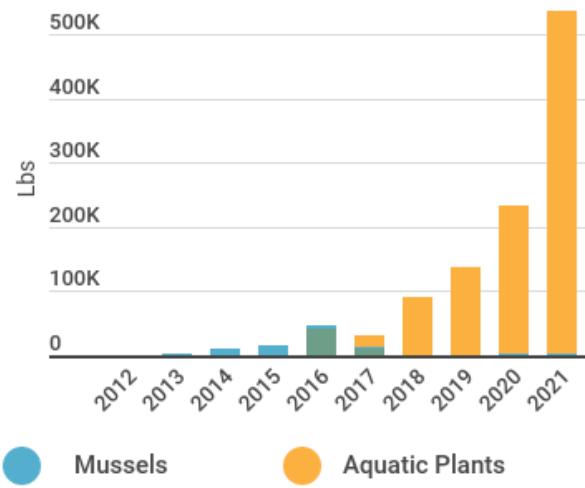


Figure 2: Oyster, mussel, clam, and aquatic plant production, 2012 to 2021.

Source: Alaska Department of Fish and Game.

Aquatic plant production represents one area of mariculture that has been targeted for its growth potential. Currently 97% of the world's commercial seaweed is produced in Asia. Worldwide, farmed seaweed production has grown 7% annually over the last 20 years.^{xvi} Seaweed is used to produce hydrocolloid products, food products, protein replacement, bioplastics, and more; however, Alaska seaweed and kelp is primarily sold to food markets and as animal feed currently.

Alaska's commercial seaweed producers are still limited by low volumes and high production costs. Achieving larger economies of scale will be necessary to enter the broader global market. Forty-nine seaweed mariculture permits were submitted to the State of Alaska between 2017 and 2021. In addition to a limited number of producers in the state, seaweed and kelp growers also have a limited number of buyers for their products. Blue Evolution and Seagrove Kelp Co. are the two commercial kelp buyers in the state, serving growers in Kodiak and Southeast.^{xvii}

Critical Issues for Alaska Mariculture

- Capacity for site permitting and permit backlog.
- High production cost.
- Regulatory and permitting barriers.
- Difficulty of accessing global markets.
- Cultivation of seed stock.
- Impacts of climate change, such as water temperature and ocean acidification.
- Water pollution.

Opportunities for Alaska Mariculture

- Expansion of seaweed buyers diversifying the supply chain and growth in uses and products.
- Mariculture research and product development.
- Growing aquatic plants for carbon capture to mitigate climate change.
- Marketing Alaska oysters to restaurants and other premium buyers in the Lower 48.

- Marketing mariculture products and farm tours to Alaska visitors (cruise industry, lodges, etc.)
- Marketing of premium “Alaska Grown” products.

Marine Services Industry

Marine Services Industry at a Glance:

- Approximately 380 jobs in boat and ship building and repair statewide in 2020.^{xviii}
- A fleet of over 9,000 vessels greater than 28ft in length.^{xxix}

Alaska's dependence on the marine environment runs deep—from Inupiat whale hunters in *umiaqs* millennia ago, to Bristol Bay sailboat gillnetters in the last century. Today, almost all economic activity in the state has ties to maritime activities. Ocean transportation moves goods and people to the state and around the state and delivers fuel to communities and industry sites around the state. Boats are a tool for mining, seafood, tourism, and more.

All of this means that while the state is dependent on marine vessels, vessel operators are dependent on a robust marine services industry to maintain the current fleet and build new vessels. The marine services industry refers to the activities which facilitate the operation and maintenance of Alaska's fleet. According to a 2014 study, Alaska has an aging fleet of over 9,000 vessels greater than 28 ft in length with countless more smaller craft used for subsistence harvesting, recreation, transportation, and patrol.^{xx}

Alaska's in-state boat and ship building and repair industry is small, directly supporting approximately 380 jobs, and seasonal, with employment fluctuating between a peak of 454 jobs in March 2020 and a valley of 330 jobs in July 2020.^{xxi} However, the industry is a growing force with the development of key assets, including the Vigor shipyard in Ketchikan, the JAG Alaska, Inc. Shipyard facility in Seward, and a handful of small boat and ship builders scattered across the state.

Boat and Ship Building Employment in Alaska

Annual boat and ship building and repair industry employment, 2011 to 2020.

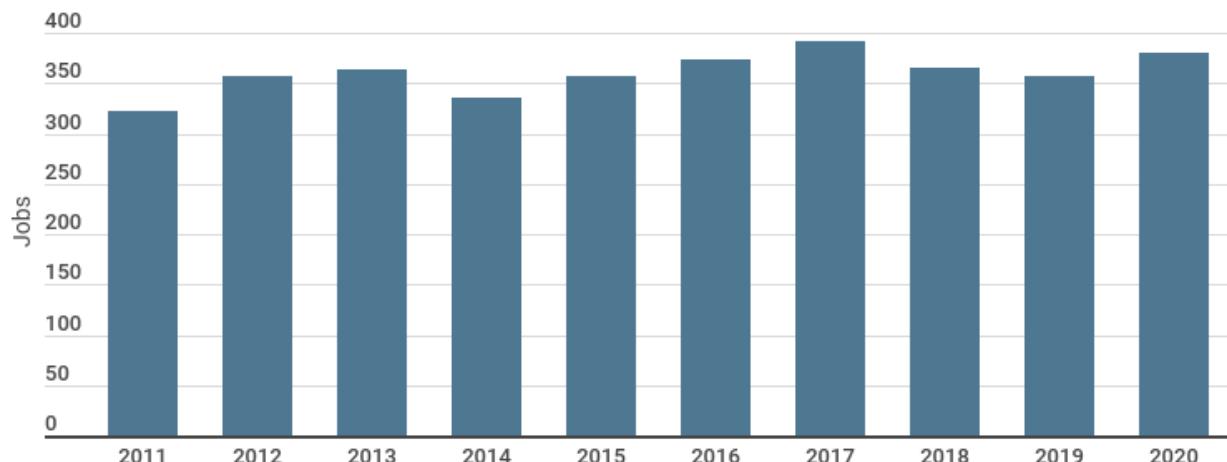


Figure 3: Annual boat and ship building and repair industry employment, 2011 to 2020.

Source: QCEW.

While Alaska's marine services industry is small, it is important to recognize the value of capturing manufacturing and maintenance work that would otherwise go to out-of-state sources, predominantly Washington. A 2015 report published by McKinley Research, *Ties that Bind*, estimates that 5,300 jobs in the marine services industry in Puget Sound stem from Alaska business.^{xxii}

Key constraints for Alaskan companies in this space include workforce challenges, capacity limitations, high energy costs, and access to materials. However, if Alaskan companies can find ways to compete with out-of-state firms by lowering costs or finding other comparative advantages it would reduce leakages out-of-state and improve the economic resilience of industries dependent on maritime activities.^{xxiii}

Critical Issues for Alaska Marine Services Industry

- High cost of doing business.
- Seasonality of demand for services.
- Workforce shortages.
- Access to working capital and financing for fixed assets.

Opportunities for Alaska Marine Services Industry

- Capture a larger share of repair and service business currently going to Puget Sound.
- Developing vessel technology innovations to meet the needs of Alaskans, providing an export opportunity.
- Expansion of maritime tech startups supported by the Alaska Ocean Cluster.
- Growing Alaska's maritime dependent industries (i.e. seafood and marine cargo) to grow business for the state's marine services industry.

Agriculture

Agriculture at a Glance:

- Alaska has approximately 850,000 acres of operated farmland.^{xxiv}
- Approximately 1,050 farms operated in 2021.^{xxv}
- Agriculture revenue has increased over the last two decades, reaching \$39 million^{xxvi} in sales in 2017 in real 2021 dollars.^{xxvii}

Many areas of Alaska have a long history with agriculture, from Palmer which was formally established as an agricultural colony in 1935, to reindeer farming in western Alaska which commenced in the late 1800s and continues today.^{xxviii} While the scale of Alaska's agriculture industry does not lend itself to export—with the exception on the booming peony industry—the products aid Alaskan self-sufficiency and provide valuable import substitution for goods that would otherwise be imported from out-of-state.

A wide variety of agricultural products are produced in Alaska, predominantly for in-state consumption. Nursery, greenhouse, floriculture, and sod production (which includes peony growers) ranks the highest in the state in terms of gross market value of sales, with \$16.9 million in total sales in 2017.

Flower Production Drives Agriculture Revenues

Value of agriculture products sold by product in real 2021 dollars, 2017.

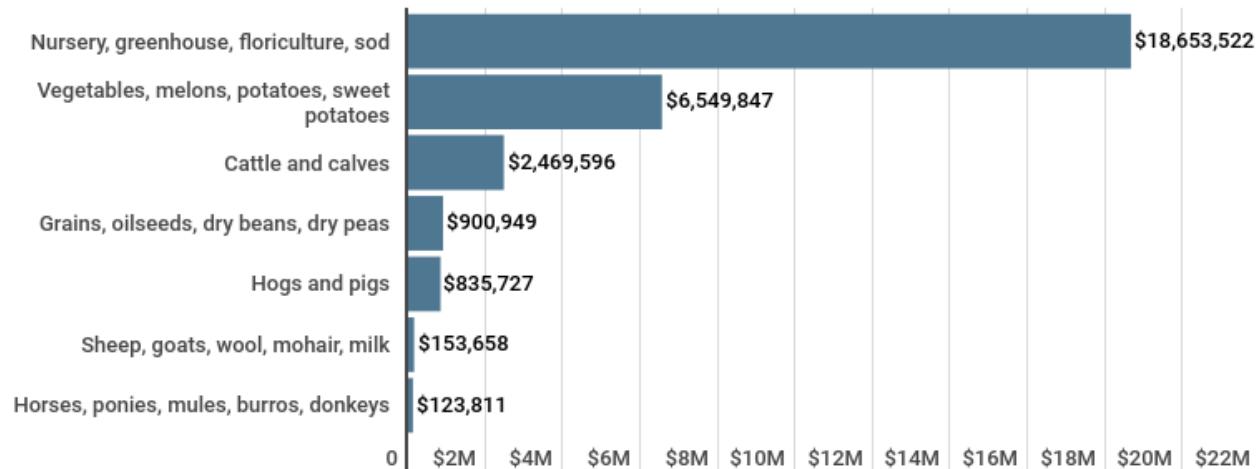


Figure 4: Value of agriculture products sold by product in real 2021 dollars, 2017.

Source: USDA.

Over the last two decades the total acreage of farmland in Alaska has grown. However, the average farm size has decreased. This is perhaps a function of a transition in the type of agricultural activity in the state. While farming activities which require large swatches of acreage, like hay or barley production, still play a role in the state's agriculture industry, the rise of micro-farms for small-scale vegetable production and peony farming has started to shift the industry. Despite this transition total farm sales have grown substantially.

Growth in Quantity of Farms outstrips Growth in Farmland

Total acres farmed compared to total number of farms in Alaska, 2012 to 2021.

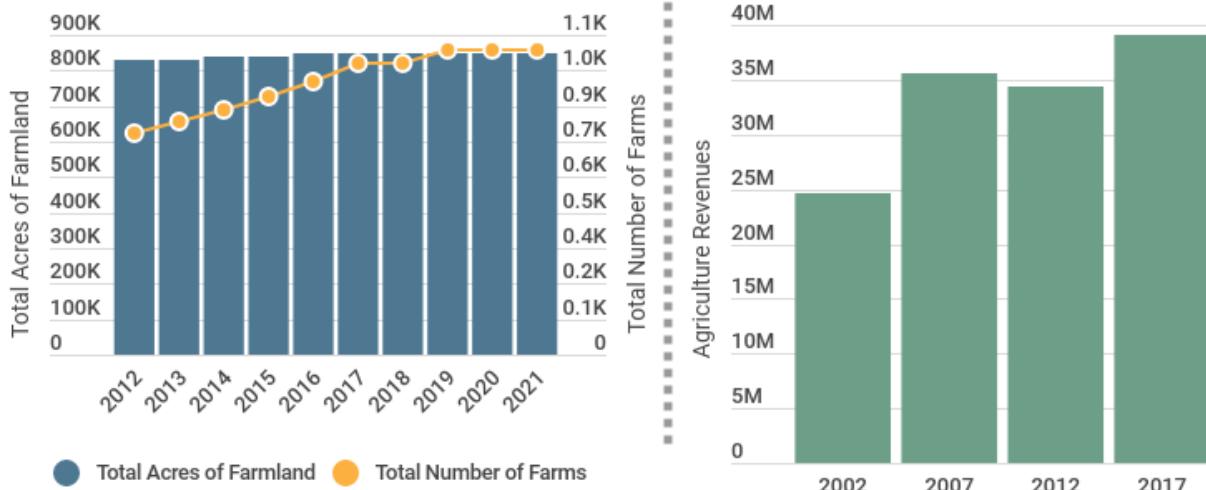


Figure 5: Total acres farmed compared to total number of farms in Alaska, 2012 to 2021; Estimated total agriculture sales in real 2021 dollars, 2002 to 2017.

Source: USDA.

Critical Issues for Alaska Agriculture

- Land availability.
- Succession planning—finding the next generation to step into established operations.
- High cost and logistical hurdles of meeting FDA/USDA requirements.
- High cost of operations in isolated areas.

Opportunities for Alaska Agriculture

- Growing local supply chains (i.e. Alaskan brewers using Alaskan barley and other Alaska grown products).
- Substituting in-state produce for imported produce to keep money local and increase resiliency.
- Maturation of high growth agriculture “cash crops” like peony production.
- Controlled environment agriculture of CEA (e.g. hydroponics and containerized growing systems) enabling year-round production.

Aerospace and Aviation

Aerospace and Aviation at a Glance:

- A total of 6,451 jobs were supported by aerospace and aviation-related industries in 2020.^{xxix}
- Aircraft engine and parts manufacturing exported \$96 million in products in 2020, ranking 14th in the state's total exports.^{xxx}
- FAA's Alaska Region has 2.4 million square miles of airspace.^{xxxi}
- Alaska hosts an FAA-designated test range for unmanned aircraft, and the University of Alaska Fairbanks is a global leader in the field.
- The Pacific Spaceport Complex – Alaska hosted its first private sector launch in 2018. In 2021, the launch site hosted 2 launches, both commercial.^{xxxii}

Aviation is not a new sector in Alaska's economy. Alaska's history has been dotted with the names of many firsts since the invention of aircraft: Noel Wien (Alaska's first commercial aviator), Ben Eielson (first to fly mail), and Joe Crosson (first to land on Denali's glaciers). Coinciding with that list of firsts is a history rich with aviation innovation and technology development, from airplane skis and floats to specialty bush plane tires designed to land on sandbars.

In 2020, aviation and aerospace-related industries supported 6,451 direct jobs in Alaska. This area of the economy was impacted by the COVID-19 pandemic and associated travel reductions. Prior to the pandemic the industry experienced slow but steady growth despite the statewide recession between 2015 and 2019. Though small, the aerospace parts manufacturing sector specifically has shown strong growth, nearly tripling the number of jobs over the last decade. This includes companies like Airframes Alaska and Airglas, who build aircraft components in Alaska and export them globally.^{xxxiii}

Aviation and Aerospace Related Industries Job Growth

Employment in aviation and aerospace related industries, 2011 to 2020.

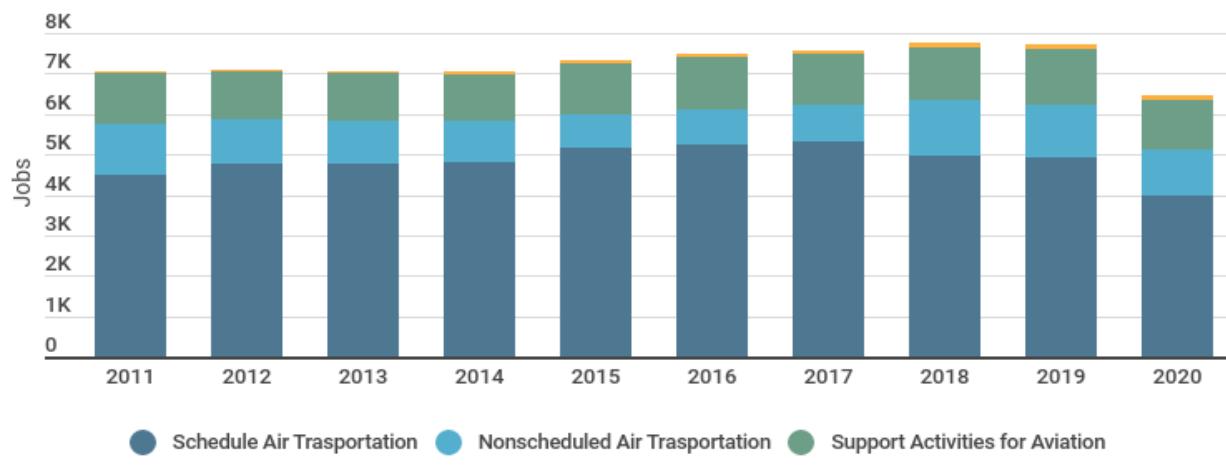


Figure 6: Employment in aviation and aerospace related industries, 2011 to 2020.

Source: QCEW.

According to a report published by the State of Alaska Department of Transportation and Public Facilities, the aviation industry in Alaska supported more than 35,000 jobs in Alaska in 2017.^{xxxiv} This considers the additional indirect and induced impacts of the aviation industry. The industry holds an outsized impact in Alaska's economy, representing 8% of the total employment in the state.

Today Alaska is also leading in other areas of aerospace. The Pacific Spaceport Complex, a launch site on Kodiak Island, facilitates launches by commercial and government partners. Another valuable asset, the Alaska Center for UAS Integration at UAF, operates one of six FAA unmanned aircraft test sites. Both sites are examples of innovation and technology development emerging out of Alaska's miles of airspace.

Critical Issues for Alaska Aerospace and Aviation Industry

- Supply chain isolation.
- High cost of operations.
- Complex regulatory processes.
- A need for greater awareness of Alaska as a first market.
- Access to high skilled workforce (technology skill sets, coding, etc.)

Opportunities for Alaska Aerospace and Aviation Industry

- Participation in recurring business from the low earth orbit (LEO) satellite industry.
- Marketing aerospace facilities to commercial operators
- Strategic northern location to access northern latitudes.
- Scale of available airspace to test new technologies.
- Integrated workforce and training opportunities in communities (Kodiak) and the University of Alaska system.

ⁱ Personal communication with Christopher Pike of the Alaska Center for Energy and Power, September 7, 2022.

ⁱⁱ Renewable Energy Atlas of Alaska, 2019. Alaska Energy Authority and Renewable Energy Alaska Project (REAP)

ⁱⁱⁱ Energy Transition Investment Trends 2022, BloombergNEF,

<https://assets.bbhub.io/professional/sites/24/Energy-Transition-Investment-Trends-Exec-Summary-2022.pdf>

^{iv} Renewable Energy Atlas of Alaska, 2019.

^v AVEC Annual Report, 2021. <https://avec.org/wp-content/uploads/2021-Annual-Report.pdf>

^{vi} Personal communication with Christopher Pike of the Alaska Center for Energy and Power, September 7, 2022.

^{vii} <https://www.safie.hq.af.mil/News/Article-Display/Article/2811527/eielsonafb-announced-as-site-for-air-force-micro-reactor-pilot/>

^{viii} Alaska Explores Cold Temp Carbon Removal and Storage Tech, <https://clean-energy.thebusinessdownload.com/alaska-explores-cold-temp-carbon-removal-and-storage-tech/>

^{ix} ADF&G. "Aquatic Farming: Operations with Production Data." Retrieved from https://www.adfg.alaska.gov/index.cfm?adfg=fishingaquaticfarming.aquaticfarminfo_operations_production

^x McKinley Research Group. (2022). *Alaska Seaweed Market Assessment*.

^{xi} ADF&G. "Aquatic Farming: Oyster Production Data." Retrieved from https://www.adfg.alaska.gov/index.cfm?adfg=fishingaquaticfarming.aquaticfarminfo_oysters

^{xii} *Ibid.*

^{xiii} Alaska Mariculture Task Force. (2021). *Final Report to Governor Dunleavy*. Retrieved from https://www.adfg.alaska.gov/index.cfm?adfg=fishingaquaticfarming.aquaticfarminfo_operations_production

^{xiv} Alaska Sea Grant. "State of the Mariculture Industry in Alaska: 2021 Sales and Current Permitting Statistics." *Shellfish and Seaweed Growers Program*.

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- ^{xv} ADF&G. "Aquatic Farming: Aquatic Plant Production Data." Retrieved from https://www.adfg.alaska.gov/index.cfm?adfg=fishingaquaticfarming.aquaticfarminfo_aquaticplants
- ^{xvi} McKinley Research Group. (2022). *Alaska Seaweed Market Assessment*.
- ^{xvii} *Ibid.*
- ^{xviii} DOLWD. *QCEW*.
- ^{xix} McDowell Group. (2014). *Trends and Opportunities in the Maritime Industrial Support Sector*.
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- ^{xxi} DOLWD. *QCEW*.
- ^{xxii} McDowell Group. (2015). *Ties that Bind: The Enduring Economic Impact of Alaska on the Puget Sound*.
- ^{xxiii} UACED. (2018). *Emerging Sector Series: Boat and Ship Building*.
- ^{xxiv} USDA. *2017 Census of Agriculture State Profile: Alaska*. Retrieved from https://www.nass.usda.gov/Statistics_by_State/Alaska/index.php
- ^{xxv} *Ibid.*
- ^{xxvi} Total agriculture sales were calculated using USDA Census of Agriculture data for Alaska. Total sales include the value of total crop sales and total livestock sales less aquaculture sales. Aquaculture is discussed elsewhere in this report and, therefore, was removed from the discussion in this section.
- ^{xxvii} USDA. *2017 Census of Agriculture State Profile: Alaska*. Retrieved from https://www.nass.usda.gov/Statistics_by_State/Alaska/index.php
- ^{xxviii} UAF Institute of Agriculture, Natural Resources, and Extension. "Reindeer History in Alaska." Retrieved from https://reindeer.salrm.uaf.edu/about_reindeer/history.php
- ^{xxix} DOLWD. *QCEW*.
- ^{xxx} U.S. Census Bureau. *State Exports from Alaska*. Retrieved from <https://www.census.gov/foreign-trade/statistics/state/data/ak.html#:~:text=Top%2025%20Countries%20Based%20on%202020%20Dollar%20Value,%202021%2C083%20%2023%20more%20rows%20>
- ^{xxxi} FAA. "Alaska Region." Retrieved from https://www.faa.gov/about/office_org/headquarters_offices/ara/alaskan_region#:~:text=The%20Alaskan%20Region%20is%20a,are%20not%20connected%20via%20roads.
- ^{xxxii} Alaska Aerospace Corporation. *2021 Annual Report*. Retrieved from <https://akaerospace.com/wp-content/uploads/2022/02/2021-AAC-Annual-Report-final-web.pdf>
- ^{xxxiii} UACED. *Emerging Sector Series: Aviation and Aerospace—Growth and Obstacles in the Aviation and Aerospace Sectors in Alaska*. Retrieved from https://static1.squarespace.com/static/59f6b60bcf81e02892fd0261/t/5f4d8249881fc34ab4348d04/1598915174295/Emerging_Sector_Series_Aviation_Aerospace.pdf
- ^{xxxiv} State of Alaska Department of Transportation and Public Facilities. *The Economic Contribution of the Aviation Industry to Alaska's Economy*. Retrieved from https://www.alaskaasp.com/media/3196/economic_cont_exec_sum_final.pdf