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Alaska's economy is based on knowledge Research – the expansion of knowledge – can improve the state's resilience and competitiveness and contribute to human progress. While Alaska's vast size but

6 One Health Human health, animal health and environmental health are all ineutricably linked, necessitating multiclissiplinary approaches and delivering effective physical and behavioral health care in the Arctic and subarctic

7. Transport, Communications and Information Land transport, shipping aviation, aerospace, telecommunications and information technology in northern environments

As Alaska addresses these critical S&T research arenas, quality kindargarten through twelfth grade (K-12) and university education, with a focus on science, technology, engineering and math (STEIV) instruction is orucial to our success. This report presents a summary of innovative programs and strategies to build the STEIV education pipeline. The report concludes with a discussion of how the State and UA cancellaborate to partner with the private sector to build aculture of entrepreneurship in Alaska Developing Alaska's science and technology capabilities is critical to the state Research is widely recognized as the most significant engine of economic growth, and also constitutes an economically significant "inclustry" inits ownright: The University of Alaska, for example, concluded \$154 million in sponsored research in 2021-22, including \$1365 million at the University of Alaska Fairbanks

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This report is a product of the Alaska State Committee for Research (SCoR), an advisory body or ealed to function as the state committee for Alaska EPSCoR (Established Program to Stimulate Competitive Research) and EPSCoR-like programs This responsibility induces

Oversight and guidance for EPSCoR and EPSCoR-like programs in Alaska as competitively funded by the National Science Foundation and other federal agencies; Promoting research and development as an enterprise and as an engine for economic development in Alaska

#### Strategies

AlaskaNSF EPSCoR has orafted a 5 year (2023-29), \$20 million research proposal, entitled "Glaciers to Gulf," to study how dimeter included landscape change is impacting marine resources oritical to communities on the Gulf of Alaska Nembers of impacted communities ware extensively involved in orafting the proposal and will save as advisors and collaborators throughout the project. Outcomes of the research will include valueble new data streams as well as web tools, reports and visualizations for communities to use in preparing for, and ring for, E ÍÐÏÈ&FI ≜Í I Ì€HÍ Î€&ÉEC&ÃÂÅÄÄÅÅÄÆEEÁÅ&ÄÊÀB&ÇÅÅÉ&EÁÂÅÃDEÇÅÀEÀ

Introduction Oil has been the linchpin of Alaska's economy for a half-century, but Alaskan production is down significantly from its 1988 peak. However, according to the U.S. Geological Survey (USGS), Alaska still contains the largest undiscovered conventional oil and gas potential in the nation and also has significant unconventional resource potential in tight gas, shale oil, and coal reservoirs. Alaska also has large reserves of strategic minerals, which have received considerable recent attention at both the state and national levels. The state sedes to provide innovative solutions to extractive inclustries to improve efficiency, especially during financially difficult times.

Research Initiatives

dements, which have been found in more than 70 different deposits across the state. Making informed mineral permitting decisions that minimize harm to the environment is a priority of the state. Assessing public lands for mineral potential, constructing or edeposit models, developing new techniques for mineral deposit exploration, and concluding research into mine ventilation, remediation, tailings handling systems engineering and technologies are also goals of the state. In addition, Alaska has the potential to further profit from its mineral resources through in-state processing and use.

# economic security goals. The 2022-23 state budget also included specific appropriations for critical mineral and rare earth element research at the UA.

The Alaska State

The Food-Energy-Water (FEW) nous is the intersection of three interdependent components that, together, are needed to sustain life FEW/research in Alaska foouses principally on the interdated ways to provide these three necessities to the state's isolated towns and villages These unique communities have ample supplies of dean water; electrical microgrids separated from larger grids; and a history of hunting and fishing but little agriculture

Agriculture. Alaska sisolation and dimatemake it extremely "food-insecure" and it is estimated that less than five parcent of food eaten in Alaska is produced in the state. Alaska's short but highly productive growing season has strong potential for large-scale agriculture, but less than 1 million aresstatewide are used for farming. There are also economic opportunities in certain high-value agricultural products for which Alaska's high latitude is an advantage, such as reincher antlers, peonies, and golden root. Research into bolstering local food production and improving food security is thus oritical to the state as awhole, as is continued study of the neusof food, energy and water. (Wariculture is discussed in Arena 4)

Renevable Energy. Generating renevable energy is a primary focus of Alaskan FEW/research eAttribly phylion fights bioAlasta Depacially rural Alaska, are astronomical; more cost-effective methods of energy production and distribution are outid to ensuring the future of the state stremote communities In addition to conventional energy resources (see Arena 2), the state's landscape holds significant potential for alternative energy Alaska contains abundant fossil fuel alternatives, including more than 50% of the nation's wave energy resources and over 90% of its river current and tidal energy resources Renevable energy possibilities for Alaska include opportunities for the State of Alaska, its residents, and its inclustries ACEP provides leadership in developing energy systems for islanded, non-integrated electric grids and their associated oil-based heating systems, and researches atternative energy sources as well as more efficient use of nonrenewables ACEP facilities include apower systems integration lab, a wind-diesel generator testbed, and arriver generator test site

Theother side to the Alaskan energy challenge is conservation. Reducing power and heating costs in rural Alaska is a high priority for the state. The state leader in home energy efficiency research is the Cold Climate Housing Research Center, nowpart of the Department of Energy National Renewable Energy Laboratories, which develops facility designs, materials, and construction techniques for the subarctic and Arctic

Renewables can feed back into the new sin several different ways among the possible solutions that can be powered by renewable energy sources are Arctic designed greenhouses, modular water treatment systems installed in individual homes, and advanced algorithms to optimize usage of variable renewable energy generation, such as wind and solar.

Water. Alaska contains abundant water resources, but challengesstill remain insupplying dean water and treating sewage in extreme dimates. Additionally, as Alaska's dimate warms the timing form quantity and distribution of Alaska's freshwater resources is changing and inching so is charactically affecting ecceptions and communities including subsistence food resources, community water supplies, agriculture, and energy production. The Water and Environmental Research Center (VERC) is part of the UAF. Institute of Northern Engineering and concludes basic and applied research related to water and environmental resources. Research disciplines at WERC include environmental, civil, and arctic engineering environmental science, oceanography, limology, hydrology, microbiology, goothemistry, and hydraulics. Current research projects include hydrologic, meteorological and habitat monitoring of various. North Sloperivers, an examination of long-term mercury levels in the Aleutians, and astudy of catastrophic themoleast lake drainage in the Arctic.

## Strategies

UAF runseparimental famsin Fairbanks and Palmer, and the UA Cooparative Extension Service hastaken the lead at the university level in researching and advocating local food production. A state organization, the Alaska Food Policy Council, works toward a goal of creating a healthier, more secure, and more self-reliant Alaska by improving the states food system. The council conducts research and makes policy recommendations in areas such as local food purchasing programs, food production and transport infrastructure, and workforce development. Two current working groups sponsored by the council are focused on Indigenous foods and on food waste UAF, the Alaska Climate Adaptation Science Center, and the U.S. Department of Agriculture (USDA) recently collaborated to produce the Alaska Garden Helper, an easy-to-use tool that enables Alaskans to see

projected changes to their communities' growing conditions, such as changes in growing season length, annual minimum temperature and hardinessizones. The state Division of Agriculture received arecent USDA award to increase its technical assistance capacity within the state, focusing primarily on the peopy inclustry, which is one of the fastest growing and promising inclustries in Alaska agriculture

In 2017 the Alaska Energy Authority (AEA) - an organization charged with coordinating state energy priorities - produced the Alaska Affordable Energy Strategy, which outlines ways to deliver costeffective energy to rural areas of the state. The authoritative report identifies new infrastructure opportunities for delivering more affordable energy, and examines the efficacy of existing energy programs and of potential policy or regulatory charges that could contribute to more affordable and reliable consumer energy in rural communities. AEA more recently produced a Renevable Energy Atlashightighting potential energy sources statewide, and also discussing energy efficiency.

In recent years, various state funds have been used for widespread biomass, geothermal, wind, hydropower, waste heat recovery, and energy efficiency projects, including capital funding in the 2022-23 state budget. Nost significantly, a Renewable Energy Grant Fund established in 2008 has avarded \$275 million to 244 renewable energy projects. ACEP has been the central vector for renewable energy research, including recently funded projects focused on hydrokinetic turbine designs for tidal and riverine currents and on home heaters that store renewable.

## destricity could be used to heat themal stokes or growproduce in greenhouses, for example, and gathering wood for biomass systems could add local jobs

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earning them recognition for their æsthetic and structural properties. Warket research can also help in the development of value added products. The state also works to facilitate wood energy, inducing the use of low grade timber, wood waste and wood pellets for biomass projects. Field trials of alternative systems, inducing bailers, forwarders, and in-field chipping systems, could help reduce biomass harvest and transportation costs.

### Strategies

UA has made recent stricts toward becoming a world-dass occan change research engine, inducing establishing an Ocean Acidification Research Center and operating , addod-dassice-capable research vessel; the latter is stated for \$94 million in improvements to its home port in Sevard. In 2018, the Northern Gulf of Alaska Long-Term Ecological Research (LTER) was established to perform oceanographic observations to better understand dimate change at established station locations in the Gulf of Alaska

In 2016, the state created a Mariouture Task Force, which delivered a final report in 2021 with recommendations to boost Alaska's mariouture industry. This final report indicates that further marioutural research is needed to facilitate growth of the aquatic farmindustry, inducing studies of maximizing growth rates, identifying innovations for efficiency, identifying and mapping natural limiting factors to production such as weather and water current exposure, and understanding genetic relationships among areas to ensure permitting of sustainable mariouture.

Alaska NSF EPSCoR's proposed "Glaciers to Gulf" project will directly address research needs indicated in the state mariculture plan. The five-year project would use remote sensing modeling environmental data, field surveys, and lab and field experiments to understand and quantify changes to freshwater and material export into the Gulf of Alaska, and how this impacts species critical to mariculture and subsistence harvests. The effort would materially improve the ability of marine harvesters and farmers to respond to dimate driven landscape change.

The state Mariouture Plana's olicit to the creation of an Alaska Mariouture Alliance and an unber of legislative actions designed to foster development of the industry, inducing streamlining permitting processes and establishing a state revolving loan fund for mariouturalists. The state can write a funds inits 2022-23 budget for mariouture research, industry support and work force development. Another major development was a 2022 UA conference, "IV ariouture for Alaska's Future. Status, Challenges and Opportunities," that brought together practitioners, regulators, policy makers and scientists to support expansion of the industry. A UA researcher also collaborated with Alaska Sea Grant and the Native Conservancy to develop a site assessment toolkit to help kelp farmers test locations for potential placement of their farms, which has since been licensed for production by a California company.

Alaska's 586,412 square miles encompass a wide array of terrestrial and marine ecceptions, which support diverse wildlife and abundant commercial, recreational, and subsistence resources The Alaskan environment, to alarge extent, defines the people of Alaska, and ensuring the health and subtainability of this environment is crucial to the state as a whole

Monitoring Environmental Change. High-quality dimate observations over extended periods are the only vay for researchers to tease out natural versus human induced change, ansossary dement of understanding and predicting dimate patterns. The state seeks to facilitate this environmental monitoring resource assessment, autonomous underwater vehicles and small satellites

Fireand Earth Science

Fireresserch in Alaskais spearheaded by the Alaska Fire Science Consortium, an interagency group headquartered at UAF's International Arctic Research Center. The mission of the consortium is to coordinate fire science delivery efforts and to facilitate communication between scientists and resource managers. The current NSF EPSCo "One Health" refersto integrated research into the interrelated subjects of human, animal and environmental health - a critical area of research, education and outreach that has seen increased emphasis in Alaska Najor Alaskan health issues include environmental contaminants and infectious diseases, as well as chronic maladies like heart disease, cancer, and diabetes, and preventable conditions like obesity and substance abuse. Alaska's location on bird migration routes makes it susceptible to avian borne pathogens, while dimate change may increase the distribution, spread, and E ÍÐÏÈ&FI ≜Í I Ì€HÍ Î€&ÉEC&ÃÂÅÄÄÅÅÄÆEEÁÅ&ÄÊÀB&ÇÅÅÉ&EÁÂÅÃDEÇÅÀEÀ

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Alaskahaslesstransport and communication infrastructure than any other state. The state has potential for pioneering approaches to land and sea transport, aviation, ærospace, and information technology. In addition, improved telecommunications through the Arctic would place Alaska at the crossroads of global telecommunications, data, and financial networks and position the state for economic growth and newtechnology industries

Shipping. Alaska is heavily involved in addressing safety, environmental and

Thus, scalable networks taking advantage of microwave, optical fiber cable, and satellite technologies will offer availably of new opportunities. An important technology in this context is low earth orbiting (LEO) communication satellites, which can enable available range of data speeds in unpopulated areas. This technology can be improved by research aimed at solving problems of space debris, light pollution, and satellite-to-satellite radio interference. Also important will be research aimed at techniques for laying optical fiber cable over permafrost soil, through river crossings, and inniverbads

### Strategies

Alaska's priorities for the Arctic entail promoting economic and resource development, including facilitating newport systems and improving marine infrastructure to strengthen Alaska's capacity to

orbit using a privately owned rocket, which has staged five launches at the facility.

AlaskaGovernor MikeDunleavyestablished aGovernor's Task Forceon Broadband in 2021, which issued a find report in December 2021. The panel identified communities most in need of upgraded or new infrastructure, recommended a buildout plan for bringing high-speed broadband to all Alaskans, evaluated broadband technologies, identified hurdles to deployment, and provided recommendations for state participation and funding Asaresult, the Alaska Legislature established The most significant way for the state of Alaska to contribute to S&T innovation is through ensuring quality K-12 and university educations, especially in science, technology, engingering and math (STEM) fields. The contributions of engineers, scientists, and other STEM workers are critical to the state, as they solve pressing problems and bolster the economy.

K-12E ducation. Aladra's biggest educational challenge is K-12 teacher retention, especially in rural areas. At issue is not just retention in general, but t—  $\dot{U}$  ‡

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Recent state investments in UA science infrastructure induce engineering buildings at UAA and UAF, health and integrated sciences buildings at UAA, the Murie Life Sciences Facility at UAF, and a NOAA-UAF fisheries facility in Juneau The 2022-23 state budget also inducted funds to modernize the UA's student information technology system UA operates the Delta Mine Training Center, a world-class training and research center that features an underground mine, rock and gravel quaries an equipment fleet, and modern mining and construction machiney.

UA asoimproves infrastructure through collaborating with feeteral programs the current Alaska NSF EPSCoR award includes STEM education programs and funding for five new faculty hires, and EPSCoR's 2023-2028 proposal includes four more hires, both also fund multiple postdocs and gaduate and undergraduate students. The proposed EPSCoR program also includes research into at-science integration, placebased inquiry, and intentional practices in broadening participation, proven ways to promote interest in STEM among diverse learners and the general public. The NIH BLaST program offers funding opportunities and programs for undergraduate and graduate UA students in biomedical fields, with a focus on rural Alaskans. Improving Alaska's S&T landscape requires cooperation between leaders in government, academia, research goups, business, and organizations. Perhaps the most important ways tale and local agencies can foster increased S&T development is to provide entrepreneurs with support to cross the "valley of death," the challenging step between developing a product and actually producing and marketing it. This support can take the form of instruction and business connections, or the more direct form of venture capital. Several programs already exist in Alaska that provide financial support and other services to inventors hoping to establish a market for their innovations.

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Center ICE runs an Innovation Accelerator to support the development of academic research into real-

ACEP	AlaskaCenter for Energy and Power
ACUASI	AlaskaCenter for Unmanned Aircraft Systems Integration
AEA	AlaskaEnergyAuthority
AIDC	Arctic Infrastructure Development Center
ANSI	AlaskaNativeSuccessInitiative
ANTHC	AlaskaNativeTribal HealthCenter
BLaST	Biomedical Learning and Student Training
CANHR	Center for Alaska Native Health Research
COHR	Callege of One Health Research
EPSCoR	Established Program to Stimulate Competitive Research
FAA	Federal Aviation

NSF	National Science Foundation
R&D	Research and Development
R/V	Research Vessel
S&T	Science and Technology
SCoR	Alaska State Committee for Research
SILKAT	Sustaining Indigenous Local Knowledge Arts and Teaching
STEIM	Science, Technology, Engineering and Math