The Climate Action Leadership Team's Climate Change Action Plan is a compilation of numerous ideas drawn from team members, public comment, and the expert and technical panels convened under the CALT's auspices. This is not a consensus document, though there was broad agreement on many of the recommendations. It does provide potential pathways for the state to consider in its implementation of the State's climate change policy. Recommendations should be interpreted not as prescriptive but as a suite of options, which inform agency efforts. The action plan aims to provide a comprehensive approach that strikes a balance between aspirational goals and feasible implementation. As a draft submitted to the Governor in September 2018, the Climate Change Action Plan will continue to elicit public feedback, agency input, and ultimately administration and legislative decisions.

1. Strengthen local and State governance, build State agency capacity, and enhance collaboration and action between state agencies and with local and tribal governments.

1.1 Support local and tribal governments in their efforts to plan for and address the impacts of climate change.

Action 1.1A: Encourage and facilitate a strong network of municipal governments, Alaska Native Tribes, tribal consortia, and Alaska Native Regional and Village Corporations, which will leverage resources, share knowledge and maximize efficiencies and purchasing power.

Alaska communities and stakeholders have identified a significant gap in the State and federal government's capabilities to coordinate responses to climate change. Formalizing a stronger collaboration between local and regional leaders will help to address this issue. The State Co-Chair of the Denali Commission in cooperation with the Alaska Native Tribal Health Consortium (ANTHC) and the Department of Commerce, Community and Economic Development Division of Community and Regional Affairs (DCRA) should facilitate and enhance networking and sharing.

The State should evaluate State and federal processes and protocols for contractual and bidding activities, and survey communities, tribes, and local governments to identify mechanisms for closer collaboration and communication and to identify barriers and opportunities to overcome them. The network should meet quarterly by teleconference, and 1) share and sustain participant cooperation; 2) address cost-neutral ways to collaborate; and 3) serve as a mechanism for fostering increased coordination among the network members.

Action 1.1B: Develop agreements that recognize local and Indigenous rights to self-determination as part of risk and resilience planning and adaptation.

While the State can play an active role in climate change adaptation efforts, it is important to recognize and facilitate maximum local self-government. Local and regional planning efforts must be led at the local level, by municipal and tribal governments, in cooperation with regional stakeholders, and state and federal agencies. State agencies can support, enable, and empower communities in this process.

The Governor's Office, Governor's Tribal Advisory Council, and the Department of Law should work with the Alaska Municipal League and Alaska Federation of Natives to develop a template Memorandum of Understanding for government-to-government agreements between State agencies, tribes and municipalities. These agreements should clearly respect and support the rights of local governments to develop culturally and place-appropriate climate adaptation strategies, and identifies the role of the State in support of those efforts.

Alaska's Department of Homeland Security and Emergency Management should provide community and regional hazard mitigation plans translated into the first languages of the people who reside in the city or village for which the plan is written. Additionally, the State should work with small rural Alaskan communities that have small populations with multiple local governing bodies to develop a multijurisdictional hazard mitigation plan, as permitted, if the communities request to develop a single hazard mitigation plan.

Agreements may need to be in place to address food security as well. The State can continue to seek tribal government input into fish and game regulations, especially as it relates to climate and environmental change.

Action 1.1C: Increase community capacity to plan for and adapt to climate change through technical support and the reduction of intergovernmental barriers.

Many communities lack the capacity to fully respond to the impacts of climate change. To respond to this need, the Governor should establish the Climate Adaptation Interagency Working Group (CAIWG), which should include the Department of Military and Veterans Affairs (DMVA) and the Department of Commerce, Community, and Economic Development (DCCED). The CIAWG should work on providing climate adaptation resources to communities and serve as a liaison between communities and the federal government. This CIAWG will have regular calls with representatives from each region of the state, and will respond to communities' requests for data and technical support as feasible, enlisting support from private organizations as necessary.

The CIAWG should coordinate provide technical support for local adaptation efforts, including planning and implementation, as well as compiling, coordinating, and facilitating the resources necessary to analyze climate financing opportunities for communities. The State should work through the CIAWG to establish a data clearinghouse or "knowledge hub" in collaboration with the University of Alaska and other partners, including Adapt Alaska, to serve as the central repository for climate adaptation, mitigation and resiliency resources. The clearinghouse will not only enhance community-university partnerships, but also provide a one-stop contact for those seeking additional climate change information..

The State should work with the Alaska congressional delegation ensure that federal cost-benefit analysis requirements recognize the unique circumstance of Alaskan communities.

Additionally, the State should review the statutes and regulations associated with the sun-setted Alaska Coastal Zone Management Program (ACMP). An analysis of these might be beneficial for state agency activities in moving forward, or provide guidance for coordinating local, State and federal government efforts. The State can work toward increased that efficiencies and opportunities for coordination and information sharing.

1.2 Support research and data gathering and engage municipal and tribal governments in community risk monitoring, assessment and planning.

Action 1.2A: Support environmental and climate research and monitoring programs in response to prioritized community needs.

A lack of data and a limited ability to gather new data, are hindering adaptation and response planning. Vulnerability and risk assessment, and resilience planning, depend on access to data and the corresponding analyses. To address this, existing programs need to be bolstered, a full inventory of available equipment, programs, and information is identified, and community needs identified and prioritized. These programs include ocean, coastal riverine observing programs and platforms to track and understand sea level change, erosion, precipitation, ocean acidification, harmful algal blooms, permafrost thaw and other environmental changes, as well as to improve mapping, bathymetry, flood forecasting and climate modeling.

An action team led by the University of Alaska can support this effort, and include such partners as the Alaska Departments of Natural Resources (DNR) and Environmental Conservation (DEC), the Alaska Ocean Observing System (AOOS), the Alaska Ocean Acidification Network, the Alaska Harmful Algal Bloom Network, and the Alaska Water Level Watch and Integrated Coastal Mapping Initiative, as well as federal partners. The action team will work with these existing network to establish priority actions that will lead to better understanding of ocean and riverine ecosystems and the changes occurring in them; and funding needs for these issues, ensuring state agency participation in these activities, and identifying funding resources needed to implement the networks' action plans. The action team should review current data and information management systems and make recommendations for how best to strengthen them in support climate change adaptation and response.

Funding for environmental monitoring efforts is currently not sufficient to meet known needs, and especially those in Western Alaska where land and ocean changes due to climate change are dramatic and year-round data is lacking. Funding for the University of Alaska, state agencies, and existing networks will need to increase.

The action team should make recommendations on the potential for using new technologies that can collect environmental data more efficiently and cost-effectively, such as , such as remote monitoring with ship- and land-launched UAV & USV systems, as well as the use of collaborative

community based-monitoring projects, such as ANTHC's Local Environmental Observer (LEO) program and initiatives by DNR's Division of Geological and Geophysical Surveys and the Alaska Ocean Observing System.

The action team should assess the need, requirements and mechanisms for placing equipment on and utilizing federally funded and operated sites to expand the monitoring of Arctic and Sub-arctic climate change indicators, especially if federal spending authority on climate change research is further restricted. The State should increase support and advocate for federal funding as necessary to increase the availability and utility of data that can be used to inform community decision-making.

Action 1.2B: Increase the efficacy and accessibility of vulnerability and risk assessment tools and activities, including their utility for monitoring, evaluating and prioritizing threats.

In addition to gathering data, it is also necessary to evaluate threats and incorporate effective responses into community risk assessment plans. The Denali Commission has worked with the University of Alaska Fairbanks to develop a useful risk assessment methodology for climate change-related impacts to communities. The Alaska Risk Mapping, Assessment and Planning (Risk MAP) Program, a partnership between the State of Alaska and the Federal Emergency Management Agency (FEMA), can be further invested in to address data gaps, increase public awareness and understanding of natural hazards, and lead effective engagement in mitigation planning.

State and federal agency cooperation, in coordination with the Denali Commission, will be essential to delivering useful tools. The State may want to fund a position at the Denali Commission to help facilitate this work. This position could work closely with UAF's Alaska Center for Climate Assessment and Policy (ACCAP) and Scenarios Network for Alaska + Arctic Planning (SNAP) programs, and Alaska Sea Grant.

The State should consider expanding training and support, including any associated funding for the Local Environmental Observers Network (LEO), which provides significant real-time observation and monitoring of environmental changes. The State could create a catalog of existing tools for use by communities; and encourage federal agencies (NOAA, USGS and the U.S. Army Corps of Engineers especially) to share their tools and make them appropriate for Alaska conditions.

Action 1.2C: Develop community and regional risk and resilience plans in partnership with local and regional leaders, and including strong public engagement.

The State already has a methodology and system for community risk planning. This process can be strengthened by increasing funding for the DCRA's Alaska Climate Change Impact Mitigation Program (ACCIMP), which will provide technical assistance and funding to communities imminently threatened by climate-related natural hazards such as erosion, flooding, storm surge, and thawing permafrost.

In conjunction with planning at the local level, the State can also conduct its own statewide risk and resilience planning effort, which should be informed by community-led processes. This effort must include the identification of priorities and additional investments necessary for under-resourced and at-risk communities. This effort will take a combination of state, federal and private partner resources.

The new Climate Change Adaptation Clearinghouse or "knowledge hub" identified in Action 1.1C would be used to help coordinate research among scientists, as well as to Tenable the State and local communities to know who is doing what research, where. This creates a positive feedback loop. An existing example of this kind of coordination is the North Slope Science Initiative.

1.3 Strengthen existing and further implement effective, efficient systems for community adaptation and relocation.

Action 1.3A: Create a policy framework for federal and state agencies to implement community relocation and adaptation.

One of the challenges facing at-risk communities is the lack of a formal federal or state policy on responses to climate change, especially as it relates to relocation. An interagency approach will be necessary to obtain funding for and implement strategies and coordinate and assist with planning.

Though it is likely that the federal government will need to lead relocation efforts and provide funding, the State has an important role. DEC, DCRA, and DMVA and the Department of Transportation and Public Facilities (DOT&PF) should develop a strategic plan that provides for the implementation of this process, including in support of DCRA's community risk planning and the recommendations of the interagency working groups for threatened communities. The state can assist communities in making the case for funding and advocate overall for increased federal funding to address this issue. Implementation should be consistent with community defined priorities and decisions.

Action 1.3B: Collaborate with federal agencies on the development of a federal implementation plan, with associated funding in place, for threatened and at-risk communities, responsive to local and regional planning.

It is important to recognize that while the State has a role in responding to the impacts of climate change, much of the responsibilities remain with federal authorities. There is no consistent or overarching federal policy related to the issue, which hinders action in the short term and leads to uncertainty in the long term. The State's role can be augmented with more effective federal policy in place.

The State should request the Alaska Congressional Delegation to secure enhanced federal funding in existing programs to address and prevent damage resulting from permafrost degradation, loss of sea ice, and coastal and riverine erosion. The Governor's office should advocate for these changes with the Congressional Delegation, the White House, and applicable federal agencies, including Department of Homeland Security and Department of Interior.

The State should recommend changes to federal programs, such as under the broad authority provided in US Code Title 25, aka the Snyder Act of 1924, which covers Indian Affairs, the Bureau of Indian Affairs, Office of Trust Services, Tribal Resilience Program, which was created and received appropriations for a Tribal Climate Resiliency Grant Program.

The State should explore opportunities to enhance the Stafford Act, expanding the definition of "major disaster" in 42 U.S.C. § 5122(2) to include damage resulting from permafrost degradation, loss of sea ice, increased storminess, and coastal and riverine erosion. Changes to the Stafford Act will have national implications and may not result in the direct action beneficial to Alaska communities.

The Governor will request that the Denali Commission and DEC co-lead the development of an action plan for threatened and at-risk communities, including a strategy for implementing adaptation and relocation strategies. Increased funding for the Denali Commission is essential to supporting this effort and to building capacity. The action plan will incorporate existing local and regional plans, and will be developed in coordination with community and regional leadership. It will leverage the Denali Commission's newly developed vulnerability index and make corresponding recommendations for action, with targeted federal funds identified for each action.

Tools to make available to communities and to coordinating agencies could include the U.S. Climate Resilience Toolkit, which has been developed by NOAA, or the U.S. Climate Alliance Toolkit. The State should downscale this approach and develop a model Alaska toolkit that helps to share Alaska's story and exports Alaska knowledge.

Action 1.3C: Include Western science and Indigenous Knowledge in adaptation actions.

The appropriateness of adaptation responses depend on good information, which must come from both western science and Indigenous Knowledge (IK). The complementing use of both knowledge systems produces science-informed, culturally relevant, place-based solutions.

Some of the data necessary for adaptation action does exist, and together with ANTHC and the Denali Commission, the UAF SNAP program, and the Alaska Ocean Observing System's Ocean Data Explorer, can provide a large variety of Alaska and Arctic research data. However, there remain significant data gaps in much of the Interior and Western Alaska, as well as along the Western coast.

A substantial effort must be made to work through a strategy to identify, develop and improve the processes in place necessary for community adaptation or relocation. The State should employ a co-production of knowledge approach that incorporates both Western science and Indigenous Knowledge.

Action 1.3D: Create opportunities for training community members to plan for and execute adaptation actions

Building local capacity is essential for adequate and appropriate climate change response and adaptation. While this is an essential service in many respects, it is also a growth opportunity for the state. Developing the expertise and skillset necessary to respond to the impacts of climate change is an exportable knowledge, from which Alaskans can derive future benefit.

While many of these efforts are currently led by government agencies, ANTHC, or by private contractors, there is room for additional home-grown solutions. The State can promote local innovation and the development of a regional workforce, and can support future companies that emerge to meet the climate change challenge. The State can assist by identifying and helping to remove barriers to community-led relocation efforts (including engineering, design and construction).

The State's workforce development programs (see policy statement 5) should include climate change relocation, perhaps in collaboration with regional ANCSA corporations. From this could emerge new business development opportunities, including opportunities in other regions of the world facing similar challenges, such as the Canadian north, rural America, and islanded communities. A priority should be matching the skill sets of returning/retiring veterans to those in demand in the clean energy/utility workforce through programs such as Helmets to Hardhats.

1.4 Commit to long-term, strategic state leadership on climate change issues that includes immediate action, mainstreaming climate change within existing state activities, and implementation and continued evaluation of the Climate Action Plan.

Action 1.4A: Factor climate change into all intersecting state agency missions, policy, and programs.

The concept of "mainstreaming" climate change action recognizes that climate change intersects with much of the State's current activities. Existing and new statutes and regulations will have to grapple with climate change impacts on State programs, and the ability of these programs to mitigate or help adapt to climate change.

In order to build on the effort initiated by Administrative Order 289 and through their participation in the Cabinet Climate Team, each State department and agency should continue to prioritize, develop, implement, and recommend the State's climate strategy. The Governor will immediately

issue an Administrative Order directing all state agencies to consider the economic, environmental, cultural, and other effects of climate change on their decisions. State agencies will undertake an immediate, comprehensive review of State activities affected by climate change and the statutes and regulations guiding those management decisions.

Additionally, the2009 report of the Immediate Action Working Group (IAWG) of the Climate Change Sub-Cabinet provides significant detailed action items and implementation actions in response to information and requests that were gathered from interviews with impacted rural Alaskans and many agencies personnel. This report can be referenced as a secondary guide for state agencies. In addition, the State should review the sunsetted Alaska Coastal Zone Management Program and determine lessons learned and best practices, thus ensuring any new efforts would address both the broad scope of climate impacts and the need for economic development in rural Alaskan communities, and take into account the opportunities and efficiencies gained through stronger cooperation.

Action 1.4B: Formalize a mechanism to prioritize climate change interests, such as the Climate Action Leadership Team, and reconstitute the Division of Intergovernmental Coordination within the Office of the Governor as the appropriate host.

Given the complexity of climate change and the degree to which multiple agencies and levels of government must respond, and to avoid duplication and conflict, the State needs greater capacity for inter- and intra- governmental coordination. Initiating something like the old Division of Intergovernmental Coordination will be an important step in strengthening climate change communication and collaboration, even as it addresses other coordination at the discretion of the governor.

The Governor's Office, working with the Department of Law and legislative staff, will encourage the CALT to further the implementation of this climate action plan, as approved by the Governor. CALT will maintain its current form and membership as articulated in AO 289.

The State should name lead climate staff for each agency to report to the Governor's Senior Advisor on Climate Policy, and to assist in the implementation and evaluation of the climate strategy. All relevant State agencies or affiliated bodies (political subdivisions, with the exception of municipalities) should each nominate a Climate Change Liaison (CCL). CCLs will participate in monthly meetings with the Governor's Senior Advisor on Climate Policy and help to guide the implementation of the State's climate strategy within their respective agencies.

Increased inter-governmental coordination should include tribal governments and all federal agencies with intersecting interests, including the Denali Commission. The State should cooperate with federal agencies and advocate for appropriate programs to address research, adaptation and mitigation efforts, and within Congress for necessary financial resources. The State should also sufficiently fund State and university participation in international climate change forums, including

the Arctic Council, the United Nations Intergovernmental Panel on Climate Change, and relevant national and regional cooperative efforts in the U.S., and consider joining the U.S. Climate Alliance.

Action 1.4C: Include immediate climate action within the mission of the Governor's Disaster Policy Cabinet

The impacts of climate change will be felt by Alaska's communities, economy and environment. The effects will exhibit themselves as permafrost degradation, storm surge, ocean acidification, coastal and riverine erosion, and species migration. The negative outcomes from these will include loss of food security, fisheries closures, infrastructure loss and degradation, and the need for communities to relocate where protecting in place is not possible.

The Disaster Policy Cabinet should incorporate climate hazard mitigation and response into its directive, and should develop a procedure for State agencies to respond to climate disasters, ensuring the quick deployment of resources after the Governor has issued a disaster declaration. The Disaster Policy Cabinet could also organize a sub-group to function as an Immediate Action Working Group that would coordinate with at-risk rural communities in conjunction with a slow-moving disaster.

The Governor's Office, in collaboration with the Disaster Policy Cabinet and the Department of Military and Veterans Affairs, should develop a legislative proposal to establish a State-funded hazard mitigation program. This State-funded program, if approved, would meet the non-federal cost share requirements of federal mitigation programs (including the FEMA Hazard Mitigation Grant program) to leverage federal funding for projects to reduce the threats and risks of hazards that are the results of a warming climate.

2. Better understand and work to address natural, human health, environmental and ecosystem changes.

2.1 Using a co-production of knowledge approach that integrates western science and Indigenous Knowledge, monitor and gather data needed to better understand the impacts of climate change on natural environment and to identify hotspots that contribute disproportionately to ecosystem resilience and health.

Action 2.1A: Support increased ecosystem scale and cumulative impact research of impacted or threatened environmental systems within State agencies.

The Department of Fish and Game (DF&G), Department of Natural Resources (DNR), and the Department of Environmental Conservation (DEC) actively monitor and are responsible for the health of the environment and living resources. There is a clear awareness of and concern for climate change's impacts within these agencies. Given the scale of the challenge, however, the capacity of State agencies should be increased.

The Governor should propose increased funding for agency research and partnerships to provide baseline information and to study climate impacts to ecosystems and the cumulative impact of multiple uses, including fish stock impacts. The State can leverage and advocate for increased federal funding, strong university grant applications, and philanthropic funding in support of this effort.

Action 2.1B: Invest in programs that provide critical marine, atmospheric and terrestrial data, including operations, equipment and infrastructure.

In some parts of the state there is existing local research infrastructure to support research and monitoring at the local level. However, in much of the rest of the state, this infrastructure is lacking; stifled local economies limit research capacity, which reduces the availability of local data and hinders informed State and local government decision-making.

The State should identify needs in this area, and create and implement a state plan to fund and develop that infrastructure. The University of Alaska, federal partners, and partner organizations such as AOOS, North Pacific Research Board (INPRB), and Alaska Sea Grant would be potential collaborators.

DF&G, DNR, and DEC should assess their respective data-gathering capacities, and deliver recommendations for future State investments in data collection through their agency's Climate Change Liaisons. A key priority investment would be a State/Federal partnership in developing community decision-support tools for coastal hazard (flood) forecasting capabilities. These are already operational or under development along the Pacific Coast states. For example, the USGS Pacific Coastal and Marine Science Center has developed a Coastal Storm Modeling System to provide more detailed predictions of coastal flooding due to both future sea level rise and storms integrated with long-term coastal erosion. The opportunity remains limited in Alaska because of inadequate observational data for tides, nearshore bathymetry, beach morphology, etc. A deliberately arranged partnership among State and Federal agencies that brings targeted resources to bear could change the capacity to model and forecast storm events along Alaska coastlines.

The State should advocate for sustained and increased federal funding on behalf of this effort and to strengthen Alaska's science and research capabilities overall.

Action 2.1C: Make data available and sharable to facilitate the assessment of impacts and monitor the rate of change within marine, freshwater, atmospheric and terrestrial systems.

The State should host a statewide data management conference to assess the state of data sharing between government, private sector and academic researchers and data managers. This can be coupled with existing efforts led by the Alaska Geospatial Council, as well as national data collection and management.

This conference should develop recommendations about the accessibility of marine, freshwater, and terrestrial data through existing data portals, and the potential utility of a centralized "climate collaboratory." Such a portal could be housed at the University of Alaska and contributors can include the University of Alaska, state resource agencies (DF&G, DNR, DEC), AOOS, and federal resource agency partners (the U.S. Fish and Wildlife Service (FWS), the U.S. Geological Survey (USGS, and the National Oceanographic and Atmospheric Administration (NOAA)).

Existing data portals include AOOS' Ocean Data Explorer, Arctic Environmental Response Management Application (ERMA), the National Ecological Observatory Network (NEON), the Local Environmental Observer Network (LEO), the Alaska Energy Authority (AEA) data portal, and NSF's ACADIS. There are also good international examples to explore as models, including Canada's, and domestic models used by some industries (e.g., fisheries). Open and public access and ease of use are key elements to consider.

2.2 Adopt an approach that understands ecosystem and food security health as part of human and community health.

Action 2.2A: Assess climate impacts to food security and improve approaches and policy that work toward sustainable and locally accessible fish, wildlife and plant harvests.

While the State cannot relocate fish and wildlife due to the impact of climate change, in the way that it might be able to for communities, it can work to better understand these impacts and include this these factors in management decisions. This is consistent with current agency statutes but adds a layer of focus on climate change.

Management decisions will continue to wrestle with food security and subsistence priorities, who has access and with what limits to put in place. Agencies that work toward the sustainability of these resources will have to consider the additional challenges presented by climate change.

The State should initiate an assessment that considers food security not only from the perspective of subsistence or commercial resources, but also explores a natural disaster elsewhere that affects food shipments to Alaska. This can include all the other climate-related disruptions to the vast web of food systems that the state currently relies on and is vulnerable to. As part of the assessment, Alaska should assemble a multidisciplinary team that includes farmers, indigenous knowledge holders, grocery store owners, transportation officials, soil scientists, public health experts and local government planners, who together with the Alaska Food Policy Council, and university researchers, should produce a white paper to help guide future decision-making.

The State may need to consider revising fish and game policy and regulation with community input, in order for communities to continue to meet their nutritional requirements and cultural well-being with changing seasonality.

Action 2.2B: Collaborate with local, regional, federal, and international partners working on One Health initiatives and integrate leading practices as they apply to climate change impacts.

"One Health" is a term used to describe the important connections between people and the environment, and the health impacts if one or the other is suffering. The Office of the State Veterinarian operates within the "One Health" model. This model is a worldwide strategy which recognizes that human, animal, and environmental health are intricately related and seeks to expand interdisciplinary collaborations and communications across these health disciplines. This is demonstrated by the OSV's close working relationship with a number of diverse community, state, and national partners.

The State Epidemiologist, in collaboration with ADF&G and University of Alaska researchers,should prepare a recommendation for moving forward with a statewide One Health policy.

The Department of Health and Social Services (DHSS) and DEC's Division of Environmental Health should prepare a summary of agency work on One Health initiatives, including plans for future collaboration.

Action 2.2C: Continue and increase monitoring and reporting on ocean acidification and the impacts of acidification on Alaska's fisheries and coastal/marine ecosystems.

Alaska's State and federal waters are home to the nation's largest and most sustainably managed fisheries, including a growing mariculture industry. The threat of ocean acidification is significant both to the state's economy and to local communities and individual livelihoods.

The State should research best practices as they relate to these issues, including methodologies applied by other regions. Where research is lacking, the state will pursue additional resources, especially for the University of Alaska's Ocean Acidification Research Center and biological impact testing at NOAA's Kodiak Fisheries Lab. The Alaska Ocean Acidification Network is taking the lead on coordinating research and observing efforts, and in engaging with fishermen, tribes, and others potentially impacted by ocean acidification, to slow the rate of change and to develop fisheries and mariculture that are less sensitive to ocean acidification.

The State should launch an X-prize competition that focuses on innovative solutions to slowing the pace of ocean acidification.

Action 2.2D: Assess and ameliorate the impacts of climate change on the health of individuals and communities.

The State should acknowledge that rapid changes in climate and environment will manifest impacts in the health of Alaskans and our communities through stress-induced trauma and other

consequences to well-being, potentially through food insecurity, suicide, or through physical injuries incurred during adaptation efforts. Other impacts to human health may result from zoonotic diseases, perhaps transmitted through parasites (like Lyme disease) not currently existing in Alaska. Research is needed on all aspects of physiological and mental health to reduce or prevent consequences of a changing climate from adversely impacting the health of Alaskans.

2.3 Develop and implement ecosystem-scale resource management programs.

Action 2.3A: Conduct baseline studies and monitoring necessary to understand ecosystem process and changes that guide community and state decision-making and risk assessment.

DF&G, DNR and DEC should seek funding for and prioritize baseline studies and monitoring programs in communities and regions most threatened by climate change, ensuring the accessibility of reliable data to inform decision-making.

The State should expand efforts to connect ongoing or increased monitoring to resource management actions, policies and decisions, as well as vulnerability and risk assessment. State policy should continue to support sustained access and sustainable harvest by Alaska residents to locally available fish, wildlife, and other renewable resources.

In order to increase the focus on climate change impacts, the State should include a climate impact assessment, including impact on Alaska's commitment to reducing greenhouse gas emissions, in evaluation of proposed future state and community development, within an Environmental Impact Assessment.

Action 2.3B: Strengthen systems for research-informed natural resource and coastal hazard management among state, tribal, local and federal land and resource managers.

Natural resource management decisions should be based on good science and best practices. Given the complexity and scale of the challenge of climate change, it will become necessary to increase the State's capacity to identify and meet research needs, strengthen the incorporation of research into decision-making, and work with other levels of government, especially tribal governments and associations.

The Governor should direct DNR, DEC, and DF&G to work with Alaska Native Tribes, tribal consortia, and Alaska Native Regional and Village Corporations, to prepare analysis of current cooperation and Indigenous Knowledge use in natural resource management. Based on the analysis, the agencies should prepare and implement a plan to strengthen and replicate what is currently working.

The State can work with the university or other appropriate organizations to host trainings for state employees on existing tools and products that incorporate Indigenous Knowledge. For example,

ACCAP could host trainings on the use of the Historical Alaska Sea Ice Atlas, which is updated annually by AOOS.

The State's land and resource managers should host an annual resource management roundtable attended by experts from tribal and municipal governments, and include a review of food production and security. This discussion should produce a white paper on progress made, areas to be addressed, and priorities for implementation.

Action 2.3C: Develop and implement mechanisms that bridge Western science and Indigenous Knowledge in the co-production of knowledge, enhance ecosystem awareness, minimize negative impacts, and strengthen resource management.

The State should convene a working group to define a co-production of knowledge approach that can be implemented across State agencies. In partnership with the IACWG, the Governor's Tribal Advisory Council can lead this process, in cooperation with the state's *Science Committee on Research (SCOR).*

The State should initiate and participate in conversations about the co-production of knowledge at the national and circumpolar scale, as well, which can help to share Alaska's perspective but also bring in new expertise to be applied in the state. Supporting other venues that link scientists with Indigenous Knowledge practitioners is another specific action.

Action 2.3D: Assess State response options for threatened ecosystems, including reviewing harvest planning or identifying innovative solutions.

DF&G's Division of Habitat should prepare and publish an annual summary of threatened ecosystems, including plans for protection and restoration.

The Governor's Mariculture Task Force should encourage and assist aquatic farm operators in the collection of ocean data at farm sites, working with the NOAA Regional Aquaculture Coordinator for Alaska and the University of Alaska to promote and test technologies and processes that may mitigate ocean acidification in Alaska's coastal waters.

The State should collaborate with other levels of government, and municipal and Alaska Native Regional and Village Corporation land and resource managers, to ensure an ecosystem approach.

3. Invest in, partner with, and encourage private sector diversification, and the growth of Alaska's adaptation and mitigation services, clean energy and ocean economy.

3.1 Support and incentivize energy efficiency, renewable energy, de-carbonization and electrification across all sectors.

Action 3.1A: Sustainably increase value-added economic activities (e.g.; fisheries, transportation, agriculture, mariculture and marine biotechnology, and petrochemicals) that leverage clean energy and maximize in-place opportunity for local residents.

In order to move toward a climate resilient economy, characterized by less reliance on fossil fuels for energy, the State must embrace local clean energy that can power value-added economic development. Diversification in this way will strengthen the State's economy overall and increase opportunities for local residents.

Private sector innovation is increasingly driving economic development in the state. This trend can be supported within priority industries, with incentives in place where clean energy is used. Supporting centers of innovation such as business accelerators and incubators focused on supporting startups focused on value-added activities is critical to creating private sector innovation and fomenting an entrepreneurial approach.

The state should encourage manufacturing processes that utilize our petroleum resources for petrochemicals and other products that are not used in combustion.

The State should consider ways in which to support an ocean "cluster" or priority area of economic activity that, with increased investment and access to research and resources, is able to leverage individual efforts for larger sector growth. A focus on diversification and in-place opportunity is necessary as part of a strategic energy transition.

DCCED has investment loans for alternative energy systems or energy conservation in commercial buildings, fisheries, mariculture, and rural development. These can support or be amended to support increased value-added opportunities that have a clean energy component.

Action 3.1B: Develop new carbon-neutral models of community economic development that support diversification, leverage local investment, and strengthen the clean energy economy.

State and local governments should encourage carbon-neutral economic development within Alaska communities. This can be accomplished by reprioritizing local investment, local production/consumption of goods (including food and seafood), recycling, and community development processes.

As applicable, the Department of Administration (DOA) should add criteria to State Requests for Proposals (RFPs) that gives preference to proposals with clean energy or energy efficiency components. Similarly, municipal government RFPs can give preference to proposals supporting clean energy or energy efficiency.

State and municipal governments can consider micro-loans to businesses that focus on carbon-neutral products. This can be done in collaboration with Alaska Native Tribes, tribal consortia, and Alaska Native Regional and Village Corporations.

The state should increase collaborations for program delivery and the opportunity for public private partnerships. The State and local governments should prioritize ways in which to make program delivery more efficient and effective, including to review the opportunity for public private partnerships and collaborative services.

Especially important will be the ability to restructure grant, loan and capital project funding from federal and state budgets to support an energy transition. State and federal funding guidelines will need to remove inefficiencies and barriers that may hinder clean energy use and energy efficient projects.

Action 3.1C: Promote diversification and local access to fisheries, and develop mariculture at a scale accessible and affordable to coastal residents.

Warming oceans and ocean acidification are changing the abundance and distribution of fish and other marine life. Fish species are moving to new places, and fishing communities will need affordable in-place opportunity to diversify, develop new fisheries, and launch small-scale mariculture operations. Relocated communities will likewise need in-place economic opportunity. Alaska will actively promote access opportunities for community-based fishermen and guide development of Alaska's mariculture industry to meet the needs of coastal residents.

The State should consider ways in which to develop mariculture and blue jobs (marine construction, tourism, recreation, transportation and energy) as an in-place diversification opportunity for small-scale fishermen impacted by ocean warming or acidification, and communities forced to relocate.

DF&G should partner with the Alaska Ocean Acidification Network and others to consider impact of ocean acidification and other marine changes in an assessment of marine climate impacts such as warming water, invasive species, ocean acidification, ecosystem changes, and species migration. State fisheries management policy should buffer against resource change, create flexibility to respond to evolving conditions, and maximize access opportunity for Alaska coastal residents.

3.2 Support diversification, investment and established business expertise within the sectors addressing climate change mitigation or adaptation.

Action 3.2A: Consider adaptation processes and technology as an export opportunity, such that Alaskans are able to meet a global demand for climate change adaptation services.

The Division of Economic Development should lead this effort as part of its Comprehensive Economic Development Strategy.

AEA should work with the Alaska Center for Energy and Power (ACEP) and the Cold Climate Housing Research Center (CCHRC) to produce a review of existing programs and efforts that export technological expertise, including recommendations for future policy priorities to increase Alaska's knowledge export.

A multi-organizational effort will be asked to develop a new template for community development that is responsive to climate migrants. The effort should include best practices in the areas of rural/urban planning, economics, social science, engineering, building science and transportation design are implemented. Creating such a template would give Alaskans an opportunity to share our expertise with others who undoubtedly will also be moving communities in the future.

The State will need to identify and mitigate economic impacts associated with climate change. Economic adaptation is a major component of an energy transition and community adaptation. As part of assessing economic impacts, the State should consider potential impacts to resource-dependent industries such as fishing and tourism, and devise adaptation mechanisms; implement transition plans for any displaced workforce; and be able to adjust plans and regulations to account for changing environmental conditions.

Climate change regulations, and investments in renewable energy and energy efficiency, will affect the state and private sector workforce. A trained and experienced workforce will be essential as climate change goals are advanced. While the workload will increase for permitting and regulatory agencies, and skillsets will need to evolve or be added within industry, this is an opportunity for the state to demonstrate leadership and possibly export that knowledge and know-how to other jurisdictions that are not as far advanced. Early investments in training will help the State implement large permitting and regulatory changes.

Action 3.2B: Promote and export technological and process innovation as it relates to carbon emission reduction and sequestration.

DNR should add within its statutes carbon sequestration as one of many multiple-uses of state lands, and the Division of Oil and Gas (DOG) will review best practices and emerging technologies related to carbon capture, storage, use and sequestration (CCS). DOG will work with the Alaska Oil and Gas Conservation Commission (AOGCC) to evaluate feasible application consistent with climate change goals and continued economic competitiveness.

The University of Alaska should review current research related to CCS and report to the Governor's Senior Advisor for Climate Policy on opportunities for further investigation. An inventory of current capacity within the University to address this issue should be undertaken, and capacity developed where gaps emerge.

The State should promote research at the University of Alaska Fairbanks related to carbon emission reduction and mitigation. The State must emphasize and support collaboration between the UA system and business accelerators and incubators that are focused on supporting high growth companies to export technologies, processes and business models related to climate change mitigation and adaptation.

The State should identify leading global efforts to address CCS and participate actively in those venues, including convening a workshop in Alaska that invites international experts and develops recommendations for policy, process and technological advances.

Action 3.2C: Increase, and promote as growth opportunities, careers that contribute to addressing climate change, including engineering, architecture and design, business and entrepreneurship.

The State should support the sharing of knowledge between the CCHRC, AEA, University of Alaska Fairbanks Arctic Engineering, DOT&PF, Department of Labor & Workforce Development (DOL&WD), Launch Alaska and other organizations that address climate change mitigation and adaptation. This sharing should include sustainable building practices and career development opportunities in the "climate collaboratory" hosted by the University of Alaska.

The University of Alaska should draw on the existing Engineering course catalogue to examine the feasibility of offering a Certificate Program or Minor within the renewable/clean energy sector. The Alaska Center for Energy and Power (ACEP) and individual faculty members across the UA system are contributing a great deal to Alaska's growing reputation as a center for excellence in renewables. Establishing and publicizing a clear pathway for aspiring Alaskan engineers to participate and contribute to this trend should be a priority.

In order to promote the opportunities within these industries over the long-term, the Department of Education and Early Development (DEED) must emphasize and support K-12 STEM (science, technology, engineering and math) curricula related to energy and climate literacy. Alaskan engineers, architects and designers are world leaders in cold climate building technologies and many are deeply rooted in the state. A real opportunity exists to foster a network of mentors aimed at K-12 and college age students as they participate in science fairs and competitions. The State should also support the amplification of a wide "STEM ecosystem" that does not exist solely within DEED – one that includes utilities, universities, industry, "maker" and robotic clubs.

DOL&WD should reevaluate current and the potential for new clean energy and climate change careers, updating their *Green Jobs Report* and providing career pathways as part of their training programs. The UAF/DCCED report, "Emerging Sector Series: Growth and Obstacles in the Renewable Energy Sector in Alaska," also applies.

The State should invite a blue ribbon panel of architects, engineers, and designers to discuss changes occurring in the sector, best practices, and how to prepare for an uncertain future. The

outcomes of this process will be an addendum to the Division of Economic Development's Statewide *Comprehensive Economic Development Strategy*, which currently mentions climate change just a few times but importantly as it relates to resilience and threat.

3.3 Develop a strategic plan for growth within the ocean economy, to include transportation, commercial fisheries, energy and food, and considering incentives for value-added business development.

Action 3.3A: Conduct a strategic assessment and plan for Alaska's ocean economy.

Alaska's ocean economy includes the marine construction, food, tourism, recreation, transportation and energy sectors, as well as commercial fishing and mariculture. The ocean economy is expanding due to ice melt and new resource development opportunities, even as there are concerns about protecting the environment and food security. Ocean species are moving north and the U.S. and other states have closed commercial fishing in the Arctic until further scientific baseline studies are completed.

The oil and gas sector, commercial fisheries and community development play an important role in the ocean economy. Barging firms have a major impact on resupplying communities in the summer. Cruise ships provide an economic boost in the summer in some areas of the state. Increasingly the state is seeing small-scale entrepreneurship and innovation in the ocean economy, including mariculture and food production.

There are opportunities for public private partnerships to finance large maritime or coastal infrastructure projects. The Alaska Industrial Development and Export Authority (AIDEA) can play a role in supporting growth within the ocean economy, and its mission expanded to include maritime or coastal growth as a priority. Infrastructure investment is needed for blue economic development.

New activities are emerging such as ocean energy and climate change resiliency infrastructure. An assessment of economic performance should be based on annual growth and capital investments. The state can look at what its circumpolar or other neighbors are doing with regards to ocean economy, and conduct an overall economic analysis. Climate change will impact national defense interests, including homeland security and economic security, and the State DMVA should work closely with the Department of Defense (DOD).

Action 3.3B: Develop incentives for innovation and entrepreneurship within the clean energy, food, transportation and ocean sectors that lead to local manufacturing, local consumption and product export.

Alaska's future economic development will depend on the State's ability to meet the challenges facing the state. The high costs of energy, food, and transportation inhibit economic growth and

increase the cost of living and doing business in Alaska. These high costs are opportunities for growth within the innovation and entrepreneurship sector.

Early stage venture capital investment, or start-up funds, could be directed toward new businesses focused on bringing down high costs and increasing the availability of locally produced goods. The State should help to attract outside investment, and consider leveraging state assets in combination with existing private capital. Tax incentives or credits may be considered an effective tool to encourage growth in these sectors.

Transportation accounts for around 25% of Alaska's energy use, and developing incentives for efficiencies in transportation could have a positive impact on businesses as well the climate. The energy-food nexus is also an important, often overlooked, area of energy use and encouraging local food production and consumption, as well as recycling, is an important step towards community resilience.

Alaska is home to the busiest fishing ports in the nation. The growth and innovation in marine electric vehicle technologies suggests that Alaska will be home to a burgeoning marine EV market in the near future. Staying abreast of these developments, innovating with an eye to the specific needs of the Alaskan fleet and encouraging investment should be a priority.

4. Maximize carbon neutral growth in Alaska through a rapid transition to renewable energy, electrification and energy efficiency.

4.1 Reduce oil, gas and mining industry greenhouse gas emissions in Alaska by 30% (over 2005 levels) by 2030, with the target increased over time to accommodate advances in technology and/or economic impacts.

Action 4.1A: Consider mechanisms to ensure that oil and gas development is conducted more efficiently and with decreased emissions, and with continued private investment.

Alaska's industrial sector produces approximately 57% of gross GHG emissions in Alaska on an annual basis (2015 data). The biggest difference in overall state emissions must begin with the largest emitter. The State should set a target to reduce emissions from this sector by 30%, which is consistent with the 2015 UN Paris Climate Agreement. Any target should be Alaska-specific, and take into account Alaska's unique circumstances, with cognizance of national or global targets. At the same time, Alaska's economy and state budget depend on the competitiveness of this sector. Any approach to decreasing emissions within the oil and gas industry should account for the associated economic impact, and mitigate negative financial impacts to the greatest extent possible.

While DEC, DNR and AOGCC continue to work together to identify best practices for reducing emissions, an early review of potential solutions include facility upgrades and changes in facility operations. The State should conduct a global review of technological and process innovation that

has resulted in cost-effective reductions in emissions. The State should consider ways to incentivize industry action, both through regulatory changes and/or financial incentives.

Location and field-life have significant economic impact on technology-based options, and the state should continue to work with the oil and gas industry to improve North Slope and Cook Inlet operations to help meet climate change goals. Similarly, the State should consider whether GHG-limiting technologies complicate or erode the effectiveness of other technologies (e.g.; more energy-efficient turbines and fuel gas CO2, removal would likely require double investment in both carbon and criteria pollutant reduction systems).

Operational changes or retrofits may be expensive, and the State should consider mitigation efforts to decrease the negative effect on the state's economy. The State can reduce the technological and regulatory costs of implementing potential options, and increase the benefits from carbon sequestration.

The state can take a leadership role in increasing the effectiveness and efficiency of its regulatory authority, even as it advocates for federal regulatory change. However, it is not feasible to wait for federal change and the state can ensure that its policy and regulatory system is doing its utmost to support the state's climate change goals and economic development.

Action 4.1B: Consider the development of a high-efficiency central power plant at Prudhoe Bay, and interconnectedness between oil fields, as well a new ULS oil refining operation plant.

Significant emissions reductions could occur by building a large, high-efficiency central power plant that could service multiple fields – and nearby communities. In order to increase the feasibility of this effort, the State will have to amend its approach to royalty payments for gas used to generate electricity that crosses unit boundaries, work with industry partners on the regulations necessary to create a public utility, and advocate for flexibilities within federal laws and regulations to address barriers (such as changes to the Clean Air Act (CAA)). The State should also incentivize the development of a ULS oil refining operation plant in order to reduce transportation emissions.

Industry should work with the UAF's ACEP to design an effective and highly-efficient North Slope utility operation, that combines consideration of renewable energy integration with system efficiency.

Another option is to develop capacity for transmitting electricity via HVDC or HVAC.

DNR and the oil and gas companies should consult with the North Slope Borough, Alaska Native Tribes, tribal consortia, and Alaska Native Regional and Village Corporations to identify mutual benefit to communities and shareholders, as well as projects.

Action 4.1C: Identify ways in which to reduce fugitive emissions and increase carbon capture, use, storage, and sequestration.

In 2015, the industrial sector produced over half of Alaska's GHG emissions. Fugitive methane contributed over 19% of the carbon dioxide equivalent (CO2e) emitted by this sector in 2015. Most of the fugitive methane comes from oil production; a small portion comes from natural gas production.

Fugitive emissions are released from pressurized systems, such as internal combustion engines, during industrial operations. AOGCC should conduct a thorough inspection of North Slope and Cook Inlet oil production facilities to identify current sources of fugitive methane and make recommendations to address these.

For carbon capture projects deriving value from enhanced oil recovery (EOR), the oil and gas industry should work with State regulators to conduct a technical analysis to choose appropriate carbon capture technology and the best reservoir for carbon-injection to maximize economics, including relating to EOR benefits.

For carbon capture projects away from known geologic traps, the State and industry should form a working group to conduct a technical analysis of size and type of facility modifications, the choice of appropriate carbon-capture technology, and search for nearby sequestration opportunities or plan for a pipeline to known reservoirs with proven seals.

The State should be cognizant of the fact that CCS requires more energy, and a preferred approach is to focus on efficiency and minimizing the amount of carbon to be captured, and then treat a smaller volume of exhaust gases.

The State should negotiate with existing leaseholders to determine the feasibility of and/or industry mitigation measures for carbon capture, storage and sequestration; and included directly into all future lease agreements.

Action 4.1D: Set a target % of renewable energy that should be included in new oil, gas, mining and industrial projects.

Renewable energy goals should be established as part of the leasing process, including through alternatives developed during an Environmental Impact Assessment.

Renewable energy goals could be achieved by subjecting the oil, gas and mining industries that self-generate, or plan to self-generate, to the same renewable milestones contained in any renewable portfolio standard (RPS) that the state may establish. An RPS can be fashioned to suit the needs of a state and would need to be established by the state legislature, or through a voter referendum. An RPS that covers industry could have a stricter standard for new development and

give existing developments time to ramp up the percentage of renewables used. The standard for existing development could also give industry credit for making existing carbon intensive electric generation less carbon intensive through efficiency.

Renewable energy makes even more sense if a central power plant were to be developed. The State should encourage the oil and gas sector to make use of existing renewable energy funding through AEA or other agencies.

Action 4.1E: Incorporate GHG emission assessment into proposed development on state, borough, tribal and municipal lands to evaluate project impact on achieving Alaska's climate and carbon-neutral goals.

Similar to the Health Impact Assessment, a Climate Impact Assessment should be incorporated into a project's Environmental Impact Assessment. The Climate Impact Assessment should include GHG emissions associated with the act of development and ongoing contribution through use (e.g., road building that increases vehicle traffic); also mitigation, alternatives, and a cost-benefit analysis.

While the burden or cost to perform the assessment would rest with the project proponent, this will be implemented over time and on a sliding scale to accommodate the variety and capacity of project proponents.

As part of this process, the State should identify research gaps, including tools that valuate land, forest, wetland and water carbon sequestration.

4.2 Increase building efficiency in both residential and non-residential sectors by 30% (over 2010 levels) by 2030, with the target increased over time to accommodate advances in technology and/or economic impacts.

Action 4.2A: Establish a statewide residential building and energy efficiency code for new residential construction.

The State should request that CCHRC submit and/or review proposed state residential building construction codes and methods that incorporate low energy use standards for new construction. Additionally, CCHRC could submit and/or review residential retrofit energy standards, similar to the AHFC Home Energy Rebate Program energy standards.

A model for this was recently introduced in the Alaska State Legislature through House Bill 259, which was support by the Alaska Homebuilders Association as well as a group of stakeholders who have been working toward such a statewide code for several years.

A State working group of relevant agencies should evaluate the potential for and effectiveness of such a code (ASHRAE Standard 90.2), and a pathway for implementation.

As part of this effort, the State should update design and engineering standards to incorporate expected climate change impacts, with life cycle and energy efficiency priorities. Key partners to establish these design standards include all departments and agencies of the University of Alaska and the State that are tracking climate change and its impacts on soils that underlie existing infrastructure, as well as those who model future river and sea levels. Other partners would include CCHRC, and the architectural and engineering communities. DOA should oversee the effort and implement standard changes in state public buildings.

Action 4.2B: Establish programs to finance and support residential, commercial and public building energy efficiency retrofits.

The State should provide approximately $125M of state funding for reinstating the AHFC Home Energy Rebate Program that has been shown to reduce energy consumption up to 17% annually in many Alaskan homes.

Programs to finance and support residential, commercial and public building energy efficiency retrofits could be developed under the auspices of a “green bank.” Green banks are public finance authorities that use limited public dollars to leverage greater private investment in clean energy. Their goal is to accelerate clean energy market growth while making energy cheaper and cleaner for consumers, driving job creation, and preserving taxpayer dollars. Green banks deploy public capital efficiently through financing to maximize private investment and lower the costs of clean energy to spark consumer demand. Rather than rely strictly on grants that cannot bring markets to scale, green banks use limited public funds to offer financing that attracts private investment. This way each public dollar goes further and can be recycled. Green banks also facilitate market development by working with originators and lenders and offering the information consumers and businesses need to confidently purchase clean energy. By connecting capital supply and customer demand, green banks grow markets.

The State can also develop a wider application of the new Commercial Property Assessed Clean Energy (C-PACE) legislation through additional amendments to current state laws. In 2017, the Alaska State Legislature passed a bill that now authorizes municipalities across Alaska to set up Commercial Property Assessed Clean Energy (C-PACE) programs to finance energy efficiency improvements on commercial buildings. Under a C-PACE program, commercial building owners are able to borrow money from their local property tax authority and then pay the municipality back through a special tax assessment on the building. This type of financing tool attaches the debt to the property, rather than to the building owner that borrows the money. It also typically gives the borrower more time to repay the loan than a commercial loan would, allowing the annual energy savings from the building improvements to immediately exceed the special tax assessment payments. AEA is working with C-PACE experts from around the nation and several interested Alaska municipalities to develop a C-PACE program that individual municipal assemblies can adopt. However, once the C-PACE programs are adopted by local tax assessment districts, those

municipalities must still find dollars to loan to commercial building owners who wish to participate in the program.

Action 4.2C: Implement a standard by 2030 of net-zero energy construction of new public buildings, and energy efficiency requirements for state financed buildings.

A standard for the construction of new energy net-zero public buildings could be established before 2030, but a phased approach of implementation to 2030 would give the architecture and engineering community plenty of time to implement it. The State should consider a geographic approach and feasibility review to determine where this is practical. Net-zero is challenging in Alaska because there is not the same potential for consistent solar power as other areas of the US, but this could be considered within AIDEA financing considerations. Because of the diversity of where this will be most feasible, the State should apply energy efficiency standards when net-zero is not feasibly. DOA should oversee the standard for state public buildings. There is already existing research that has been done by CCHRC that could be used to help develop the standard.

4.3 Increase the percentage of all electricity generated from renewable resources to 50% (over 2010 levels) by 2030 and improve the energy efficiency of electric generation through economic dispatch.

Action 4.3A: Implement a Renewable Energy Portfolio Standard (RPS) and Energy Efficiency Resource Standard (EERS).

The percentage of electrical needs met by renewable generation has increased from 22.4% in 2010 to 30.2% in 2016. Of the renewable generation, about 90% is produced by hydropower and 10% by wind power. Because so much renewable generation comes from hydro there are year to year fluctuations in overall renewable contribution based on weather. In years with little snow and low precipitation, the state may see a decrease in total renewable generation with no change in installed capacity. The only large renewable project currently slated for near term construction is the expansion of the Bradley Lake hydro facility on the Railbelt. If the expansion had been operational in 2016 it would have added less than 1% to total statewide renewable generation. Changes in current policy will need to be made to achieve this goal.

However, a 50% by 2030 Renewable Portfolio Standard (RPS) for Alaska is feasible and should include other structural reforms. The RPS would include hydropower, meaning the state is starting at roughly 30% renewable in 2018. Milestones for utilities and industry should be set and accelerate as we approach 2030. For example, 35% by 2020, 40% by 2025 and 50% by 2050.

Based on current progress and trends, AEA expects that the state will have a 5% increase in per capita energy efficiency by 2020, using 2010 as the baseline year. State programs such as the Home Energy Rebate, Weatherization, and New Home Rebate program have helped to increase the energy efficiency of nearly 40,000 existing or new residential buildings, out of a building stock of 280,000,

although much of the money for these programs was appropriated prior to 2010. The majority of Alaska's increase in energy efficiency has come from reductions in the consumption of electricity, primarily through improvements to consumer technology and behavior changes that have occurred largely outside of the state's involvement. At the current rate of improvement and funding levels, the state would expect to reach the 15% goal (2010 goal) around 2045.

A full impact analysis of an RPS and/or EERS has never been done for Alaska and should be a prerequisite to any implementation. There have been high level analyses done in the past that have indicated an EERS and/or RPS could be beneficial in Alaska but even these would need to be revisited in light of the recent investments in generation infrastructure within the Railbelt, as well as potential plans to establish a Unified System Operator, or Independent System Operator within the system.

EERS and RPS policies are best practices that have been proven effective in interconnected states in promoting the use of energy efficiency and renewable energy as resources to meet consumer demand in other parts of the country. Most EERSs and RPSs are structured to protect the financial interests of both the utility and its various classes of customers. The State would not want a policy that set requirements without reasonable utility cost test parameters. However, policy makers, in considering the full impacts and costs of climate change, could require that these cost tests consider the full cost of non-renewable/efficiency sources power (e.g. carbon cost).

Action 4.3B: Improve electric generation efficiency in the Railbelt through a region-wide system operator and economic dispatch.

In the Railbelt, an example of a public-private partnership would be network of the six existing public electric utilities operating together and purchasing renewable electricity from private, independent power producers who take all the up-front risk of power plant development and sell into the network through power purchase agreements. In order for this to work, several reforms that the Regulatory Commission of Alaska (RCA) and the Alaska State Legislature have already been considering must be implemented, including the formation of a regional system operator. The regional system operator would enforce regional reliability and interconnection standards. Those standards could be developed voluntarily, or by the RCA. Interconnection standards should ensure non-discriminatory access to the grid.

A regional transmission utility should be formed to make investments in the grid infrastructure. Perhaps most important for the long-term, the Railbelt utilities should consider regional and enforceable integrated resource planning for both new transmission and generation. This planning regime should be consistent with other State energy policies and goals (like an RPS). The RCA could mandate this planning regime today, though it is questionable whether the Commission has the requisite "siting authority" to enforce planning by having the ultimate decision on whether a power plant or transmission line is built. If the RCA needs such siting authority, the legislature should specifically grant it.

Action 4.3C: Improve electric generation efficiency in rural Alaska through optimized power generation maintenance, improved renewable integration strategies and reduced line loss.

In the 1980s, state government "electrified" rural Alaska. Since that time, there have been abundant grant funds available to assist in maintaining that infrastructure, most of them federal, through primarily the Rural Power System Upgrade (RPSU) and Bulk Fuel Upgrade (BFU) programs managed by Alaska Energy Authority. Over recent years, there has been a precipitous decline in the availability of funding, while the need for maintaining that infrastructure has remained constant. The resulting difference in need versus ability to meet that need requires a shift in the way projects have historically been selected and funded, and a new emphasis on project optimization, to ensure a maximum economic life of infrastructure as well as infrastructure that is efficient, safe, reliable and affordable to the greatest extent possible.

There are close to 200 isolated power systems in rural Alaska. Most of them rely exclusively on diesel. Some of them have renewable energy integrated. Regardless of the make-up, each of these systems requires ongoing and careful maintenance and operations, including appropriately trained and locally available staff, and requirements (sending inspection logs, having a maintenance contact, etc.).

To optimize the diesel maintenance of existing and future generation infrastructure, a key to efficient and long-term use, AEA's Circuit Rider program should be integrated with utility financial and operations management training, as is being piloted by AEA, to ensure that the utility operator and manager collaborate effectively to meet customer needs for safe, reliable, and affordable energy. The program should also provide utilities with training on how to diagnose line loss issues and recommend potential resources for reducing losses.

Many of the State and federal programs that supported improving community power production and increasing renewable energy have been curtailed due to budget cuts and shifting priorities. In order to meet its climate goals, the State should consider reinvesting in these programs, which include AEA's Rural Power System Upgrade (RPSU) and Bulk Fuel Upgrade. Proposed changes to the RPSU program should include an increased use of debt financing to both extend the State's capital funds and provide increased natural incentives for optimum operation. Debt financing, particularly through AEA's Power Project Loan fund, would allow for greater requirements and a longer-term relationship with the utility than is commonly had through a grant. In selecting a project in a community, the RPSU program should weigh all reasonable energy sources—diesel and renewables—to serve the community's needs.

Additionally, the Renewable Energy Fund and the Emerging Energy Technology Fund should be fully capitalized, with emerging energy technology focused on that which helps to meet reduced carbon emission goals, including within the oil and gas industry. More robust project financing tools, including consideration of a Community Energy Fund for Alaska, should be considered.

Bulk fuel upgrades, provided by AEA and the Denali Commission, have been beneficial across rural Alaska and this program will remain a critical part of the safe, reliable and affordable energy solutions portfolio for rural communities. However, increased investment and guidelines that focus on efficiency and the ability to integrate renewable energy are also necessary.

Finally, the State should evaluate the opportunity to align state programs that finance and support electricity generation in rural Alaska with an aim to accelerate the utilization and integration of renewable resources where appropriate and improve efficiency. The Alaska Energy Authority should be the lead on this effort, and its capacity and authority expanded such that it can carry out an effective implementation plan.

4.4 Increase the efficiency of and reduce carbon emissions in air, rail, road and marine operations and transportation, and promote the use of more efficient and lower-emitting fuels.

Action 4.4A: Prepare for and promote a rapid transition to the electrification of passenger vehicles, including providing for the requisite EV charging infrastructure on Alaska's primary road systems and within communities.

The transportation sector is Alaska's second greatest source of greenhouse gas emissions. The State should prepare for and promote a rapid transition to the electrification of passenger vehicles, including providing for the requisite electric vehicle (EV) charging infrastructure on Alaska's primary road systems and within communities.

The EV charging infrastructure on Alaska's primary road systems will require cooperation among local governments including the Kenai Peninsula, Municipality of Anchorage, Mat-Su Borough, Copper River basin and Fairbanks North Star Borough. It will also require coordination with the six Railbelt electric utilities. Coordination of these entities has already begun, led by entities such as AEA, the Municipality of Anchorage and REAP. DOT& PF can assess the efficiency of the State vehicle fleet and research and implement efficiency improvements as they are feasible.

The State should establish a phased approach to transitioning the vast majority of state vehicles to EV by 2030. The State should explore energy efficient lighting for roadways and a review of energy efficiency of state-owned ferries. Many of the same energy efficiency measures can be performed as on State-owned facilities.

In addition to passenger vehicles, the State can support lower carbon fuels in other areas of the transportation sector. Scandinavian countries and the US Navy are currently developing marine and hybrid electric powered ships. Advancements in marine propulsion technology have the potential to impact Alaska's fishing fleets, suggesting that Alaskans should have an active role in the development of these technologies. Not unrelated is the burgeoning interest in electric ATVs, snowmachines and boats – a potential boon to rural Alaskan communities looking to exploit

secondary loads from renewable generation. Research should include a review of the potential for electrifying fishing vessels or expanding the use of low-carbon biofuels within the aviation industry.

More specifically to the fishing industry, the State should encourage or establish programs to research, finance and support commercial vessel energy efficiency retrofits, modifications, and repower.

Action 4.4B: Promote public transportation between and within Girdwood, Anchorage, Fairbanks, Juneau and the Matanuska-Susitna Valley, including the potential for commuter rail, and use of the existing rail lines and stations.

No public transportation systems in the country are revenue neutral – each costs local, state and federal money to support them. That portion of the transportation system that is most highly subsidized is our public road system. Effective transportation is a public good, and it is required for a healthy economy.

Research on how and whether to establish a commuter rail network in Southcentral Alaska has been ongoing for nearly two decades. A commuter rail system is often considered when oil prices are high and the cost of gasoline increases. It is time to take a long-term approach that assumes higher oil prices in the long-term and assumes continued population growth in the Mat-Su Borough, the fastest growing area of the state. If those two assumptions are correct and no commuter rail system is established, it means that more public money will be required to continue to widen the Glenn Highway, and more money will leave the state's economy as commuters spend more on imported gasoline. The State should produce a transit plan for the Railbelt.

Much of the capital infrastructure required for commuter rail is already built, including the railroad tracks. Some of it, like the train stations at Anchorage International Airport and the state fairgrounds in Palmer, receive virtually no use from Alaskans. Further capital infrastructure can be supported through federal transportation grants. It is the operating costs of a commuter rail that local governments would have to subsidize.

Reduced revenues from shipping jet fuel and coal now have the Alaska Railroad looking for other sources of revenue. A pilot commuter rail program could start with self-propelled train cars and annual season ticket subscriptions. More train cars could be purchased as more season tickets are sold. Those Alaskans who work along the railroad tracks at JBER, downtown Anchorage, Anchorage International Airport and the Dimond Center already provide more than enough people to give a pilot program a start. Ride sharing services like Uber and Lyft, along with Anchorage People Mover, would also be part of getting people around the city once they are in Anchorage from the Mat-Su or Girdwood. The Railroad could also establish parking lots that commuters could use to park their cars during the week as they take the train back and forth in the mornings and evenings. Establishing a commuter rail service also provides essential redundancy to the region's transportation system, which is crucial to Southcentral's resiliency when the either natural or man-

made disasters strike. To promote the use of public transportation, allocate a much higher percentage of Alaska's Federal Highway Administration (FHWA) funding to commuter systems in populated corridors including commuter rail service where existing Alaska Railroad track is available.

Finally, the State should encourage the use of and investment in more non-motorized transportation routes, such as bike and pedestrian paths, as a way to encourage reduction of carbon emissions.

4.5 Produce by 2020 a comprehensive low-carbon energy strategy and transition plan, with corresponding impact analysis, scenario development, timelines and targets.

Action 4.5A: Conduct an analysis of sectors that will be impacted by the state's energy transition to a low-carbon future.

Clearly, transitioning from an oil and gas economy to a low-carbon economy is a challenging and uncertain process. The State can be committed to change and a clean energy future while mitigating the negative impacts to industry. In order to accomplish this effectively, a careful analysis will need to consider ways in which a variety of sectors will be impacted, where new regulations will have the most impact, and how to minimize overt disruption of the state economy.

These questions are being considered by multiple oil-producing regions around the world and the dilemma of potential short-term costs is outweighed by the concern for long-term sustainability. Alaska is not alone in its leadership, nor will change make it less competitive globally.

Clearly, incentives and regulations that decrease GHG emissions will forever change the landscape of energy production in Alaska. Gas resources will become more valuable, which will contribute to the efficacy and opportunity to export Alaska's natural gas. The value of petroleum resources will be consistent with the market for petroleum resources, which the EIA and others estimate will continue to be the primary global energy source well into 2050. While carbon pricing or other types of measures will impact value or cost in Alaska, they will equally be felt across the world.

Alaska's oil and gas industry is resilient, and comprised of global energy companies able to invest in and ensure the longevity of their energy profiles, which range from oil and gas to, increasingly, renewable resources. The size and quality of Alaska's oil and gas deposits will continue to attract and sustain industry investment, and the State should work with industry to ensure global competitiveness.

An energy transition plan does not mean the end of the oil and gas industry in Alaska. In fact, it ensures that the state maintains a steady hand on increasing field life and industry competitiveness. A transition plan should include ways in which to introduce new technology or regulations in ways that minimize negative impacts. The State should include in all its analysis a market evaluation mechanism.

Importantly, an energy transition plan will have to consider the State's fiscal policy, such that the state's budget is less reliant on oil and gas royalties and taxes, and includes new methods for revenue generation that accommodate and respond to a clean energy and diversified economy. This will also enable the State to utilize new budget tools to incentivize or otherwise invest in an active resource development sector that includes a focus on reducing greenhouse gas emissions

The final product, produced by a recognized third-party, will include an evaluation of capacity, strengths, and gaps, and the appropriate timescale for implementation based on prioritization. The evaluation will include economic modeling of GHG reduction policies and their impact on multiple sectors.

Action 4.5B Update and expand the scope of the Alaska Affordable Energy Strategy.

The Alaska Affordable Energy Strategy (AkAES) was a comprehensive research and analysis project that produced a suite of recommended policy, regulatory and funding changes that collectively could improve energy affordability in non-Railbelt communities. This project was initiated by 2014 Alaska LNG project legislation that directed AEA to prepare a plan to develop infrastructure that will deliver affordable energy to areas in the state that will not have direct access to a North Slope natural gas pipeline. AEA investigated potential pathways, both infrastructure and non-infrastructure solutions, to long-term energy affordability. A key component of the AkAES was compiling, storing, and analyzing data, and ensuring that it continues to be meaningful for available to stakeholders. AEA delivered the final report to the legislature in December 2016.

The Alaska Affordable Energy Strategy should be updated to include all areas of the state, support the climate action strategy, and incorporate a strong stakeholder engagement process, the result of which is time sensitive to economic and societal impact, and with mitigation options in place. The Strategy should look at state policy, promote market-based solutions, technological innovation, and transition to renewable energy and natural gas where appropriate.

The Strategy should complement, help inform, and stand alongside the energy transition plan, while focusing on community level activities. AEA should lead this effort and increasing their capacity and authority will be necessary to implement the project effectively.

Action 4.5C: Promote and develop natural gas as an international bridge fuel for export and for domestic use.

For Alaska, perhaps its biggest contribution to efficient and cost-effective emission reductions is to expand the use of natural gas as a cleaner and low-carbon alternative to diesel. This will need to be regularly evaluated against renewables, as part of the State's strategic planning efforts. The Alaska LNG project offers a significant opportunity to increase the in-state use of natural gas and decrease high-carbon use in larger markets (e.g., China's potential purchase of up to 15 million metric tpy of Alaska natural gas would reduce China's GHG emissions by nearly 2%, which represents more than

five times the annual Alaska total). Alaska LNG includes several offtake locations that enable the delivery of North Slope natural gas to communities along the pipeline, providing a direct opportunity for these communities to reduce their GHG emissions via fuel substitution, and contribute to electrification of the state.

As part of the integration of natural gas into the state's energy system, appliances and heating appliances can be replaced with more energy efficient equipment, alternative energy sources such as heat pumps, and a State program established to support this transition.

Provide legislation to support additional funding for AIDEA's Sustainable Energy Transmission and Supply (SETS) loan program. This program was only used once for the now established Interior Energy Project. Further utilization of this program would provide for a greater usage of natural gas as supply increases.

Action 4.5D: Require medium and large emitters to report greenhouse gas emissions to the State and to municipalities, and establish the baseline for and increase monitoring of emissions.

The Greenhouse Gas Emissions Inventory published by the DEC Division of Air Quality is essential to tracking progress on the climate change strategy. The state should increase the resources available to address any current gaps, increase data collection and analysis. DEC should determine the appropriate scale, frequency, and data collection for reporting needed to support climate-relevant policies.

At the local level, increased data acquisition and sharing is essential to community planning. The State should encourage, support or otherwise work with communities to secure, greenhouse gas (GHG) emission data from local emitters. This data is essential not only for climate change efforts, but also for energy efficiency programs and transportation planning.

5. Expand climate and environmental science, natural resource and energy education, awareness and workforce development.

5.1 Implement the Alaska Natural Resource and Environmental Literacy Plan.

Action 5.1A: Implement and support the required structural components that have been identified in the existing plan, written collaboratively in 2013 by the statewide environmental educators association ANROE, DEED and DF&G.

The State should create and support an active statewide Natural Resource and Environmental Literacy Leadership Council, comprising professionals from school districts, natural resource agencies and industries, tribal organizations and Native corporations, educational nonprofit organizations, and outdoor recreation organizations.

The State should create and support school or school district liaisons to facilitate the integration of the plan at the local level; support a paid coordinator who has the resources and flexibility necessary to provide assistance in plan implementation to the diverse stakeholders involved; and initiate a mechanism for periodic review and updating of the 2013 the "Alaska Natural Resource and Environmental Literacy Plan " to ensure on-going progress.

Complex and global issues such as climate change require a strong understanding of natural science, resource management, and environmental change. The best way to address this is by increasing educational attainment in Alaska and increasing student proficiency in math, technology, engineering and science. Because of Alaska's land and resource endowment, it is additionally important to include a focus on natural resource and environmental science, which will ground future Alaskans in the sustainable management, development and conservation of renewable and non-renewable resources. A critical and firm understanding of energy issues, both for export and domestic use, and the ways in which Alaskans power and heat their homes or run their businesses, is especially important in a state with current high costs of energy and a dependence on oil and gas revenue.

The State should immediately implement the Alaska Natural Resource and Environmental Literacy Plan developed by DEED and DF&G, which includes a thoughtful and deliberate focus on these issues and reinforces STEM education. As part of this effort, the State should strengthen capacity within the state by investing in and increasing the number of science and engineering content specialists within DEED.

At the same time, the State can work with partners in the delivery of these programs. For instance, the state in the past has supported the work of the Alaska Resource Education (ARE), which has been working to increase natural resource education since the 1980s. ARE has worked with DEED to develop curriculum that coexists with teaching standards, and to train teachers on how to use the curriculum. Support for this program should be reinstated and ARE can partner with the university's science and natural resource management programs to strengthen energy literacy and natural resource and environmental science.

In order to increase energy literacy, DEED should encourage all school districts to promote and teach STEM curricula such as *AK EnergySmart, Wind Wise* and *Wind for Schools*.

Action 5.1B: Increase teacher support, training and curriculum implementation.

Ultimately what is taught in the classroom depends on the quality of the state's teachers and the resources they have at hand. The State and its partners can encourage local school board consideration of increasing natural resource and environmental science curricula in the classroom, and it will be up to local school boards to determine the extent to which climate change is addressed. Rather than a state mandate, local control and local decision-making will be an important element in establishing what should or should not be taught, even as the state provides

general guidelines around natural resource and environmental science, which help students make informed decisions about the world they live in and future they will inherit.

The State should support and promote summer teacher trainings linked with existing University K-12 natural resource, climate change and environmental education programs, including programs like the Alaska Global Learning and Observations to Benefit the Environment (GLOBE, www.globe.gov); the Arctic and Earth STEM Integration of GLOBE and NASA Assets; and the Arctic Harvest: Public Participation in Scientific Research. The state will generally need greater investment in Alaskan teachers to ensure less turn-over and a greater focus on "home-grown" teachers in across the state.

Teachers who improve and excel should be recognized and rewarded. The Governor should establish a teacher recognition award program for outstanding environmental science education, which could come with resource incentives such as access to experts, technology or field school programs for students.

Finally, in terms of teacher resources, there needs to be a greater deployment of STEM focused resources and investment in programs like the Alaska Native Science and Engineering Program (ANSEP), REAP, Juneau Economic Development Council's Lego League, and ARE. As part of this process, the State's partnership with the University to establish a climate collaboratory should result in an increase of available and credible resources for teaching.

5.2 Strengthen the University of Alaska's emphasis on research and education on science, climate change trends, impacts and opportunities, vulnerability, adaptation and mitigation, as well as related natural resource management and hazard forecast.

Action 5.2A: The state will communicate to the University of Alaska Board of Regents the importance of increasing educational attainment, STEM education and training opportunities, natural resource and environmental science resources, Arctic and climate change awareness.

The University has a strong role to play in modeling the behavior it hopes to see established across the state, and it is encouraging to see already the credence it places on sustainability within on campuses. These efforts should be encouraged and reinforced by the State. To support the University's overall sustainability goals, the state should articulate the importance of, and fund, programs that support natural resource and environmental science, STEM, and climate science.

The State should encourage and support interdisciplinary study of climate change through development of major and minors across departments. The University should take a more prominent role as the leading state entity addressing both research on climate change adaptation and education, training and workforce development within Alaska. One of the ways in which the University can do this is to establish a general education requirement related to environmental science, climate change and renewable energy.

The State should support University efforts to offer a competitive grant program for faculty and students focused on research related to science, climate change causes, adaptation and mitigation, as well as related natural resource management; support the hiring of new faculty who conduct research in these areas; and promote graduate and undergraduate interdisciplinary education at UA to meet state workforce needs related to science, climate change causes, adaptation and mitigation, as well as related natural resource management.

The State should promote and support efforts to bridge science at the University with State and private practitioners, including existing programs at that are explicitly designed to bridge science and management and policy realms, including but not limited to, the Center for Arctic Policy Studies, the Alaska Center for Climate Assessment and Policy, the Alaska Fire Science Consortium, Community Partnerships for Self-Reliance, the Alaska Climate Adaptation Science Center, and the Alaska Center for Energy and Power. The State should also incentivize State agencies to collaborate with the above existing programs.

As part of this process, and in order to grow public awareness, faculty can be encouraged to develop and deliver short courses for policy-makers (state and local level) related to climate change impacts, risk/vulnerability, and transition strategies in energy and other economic sectors. The State should support a dedicated "science shop" coordinator to be a liaison between community groups, tribes, state agencies and University students faculty and affiliate researchers. This liaison would help match up community needs with scientific expertise at the University and help define student research projects that will fill information needs while educating students.

The University can be encouraged to invest further in its natural resource and environmental science programs, including to support teaching and research in environmental science and natural resources education. A competitive grant program for developing teacher resources, within the University, or State-funded, could be leveraged by faculty and students. Past programs such as the sustainability program at UAA Mat-Su Campus and the current occupational endorsement at UAF Bristol Bay Campus can be the starting point for a much more robust program that leads into internships, apprenticeships, and employment, and the State should work with APU and other tribal colleges to expand on their sustainability emphases.

ACEP is a good example of a university program that is quickly seeing global interest by those focused on sustainable energy systems. The University and State can continue to support this program, and identify others, in order to attract Alaskan, national and international students and experts.

5.3 Increase public awareness of climate change impacts and human/environmental vulnerability.

Action 5.3A: Maintain a public campaign to increase awareness of the impacts of climate change and carbon reduction .

The State's leadership in addressing climate change adaptation, response and mitigation is an important story to share across the nation and globe. Alaska's climate change strategy is a comprehensive, responsive and evolving effort that highlights Alaska's position in the Arctic, and the impacts felt by Alaskan businesses and communities. Sharing the State's story will attract financial and human resources as well as promote the exchange of best practices and knowledge with strategic partners.

The State's communications team should partner with scientists and university partners to develop a climate science, resource and energy literacy program for journalists and TV weather news casters.

Many rural Alaskan communities are the recipients of renewable energy systems and yet lack an energy literacy framework to appreciate how exactly these systems are benefiting the community. A "K-Gray" approach to energy literacy that is specific to installed projects should be prioritized in order to ensure the proper maintenance of costly renewable systems and to simultaneously spur curiosity and encourage a pipeline of future energy champions.

Action 5.3B: Develop and deliver community awareness events related to energy literacy, climate change impacts, responses and opportunities in both rural and urban communities.

Organizations across Alaska have an important role to play in meeting the challenge of climate change, and State efforts alone will not suffice. The State should encourage private, academic and non-profit sector science communication of climate change. The State should partner with local governments and non-profit organizations to engage the public in dialogue and reviews of research and government action.

The State should increase general "energy literacy" among all Alaskans, to improve understanding of the impacts of current energy use and opportunities related to a transition to clean energy systems.

The State should be involved in public awareness efforts that, much like the K-12 STEM initiative, is intended to bridge the gap in public understanding of natural science, resource management, and environmental change in order to make informed decisions about complex and global issues such as climate change. The campaign could include "K-Gray" Energy Literacy classes. Trainings and lifelong learning opportunities will be essential in the coming years. Alaskans are on the cusp of a new era where potential career pathways, entrepreneurial opportunities, policy makers/politicians, homeowners and advanced degree seekers will all be dependent on a meaningful understanding of the true nature of the costs of energy in modern society.

The State should build awareness of and promote its climate change objectives, including by calling attention to renewable energy and energy efficiency goals, and identifying things that the public can help with, such as increased use of non-motorized and low carbon transportation methods. This can include support of safety corridors for pedestrians and bicyclists along major roadways and within municipalities, and support for non-profits developing bike trails such as Bike Anchorage.

Action 5.3C: Encourage and support Alaska's field stations to conduct, coordinate and share climate change research with each other, the public and among university researchers and state managers.

Our marine and terrestrial ecosystems are already responding to a changing climate and thus challenging the State's ability to develop, conserve, and maximize the use of Alaska's natural resources consistent with the public interest over decadal scales. Such resources that will be directly impacted by changing climate include marine and freshwater fishes, shellfish, timber, and wildlife. Other non-living resources such as minerals, oil and gas, and hydropower will also be affected through impacts of permafrost degradation or limits to ice road construction. Alaska is a resource extraction state, and a viable economy requires sustainable harvest and access to existing assets. Maintaining a strong resource base requires an understanding of maintaining sustainable populations, habitats and production under evolving conditions. Ecosystem based management is essential for living resources. For non-living resources, optimum management will still need advances in engineering and logistical techniques to address consequences of degrading permafrost, limitations in water resources, and increases in such threats as diseases, invasive species and pests. Advances in science and engineering are essential to enable our state and our residents to better adapt and thrive in these evolving conditions. Researchers at the University of Alaska are already doing so and these efforts should be supported and enhanced.

5.4 Facilitate the development of energy, adaptation and mitigation training and workforce development programs.

Action 5.4A: Expand statewide efforts to train Alaskans, with specific attention to underserved areas, in residential and commercial energy audits, weatherization and retrofit techniques.

The relatively few public facilities in rural Alaskan communities are often managed without a clear strategy, and maintenance is reactive as opposed to preventative. There are existing training programs for facility/energy managers that could be implemented to train a single "village energy manager". There should be an effort to demonstrate to tribal/city administrators and community leaders the cost effectiveness of creating this paid position and providing for training.

These efforts must meet Alaskans where they are, and be focused on real job opportunities. Many rural Alaskans cannot afford the time away from their families and communities to travel to distant urban centers for training. Local and regional training should be encouraged, including the use of apprenticeships and circuit riders. K-12, training and university programs should be networked to avoid duplicity, and fill identified gaps. There should be greater use of distance learning and web-based training to enhance worker skills.

DOL&WD and DEED should continue to collaborate with stakeholders that are already a part of the Alaska Network of Energy Education and Employment (ANEEE) to identify ways to leverage existing

state programs and resources that can increase energy literacy and focus on underserved areas of the state.

Besides DOL&WD and DEED, other parties interested in this include the Denali Commission, ANTHC, AEA, the Alaska Housing Finance Corporation (AHFC), the ACEP and the Renewable Energy Alaska Project (REAP). Labor unions will contribute their input into training and skills necessary for local workforce development. A recognition program should be established to certify this new skillset.

The Denali Commission should reestablish its workforce development program and work with the congressional delegation to secure necessary funding for training and capacity building, consistent with its role as federal lead for climate change coordination.

AHFC and AEA will work with DOL&WD to develop a chapter on this topic in the *Green Jobs Report* and contribute to the State's strategic plan.

Action 5.4B: Support existing and establish training centers across the state to train on various renewable energy production (solar, wind, hydro, biomass, geo-exchange, etc.), transportation efficiency and alternative fuels.

Many training centers are already established. However, it is often difficult for any one of the smaller centers to offer programs in these areas because there are not enough trainers or students to support the programs. Train the trainer programs should be established to increase the number of instructors. K-12 STEM curricula should be emphasized and supported by DEED to increase the number of interested students. Importantly, program curricula should be designed with specific jobs in mind like building energy management, or power plant operation. There should be greater use of distance learning and web-based training to enhance worker skills.

In addition, there should be greater collaboration, coordination and knowledge sharing among the ten Alaskan Regional Training Centers (RTCs) spread throughout the state. RTC's should play a key role in identifying the most effective curricula and instructors within specific training sectors – and cooperate in the outreach and delivery of these programs.

Consumer interest in a clean energy economy will increase through consumer education and exposure to the clean energy industry. Growth of the industry can be facilitated by state policy, including enforceable efficiency and renewable standards such as a Renewable Portfolio Standard (RPS). The above-mentioned efforts to increase STEM education and training could have a significant long-term impact on the number of young people that are oriented towards energy efficiency, renewables, electric transportation, local food, et cetera. The Real Estate sector in Alaska lags behind the Lower 48 in the promotion of energy efficiency ratings such as the HERS (Home Energy Rating System) Index. These ratings serve as a value added incentive for builders, buyers and sellers – and should be encouraged.

The State should increase funding for the Alaska Vocational Technical Center (AVTEC). The institution is first among the RTCs and is widely acknowledged as an affordable, practical and effective pathway for Alaskans seeking sustainable careers and one of the state's real strengths and bright spots in training Alaskans and elevating energy literacy. The institution is understaffed and asked to do a great deal with modest funding.

DOL&WD's *Green Jobs Report* should include a strategic plan that includes a stepwise approach to assessing job needs currently and identifying clean energy jobs that don't exist yet but that will as part of an energy transition. As growth in the industry occurs, the State should be prepared to increase support of training and workforce development. AEA should be the co-lead on this project.

Action 5.4C: Continue to strengthen capacity around and expertise related to effective and efficient microgrid development.

An efficient microgrid starts with a holistic approach that includes efficient buildings and trained personnel. The state should support entities and partnerships that are already focused on increasing Alaska's ability to export its expertise in microgrid development, including AEA, REAP, ACEP, Launch:Alaska, the Center for Economic Development at UAA and the UAA Business Enterprise Institute.

Alaska's disparate communities over vast distances and continued efforts to deliver remote education and training position Alaska to be a world leader in terms of creating and delivering digital educational content. If STEM skills and general energy literacy are at the core of affecting how Alaskan's think about and respond to climate change then delivering these lessons over long distances in a compelling fashion (including the use of Augmented Reality (AR) and Virtual Reality (VR)) is a tremendous opportunity.

The building trades and unions have expressed an interest in "cross-training" apprentice hires in clean energy and energy efficiency. For example, HVAC trainees are expected to be familiar with modern building monitoring technologies. An opportunity exists to encourage and expand this growing interest in transitioning traditional occupations to "green" or "clean" jobs.

New clean energy technologies are being considered and experimented with by traditional Alaskan industries within the resource development field (mining/oil & gas, maritime). For example, companies working in the emerging energy storage/generation field may find sales opportunities and offer technical expertise in remote Alaskan work sites. Universities across the country are leveraging clean energy intellectual property, research and expertise to form strategic partnerships with private stakeholders – and inviting other universities to join these partnerships where relevant. The University of Alaska should aggressively seek out partnerships that capitalize on the wealth of experience and knowledge it possesses within the microgrid sector.

Action 5.4D: Develop workforce development programs for Alaskan workers displaced from fossil energy industries (and support industries) as a result of reduced global and local demand for Alaska's non-renewable energy resources.

Similar to the Pipeline Training Center in Fairbanks, the State should work to anticipate a potential workforce need as part of a clean energy transition. TVEP funds should be allocated to training Alaskans transition from oil, gas and coal industries.

The focus of this workforce development should be on skills related to energy efficient building retrofits, renewable energy systems development, and additional diversified economic sectors. Some support industry contractors may be able to easily shift to support clean energy projects.

6. Make, attract or leverage financial investments that enable the state's climate strategy.

6.1 Increase the financing available for low-carbon renewable energy and energy efficiency activities.

Action 6.1A: Establish a Green Bank to develop long-term state-led financing of renewable energy and energy efficiency.

Programs to finance and support residential, commercial and public building energy efficiency retrofits could all be developed under the auspices of a state "green bank." Green banks are public finance authorities that use limited public dollars to leverage greater private investment in clean energy. Their goal is to accelerate clean energy market growth while making energy cheaper and cleaner for consumers, driving job creation, and preserving taxpayer dollars. Green banks deploy public capital efficiently through financing to maximize private investment and lower the costs of clean energy to spark consumer demand. Rather than rely strictly on grants that cannot bring markets to scale, green banks use limited public funds to offer financing that attracts private investment. This way each public dollar goes further and can be recycled. Green banks also facilitate market development by working with originators and lenders and offering the information consumers and businesses need to confidently purchase clean energy. By connecting capital supply and customer demand, green banks grow markets.

In Alaska, energy efficiency grant programs administered by AHFC and AEA have absolutely proven the business case for energy efficiency. From 2008 to 2015 the Alaska State Legislature appropriated more than $600 million to fund the state's low-income weatherization and home energy efficiency rebate programs. Those programs helped more than 45,000 Alaskan homes become more energy efficient, with an average energy savings of 30% per household. Today, AHFC estimates those improvements are saving the equivalent of 25 million gallons of heating oil every year. Under a state green bank, individuals and business owners could borrow money for energy efficiency upgrades through loans that are specifically structured so that the monthly loan payment is less than the borrower is saving each month on their energy bills.

In 2017, the Alaska State Legislature passed a bill that now authorizes municipalities across Alaska to set up Commercial Property Assessed Clean Energy (C-PACE) programs to finance energy improvement on commercial buildings. Under a C-PACE program, commercial building owners are able to borrow money from their local property tax authority and then pay the municipality back through a special tax assessment on the building. This type of financing tool attaches the debt to the property, and not the building owner that borrows the money. It also typically gives the borrower more time to repay the loan than a commercial loan would, allowing the annual energy savings from the building improvements to immediately exceed the special tax assessment payments. The Alaska Energy Authority is working with C-PACE experts from around the nation and several interested Alaska municipalities to develop a C-PACE program that individual municipal assemblies can adopt. However, once the C-PACE programs are adopted by local tax assessment districts, those municipalities must still find dollars to loan to commercial building owners who wish to participate in the program. Rather than using their limited bonding authority, municipalities could borrow the dollars necessary for C-PACE programs from a state green bank, and pay the bank back as tax assessment re-payments from business owners are received.

After more than $900 million in state appropriations between 2008 and 2018 for energy efficiency improvements and renewable energy, the ability of the State to continue to provide grant dollars has been severely limited by the state's revenue shortfalls. A State green bank could continue to finance energy efficiency through loans that the bank facilitates in partnership with the private banking industry. Private sector participation is a way for the state to leverage non-state dollars to promote energy efficiency loans.

A green bank could be established through AIDEA, or through separate legislation.

Once established, the State would need a steady and predictable flow of capital that the green bank could use to leverage private banking dollars.

Action 6.1B: Explore the state's ability to access or leverage venture capital funds, reinsurance programs, and other innovative opportunities for funding.

The Department of Revenue (DOR), AIDEA and other financing arms of the state should consider ways in which to support the State's climate change strategy, especially the action plan. As part of this process, DCCED should produce a white paper on agency ability to access or leverage venture capital, reinsurance funding, startup capital, or foreign direct investment. Many of the efforts to establish and accelerate a transition to a lower carbon economy will be investable and global capital will be responsive to these goals.

Establishing an Alaska-based venture capital fund focused on early stage cleantech companies (late seed through series B) is critical to encouraging entrepreneurial companies in Alaska with solutions related to climate change mitigation or adaptation. Such a fund could be capitalized with earnings from a carbon tax or through placement of a portion of permanent fund investments in Alaska-

based venture capital funds with a focus on cleantech. This form of capital for high growth startups serves a different and complementary purpose to a Green Bank.

Action 6.1C: Apply funding from state-owned facility energy efficiency savings to clean energy investments.

In 2014, AHFC estimated that the energy bill for the state's 5,000+ buildings was approximately $642 million. If that number is closer to $500 million today with lower oil prices, even a 20% efficiency savings means $100 million could be freed up every year for public buildings to do deeper retrofits. This is $100 million that is already being appropriated by the legislature. State departments would have to be given direction by the Governor's office or Department of Administration to pursue energy efficiency measures.

Each State department should report to the Alaska State Legislature how much they are saving as a result of energy efficiency measures funded by contracts with Energy Service Companies (ESCOs) (the State could also form its own ESCO). The legislature could then elect to appropriate a percentage of those savings to a state green bank. The green bank could then finance energy retrofits in the private sector, as described.

Action 6.1D: Commit and enhance long-term funding to research, renewable energy and emerging energy technology development.

The State should seek long-term funding for research into renewable energy and emerging energy technology development Research priorities should be coordinated by the University of Alaska. Emerging technology development should be coordinated through the existing Emerging Energy Technology Fund, which is administered by AEA. Research and development should be aligned with other State energy efficiency and renewable energy goals.

This is an area, too, where the State should advocate for increased federal investments.

Action 6.1E: Implement renewable energy tax credits.

Renewable energy tax credits are one option to consider for the State to promote renewable energy development. By not being carbon based, renewables would effectively be credited if a tax on carbon-based fuels existed. Most state renewable energy tax credits are production credits that are given to developers based on the number kilowatts generated, similar to the federal production tax credit for renewables, which is being phased out. Since Alaska does have a corporate income tax, it would be possible for the State to implement, through state legislation, a state renewable energy production tax credit.

The other common renewable energy tax credit is given to individuals to incentivize behavior like installing solar panels or purchasing electric vehicles. If the State established a state income tax,

State tax credits like these could also be established. The State could also dedicate a new sales tax revenue stream (from on-line purchases entering state) to carbon reducing initiatives.

6.2 Develop pathways for carbon revenue generation and a carbon pricing mechanism.

Action 6.2A: Research and develop plan for carbon pricing, to include consideration of effective fee levels and ways in which a dividend could be applied to consumer cost and renewable energy investments.

Carbon taxes are generally set by government, and disincentivize the use of carbon-based fuels by making them more expensive. For administrative purposes, if possible most carbon taxes are levied "upstream" at the location where the carbon-based fuel is either taken out of the ground, or brought into the jurisdiction. The entity being taxed then raises the price of the product and downstream consumers must pay more, use less, and/or switch to non-carbon alternatives. Since Alaska is a state where massive amounts of carbon-based fuel are taken out of the ground, a carbon tax would be levied on far more carbon-based fuel than Alaskans actually consume themselves. This is a potential advantage of a carbon tax that Alaska has over other states and nations.

Carbon taxes can be either revenue positive or revenue neutral. In 2008, British Columbia established a revenue neutral carbon tax that is rebated back to the citizens of the province through income and business tax cuts and a low-income tax credit. Canada is set to impose a national revenue neutral carbon tax in 2018 that likely be about $35 per ton of carbon. Revenue positive pricing schemes accrue new revenue for the state, province or nation that can be reinvested in renewable energy development or other programs or funds. Several state legislatures in the US are now considering carbon pricing systems, while other states are considering setting up commissions to better understand the potential economic and policy impacts of carbon pricing.

The State should implement a revenue positive carbon tax for Alaska, not a revenue neutral tax like British Columbia's that provides dividends to compensate citizens for the increased price of carbon-based fuels. The revenues from a carbon tax could be used to fund a state green bank to loan money for energy efficiency and renewable energy (see section 4.2B above) as well as many of the programs recommended here.

DOR could levy and collect the tax. Constitutionally, those revenues would likely have to then go to the state's general fund, from which the Alaska State Legislature could appropriate dollars for the Green Bank and other programs.

The revenues from a carbon fee can be directed into multiple streams of investment, which will bring down the cost of energy where it is high, encourage renewable energy and energy efficiency, and incentivize carbon emitters to decrease carbon emissions.

A portion of the revenues should be directed to the state's newly established Green Bank. The legislature will have to determine the appropriate amount consistent with climate change strategy goals and citizen affordability.

An equitable distribution of a dividend to consumers should help to offset potentially higher power and heating costs, which occur especially in rural Alaska. Where PCE is not being applied in communities with renewable energy development, a dividend can reward good behavior.

Finally, a portion of the revenue should be used to help offset short-term impacts felt by those to whom the fee applies. A structure will need to be developed such that impacts do not overly burden the company or disrupt economic development in the short term, even as this support should ramp down as time passes.

The adoption of carbon pricing at the state level increases the economic risk for Alaska. These risks need to be understood better before proceeding. At the very least, the reality is that costs at one level will be passed onto consumers and downstream businesses. A dividend approach helps to alleviate this, but other ways to approach it are to ensure the fee is not overly burdensome or high, and can scale up over time as technology and processes improves.

In order to be effective in its implementation of a carbon fee and dividend, the state should conduct an analysis of carbon pricing mechanisms and ask for an update from ISER on their study of a carbon fee and dividend impact on rural Alaska.

Action 6.2B: Consider the benefits or costs of endorsing national fee and dividend legislation, including specific Alaska requirements.

There are benefits to a national decision on implementation of a carbon fee and dividend, and while the state may act sooner than the nation in developing a carbon price and dividend, the state should also advocate for national legislation. The benefits from this include a level playing field and streamlined expectations across the sector, reducing overall the risk to make uncompetitive any single state's industry.

As carbon fee and dividend programs are considered at the national level, Alaska should advocate for state-responsive priorities and needs, such that Alaska communities and businesses see impacts commensurate with their circumstance – high energy cost plus low overall emitters. Additionally, if the state has approved its own carbon fee and dividend program, then implementation at the federal level will have to accommodate the state's system and not duplicate processes or increase the overall societal burden.

Action 6.2C: Encourage opportunities for carbon sequestration, through use of Alaska natural resources, lands and maritime environment.

Today, California law allows California emitters to purchase carbon credit offsets issued from carbon mitigation activities in all four west coast states, including Alaska. Sealaska Corporation and other Native entities have already begun to take advantage of this provision in California's cap and trade system. Sealaska was recently issued 11 million carbon credit offsets by the California Air Resources Board to set aside 165,000 forested acres for use as a carbon bank for 110 years. The State should investigate the opportunity to sequester carbon on forest and carbon resource land, like coal deposits, that the state owns.

DNR and DF&G should explore public lands and waters available for sequestration. Industry here and elsewhere may prefer a carbon offset, which the state should explore as an alternative to carbon pricing. The advantage of carbon offsets is their global applicability, and the opportunity to bring funding into the Alaska economy and state budget with less economic risk and potential for economic disruption.