GAP ANALYSIS OF ALASKA'S CLEAN ENERGY EDUCATION & TRAINING OPPORTUNITIES

K-12 / CAREER & TECHNICAL / UNIVERSITY

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REAP Renewable Energy Alaska Project

ALASKA NETWORK of ANEEE ENERGY EDUCATION AND EMPLOYMENT

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INTRODUCTION

This gap analysis seeks to catalogue the curricula, programs and pathways by which i) Alaskan K-12 students; ii) Career and Technical Education (CTE) trainees and; iii) Alaskan University students might increase their energy literacy, combat the high cost of energy in Alaska, discover careers and improve overall quality of life in the state. The primary goal of the analysis is to identify areas of strength, opportunities, needs, bottlenecks and clean energy education/training gaps.

Mapping the who, what, when and where of energy lessons, trainings, certificates and degrees throughout the state will enable more conversation, coordination, alignment and efficiency amongst the various stakeholders working toward a more energy literate Alaska. These stakeholders include educational institutions, research institutions, governmental agencies, Alaska Native corporations, industry, young people seeking education, and adults seeking further education.

Ten thousand years ago, human survival in Alaska depended on a community's ability to do the following:

- Trace energy flows and think in terms of energy systems.
- Know how much energy is used, for what purpose, and where the energy comes from.
- Assess the credibility of information about energy.
- Communicate about energy and energy use in meaningful ways.
- Make informed energy use decisions based on an understanding of impacts and consequences.[1]

The basic tenets of energy literacy in Alaska have not changed over these last ten thousand years. The nature and role of energy in the world, and our daily lives, is still crucial to basic survival. Ironically, technological developments have absolved today's average Alaskan from both an understanding and ability to answer basic energy questions. Too many modern Alaskans cannot solve basic energy problems for themselves, or meaningfully weigh-in on complex energy issues. Understanding and applying the principles of energy literacy have been hallmarks of human progress throughout history. As human activity is conclusively impacting the Earth's climate, to the detriment of human populations, the pursuit and understanding of clean energy technologies has never been more urgent. If Alaska is to meet its unique energy needs, utilize its abundant renewable resources and confront the reality of climate change – its populace must strive to be among the most energy literate in the world.

[1&2] Department of Energy

CLEAN ENERGY EDUCATION BY LEVEL: K-12, CAREER AND TECHNICAL EDUCATION (CTE), UNIVERSITY

Energy literacy expands along a continuum that begins at home and extends through school, to post-secondary education, through community organizations, into the workplace and finally within the particular pursuits of our daily lives. There is no energy lesson not worth learning and energy lessons are always on-offer in Alaska, inside and outside of classrooms. The Alaska Network of Energy Education and Employment (ANEEE) was conceived by Alaska energy stakeholders and funded by the Office of Naval Research with the express purpose of identifying pathways that lead Alaskans toward a greater energy literacy and capacity to take on the challenges posed by the high cost of energy in Alaska. The categorizations (K-12, CTE, University) used in this gap analysis are a practical means to organize and distinguish a wide array of clean energy offerings within the wider framework of general energy literacy.

METHODOLOGY

This gap analysis was based on a combined approach of collecting and analyzing qualitative and quantitative data. Clean energy as defined here includes renewables and energy efficiency measures, practices and technologies. Quantitative analysis included documentation of clean energy teaching/training data, such as numbers of teachers involved, training programs, degree programs and relevant occupations within the state of Alaska.

Structured, semi-structured and informal discussions that informed this analysis were conducted with K-12 teachers (rural and Railbelt[2]), CTE instructors, University of Alaska and Alaska Pacific University professors. More than 50 students from K-12, CTE and University sectors were engaged in an individual, classroom or workshop setting. The focus of these discussions was energy literacy; specifically, curriculum and training. Discussions and interviews were held with the Commissioner of Alaska's Department of Education and Early Development (DEED) and the Commissioner of Alaska's Department of Labor and Workforce Development regarding efficiency related occupations. School district and university facility managers, as well as commercial facility managers were queried about skill and training requirements for employees charged with efficient maintenance and operation of Alaskan buildings. The State Director for the US Department of Labor Apprenticeship Office was consulted in regard to energy specific apprenticeship opportunities. Public, private, and Alaska Native Corporation workforce development professionals were consulted about past and present training opportunities in the clean energy sector. Representatives from federal and state agencies responsible for energy education, training and technical assistance programs throughout the state participated in informational interviews, including: DoE, Indian Energy, Denali Commission, US Department of Agriculture (USDA), National Renewable Energy Laboratory (NREL), Alaska Energy Authority (AEA), Alaska Native Tribal Health Consortium (ANTHC). Rural and Railbelt utility managers,

[2] The Alaskan *Railbelt* typically refers to urban/suburban communities along the road/rail system that extends from the Kenai Peninsula to the Fairbanks Northstar Borough. Communities in Southeast Alaska such as Juneau, Ketchikan and Sitka are similar to medium sized Railbelt communities in terms of demographics and infrastructure, but are not part of the Railbelt as they cannot be accessed by road. Alaskan *Hub* communities typically refer to regional population centers (> approx. 2000 people) within Interior and Coastal Alaska, also not accessible by road.

clerks, linemen, wiremen, power plant operators, millwrights, union training coordinators and private training contractors were also consulted about training schedules, materials and regimens.

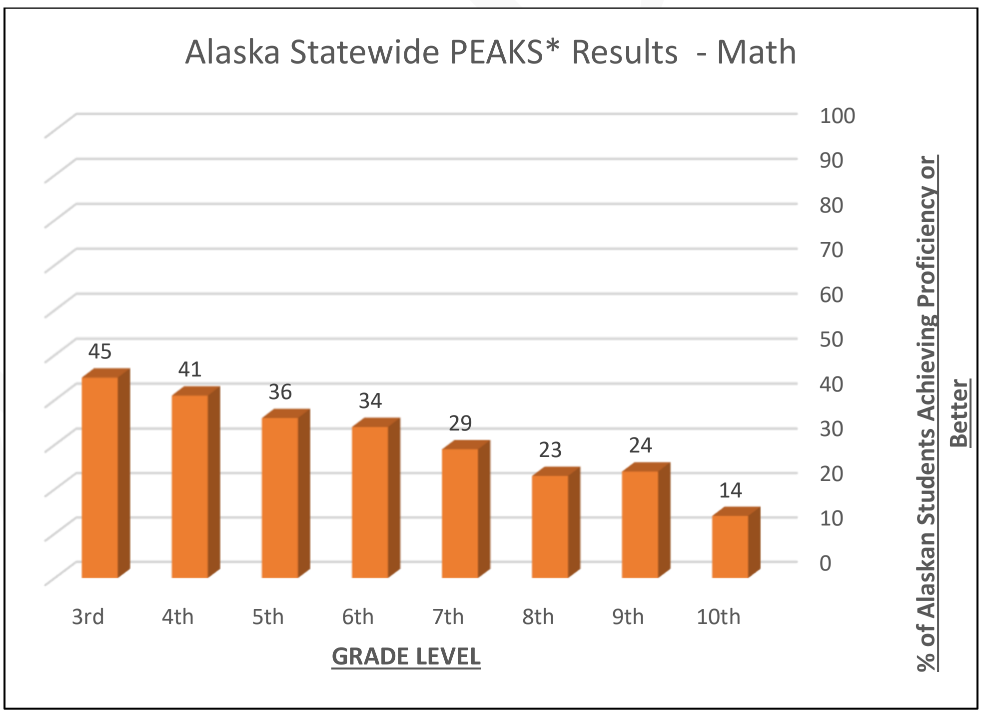
ANEEE convened a focus group of Alaskan energy educators to determine the perceived needs of students, teachers, community members and employers within the clean energy sector. An overall qualitative assessment included a review of the historic roles of government entities, businesses, key stakeholders and public institutions administer, compete or collaborate within Alaska's clean energy sector. This included a literature review and interviews with key people. Findings in the gap analysis also draw upon interviews and numerous white papers produced by Alaskan organizations researching Alaska specific energy efficiency issues, including those produced by the Alaska Housing Finance Corporation (AHFC) and the Cold Climate Housing Research Center (CCHRC).

The methodology included an effort to document curricula, training and degree programs offered by outside jurisdictions (the Lower 48 and European Union) in each of the clean energy education categories under consideration. In addition, clean energy skill competencies and training gaps were identified within the specific context of Alaska's clean energy demands and labor market.

K-12 – CLEAN ENERGY EDUCATION

Energy literacy entails some understanding of civics, politics, history and sociology; but is rooted at its core in science, technology, engineering and math (STEM). Meaningful efforts to expand energy literacy in Alaska must confront the ongoing STEM crisis taking place throughout Alaska at all grade levels.

Third grade is often identified as the most consequential year in a student's life, a year of intellectual transformation. Successful third graders move from *learning to read* and toward *reading to learn*. Underperforming third graders are four times more likely to drop out of high school than their more proficient classmates.[3] There is a winnowing down of Alaskan third graders able to meet basic grade level competencies, and this has an outsized impact on educational and career opportunities. Recent state testing is not conclusive, but the numbers for Alaskan third graders are not good. Less than 45% of students are proficient at grade level math and only 38% of students are English Language Arts proficient.[4] This winnowing down becomes more severe as students move through the school system; Alaskan third graders as a whole represent the highest scorers across the entire K-12 system. A mere 14% of Alaskan tenth graders are proficient at grade level math (Advanced Arithmetic/Algebra I).



[3] How Third Grade Reading Skills and Poverty Influence High School Graduation
*Performance Evaluation for Alaska's Schools (PEAKS) is the state's federally mandated standardized test
[4] 2017 PEAKS results

A case can be made that, because the recently developed Performance Evaluation for Alaska's Schools (PEAKS) statewide assessments have produced only two years' worth of data, definitive conclusions regarding these scores are premature. It is also the case that Alaska's statewide student profile is highly unique, which makes comparison to other states problematic. But, to the degree that standardized tests are one of many tools that indicate how young Alaskans are faring in a highly competitive world, the results and downward trend by grade level, are worrisome.

Energy literacy and STEM are not equated in this gap analysis, but they are inextricably linked. Meaningful energy literacy efforts, and an understanding of Alaska's clean energy potential, are dependent on a student body with STEM competencies far greater than those in evidence today. We need to better prepare the ranks of future Alaskan students, workers, entrepreneurs, homeowners, teachers and parents.

SCOPE

Statewide K-12 extracurricular education efforts are by definition ambitious. No matter the state or the subject matter in question, there are bound to be a common set of obstacles in introducing lessons that are not part of the regular curriculum. Time is a limited commodity in every classroom and the competition to win over teachers and students working outside mandated curricula is fierce. In Alaska, there are added challenges unique in both number and character. The ever present rural/Railbelt divide requires close attention to cultural diversity, historical grievances and the persistent web of logistical barriers that are familiar to generations of Alaskans. The following categorizations are useful in addressing specific challenges to the implementation of an extra-curricular energy literacy program in Alaska:

I. **Curriculum**

II. **Establishing Metrics of Efficacy**

III. **Outreach and Awareness**

IV. **Delivery: Classroom Teaching /Teacher Training/E-Learning/Distance Learning**

V. **Strategic Partnerships**

I. CURRICULUM

High quality lessons and materials are a cornerstone to any educational endeavor. Alaska has an abundance of quality energy literacy curriculum ready for traditional classroom learning environments, including Alaska-specific clean energy lessons, modules and hands-on activities. Specific curriculum focused on wind, solar, hydro, geothermal, biomass, energy storage and other clean energy resources can be easily accessed by clean energy educators from a variety of online sources.

Existing Curricula

- Like many states, Alaska has developed a specific energy curriculum that is aligned with articulated state standards. Developed in partnership with Alaska Housing Finance Corporation, Alaska Center for Energy and Power and Renewable Energy Alaska Project (REAP); *AK EnergySmart*[6] includes a variety of grade level appropriate modules, lessons and materials that focus primarily on energy efficiency, while touching upon power generation. A first grader may learn the insulating properties of otter fur, while seniors in high school study the design of renewables within a rural Alaskan microgrid system. *AK EnergySmart* includes several modules that deal specifically with building science, and is flexible enough to incorporate the fast-developing world of clean energy technologies. Classroom presentations of *AK EnergySmart* also serve a dual purpose as energy educators are able to model the delivery of specific energy lessons to teachers - and thereby train regular classroom teachers in attendance (with Continuing Education credits available). In addition, *AK EnergySmart* serves as the foundational curriculum for the *Power Pledge Challenge*, an annual energy conservation competition amongst more than 3,000 K-12 students in Alaska, representing four different school districts that are served by six separate electric utilities.

- The second most prevalent clean energy curriculum taught in Alaska is *Wind for Schools*, a program developed by the Department of Energy, and delivered by REAP via classroom visits, video-conference and teacher trainings. Hands-on curriculum includes a wind turbine design competition for students in grades 4-12 (*Kid Wind*). Additionally, some Alaskan schools have installed small wind turbines on-site as demonstration projects. There are currently seven turbines across the state that were installed through the *Wind for Schools* program from 2009 to 2011.

- The Sustainable Energy Program at UAF, Bristol Bay is able to offer Dillingham, Alaska's K-12 community a wide range of educational opportunities ranging from lessons in efficiency to small renewable energy systems; with some high school students able to earn college credit.

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[6] *AK EnergySmart* is a free curriculum resource designed to give Alaskan youth an understanding of the economic and environmental costs of power generation and the importance of conserving energy at home and school.

- In the village of Kokahanok, Alaska; the US Department of Energy's Office of Indian Energy has piloted an effort to develop a place and technology-based curriculum. Lessons are targeted toward rural Alaskan microgrid communities where the high cost of fuel is a major factor affecting quality of life. High school level lessons are designed to foster student interest in the day to day workings of the village power plant, grid, and utility office. Lessons include basic power plant operations, diesel efficiency, calculating Power Cost Equalization (PCE) numbers, business math, basic electricity principles and meter reading.

- Alaska Resource Education (ARE) is a non-profit dedicated to educating Alaskan students about oil, gas, mineral and forestry resources within the state. With an emphasis on resource extraction and industry; the organization has on offer a K-8 energy literacy curriculum that incorporates lessons on energy conservation, the sun as an energy source and renewable concepts. ARE employs one full-time energy educator.

- Beyond *AK EnergySmart* and *Wind for Schools*, there are scores of federal and state agencies, nonprofit organizations, educational institutions and individuals who have made compelling clean energy literacy content available online, often free and aligned with Next Generation Science Standards (NGSS). (*K-12 STEM Appendix*)

Curriculum Gaps

Finding #1:
STEM deficiencies amongst Alaska's students hamper the impact of any well developed clean energy curriculum. Most recently the Alaska Department of Education and Early Development (DEED) published *Alaska's Education Challenge Report*; a series of proposals and recommendations produced by survey and stakeholder meetings that address the STEM achievement gap. Teacher retention, poverty, language and cultural barriers have long been conjectured to be root causes of the achievement gap.[7] Based on conjecture, a myriad of strategies have been suggested to address the performance gap, the efficacy of which are unknown.

Recommendation

- There is some consensus amongst Alaskan educators regarding the need for objective analysis of the state's educational system and performance shortfalls. [8] Current political leadership in Alaska has ruled out the level of investment such analysis requires. Advocacy for a comprehensive, expert study seems warranted. Until then, a survey of other analyses and actions taken by states facing similar STEM achievement gaps is recommended.

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[7] Alaska STEM: Education and the Economy, *Report on the Need for Improved Science, Technology, Engineering and Mathematics Education in Alaska*

[8] Alaska students' math and reading scores below national average on 'national report card'. ADN, April 10, 2018

Finding #2:
Clean energy curriculum in Alaska incorporates STEM on a more conceptual basis, as opposed to the application of STEM based computations and skills.

Recommendation

- Develop and make available clean energy problem sets to STEM classroom teachers for incorporation into established curriculum. The problem solving, analytical and computational skills required to determine *if* and *where* Alaska clean energy projects might work - could be a rich resource for exercising core STEM competencies.

Finding #3:
Rural Alaskan students are not being reached in equal proportion to their urban or road system counterparts with clean energy curricula. This is due in part to the lack of compelling clean energy curriculum designed specifically for distance and E-learning recipients, *i.e. rural school districts.*

Recommendations:

- The Alaska Network of Energy, Education and Employment (ANEEE) is well placed to leverage existing networks (such as Alaska Staff Development Network, T3 Alliance, Lower Kuskokwim School District Summer Academies EXCEL, ANSEP, CODE.org, etc.) that serve this demographic and facilitate convenings comprised of rural Alaskan educators, administrators and clean energy curriculum experts with the express purpose of exploring avenues for the adaptation of existing traditional clean energy curriculum to E-learning and distance learning environments.

- In conjunction with REAP energy educators, ANEEE might invite select teachers to develop place-based clean energy classroom curricula by facilitating introductions and interviews with clean energy industry experts and field trips to clean energy projects that are positively impacting the teacher's region.

- The Alaska Energy Authority (AEA), in partnership with REAP, developed the *Renewable Energy Atlas of Alaska*. Alaskan energy educators are well positioned to develop lessons that point to specific rural Alaskan renewable energy projects within this atlas. Existing online clean energy curricula might be leveraged to create innovative and enriching place based lessons that can be utilized by classroom teachers working within particular rural Alaskan regions.

- Explore opportunities to utilize rural school buildings as object lessons in clean energy. The fact that school buildings themselves are increasingly being built and retrofitted with clean energy technologies make energy literacy relevant and conspicuous within the daily lives of teachers and students. AHFC has recently installed an open source internet dashboard and sensor based Building Monitoring system (BMONs) throughout the school buildings in the Mat-Su Valley District. REAP and AHFC are exploring the possibility of expanding the *AK EnergySmart* curriculum to include BMONs as a learning tool that allows students to measure and monitor energy use within their own school building.

These are the sort of curricular innovations that lead to widespread engagement and encourage behavioral adaptations.

Finding #4:

The food security/clean energy nexus is attracting great interest in Alaska, yet there is little in the way of subject matter curricula.

Recommendation:

- Recently published by the Cold Climate Housing Research Center, the *Biomass Greenhouse Handbook* serves as a *how-to* guide for school districts interested in growing their own food with a biomass heat source. This guide, along with the various other solar and heat pump based greenhouse projects around the state might serve as the basis for curriculum that is highly relevant and useful in addressing the food security/energy nexus.

Finding #5:

The ability to reach as many students as possible with hands on activities is often limited by the resources needed to deliver "kits" such as those utilized by the *Wind for Schools* curriculum and the heat loss/insulation lesson, *Snug House,* from *AK EnergySmart.*

Recommendation:

- Use efforts such as assembling inventory/vendor lists and fund raising strategies to facilitate the purchase of clean energy kits might include for school districts, parent groups or other associations that might be interested in increasing their capacity to deliver clean energy lessons.

II. ESTABLISHING METRICS of EFFICACY

Developing metrics to evaluate the impact of specific lessons is as important as it is difficult. How does one measure the efficacy of curriculum that is so heavily dependent on an individual teacher's talents to communicate, impact and inspire?

Finding #1:
The number of full-time energy educators confirmed as currently working in Alaska is four, and three are employed by REAP. Historically the dominant strategy employed by REAP's energy educators has been to reach as many students as possible.

Recommendation:

- Continue to develop an alternative outreach strategy; a deeper, more focused approach that seeks more contact with fewer students over a longer period of time.

Finding #2:
The number of classrooms, students and teachers touched through the *AK EnergySmart* and *Wind for Schools* programs by REAP's energy educators are recorded. Energy lessons delivered by classroom teachers and other instructors in the state are not tracked in any easily discernible way The number of lessons downloaded from the AK *EnergySmart* website is tracked and the number of teachers earning CTE credits for energy education training sessions, is also tracked. Less available, is the data concerning which particular lessons teachers are choosing to deliver from within AK *EnergySmart* upon completion of curriculum training; and how often these lessons are delivered.

Recommendation:

- Utilize software such as *Google Analytics* in tracking as much quantitative data as is relevant when lessons are downloaded from the AK *EnergySmart* website. Formulate an efficient outreach strategy to contact teachers likely to have been exposed to energy education training and solicit data through questionnaires. Utilize incentives to encourage teachers and administrators to respond in a full and timely manner.

Finding #3
Combined grade level classrooms, typical of rural Alaska, utilize curricula differently than traditional classrooms segregated by grade level. Specific energy lessons are likely to differ in application and impact based on classroom composition, curricula are rarely developed with these mixed classrooms in mind.

Recommendation:

- Rural Alaskan teachers, administrators and relevant networks serving this demographic might be consulted as to the dynamics of mixed grade level classrooms and the types of lessons that are best suited for these environments.

Finding #4
There is no baseline energy literacy metric for Alaskan students from which to measure improvement after exposure to specific curriculum. Further, there is very little quantitative or qualitative data that might allow for a comprehensive evaluation of the impact of curriculum and energy education efforts in Alaska.

Recommendations:

- In 2017, the National Energy Foundation conducted a nationwide survey of high school students - an energy literacy assessment questionnaire. The survey consisted of three blocks: Behaviors, Energy Literacy Concepts, and Attitudes. In addition, a growing body of work examining best practices in constructing energy literacy surveys is readily available. [see SURVEY APPENDIX]

- REAP is in the process of adapting this student friendly questionnaire to develop Alaska specific questions for distribution in Alaskan classrooms. Before/After surveys could also be deployed. REAP can then compare scores of students who have been exposed to REAP's energy literacy offerings with students/classrooms that have not yet been exposed. Efforts to prioritize which lessons might best be improved, modified or in some cases replaced would benefit from such data collection.

- Experiential surveys for both teachers and students would be beneficial to develop qualitative data on specific energy lessons.

- Separate surveys and informal interviews could be deployed to improve and evaluate E-learning/distance lessons.

- Energy educators, STEM instructors and curriculum developers could be convened to discuss best practices and next steps to develop metrics for energy education in Alaska.

III. OUTREACH and AWARENESS

128,800 ALASKAN STUDENTS

8,050 ALASKAN TEACHERS

3 ALASKAN CLEAN ENERGY EDUCATORS

1 ALASKAN NATURAL RESOURCE ENERGY EDUCATOR

22% OF TEACHERS WORK OUTSIDE THEIR AREA EXPERTISE

Energy educators in Alaska are confronted with a "retail" reality in their efforts to forward energy literacy. Teacher time, student time, administrative support, safe learning environments; these are all fields of intense competition amongst outside institutions making a compelling case that *their* particular curriculum, lessons, materials and teachers deserve to be heard. Current REAP energy educators build on established relationships for return appearances within certain schools and classrooms. New inroads are typically formed through either a grassroots approach of contacting individual teachers or top-down inquiries to superintendents.

The easiest entry points are teachers and administrators familiar with energy literacy offerings, individuals who recognize the intrinsic value in increased energy literacy. Teacher champions are effective allies, but sometimes powerless to approve or implement outside curricula. Superintendents may be harder to interest, but more capable of motivating action on the part of several teachers. In both cases, making contact and eliciting a positive response is difficult.

Finding #1:
Cold-calls, emailing and public presentations are time intensive endeavors that are not the best use of a limited resource: energy education instructors. Time spent trying to interest school districts and teachers in energy literacy is time not spent training teachers and instructing students in the principles of energy literacy.

Recommendation:

- A strategic, targeted campaign designed to create awareness and utilization of energy literacy curriculum amongst Alaskan educators, administrators, students and parents. Gaining the attention of educators and administrators poses an initial challenge; However, this is achieved, there are numerous paths within existing state standards where impactful energy lessons could be delivered. An initiative of Alaska's Department of Education and Early Development (DEED), the Alaska Science Curriculum Initiative (AKSCI), has explicitly mapped where energy literacy lessons might best be taught within the K-12, Physical Science, Earth Science, and Biological Science curriculum. (*Figure 1*).

Grades	Standards Woven Throughout Units	Year	Physical Science	Earth Science	Life Science
Grades K-2	Inquiry and Process Science and Technology Cultural, Social, Personal Perspectives and Science History and Nature of Science Traditional and Ecological Knowledge	1	**Properties of Matter** 1. Classifying Matter 2. Observing Reactions	**Water Cycle, Rock Cycle, Weather** 1. Observing the Weather 2. Freezing, Thawing & Evaporating 3. Looking at Rocks	**Biodiversity** 1. Living & Nonliving 2. Needs of Living Things/Life Cycles 3. Alike & Different
		2	**Motions & Forces** 1. How Things Move 2. Vibrations Make Sound 3. Magnets	**Forces that Shape the Earth** 1. All Sizes & Shapes of Rocks 2. Changes Happen to Our Surroundings	**Interdependence in Ecosystems** 1. Plants & Animals Need Each Other 2. Different Places, Different Plants & Animals
		3	**Energy Transfer & Transformation** 1. The Sun Warms the Land, Air & Water 2. Insulation	**Solar System & Universe** 1. Observing the Sun 2. The Moon Looks Different 3. Stars in the Sky	**Adaptations & Changes Over Time** 1. Plant & Animal Features for Survival 2. Offspring & Parents 3. Alive in the Past
Grades 3-5		1	**Properties of Matter** 1. Solid, Liquid, Gas 2. Heating, Cooling & Change	**Water Cycle, Rock Cycle, Weather** 1. Water Movement 2. Rocks & Soils 3. Weather Patterns	**Biodiversity** 1. Comparing & Sorting Living Things 2. Systems and Structures
		2	**Motions & Forces** 1. How Forces Change Motion 2. Moving Without Touching	**Forces that Shape the Earth** 1. Features of the Land 2. Erosion, Deposition & Soil 3. Catastrophic Events	**Interdependence in Ecosystems** 1. Food Chains & Energy 2. Interactions Between Organisms
		3	**Energy Transfer & Transformation** 1. Insulators & Conductors of Heat 2. Different Kinds of Energy 3. Changes Made by Energy	**Solar System & Universe** 1. Changing Daylight, Changing Seasons/Movements of Earth 2. Phases of the Moon 3. Objects in the Sky	**Adaptations & Changes Over Time** 1. Organisms Match their Environment 2. Traits are Inherited 3. Fossils

Grades	Standards Woven Throughout Units	Year	Physical Science	Earth Science	Life Science
Grades 6-8	Inquiry and Process Science and Technology Cultural, Social, Personal Perspectives and Science History and Nature of Science	1	**Properties of Matter** 1. Atoms, Molecules & States of Matter 2. Mixing & Separating 3. Physical & Chemical Changes	**Water Cycle, Rock Cycle, Weather** 1. Igneous, Metamorphic, Sedimentary 2. Water, Earth & Weather 3. Weather & Energy	**Biodiversity** 1. Dichotomous Keys & Taxonomy 2. Cells, Tissues, Organs & Systems 3. Behaviors for Survival
		2	**Motions & Forces** 1. Magnets & Currents 2. Waves 3. How Light Travels 4. Forces	**Forces that Shape the Earth** 1. Inside the Earth 2. Changes Related to Tectonic Plate Movement 3. Mapping & Stewardship	**Interdependence in Ecosystems** 1. Food Webs 2. Flows, Cycles & Conservation 3. Energy for Changes
		3	**Energy Transfer & Transformation** 1. Energy Changes Form 2. Explaining Changes of State (solid, liquid, gas)	**Solar System and Universe** 1. Tilt & Rotation 2. Planets, Stars & Distances 3. Modeling the Solar System	**Adaptations & Changes Over Time** 1. Reproduction 2. Adaptations for Survival 3. The Role of Genes
Grades 9-12		1	**Properties of Matter** 1. Periodic Table 2. Atomic Structure 3. Chemical Reactions	**Water Cycle, Rock Cycle, Weather** 1. Modeling the Rock Cycle 2. Water, Carbon & Oxygen Cycles 3. Climate	**Biodiversity** 1. Structure & Function 2. Kingdoms, Phyla & Divisions 3. Cells & Systems 4. Learning & the Brain
		2	**Motions & Forces** 1. Newton's Laws 2. Interactions of Electric & Magnetic Forces 3. Movements of Waves	**Forces that Shape the Earth** 1. Erosion, Deposition & Humans 2. Plate Tectonics Model & Theory	**Interdependence in Ecosystems** 1. Carbon & Nitrogen Cycles 2. Population Dynamics 3. Impacts of Changes in Ecosystems
		3	**Energy Transfer & Transformation** 1. Types of Heat Transfer 2. Useful Energy 3. Electrical Circuits	**Solar System & Universe** 1. Tides 2. Aurora 3. The Universe & its Changes	**Adaptations & Changes Over Time** 1. Chromosomes, DNA & Inheritance 2. Natural Selection & Evolution 3. Issues in Genetics

Figure 1 from Alaska K-12 Science Curricular Initiative (AKSCI)

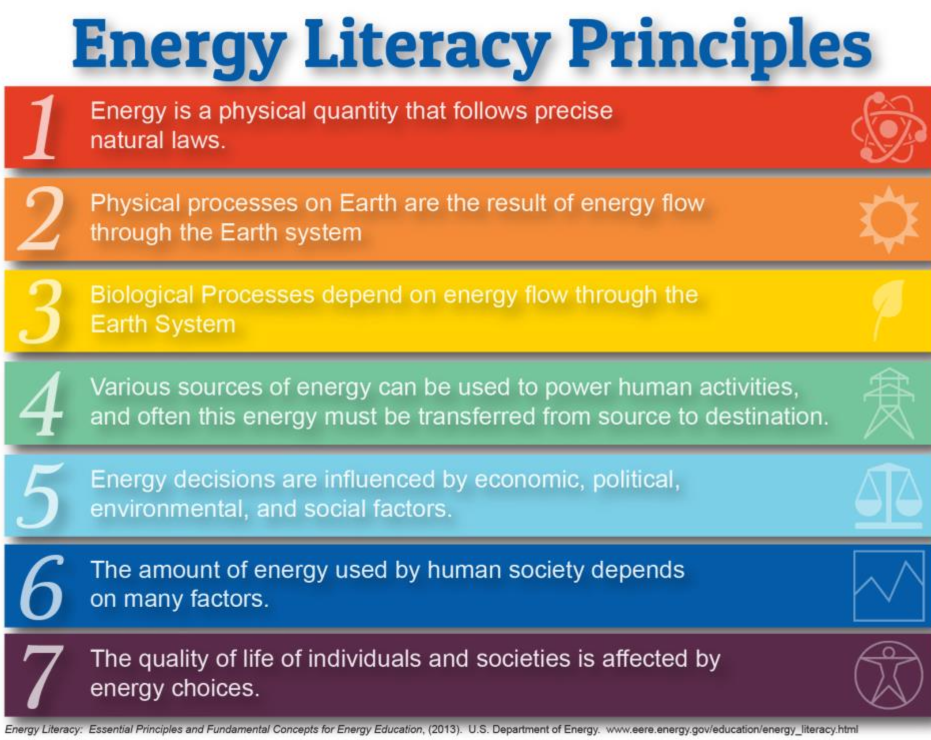
The convergence of state standards and energy literacy lessons should not be surprising. Energy permeates every aspect of our existence - consequently, there is perhaps no STEM principle, lesson, assignment, project or classroom conversation that could not be reconfigured through an energy literacy framework. World and U.S. History might easily be read as a continuous quest for sustainable energy resources. Subject alignment and relevance is not a hindrance to the adaptation of energy curriculum in Alaska schools.

Finding #2:
Alaskan teachers are bound to specific lessons, under immense time pressures, are often not teaching in their subject area of expertise, teach in less than optimal classroom environments and face a flurry of demands and expectations from a hierarchy of supervisors. With such limited bandwidth, many teachers and administrators may simply be unaware of the existence of curriculum like *AK EnergySmart, Wind for Schools*; not to mention the importance/relevance of energy literacy in general.

Recommendation:

- Develop a widely and consistently distributed *one-sheet* describing the Alaskan offerings, and the benefits of energy literacy lessons could open new doors or create an atmosphere of greater receptivity to current outreach efforts. While not recommending a complete takeover of the STEM, art, history, sociology and civics agendas within our schools – this strategy would emphasize the relevance of energy literacy as a compliment to nearly every conceivable lesson plan. Energy educators could position themselves as willing to tailor or help navigate classroom teachers toward materials and lessons to further specific classroom goals. Energy educators are positioned to lighten the load, not burden classroom teachers.

  Such an approach might include the deployment of expertly crafted resources, images, examples and posters such as those available within the U.S. Department of Energy's *Energy Literacy Guide: Essential Principles and Fundamental Concepts*[9]:



[9] *Energy Literacy Guide: Essential Principles and Fundamental Concepts*, US Dept. of Energy

These principles serve as a framework for discussing energy literacy and are not intended as strict starting points for classroom instruction. In the context of strategic efforts to communicate and leverage the value of energy literacy as a tool for enhancing STEM education, these principles (and the many subcategories that are included in the full DoE literacy guide) are as flexible as they are useful. The DoE Energy Literacy Principles and the treasure trove of supporting materials could usefully be thought of as an arsenal of marketing materials, developed by a vast team of experts who make a truly compelling case for *Why?* energy literacy.

- REAP is uniquely positioned to make the case for energy literacy, not only through its classroom offerings, but through its established history and close association with renewable energy projects, industry, government agencies and technology developers throughout the state. The glamorous narrative of Alaska as a world-leading, living laboratory for microgrid and renewable technologies could also be aggressively leveraged to increase young students' interest in clean energy.

- Expand the STEM acronym to *STEAM*. The *Arts* are a recent edition to traditional STEM efforts. Most energy literacy outreach is focused on STEM teachers, or a specific STEM unit at the primary level. The addition of *Arts* suggests a wider appeal, one that might find a greater receptivity amongst teachers and administrators who are less accustomed to making energy literacy connections within their areas of expertise.

  STEAM underscores the utility of outreach that leans into the DoE energy literacy principles. Consider the final principle on the DoE list: *"The quality of life of individuals and societies is affected by energy choices."* In 2007, the Wisconsin K-12 Energy Education Program created lessons and materials designed specifically for social studies teachers. The course provided teachers and their students with energy-enriched lessons and teaching strategies. Teachers and energy literacy curricula developers worked together to identify existing activities and emphasize themes that were particularly useful for teachers of social studies. These teachers and curricula developers also worked to develop additional activities highlighting energy aspects of one or more social studies concepts already being taught.[10]

- Re-frame, *AK EnergySmart* to target lessons and specific aspects of existing materials that touch upon arts, social sciences and even vocational education. This approach could generate interest and make initial teacher outreach easier.

[10] University of Wisconsin – K-12 Energy Curriculum for Social Studies Classes

- Career and Technical Education (CTE) in Alaska is a rare bright spot on the landscape and worth consideration in this context of overlooked classrooms worthy of greater outreach.

> - **High School Graduation Rate in Alaska - 74%**
> - **47th in the Nation**
> - **Graduation Rate amongst Alaskan CTE students - 97%**

Alaska, along with other school districts throughout the nation, is making a determined push toward expanding the reach of CTE coursework. [11] REAP staff have capitalized on this trend by participating in curriculum development sessions at the vocational magnet school, King Tech High School in Anchorage. Community members, construction contractors, administrators and educators have all demonstrated an interest in finding ways to incorporate energy literacy coursework within King Tech's (Anchorage School District's full time vocational high school) career oriented classes such as *Construction Electricity* and *Natural Resource Development*.

Finding #3:

Current energy literacy outreach and awareness efforts are typically limited to individuals within the school system – less emphasis has been placed on community outreach. It is also worth revisiting the *who* and *how* behind outreach efforts since the request for permission to come into a classroom precedes any successful lesson.

Recommendations:

- Outreach avenues worth exploring include school boards, community councils, parent teacher associations, tribal and village Councils, village elders, teacher unions, local and state politicians who have shown an interest in education issues, student newspapers, high school sporting events, and other settings where students congregate such as ferries of the Alaska Marine Highway System. Outreach might be as simple as a flyer or email.

Finding #4:

Along with a comprehensive outreach and awareness strategy for energy literacy efforts, there is not currently a process in which Alaskan energy educators can map and track the efficacy of their outreach efforts.

[11] 2018 CTE Addendum

Recommendation:

- Tracking and mapping data regarding energy educator outreach efforts by: grade level, teacher subject area expertise, manner of contact (phone, email, in-person), region/school district, semester timing, administrator title, community member, etc., might provide new guiding insights.

III. DELIVERY:
CLASSROOM TEACHING, TRAINING, DISTANCE LEARNING, E-LEARNING

Alaska's unique set of challenges in providing a rich education to all of its students is well documented. The size of Alaska, differences in rural and Railbelt learning environments, capacity to incorporate E-Learning and distance learning technologies, and state budgetary constraints pose significant challenges for educators seeking to reach Alaskan youth and provide continuing education/training opportunities to Alaskan teachers.

There are many entities actively working to disseminate STEM based lessons throughout the state (See STEM ECOSYSTEM APPENDIX). As stated above, there are at this moment, four energy educators working throughout Alaska. REAP's three energy educators work to increase energy literacy and a greater understanding of clean energy principles. Alaska's Resource Education employs a single energy educator who works from a curriculum centered upon resource extraction. These, and the many Alaskan STEM educators deliver lessons and train teachers by combination of: in-person classroom instruction, distance learning (live or recorded instruction through video, chat and/or webinar), and E-Learning, where lessons and modules are accessed online and experienced at the user's own pace.

REAP's efforts to deliver the high-quality *AK EnergySmart* curriculum is indicative and perhaps representative of the challenges faced by Alaska educators charged with a state-wide mission. The ideal scenario has expert teachers working inside the classroom. This is likely to have the greatest positive impact on learning outcomes. Teacher-student and student-student dynamics foster relationships and interactions that cannot be easily duplicated through distance or on-line learning. Body language, tone, mannerisms and behaviors are minimized or in some cases lost without real world interactions.

In 2018, REAP conducted approximately 200 teaching sessions in classrooms with one full-time STEM educator. The expansion of REAP's teaching capacity to the equivalent of 3 STEM based energy educators will have a significant impact on both the breadth and scope of REAP's efforts. Still, just three individuals covering a state the size of Spain, France and Portugal combined has obvious limitations. The aforementioned 200 teaching sessions often double as training sessions for regular classroom teachers.

REAP's energy educators model best practices in delivering the *AK EnergySmart* curriculum to students, with the understanding that the classroom teachers in attendance might absorb best practices and then be able to deliver more of the curriculum at a later date. This *train-the-trainer* model perpetuates a greater number of individuals qualified to deliver lessons in the most favorable manner possible – face-to-face . REAP's energy educators provide in-service teacher trainings that are often sponsored by school districts. Additionally, REAP energy educators seek to provide special teacher training sessions by appointment. All of these trainings include Continuing Education credits for interested teachers.

REAP and various extracurricular STEM educators reach classrooms through webinar type distance learning experiences. *Wind for Schools* curriculum and activities are taught via video demonstration with live links.

Modules from *AK EnergySmart* can be downloaded by students and teachers and utilized in classrooms independently of REAP's energy educators. This is an example of limited E-Learning - the level of on-line interactivity with the *AK EnergySmart* is, presently, fairly limited.

Finding #1:
The number of professional energy educators and classroom teachers trained in energy education is severely lacking.

Recommendation:

- The recruitment of more qualified individuals able to teach energy education may require an expansion of the pool of candidates to include those outside the teaching profession. It could be worth exploring ways to extend energy literacy teacher training to members of the general public with a proven degree of STEM competency. Such trainings could be re-tooled so that non-professional, volunteer teachers could accurately convey clear energy lessons (in or outside classroom settings) from a personal or vocational perspective.

Finding #2:
High quality E-Learning and Distance learning content on the subject of energy literacy need to be further developed.

Recommendations:

- Obvious advantages of employing on-line and distance learning are reach and flexibility. Exploring best practices in adapting existing energy literacy curriculum to take full advantage of these technologies and mediums should be a priority. The *Home Energy Basics* course from UAF, Bristol Bay's *Sustainable Energy Program* would seem a highly promising candidate for adaptation. Some course materials currently exist as a series of online videos that are by today's standards dated in terms of production value. Re-imagining this course could be a good pilot project to further develop the capacity of REAP and partner organizations to create high quality distance/on-line content.

- REAP has shown a capacity for delivering *Wind for Schools* through distance learning, but the potential for more dynamic presentations and an expansion of distance/E-Learning curriculum seems timely. High quality cameras, microphones and green-screens are the basic production tools needed for this endeavor. Alaskan organizations such as the Kodiak based, AKTeach, have extensive distance and on-line offerings – conferring with these and other organizations or agencies with demonstrated skill sets could be beneficial. The actual creation of these online/distance energy literacy lessons could also serve as a project that would tap both the expertise and enthusiasm of rural Alaskan students who as the most frequent end users of these technologies in Alaska, are perhaps the most discerning judges of quality content.

Finding #3:
Slow broadband speeds and the prohibitively high cost data plans in rural Alaska are a serious barrier to implementing E-Learning.

- **80% of U.S. 8th Graders report using a computer to complete homework every day.**
- **93% of Audited Alaska K-12 schools do not meet the U.S. benchmark of 1Mbps**
- **1.5Mbps = speed needed to stream an HD Netflix movie.**

Recommendations:

- There is no clear recommendation to remedy this issue other than the obvious: greater investment in rural broadband capacity.[12] For now, a clear and wide recognition of this problem seems paramount. Curricula development and delivery have too often ignored the fact that many intended Alaskan end users simply do not have access to the internet at home and attend schools where internet connectivity cannot support many on line lessons. Rural communities with a higher degree of connectivity, such as some in the Lower Kuskokwim School District, are demonstrating that state-of-the-art distance delivery methods and technologies can play an increasingly dominant role in the education of rural Alaskan students.

- Explore the possible use of a Wi-Fi based *intranet* installation within a rural community. It could be the case that stored curriculum delivered via Wi-Fi on a locally housed server is a workable solution for students hampered by slow or no internet.

[12] The Alaska Broadband Education Gap

IV. STRATEGIC PARTNERSHIPS

There are currently a multitude of state, federal, non-profit, and private entities with a declared or active interests in energy literacy and clean energy at the Alaskan K-12 level. Among these are DEED, DOLWD, DoE, Office if Indian Energy, Alaska Native Tribal Health Consortium (ANTHC), AHFC, REAP, ACEP, AEA, AVTEC, four of the Railbelt utilities and the Alaska Village Electric Cooperative (AVEC), the Denali Commission, the University of Alaska and others. The above organizations occasionally work in loose coordination with one another to achieve desired energy literacy outcomes, but there is a persistence of 'siloed' efforts. Energy literacy efforts in Alaska are a microcosm of the STEM education landscape in Alaska. The Alaskan STEM crisis is a regular topic of Op-Eds, a talking point for politicians and a pain point for employers. Alaska has yet to consolidate these siloed STEM efforts and form what many other municipal, state, national and international jurisdictions have: a coherent *STEM Ecosystem.*

Finding #1:

Energy literacy efforts in Alaska are hampered by the lack of a greater, coherent ***STEM Ecosystem*.**

RECOMMENDATIONS:

- Energy educators need not *build* an entire ecosystem – but are uniquely positioned to make the various Alaska STEM stakeholders (see STEM Ecosystem Appendix) aware of one another in a more meaningful way through convenings and outreach. There are established blueprints, tools and resources readily available that encourage best practices and demonstrate frameworks for the construction of STEM Ecosystems. There are organizations such as the University of Alaska, Anchorage's *K-12 STEM Outreach Office* that are enriching the STEM landscape through the organization of STEM activity calendars on a local level. Project based STEM efforts like the T3 Alliance, partnerships like the Alaska Staff Development Network and creative *STEAM* curriculum like OneTree Alaska are examples of statewide STEM stakeholders that could benefit through affiliation and coordination of efforts.

- ANEEE is positioned to build upon the community of Alaska energy stakeholders, bridge connections and use convenings to explore avenues toward a more coherent Alaskan STEM community. Shared purpose and the potential to leverage resources amongst these groups. ANEEE's continuing effort to map the Energy/STEM nexus in Alaska can serve as a roadmap toward

Finding #2

- An often-overlooked aspect of building STEM Ecosystems is the positive outcomes that result with greater parental involvement. However, "Parents with kids between the ages of 5 and 18, report that the topics of math and science are harder to discuss than drug abuse."[13]

[13] Alaska S.T.E.M.: Education and the Economy

RECOMMENDATION:

- A greater inclusion of parents as energy/STEM stakeholders on an individual or organizational basis seems likely to yield results in bridging the STEM achievement gap and increasing energy literacy.

K-12 APPENDIXES

STEM Ecosystem - State of Alaska Programs

The following is a non-comprehensive list of organizations, institutions and individuals that are all STEM aligned to varying degrees and may benefit from a stronger STEM Ecosystem. Alaska Network of Energy Education and Employment (ANEEE) is actively compiling a map of energy literacy stakeholders in Alaska within these sectors: K-12, Vocational, University.

Alaska After School Network and Mapping Tool
State organization that supports, strengthens, and advocates for quality afterschool programs and activities for children, youth, and families throughout Alaska.

Alaska Epscor: Established Program to Stimulate Competitive Research
Alaska EPSCoR improves Alaska's scientific capacity by engaging in research projects supported through National Science Foundation and state funds. Among the many STEM oriented projects under Epscor is the T3 Alliance and One Tree - efforts ACEP has shown an\\ interest in collaborating with.

Alaska Historical Society
Advocates for social studies programs throughout the state, inclusive of natural resource development and a history of energy projects.

Alaska Native Science and Engineering Program
Based at the University of Alaska, the Alaska Native Science & Engineering Program (ANSEP) is designed to prepare and support Alaska Native students from middle school through graduate school to succeed in engineering and science careers. ANSEP offers intensive academic support, exposure to industry, and the opportunity to participate in a learning community incorporating Alaska Native cultural identity.

Alaska Resource Education
A partnership between the Alaska Department of Education and private oil and gas industry interests, ARE provides STEM-focused education programs that take science principles as they relate to natural resources and make them Alaska-specific. The ARE curriculum is a collection of K-8 (adaptable 9-12) science-based lessons on mineral, energy and forestry resources to which the state science standards have been applied. The curriculum is distributed and taught through a course, kit, and other programs.

AK Energy Smart
A free curriculum resource designed to give Alaskan youth an understanding of the high economic and environmental costs of power generation and the importance of conserving energy at home and school. Twenty-seven lessons that concentrate on the science of energy conservation, efficiency and generation.

Alaska PTA
Alaska PTA is a collection of individuals across the state who serve as volunteers on the Board of Managers and on Standing and Special Committees to support local PTA units, advocate for improved education in Alaska and the U.S., and who speak together with one voice for the children and youth of Alaska.

Alaska Superintendents Association
Organization dedicated to forging relationships with local government, tribes, the business community, higher education, labor groups, our own school boards, other government entities and with one another.

AKTEACH
The Kodiak Island Borough School District offers alternative learning programs designed to meet the academic, social and emotional needs of our students in ways that are different from the traditional education environment – including developers of distance and online learning materials.

APICC – Alaska Process Industry Careers Consortium
An oil and gas funded workforce development organization. Alaska industry provided the resources to establish APICC as the vehicle for industry collaboration in preparing Alaska's future workforce. APICC works toward defining workforce needs from an employer perspective, creating statewide skill standards for jobs, developing standardized curricula to meet industry needs.

Cook Inlet Tribal Council Programs with a focus on STEM/Alaska Native Culture:

Journey Ahead, Building Our Future, and Transitions
A Learning Center and unique partnership with the Anchorage School District: the Journey Ahead, Building Our Future, and Transitions are in-school programs that provide educational services to Alaska Native and American Indian students through culturally responsive core academic classes and social support services within ASD schools.

Fab Lab
Fab Lab is a digital fabrication resource center where students use high-tech design programs, industrial-grade manufacturing machines and electronic and programming tools to develop new solutions to practical problems and transform ideas into reality.

STEM Learning Labs
Anchorage area labs designed to infuse Native culture with a fabrication-based STEM enrichment curriculum that specifically addresses the educational needs of Alaska Native students. This program aims to increase Alaska Native students' ability to reach State academic standards in math and writing, as well as improve STEM engagement and community connectedness.

EXCEL CTE

A non-profit providing supplemental academic and career and technical education intensives for rural youth and young adults across Alaska. This is accomplished through individualized, real-life academic and career-oriented experiences allowing students to receive high school credit toward graduation and dual college credit in a specific program. Its goal is for students to make a successful transition into post-secondary training and/or the workforce.

Juneau Economic Development Council STEM AK

The guiding objective of the Juneau Economic Development Council/STEM AK initiative is to increase student interest and competencies in STEM fields, organized around three strategies:

- facilitating professional development of teachers and;
- offering STEM enrichment activities to students.
- participating in advocacy and outreach to build public awareness and support.

Work is guided by a commitment to hands-on, engaged learning that links students to real world opportunities and challenges in an environment of high expectations and discovery. It works with teachers and students, government and non-government organizations, not-for-profits, and increasingly with Alaska business and industry to address the current and future STEM needs of the state.

Juneau House Build

The House Build Project is a four-way partnership with the city of Juneau, the Juneau School District, the Juneau Housing Trust, and the University of Alaska Southeast (UAS) to build affordable housing while training students in residential construction.

REACH UP – Cultural Curriculum STEM / Guidelines Interviewing Elders

Raising Educational Achievement through Cultural Heritage UP (REACH Up) seeks to provide Native students and their teachers with accurate, culturally relevant science curriculum, that improves student achievement on science, technology, engineering, and math (STEM) assessments, and trains Native youth to propose solutions to local climate change problems. Teachers receive hands-on training to improve pedagogy through elder-led culture camps and scientist-led STEM trainings. Classroom lessons interweave Native ways of knowing with mainstream science-learning to provide students with an interdisciplinary understanding of climate change and its impacts in their region.

Society of Women Engineers (SWE)

The Society of Women Engineers is composed of women who have an interest in advancing within the engineering profession, and helping others to do so. SWE is a busy society at all levels. The Society fosters professional development topics, leads technical tours, provides outreach opportunities, hosts conferences, provides training, helps collaborate and share ideas and influences politics.

Wind for Schools

The Wind for Schools project works closely with the KidWind Project and the National Energy Education Development Project to provide hands-on, interactive curricula that are supported through teacher training workshops in each of the states.

National and International STEM Ecosystems

The following are national and international programs developed to foster the growth and organization of STEM Ecosystems, with an emphasis on energy literacy.

White House 5-Year Strategic Plan from the National Science & Technology Council
"Charting A Course for Success: America's Strategy for STEM Education," STEM ecosystems as pathways for improving STEM literacy, ensuring a strong workforce and global competitiveness for all. Including a roadmap of federal agencies with capacity and programs that assist the development of STEM Ecosystems.

ASU Sustainability Fellowship
Fellowships through Arizona State University to STEM teachers from business, government, non-governmental organizations, universities, public or nonprofit research institutions for one-week trainings.

The Center for Green Schools - Curriculum for Building Science
This program is relevant to the AHFC BMONS efforts. The program:
1) provides tools, platforms, and certifications to help schools act and measure the impact they are making on people and the planet.
2) provides curriculum and online Labs Project based learning at no charge;
3) trains and convenes networks of peers to learn from each other and further their work to create green schools for all students and;
4) digs into the most pressing policy topics facing school facilities, environmental health, and sustainability literacy to give policymakers and school leaders what they need to make smart decisions for greener schools.

The Connectory
A model for searching, publicizing and mapping STEM calendar events community by community.

Energy Quest – California STEM Energy
Compilation of energy learning resources, lessons and links.

Green Impact Campaign (GIC) – STEM and Energy Efficiency – Alaska Relevant
A nonprofit organization that is bringing student volunteers and small businesses together to mitigate climate change. It provides students across the country with cloud-based tools and training to go out and conduct free energy assessments for local, small businesses in their community. Student volunteers receive professional skills through hands-on experience for future careers as climate change makers. In the process, small businesses receive the custom, actionable information they need to make their business more energy efficient, profitable, and environmentally sustainable.

National Informal STEM Education Network
Museum-centric**,** the NISE Network creates educational products for a wide range of public audiences in informal learning settings. The NISE Network also creates a variety of professional development materials for scientists and educators to raise their capacity to engage the public in current science, technology, engineering, and math (STEM).

PEAK
PEAK is a comprehensive standards-based educational program designed to empower elementary and middle school students with the knowledge to manage energy use in their homes, schools and communities. Through hands-on learning, students are inspired to pursue green careers and motivate themselves and others to take action to create a more sustainable world.

San Diego Gas & Electric founded STEM Ecosystem
Robust city model of cross industry and organizational partners.

STEM Ecosystems Initiative
Alaska is one of less than twenty states not represented within this network.

The STEM Ecosystems Initiative is built on over a decade of research into successful STEM collaborations, and seeks to nurture and scale effective science, technology, engineering and math (STEM) learning opportunities for all young people.

Launched in Denver at the Clinton Global Initiative, the STEM Funders Network STEM Learning Ecosystems Initiative forms a National Community of Practice with expert coaching and support from leaders such as superintendents, scientists, industry and others.

The 68 communities selected from across the world compose a global Community of Practice and have demonstrated cross-sector collaborations to deliver rigorous, effective preK-16 instruction in STEM learning. These collaborations happen in schools and beyond the classroom—in afterschool and summer programs, at home, in science centers, libraries and other places both virtual and physical. [Shouldn't one of the recommendations from above be for Alaska to join this network?]

Strategic Energy Innovations
Creates green communities by designing sustainability programs around the four key sectors that make up the foundation of all communities: education, housing, government, and the workforce. Through an understanding of the many facets of sustainability, it looks at the big picture and pinpoints opportunities to help communities reach their goals.

ENERGY LITERACY SURVEY/RESEARCH

National Energy Foundation – Energy Literacy White Paper

National Energy Foundation - Energy Literacy Survey Questionnaire

National Energy Foundation – Key Takeaways of the Energy Literacy Survey

Establishing Criteria for an Energy Literacy Questionnaire

TECHNICAL & CAREER – CLEAN ENERGY EDUCATION

WHAT IS A CLEAN ENERGY JOB?

Effective planning for future workforce training relies on the ability to predict and meet the needs of industry. Contemplating workforce needs of the future *clean energy economy* has proven notoriously tricky. A precise definition of *clean energy* is a moving target, one that shifts with fast developing technologies, industry needs and governmental priorities. REAP's definition of *clean energy* is broad and straightforward: renewable energy and energy efficiency. Organizations like the Brookings Institute and the Pew Charitable Trust are more expansive in their definition of the *clean energy economy:* a sector that "generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and other natural resources."[14] The ambiguity here is intentional and understandable, but the utility of this definition suffers when nearly every occupation under the sun can be construed as "clean". Certainly, an Aleut gardener working in a shipping container retrofitted with LED lights and an air-source heat pump is a clean energy worker. But, is the conscientious Haul Road truck driver who never idles the rig for more than five minutes really a member of the "clean" or "green" workforce? A young Alaskan contemplating training for a career in the clean energy economy is right to wonder, *What exactly does a clean energy occupation look like?*

Renewable Careers and Training

Alaska has a well-deserved reputation as a world leading laboratory for renewable energy innovation, but its renewable energy workforce (<700 jobs) represents approximately .2% of the 331,358 workers in Alaska – the smallest such workforce in the nation. [15] An April 2018 study by the University of Alaska's Center for Economic Development, estimates the number of renewable energy businesses in the state to be about 100; the majority of which deliver consultation and technical services.[16] Wind technicians, solar PV installers and hydroelectric plant operators are among the renewable energy careers most often singled out as occupations with high potential for future growth on a global and national scale. And while, renewable energy training needs do exist in the state, as is so often the case, things scale differently in Alaska.

Department of Energy estimates from 2016 counted 98 solar workers, 37 wind technicians and 469 hydropower workers in Alaska.[17] A single, full time, certified wind technician can responsibly manage approximately twenty turbines. Kodiak Electric Association, Golden Valley's Eva Creek Wind Farm near Fairbanks and CIRI's Fire Island Wind in Anchorage, represent the three largest wind farms in Alaska and combine for a total of 29 turbines. Warrantied, utility scale turbines like those in Kodiak are typically monitored remotely, then serviced and repaired by the manufacturer, not by on-site wind technicians. Alaskans who work

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[14] *Clean Energy Economy, Repowering Jobs, Businesses and Investments Across America*
[15] Alaska Occupational Forecast 2016-2026
[16] Renewable Energy – Growth and Obstacles in the Renewable Energy Sector in Alaska
[17] US Energy and Jobs Report State Charts, Alaska

on smaller wind farms are typically diesel operators with limited training and charged with a scope of turbine/tower work that does not usually exceed basic preventative maintenance.

Fiscal rationality suggests that Alaska not establish a wind training program in order to ready new fleets of certified wind operators and technicians, even as scores of small wind projects develop throughout the state. Similarly, residential solar in Alaska is surging in popularity, and yet the scalability of a dedicated PV installer workforce is extremely limited. On average, more than twenty percent of Alaska's electric energy is generated by hydropower, but the state's hydroelectric workforce is largely comprised of traditional utility trained diesel genset operators with some site specific, in-house training. There are simply not enough renewable energy jobs in Alaska to sustain stand-alone; wind, solar, geothermal or hydro training programs. Interested and determined Alaskans may find occasional in-state trainings within these categories that will enable them to join the ranks of renewable energy workers – but for the foreseeable future they will be infrequent, limited in scope and not accredited.

Renewable energy technologies and occupations hold an allure today that might bear comparison to previous generations' fascination with the aerospace industry. Few dreamers in the space age became astronauts, but the overarching spirit of innovation paved the way for new technologies and career paths that transformed the world. Renewable energy occupations have the potential to play a similar outsized role in expanding the impact of clean energy, and preserving the climate for future generations. Alaskans should be made aware, and proud of the myriad renewable technologies being deployed and tested throughout the state – especially in conjunction with microgrid technologies. Interested Alaskans should be made aware of the many discrete, accredited renewable energy training programs in the Lower 48 and the varied careers where these programs might lead.

Energy Efficiency Careers and Legacy Training

Where renewable occupations and technologies represent the glamour of the clean energy economy, the workaday world belongs to those working in some direct capacity to create greater energy efficiencies. In Alaska that translates to 4,421 workers or 1.3% of the state's total workforce.[18] This is again a comparatively small workforce and in terms of creating sustainable training programs – clean, green or otherwise – training needs to be meaningfully linked to jobs that exist, not jobs we wish existed. In 2011, the Alaska State Energy Sector Partnership (ASESP)[19] and Alaska Workforce Investment Board (AWIB) created an inventory of Alaskan 'green job' pathways (where employers pursue environmentally sustainable practices) and a workforce development plan to fill jobs being created in the renewable energy and energy efficiency sectors. The ASESP inventory of University of Alaska's 'green' vocational career pathways totaled 77 discrete training programs, ranging from occupational certificates in welding to an Associate of Arts degree in Renewable Energy Resources.[20] It might come as a pleasant surprise to a welder working today on the North Slope that she is part of the 'clean energy' workforce. It will come as less of a surprise to a UA Mat-Su College Sustainable Energy

[18] Alaska Occupational Forecast 2016-2026
[19] ASESP Workforce Development Plan
[20] ASESP Energy Inventory 5.27.11

Program holder that their Occupational Endorsement Certificate program no longer exists because it did not seem to connect to any coherent career pathway.

Biomass boiler operators, weatherization technicians, building energy retrofit technicians, energy managers, greenhouse operators and heat pump installers are occupations that do require specialized training and skills. But these, and the majority of clean energy career pathways in Alaska, once again, do not require stand alone or the establishment of niche training programs. Instead, clean energy training has proven most effective when located within well-established training programs belonging to traditional occupations and trade apprenticeships. These 'legacy' or 'core' training programs are increasingly adopting clean energy modules when there is a defined need for the training. The scope of work and skill sets demanded of builders, plumbers, electricians, sheet metal workers and boilermakers are rapidly expanding, transforming, and in some instances, being reimagined because of a greater focus on efficiencies, clean energy technologies and best practices. Germany, a world leader in developing a clean energy workforce, has "moved past the glitz of niche renewable energy training programs and has realized that the skills and knowledge needed to be successful in the renewable energy field are largely transferable from other industries such as electrical, industrial maintenance, and engineering."[21] This appears to be the global trend.

The clean energy transformation is under way. Renewable energy generation has doubled in the United States over the last ten years and is now responsible for 17% of the nation's power generation.[22] Nationwide "construction firms involved in the Energy Efficiency sector continued to experience an increase in the number of their workers who spend at least 50 percent of their time on *Energy Efficiency*-related work, rising from approximately 797,500 in 2015 to 1.017 million in 2016 and now to nearly 1.024 million in 2017."[23] Alaska's future clean energy infrastructure will be built and maintained by the same broad categories of workers who can proudly claim to have built the state's original infrastructure.

There are 11,901 Alaskans currently working in some capacity to maintain and heat some of the oldest building stock in the country. There are 14,859 Alaskan workers involved in raising new buildings, installing boilers, wiring and plumbing homes, insulating walls, fabricating HVAC systems, programing building controls and performing various other jobs in the construction industry. Among the 1,579 Alaskans working in power generation, there are more than a thousand managers and clerks, 460 power plant operators, 366 linemen and 47 dispatchers working for rural, Railbelt and remote Alaska utilities to keep the lights on and costs low.[24] There are hundreds of politicians, managers, public works directors and school principals in cities, boroughs and villages across the state who are charged with energy related projects and responsibilities. Given the opportunity, these are the Alaskan workers poised to make the most substantial impact on Alaska's *clean energy economy* and most will do so through a greater

[21] Renewable Energy Technician Education: Lessons from the German Energiewende
[22] US Energy Information Administration
[23] 2018 US Energy and Employment Report
[24] Preliminary Second Quarter Employment and Wages April - June 2018 and Alaska Occupational Forecast 2016-2026

energy literacy and an understanding of how energy efficiency measures can best be implemented.

Notes on Alaska's Future Workforce

Alaska has the highest unemployment rate in the nation at 6.7 percent[25] and yet Alaskan industries struggle to find workers. This incongruity points to an often-understated aspect of Alaska's total workforce picture. There are numerous well-paying jobs to be had – the more acute problem is a skills shortage amongst Alaskan workers. Alaska's construction, Oil and Gas, Maritime, Mining and Healthcare industries, have for years been unable to find enough qualified Alaskan workers to meet demand.[26] State economist Karinne Wiebold points out that more than 20 percent of nonresident workers make up the state's construction sector and the Oil and Gas sector has had outsiders totaling nearly 30 percent of the workforce.[27] The previous state Labor Commissioner Heidi Dreygas states the case plainly, "We have to invest in young Alaskans and in training, ensuring that we have Alaskans first in line to work in these jobs."

Math Skills

A shocking 86 percent of Alaskan high school sophomores are non-proficient at the Algebra I/Advanced Arithmetic level[28]. A recently completed ten-year study of University of Alaska's entering freshmen shows that 60.8 percent require remedial math or English courses before they can move on to degree-credit coursework.[29] Careers pathways are frustrated and delayed across the board when degree seekers realize basic deficiencies will prevent them from enrolling in intended courses of study.

Soft Skills – Get Up and Show Up

A fundamental problem has carried through the Alaskan school system and into the workforce that goes beyond math skills. *Soft skills* are "personable attributes that allow for effective interaction"; a good work ethic, communication, organization and cooperation are usually enumerated among the soft skills. The employer in search of good workers puts it more bluntly, *Can you get up and show up?* Incredibly, one in four Alaskan students are chronically absent – the third highest truancy percentage in the nation.[30] Soft skills also include, basic computer proficiency, ability to be drug-free, safety awareness and ability to handle stress. Recognizing these skills as fundamental, Alaska's Career and Technical Education (CTE) plan includes a softskills curriculum, *Skills to Pay the Bills*[31], designed to redress what has proven a chronic weak spot in Alaska's workforce.

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[25] Alaska Department of Labor and Workforce Development
[26] Cross Industry Workforce Development Priorities – McDowell, April 2016
[27] Alaska Journal of Commerce, 10/31/18
[28] 2017 Performance Evaluation for Alaskan Schools
[29] University of Alaska Transcript Study
[30] Alaska Rates of Chronic Absenteeism
[31] Skills to Pay the Bills, from Alaska's CTE Plan

Rural / Railbelt – Opportunity, Access and Expectations

The rural/Railbelt divide is a permanent feature of Alaskan life, culture, policy considerations and certainly workforce development. Opportunity, access, incentive and readiness are dominant factors for all potential vocational trainees no matter geographical location. But for Alaska Natives living in remote communities, location is often a determinant factor in terms of both access and incentive for training.

Clean energy career pathways should be open and readily accessible to all Alaskans, but rural Alaskans committed to living in remote communities that have survived for thousands of years face a particularly daunting challenge in the modern era, a majority of careers are nonexistent or not feasible within their communities. Training opportunities for jobs that do exist are complicated by distance and logistics – and almost always designed to support the operations and maintenance of crucial infrastructure – not individual careers or personal wellbeing. Job oriented training in rural Alaska is often seasonal, intermittent and not, by comparison, remuneratively rewarding. With a few exceptions, training opportunities in rural Alaska are sporadic, grant funded and organized with little local input around specific projects designed by outside agencies. Further complicating the picture is that the volume of rural Alaskans that need to be trained is small – even as training needs remain consistently acute and persistent.

Clean energy related training in Alaska's vocational sector is geared toward two often distinct audiences: I) Alaskan high school graduates from predominantly urban centers and hubs seeking degrees/certificates that lead to traditional career pathways and II) Rural Alaskans who may or may not acquire certificates/degrees as a result of training; including incumbent workers seeking to increase current skills and newer workers gaining access to training for the first time.

There is common ground between the needs of rural and Railbelt workers in Alaska's clean energy sector. No matter whether rural or Railbelt, maximizing access to training opportunities in clean energy requires coordination and cooperation amongst vocational institutions, industry, trade unions, utility cooperatives, state and federal agencies, and nonprofit stakeholders (Appendices 1). The most crucial Alaskan institution, in terms of clean energy training, is the Alaska Vocational Technical Center (AVTEC) – the only vocational training center operated by the state that draws from a statewide pool. Not surprisingly, AVTEC is at the nexus of the rural/Railbelt divide. There is no better frame of reference from which to observe the spectrum of challenges faced by Alaskan stakeholders as they cooperate to produce a skilled clean energy workforce throughout the state.

AVTEC & Clean Energy

Individual training needs, student competencies, access to training and eventual employment opportunities are determined in large part by where one currently lives and where one is willing to work in Alaska. "A career in a year" – AVTEC's concise motto encapsulates the obvious ambition of most enrollees, the majority of whom reside for the year in Seward, or until their coursework is completed. Construction Technology, Plumbing and Heating, Refrigeration, Diesel/Heavy Equipment Technology, Industrial Electricity and Power Plant Operations are the ‘legacy’ or ‘core’ AVTEC programs most likely to incorporate lessons and modules based on clean energy principles.

The Industrial Electricity program at AVTEC includes a listed course of *Renewable Power Generation*, where students study the theory and operation of renewable power systems; build and test wind, solar, and Hydro power systems; tower climbing. But the full course if rarely taught due to lack of demand. Instead, the school opts for the previously mentioned model where renewable energy is folded into more standard lessons regarding power generation – again the module within a legacy structure. The University of Alaska’s Matanuska-Susitna and Southeast campuses shuttered their *Sustainable Energy Occupational Endorsement Certificate* program because graduates could not connect the certificate to a viable career pathway. The curriculum continues to be taught through the University of Alaska’s Bristol Bay Campus and it represents the fullest representation of clean energy coursework in the state, taught by a single highly skilled instructor. The 21 courses within the program include an impressively diverse range, from *Home Energy Basics Basics* to *Small Wind Systems* to *Blower Door Testing* and *Building Science Thermography*. But again, the majority of these courses are rarely offered and few students complete the Occupational Education Certificate. A Process Technology instructor from another Alaskan vocational school, Kenai Peninsula College, made clear the logic behind this in pointing out that he briefly offered a very popular *Introduction to Renewable Energy* course. “Students are like sharks and jobs are blood in the water. The renewable energy courses were interesting to them, but once they discovered that it simply delayed their intended pathway to a career on the North Slope, the classes were deemed not worth the time.”[32]

It is worth noting that ACEP is exploring the potential to marry the real student interest in clean energy with real vocational opportunities that exist within Alaska’s utility sector. ACEP is piloting *Alaskan Utility Internships*. The program is looking to embed 8-10 undergrad engineering students with Alaskan utilities: MEA, Cordova Electric, Galena, TNHA (Utqiagvik), Buckland, Chugach Electric, Chaninik Wind Group (Kongiganak), AEL&P and IPEC (Juneau), AVEC and AP&T. The idea is to get students more hands-on real world knowledge on energy issues in Alaska. The next iteration of the internship looks to include students from the Process Technology program at UAF’s Community and Technical College in an effort to open up a communication pipeline that addresses the clean energy training needs of the utility sectors.

Industrial Electricity and *Power Plant Operations* are two of the AVTEC training programs that are perhaps most essential to the growth of Alaska’s clean energy workforce. Both are worth highlighting precisely because they brush up against, or are directly affected by so many of Alaska’s clean energy stakeholders. An illustrated tour of the clean energy training landscape throughout the state can be had by tracing two distinct journeys through AVTEC and the individual career pathways that ensue.

[32] Conversation with KPC Associate Professor Henry Haney 8/17

A Tale of Two AVTECs

Industrial Electricity

The state's most robust and versatile training pathway toward a career in the power generation sector and clean energy fields. One hundred percent of the 2017 Industrial Electricity graduates found gainful employment within one year of certification.[33] The coursework spans the gamut from basic DC circuits to various modes of renewable power generation. Trainees can parlay a certificate from this 1,400 hour program into a variety of highly sought after technician jobs or trade apprenticeships in and outside Alaska. The Industrial Electricity program readies one for a wide range of work within the clean energy economy, whether it be embarking on a career as an electrician, a facilities manager or an electric utility employed millwright maintaining hydroelectric turbines.

Tuition, books and tools costs $8,099 if the program is completed on time, room and board for the year in Seward is an additional $9,000. Applicants must pass a math entrance exam that necessitates a mastery of Algebra I/Advanced Arithmetic and completion of the program requires a working knowledge of calculus and trigonometry. The 2017 Industrial Electricity cohort consisted of 28 students, predominately male, the overwhelming majority are Alaska residents, approximately two thirds of the students are over 25 years of age (including one retired engineer with a PhD). All 28 students in 2016/17 were awarded certificates, and 79 percent did so in the normally allotted time. One hundred percent of the Industrial Electricity graduates found gainful employment within one year of certification.[34]

The *Industrial Electricity* program is a sterling example of effective investment in workforce training, but to a certain degree, the specific requirements for entering the Industrial Electricity program self-select for students likely to succeed. What went right within this self-selection process? It is worth reminding, two thirds of *Industrial Electricity* students are over the age of 25 and therefore have had seven years' opportunity to make up for deficiencies at the time of graduation from high school. Clearing the minimum math requirement creates a ready from day one atmosphere for accepted students, a hurdle that many Alaskans matriculating in four-year degree programs at the University of Alaska system cannot clear. Many of the *Industrial Electricity* enrollees have employment histories within other industries and are actively seeking to improve their career prospects.

Jon L.[35]

Jon, 20, graduated from Kodiak H.S. in 2016 with honors, earned one of eight scholarships on offer from Kodiak Electric Association (KEA) and matriculated in the Industrial Electricity program. In under two years, Jon completed the program and has been assigned the occupational level of Industrial Electrical Technician. Jon's training included the installation of a solar PV array that he designed. In addition, he successfully completed rope/climbing safety and was then

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[33] Alaska's Vocational Technical Center – Consumer Information

[34] Alaska's Vocational Technical Center – Consumer Information

[35] Multiple interviews and on campus visit with Jon L., who wishes to remain anonymous

instrumental in getting AVTEC's Northwind 100 wind turbine back online after months of disrepair. Jon continues to work summers as a commercial fisherman and is currently self-employed making electrical repairs to boats in Seward and Kodiak.

Jon is considering a four-year degree, is still committed to the commercial fishery in Kodiak and is exploring year round employment opportunities in Kodiak, where he is committed to working and living. He is aware of apprenticeship opportunities, though highly competitive, through the Alaska Joint Electrical Training and Trust and International Brotherhood of Electrical Workers Local 1547 (IBEW). An IBEW Outside Power Lineman apprenticeship (including 960 classrooms and on the job training hours) would enable him to train as a lineman and potentially work for KEA. Independent Alaskan electricians with in-house mentor/training programs are clamoring for individuals with Jon's proven skillset. Self-employed journeymen electricians are currently advising institutions like King Tech High School in Anchorage to find promising candidates like Jon; not out of altruism, but because they cannot staff up their operations. This is not solely an Alaska problem, a coming wave of retirement within the baby boom generation has been dubbed the Graying of the Power Generation Industry by the Department of Energy. A 2016 estimate had 45 percent of the energy workforce sector retiring by 2024 and "a recent survey of the energy sector found that 34 percent of firms faced difficulties in hiring because applicants lack experience, training, or technical skills. In addition, 30 percent of firms claimed insufficient qualifications, certifications, and education as the prime reason for not hiring new employees. In total, 77.5 percent of energy companies found hiring qualified employees to be somewhat or very difficult."[36]

Clearly Jon is in demand. His immediate plans include building a cabin in Kodiak – one powered in part by residential solar that he will design and install himself. He has discussed doing the same with other Kodiak residents interested in off-grid residential solar. Jon is obviously at the very beginning of his career and a specific pathway is undetermined, but the Industrial Electricity program has made him highly employable in a time of statewide recession.

Jon is of course a sample size of one, but his journey thus far is useful in analyzing what contributes to a best-case scenario in preparing Alaska's future clean energy workforce. What were the factors that contributed to his success thus far? Kodiak is an island that gets 99 percent of its electricity from renewable sources – and there is an island wide sense of pride and ownership in this achievement. Kodiak High School has a highly recognized and popular CTE curriculum centered around nine separate career clusters that include Science/Technology, Natural Resources, Manufacturing, Architecture and Construction. Jon participated in several of these courses and his instructors made it clear early that CTE courses were intended to enhance the educational experience of all students – no matter their post-secondary educational plans. They were instrumental in pointing out career paths that he had not considered or been aware of. Jon's father is a chemistry teacher, a principal and set high academic expectations. There is perhaps no better soft skills training than the several seasons Jon has spent as a deck hand in Alaskan commercial fisheries and it afforded him the ability to pay for his AVTEC education. KEA's commitment to Jon's educational future and financial recognition of his interest in power generation eased his transition to AVTEC. And finally, Jon is committed to making a life in

[36] Building an Energy Workforce for the 21st Century, US Senate Comm. on Natural Resources

Alaska – he seems unlikely to fall into the "brain drain" category that sees so many Alaskans seek opportunity outside the state. Jon was primed for success when he arrived to the AVTEC campus and promise awaits him after taking full advantage of the opportunity the Industrial Electricity program has afforded him.

Before moving on to discussion of the Power Plant Operations program, it is worth noting that an informal inquiry produced no AVTEC institutional memory of a single graduate from the Industrial Electricity program that came from and returned to a rural Alaskan community. It should also be noted that this program is not immune to recent societal trends. Instructors report a spike in the number of students requiring more time to finish the program because of struggles with the abuse of prescription medicines – one more challenge on the landscape.

Power Plant Operations

The AVTEC *Power Plant Operator Program (I&II)* is comprised of pragmatic training for workers whose skills are indispensable in supporting the daily life of many Alaskan communities. The Power Plant program is an Alaska Energy Authority (AEA) effort funded by the Denali Commission. Enrollees in Power Plant I are Alaska natives and/or residents of a small rural communities that rely on diesel generators to power their villages. Operators able to capably maintain and efficiently operate diesel generators are uniquely positioned to combat painfully high fuel costs and mechanical breakdowns – and thereby the high cost of electricity. Completion of Power Plant I requires 140 hours/20 days of course work and is intended to "impart to graduates the skills and knowledge necessary to reliably and efficiently operate and maintain rural power plants." The Denali Commission has estimated that approximately 60% of rural Alaskan power plant operators have attended Power Plant I (PPI) training. Power Plant II (an additional 140hours/20days) offers a more advanced exploration of diesel systems, switchgear operation, troubleshooting and servicing skills. A small fraction of PPI trainees complete PP II training. To achieve a Power Plant Operator certificate, students must successfully complete both the PPI and PP II classes. Based on the student's proficiency of the program's competencies, occupational levels/certificates of Diesel Power Plant Operator or Assistant Diesel Power Plant Operator are assigned.

The diesel generator power houses in more than 200 remote Alaskan communities are by any measure a recent feature on the landscape. It continues to be a hard-learned lesson that any efforts to integrate renewable energy technologies within these Alaskan communities must begin with the efficient operations and maintenance of the generators. It may strike some as strange that diesel power plant operators occupy a central role in Alaska's clean energy workforce future. The enormous costs of energy in rural Alaska are tied directly to the high cost of shipping diesel fuel throughout the state. There are few individuals better positioned to reduce these high costs than well trained diesel power plant operators who are able to maximize efficiencies through best practices in operations and maintenance.

AEA, Alaska Village Electric Cooperative (AVEC), smaller power providers, independent rural utilities and rural Alaskan power customers throughout state share a vital interest in making sure that the power plant operators are well trained. Former Alaska Representative, driver of the Alaska Native Claims Settlement Act, founder of the NANA Corporation, businessman and

Inupiaq elder Willie Hensley rightly points out in his biography *Fifty Miles From Tomorrow,* that the electrification of remote Alaskan villages represented the closing of a stone age technology and the easing into the 20^{th} century for many Alaska Natives. Only fifty years ago the rural landing strips near Hensley's Kotzebue boyhood home were lit by kerosene filled coffee canisters. Standing up a well-trained diesel operator workforce across the state continues to be a formidable challenge – AVTEC and AEA's Power Plant Operations course is the primary driver of this effort.

It is a common misconception that power plant operators are diesel mechanics, they are not. A good operator is a technician capable of maintaining the diesel generator set in good working order and maintaining accurate logs. The operator job is in many cases not a full time job. It is often a twenty hour a week job, but those hours are divided throughout the day so as to make other types of work or interests difficult to tend to. In many cases, it pays approximately $15 an hour, a welcome wage in communities where steady income is scarce – but far beneath the wage paid to persons doing equal work in urban Alaska. Many remote Alaskan communities have severely limited and prohibitively expensive broadband internet connectivity, few operators have access to a connected work/study space outside the shudderingly loud powerhouse. Logistics for parts and tools make preventative maintenance, trouble shooting and repairs incredibly challenging no matter the skill level of the operator.

Operators do not function independently; they are dependent on skilled managers and tribal/village leaders who are in turn responsible for financial and administrative decision making (AVEC communities excluded). Generators dispatched to Alaskan villages are operating in extreme conditions, have been typically worked on by many hands of differing capacities, repaired, cannibalized for parts or maintained in a fashion that is based more on survival mode than best practices. When the lights go out in rural Alaska, as they inevitably do, it is the operator who bears the brunt of the blame – wrongly or rightly. It is in many ways, a thankless job that every rural Alaskan community needs performed well. Again, according to the Denali Commission, nearly a third of rural operators have not attended AVTEC's training and thus have no formal training, been mentored in the community, acquired training in another setting such as the military, through previous work history or have learned some mechanical fundamentals in small engine repair. How then does an operator find their way to AVTEC for PPI training and assumption of what very well might be one of the most crucial, yet underappreciated jobs in the state?

Independent communities select likely candidates for PPI themselves – and the vetting processes are as varied as the communities themselves. AVEC exerts a bit more control over candidates as they assume ownership of the powerhouses within the cooperative – but anecdotally and practically, community leaders weigh heavily in making this decision. Operators may be in their seventies selected long ago because they demonstrated a particular genius with outboard motors. They may be a promising high school graduate who wants to remain in the community and is willing to serve under a more seasoned operator for years to come. They may have no capacity for, or interest in the work – but have been gifted the job by a relative or friend who manages the utility. All of the dynamics of small town, insular America come in to play in considering how one might come to obtain one of the very few jobs within a community that only occasionally becomes available.

The names of likely candidates are submitted to AEA which then shepherds candidates through the enrollment process. AEA provides a travel stipend and housing for the eight-week study time at AVTEC. Incumbent workers are typically not paid by the utility during these eight weeks. Many operators are not in a position to be away from family or go eight weeks without income. Many are then understandably reluctant to make the trip to Seward despite the need for training. This is especially true of those operators who might benefit most from a refresher visit to PPI or a skills advancement through PPII. Although, a renewed focus on intervention has prevented poor outcomes – some rural Alaskan trainees arrive in Seward unable to resist distractions and do not complete the PPI coursework in any meaningful way. A solid foundation of soft skills is, like in the rest of Alaska, a crucial precursor to success.

More than twenty years of working with Alaskans from all over the state to absorb the lessons of Power Plant I & II, have enabled instructor Jerry Blitz to be adept at working with highly proficient students who score low in both literacy and numeracy. Still, an inability to read or write at a certain level prevents any formal certification from being awarded to even those who show a great deal of "hands-on" skill. This is problematic in two regards. Firstly, deserving trainees are denied a sense of achievement and validation for their efforts. Secondly, there is no quantitative record of skillsets that might be used for follow up training or the establishment of a mentor or peer to peer network of operators.

Some students who pass through PPI prove competent in all course work, others may not learn much more than the proper disposal of oil. Upon completing the eight-week course, these young and older men (in a few cases women) will return to their communities and assume responsibility for power generation. Outside of rural Alaska, an individual who has completed the equivalent of PPI and PPII coursework would be assigned to work under a journeyman diesel mechanic for at least five years before assuming responsibility for the genset. Expecting a minimally trained individual to operate a diesel generator at maximum efficiency is unreasonable; expecting one to then do so under the constraints and conditions that are the norm in rural Alaska is tantamount to expecting a miracle. The incredible result is that operators do keep the lights on most of the time in rural Alaska. The inevitable and predictable outcome in perpetuating this cycle of under training, frequently repairing, and often replacing diesel systems is prohibitively expensive and, it would seem, not sustainable.

A Rural Power Plant Operator Returns from AVTEC Training[37]

Operators returning from AVTEC have few options for the sort of training that can stand in for five years under a mentor. The Department of Labor Urges Apprenticeships and makes funding available – but rural power plant operators do not typically work the requisite number of hours per week to qualify for apprenticeships. Flying out of the community for regular trainings is not financially viable, and does not address the unique nature that rural operators face in working on their own particular generators.

The only established method for improving the capabilities of an under trained operator is more training, most likely in the form of a robust circuit rider program. The obvious barrier here is cost. Both AEA and AVEC operate circuit rider programs, but both face substantial limitations. AVEC's model involves a master trainer, Norm Miller, who spends six months a year flying to each of the more than 70 AVEC communities with specific training goals in mind tailored to the specific needs of the operator and maintenance repair schedule of the generator. AVTEC's Jerry Blitz and Norm Miller have the greatest depth of knowledge in terms of training rural operators – teaching styles, manner, method, familiarity with specific rural Alaskan challenges and a unique ability to bridge a variety of cultures have earned both men enduring reputations throughout the state. AEA's circuit rider program relies on more of a triage approach, as they are faced with a vast demand for their services - two travelling technicians cover the entire state. Training occurs on AEA technician visits – but it resembles a job shadowing more than it does an AVTEC type training session. AEA, Jerry Blitz, Norm Miller and an informal network of experts are all known to take phone calls at all hours to attempt troubleshooting. Many of these call entail phone cameras as the primary diagnostic tool.

Recent technological innovations including Augmented Reality/Virtual Reality, distance learning tools and behavioral management software are being deployed in pilot programs to tackle these training issues. Both AEA and AVEC are working with the Alaskan developed software start-up 60Hertz is a subscription based program than lives on operator's cell phones in a bid to encourage better preventative maintenance performances and reporting.

Technology seems destined to play a major role in addressing the under-capacity problem of rural power plant operators – but the fundamental choking point is one that persists in nearly every rural Alaska workforce development effort that touches upon clean energy. There is a severe shortage of trainers and train-the-trainer programs. Conversely and for obvious reasons of productivity and profit, the Alaskan Oil & Gas and Mining industries are heavily insuring that there is a pipeline of trainers capable of producing a qualified workforce. British Petroleum has invested in a state of the art process technology simulator at Kenai Peninsula College. A consortium of industry interests have partnered with UAF and others to establish the Mining and Petroleum Services (MAPTS) in Delta Junction to ensure an ongoing pipeline of ready to work employees and a team of qualified trainers. These industry efforts to reach and teach Alaskans extend through K-12, vocational and university spheres as exemplified by the well-funded efforts of the Alaska Process Industry Careers Consortium (APICC). The effectiveness of these type

[37] The experiences recounted here are composite in nature, taken from various interviews with power plant operators working in remote communities.

partnerships and programs is worth emulating, but they hinge on demonstrating an obvious financial incentive to industry. The clean energy sector in Alaska has not to adopted this strategy because of a structural disadvantage. Saving money through investing in efficiencies, such as a more intensive power plant operator training, remains a more difficult sell than investments in workforce development that deliver a proven profit.

Operators are Only as Good as Their Managers – OM&M

Even the well trained rural Alaskan power plant operator will inevitably face challenges that either surpass their skillsets or are outside their control. No amount of meticulous preventative maintenance done according to schedule can overcome poor management. A manager who has not planned for inevitable rebuilds, expensive parts, made unwise fuel purchases, or not planned for the predictable emergency visit by a diesel mechanic – is a manager who is setting the operator up for failure. The operator might also fall victim to goings on at the bulk fuel farm that are outside his purview – but can have devastating effects on the genset. A lineman might be required for repairs. An operator might take ill and the utility may not have a suitable sub-operator to run things smoothly. It may be subsistence season and the needs of providing for a family supersede the responsibilities of a job that pays $15 per hour. An operator might rightly tire of the pressure to perform under adverse circumstances every day and simply quit. It is not uncommon to visit a rural Alaskan village where several knowledgeable *former* power plant operators still reside. In fact, many such individuals are pressed in to service during an emergency, a reservoir of talent that might be better leveraged. Because the efficient operation of power plants is bound so closely to management – a brief overview of training options for electric utility managers is in order.

The AVEC model centralizes utility management and therefore sidesteps some of the pitfalls associated with the multifaceted duties of a utility manager, including, but not limited to: basic accounting, record keeping, calculating Power Cost Equalization (PCE), personnel management, fuel purchasing, capital reserves for maintenance, HAZMAT, and safety compliance. The capacity of independent utility managers is often determinative in the functioning and reliability of the utility's entire operation and therefore the well-being of the entire community. A recent shift has taken place in the search for efficiencies within rural utilities that includes not just attention on the skillsets of operators (O&M), but managers and clerks as well (OM&M). Many of the same challenges that persist in the training of operators – logistics, training without pay, hiring practices, insufficient salary, employee retention, unreliable broadband communication and local governance issues – are also true in the realm of training effective managers and clerks. Although, AEA is developing a draft guide book for electric utility managers in order to stand up a pilot program through Denali and USDA funding – there is currently no sustainable training program tailored specifically for rural Alaska *electric* utility managers and clerks. There are however a variety of technical assistance and water/waste water programs that deal directly with, or touch upon, management training in rural Alaska.

There does exist in the state a highly effective rural utility management training program geared toward *water and waste water* treatment plant managers. The Alaska Rural Utility Business Assistance (RUBA) is a state administered program within the Division of Community and

Regional Affairs and funded by the Environmental Protection Agency. Clean water is a matter of life and death, where reliable rural electricity is viewed as a quality of life issue, hence the lack of institutional training support for electric utility managers. The RUBA program is highly effective and in fact attracts a large number of electric utility managers as there is a great deal of cross-over in terms of general management skills. The RUBA model is worth brief discussion and analysis because it is essentially a vocational training program administered on a statewide scale.

Central to RUBA's work is the RUBA "report card" (*figure 1*), a clear and straightforward "best practices" scoring system that awards points on a scale of 0-10 in nine separate categories. Communities that meet a certain threshold are then considered more likely to benefit from technical assistance and project planning/financing. Local Government Specialists (LGS) are deployed to increase RUBA scores through a variety of courses in the RUBA curriculum (Intro to Utility Management, Personnel Management, Financial Management, Planning Management, Organizational Management, Operational Management and Elected Officials). These trainings are held throughout the year, usually in Anchorage or Fairbanks and travel/boarding stipends are available to those who successfully complete the class. Another key component of this program is the deployment of Remote Maintenance Workers (RMWs), sometimes gratefully referred to as Remote Miracle Workers, who then assist in on-site training, trouble shooting and implementation of some projects.

	Category	Best Practice	Points	Contacts	Additional Information
Technical	*Operator Certification*	Utility has more than one operator certified to the level of the water system	10	Operator Certification Program	Regulations require that the primary operator of a water system be certified at level equal to the classification of a system. The classification of each water system can be found online at https://dec.alaska.gov/Applications/Water/OpCert/. For scoring purposes, the certification requirements considered will be for Water Treatment unless a system only requires a Water Distribution operator, in which case only Water Distribution certifications will be considered. Operators of Small Treated and Small Untreated systems who hold a Water Treatment certification at any level are considered to be certified to the level of the system. Wastewater Collection and Wastewater Treatment certifications will be considered if a community has a wastewater system but no water system. Systems that do not require a certified operator will receive full points.
		Primary operator is certified to the level of the water system and the backup operator holds some level of certification in water treatment or distribution	7		
		Primary operator is certified to the level of the water system and the backup operator holds no certification or there is no backup operator	5		
		Utility has one or more operators certified at some level in water treatment or distribution	3		
		Utility has no certified operators	0		
	Preventive Maintenance Plan	Utility has a written PM plan; PM is performed on schedule; records of completion are submitted on a quarterly basis and have been verified	25	Remote Maintenance Workers (RMWs)	A Preventive Maintenance Plan is a schedule of maintenance activities necessary for continued operation of the utility. At a minimum, the plan must include those activities required to prevent a loss of service. RMWs are available to assist in developing a PM Plans and training operators in proper maintenance. Utilities seeking 25 points must submit completed PM records to their assigned RMW on a quarterly basis. PM criteria apply to wastewater utilities if there is no public water system. Communities without a public water or wastewater system will receive full points.
		Utility has a written PM plan; performance of PM and record keeping are not consistent	15		
		Utility has no PM plan or performs no PM	0		
	Compliance	Utility had no Monitoring and Reporting violations during the past year	10	Drinking Water Program	Public water systems are required to collect water samples to demonstrate that the water meets drinking water quality standards and is safe for consumers. The Drinking Water Program provides each utility with an annual Monitoring Schedule each year. Sampling is a primary responsibility of the operator and sufficient funds for monitoring must be included in the budget. Communities without a public water system will receive full points.
		Utility had up to five Monitoring and Reporting violation during the past year	5		
		Utility had more than five Monitoring and Reporting violation during the last year	0		
		Total Technical Points	**45**		
Managerial	*Utility Management Training*	A person who holds a position of responsibility for management of the utility has completed a DCRA approved Utility Management course or other utility management training course within the last five years	5	RUBA	This person is not required to have the Utility Manager title, but must have some responsibilities pertaining to the management of the utility. This person must reside within the community and represent the utility, even in instances when the utility is managed by a third party.
	Meetings of the Governing Body	The utility owner's governing body meets routinely consistent with the local ordinance/bylaw requirements and receives a current report from the operator	5	Rural Utility Business Advisor (RUBA)	Meetings must be held as prescribed by ordinance or by rules and regulations of the governing body, with reasonable exceptions made for unforeseeable circumstances. A written or oral report from the operator or contracted utility manager must be recorded in the meeting minutes.
		The utility owner's governing body meets routinely consistent with the local ordinance/bylaw requirements	2		
		The utility owner's governing body does not meet	0		
		Total Managerial Points	**10**		
Financial	*Budget*	Utility owner and the Utility have each adopted a realistic budget and budget amendments are adopted as needed; Accurate monthly budget reports are prepared and submitted to the governing body	15	RUBA	If the utility is managed or operated by a third party, the utility owner and the contractor must demonstrate appropriate budgeting and financial reporting practices. The utility owner must demonstrate appropriate budgeting for any utility subsidies and for the contracted services. The contracted manager must also demonstrate a realistic budget for the utility. When the utility is managed by a third party, monthly financial reports must be submitted to, and reflected in the meeting minutes of, the utility owner's governing body. Utilities not under contracted management must have a distinct budget for the utility operations in order to achieve the maximum score.
		Either the Utility or the Utility owner has adopted and implemented a budget, the other has not	13		
		Either the Utility or the Utility owner has adopted a budget, but it is not being implemented	10		
		Utility owner and the Utility have not adopted a budget	0		
	Revenue	Utility is collecting revenue sufficient to cover the Utility's operating expenses and to contribute to a repair and replacement account	20	RUBA	To receive full points, the reports must show that sufficient revenues - whether from user fees, explicitly identified subsidies, or a combination of both- are being collected to meet all the utility's associated expenses, and that the utility is budgeting for repair and replacement expenses and/or already has sufficient funds saved to cover foreseeable repair and replacement costs. 'Collection policy' means a set of procedures designed to ensure bills are paid on time and in full, and to collect on past-due payments. Sending customers a bill/statement each month showing the amount owed is not a collection policy. The collection policy must include a statement of action that will be taken if past-due amounts are not received.
		Utility is collecting revenue sufficient to cover expenses	15		
		Utility has a fee schedule and a collection policy that is followed	5		
		Utility has no fee structure or collection policy	0		
	Worker's Compensation Insurance	Utility has had a workers' compensation policy for all employees for the past two years and has a current policy in place	5	RUBA	All employees of the entity which owns the utility must be covered by workers' compensation insurance. In addition, all employees of a third party managing the utility must be covered, if applicable.
		Utility has a current workers' compensation policy in place for all employees	2		
		Utility has no workers' compensation policy	0		
	Payroll Liability Compliance	Utility has no past due tax liabilities and is current with all tax obligations	5	RUBA	This criteria applies to the utility owner, as well as to a third party managing the utility, if applicable. Taxes considered include both Federal and State taxes. A utility representative must sign an IRS tax authorization form for this information to be verified for scoring purposes.
		Utility owes back taxes, but has a signed payment agreement, is current on that agreement, and is up-to-date with all other tax obligations	2		
		Utility is not current with its tax obligations and/or does not have a signed repayment agreement for back taxes owed	0		
		Total Financial Points	**45**		
		Total Points Possible	**100**		

Figure 1 ***RUBA Report Card***

The RUBA report card is essentially a process of means testing which other agencies have versions of, or are adopting as their own, including the Denali Commission. Trainings administered by the Rural Alaska Landfill Operator (RALO) and Rural Alaska Fuel Service (RAFS, a Denali Commission program), utilize similar report card models in initiating training programs targeted toward rural Alaskan entities.

The water and electricity/energy nexus is the reasoning behind the Rural Energy Initiative of the Alaska Native Tribal Health Consortium's (ANTHC) because "The high cost of energy is threatening the sustainability of rural Alaskan communities and the health benefits provided by modern water and sewer facilities primarily associated with safe water systems." In looking to other models of effective utility management in rural Alaska, ANTHC has established the Alaska Rural Utility Collective, which centralizes some of the utility functions along the lines of a co-op model, but partners with communities to manage, operate and maintain water systems as well.

The Department of Energy, Indian Office awarded Intertribal Technical Assistance grants to Alaska Native organizations in eight different regions. Examples of assistance in the management sector include on-site visits from PCE and Quickbooks experts who work with utility managers and clerks to increase capacity in best practices recording, reporting and communicating with power plant operators.

Regional Energy Coordinator for the Tanana Chiefs Conference, Dave Messier is currently managing one of these DoE grants and he emphasizes the importance of management and power plant operations thusly: "You can't manage what you can't see, and in most of rural Alaska there is a disconnect between the people using energy and the people paying for energy. Sometimes that's between a utility clerk and a power plant or water plant operator; sometimes it's between a school maintenance worker and a school system bookkeeper. As better technology becomes available and allows us to see and track energy use more closely, we'll need better training for maintenance and utility workers to learn how to operate and take full advantage of updated systems. Better training for power plant operators is also going to allow communities to take advantage of more diesel-renewable hybrid generation systems, and that will have a huge benefit in reducing diesel consumption in the years. . . One of the missing pieces for some communities is a solid utility management structure for taking advantage of all of these innovations and figuring out how to implement them in the most remote areas of the United States. I believe that in the next 10 to 20 years our villages will be able to reduce their reliance on imported diesel by at least 25% if they can take advantage of more of these innovations."

A Holistic View of Clean Energy Vocational Training

Alaska's post-secondary vocational and technical education landscape consists of ten Regional Training Centers (RTCs) aside from AVTEC that are spread throughout the state: Alaska Technical Center (ATC), Amundsen Educational Center, Galena Interior Learning Academy, Ilisaġvik College, Northwestern Alaska Career Center (NACTEC), Fairbanks Pipeline Training Center and Technical Center, Northslope Training Education Cooperative, Partners for Progress in Delta, Southwest Alaska Vocational Education Center (SAVEC) and Yuut Elitnaurviat. In addition, fifteen Rural and two Community and Technical Colleges are affiliated with either the

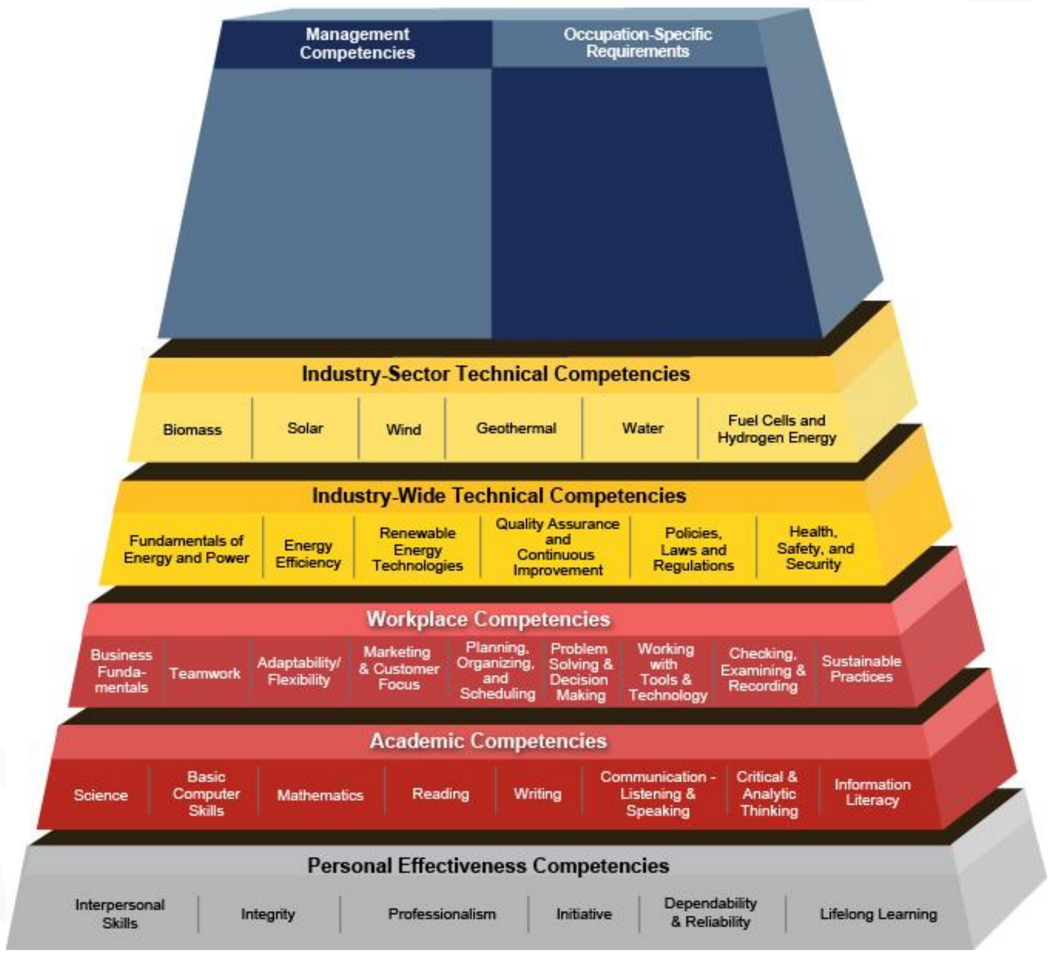
University of Alaska Anchorage, Fairbanks or Southeast. There are individuals like Mark Masteller of the UAF Bristol Bay's Sustainable Energy Program and Mike Hirt of the UAF's Rural Development/Facilities Maintenance Program who criss-cross the state utilizing these RTC's to reach scores of Alaskans and deliver clean energy lessons that deliver real world, bankable skills. But there are vastly to few trainers like Masteller, Hirst, Norm Miller and Jerry Blitz in the state of Alaska. And there are vastly too few students ready to take advantage of the lessons these trainers might offer.

Bill Stamm of AVEC delivers a standard presentation to rural communities that are newly joined to AVEC. The presentation takes a holistic approach to energy use in remote communities that follows the fuel from barge to tank farm, to power plant, to generator, to power line to house hold appliances, to meters and back to AVEC. A similar approach is enlightening when applied to the journey that the Industrial Electricity and Power Plant Operations trainee takes upon matriculating at AVTEC. The prior achievements of the typical Industrial Electricity student trainee can almost always attributed to an empowering K-12 experience and exposure to positive soft skill role models. The expectations heaped upon a Power Plant Operations trainee cannot be divorced from the capabilities and support of the very community that has sent that trainee to AVTEC. The vast network of federal, state, industry and other stakeholders that are vested in making these separate journeys successful seem invisible at times – in fact, all are working simultaneously, if not always efficiently, towards the same outcome: increased skills that benefit Alaskan communities, rural and Railbelt.

The operations inside a rural power house and the career of a skilled professional in power generation are of course a sliver of the clean energy workforce. But both are representative of challenges faced in nearly every other workforce sector that is touched by clean energy. A greater emphasis on the fact that existing, legacy jobs and careers are increasingly dependent on clean energy lessons should entail a greater investment in training programs and trainers. It is a fact that the materials and technology used to build and maintain Alaskan infrastructure are rapidly changing; the job titles of the managers, technicians and operators charged with building and maintaining this infrastructure may not change at all. But the skill sets required of these individuals are fast becoming a combination of the old and the new. Seeking new ways to integrating clean energy training lessons wherever possible should be a primary objective of Alaska workforce professionals across all sectors.

Energy: Renewable Energy Competency Model

December 2017



Employment and Training Administration
US Department of Labor

ENERGY RELATED WORKFORCE TRAINING PROGRAMS & ORGANIZATIONS

REGIONAL TRAINING CENTERS (RTCs)

- Alaska's Institute of Technology (AVTEC)
- Alaska Technical Center (ATC)
- Amundsen Educational Center
- Galena Interior Learning Academy
- Ilisaġvik College/ Northslope Training Education Cooperative
- Northwestern Alaska Career and Technical Center (NACTEC)
- Partners for Progress in Delta
- SE Alaska Career Center
- Southwest Alaska Vocational and Education Center (SAVEC)
- Yuut Elitnaurviat

UNIVERSITY OF ALASKA, ANCHORAGE – Community and Technical College

UNIVERSITY OF ALASKA, Fairbanks – Community and Technical College

UNIVERSITY OF ALASKA COMMUNITY CAMPUS SYSTEM

- **UAA:**
  Kenai Peninsula College (Kenai River, Kachemak Bay, Resurrection Bay and UAA), Kodiak, Mat-Su, Prince William Sound (Cordova, Cooper Basin)

- **UAF under College of Rural and Community Development:**
  Bristol Bay – (*Occupational Endorsement: Sustainable Energy) / Chuckchi / Kuskokwim / Northwest / Rural College / Tanana Valley / Interior-Aleutians (Aleutians/Pribilof, McGrath, Nenana, Tok, Yukon Flats, Yukon-Koyukuk)

- **UAS**
  Ketchikan / Sitka

University of Alaska, Fairbanks

- Juneau Fisheries

STATE/FEDERAL/ORGANIZATIONAL – OFFERINGS/OPPORTUNITIES

- Alaska Department of Labor and Workforce Development
- Alaska Works Partnership
- Alaska AFL-CIO
- Alaska Apprenticeship Training Coordinators Association
- Building and Construction Trades Department
- RUBA – Rural Utility Business Administration
- AVEC
- ANTHC – Alaska Native Tribal Health Corporation
- AEA – Alaska Energy Authority
- AHFC
- Rural CAP
- RAMP – Rural Alaska Maintenance Program
- AVI – Alaska Village Initiatives
- 60 Hertz
- Environmental Management, Inc.
- ARENA – Artic Remote Energy Networks Academy
- Alaska Center
- Building Energy Retrofit Wx (BERT) Apprenticeship
- Denali Commission – RAFS, ARMI – Alaska Rural Maintenance Initiative
- USDA – Rural Alaska Landfill Operators RALO
- DOE Indian Energy
  InterTribal Technical Assistance Program
- Vet GI Bill
- Construction Education Foundation
- AK Building Science Network
- 3Star`
- AHTNA, Inc.
- Aleut Corporation
- Arctic Slope Regional Corporation
- Bering Straits Native Corporation
- Bristol Bay Native Corporation
- Calista Corporation
- Chugach Alaska Corporation
- Cook Inlet Region, Inc.
- Doyon, Limited
- Koniag, Inc.
- NANA Regional Corporation
- Sealaska Corporation

UNIVERSITY – CLEAN ENERGY EDUCATION

Finding #1:
There are no in-state programs for Alaskan students interested in seeking degrees in renewable/clean energy at the BA, BS, MS, PhD level. There are no minor degrees awarded for undergraduate study of renewable energy, nor are there graduate level certificates in renewable/clean energy awarded in the state. The fact that no renewable energy degrees or certificates are being conferred in Alaska belies the fact that researchers at the Alaska Center for Energy and Power (ACEP), on the University of Alaska Fairbanks campus, are engaged in some of the most serious clean energy/microgrid research in the nation.

Student appetite for renewable energy coursework is evident, but a clear barrier to meeting this demand within the University of Alaska system is faculty bandwidth. *Renewable Energy Systems Engineering* is sporadically on offer through the Mechanical Engineering program at UAA. Department Chair Tom Ravens has expressed some surprise at the consistently strong student interest for what is, elective coursework. UA professors Getu Hailu and Jifeng Peng teach this course, and both professors are currently engaged in renewable energy research projects within Alaska. Professor Rich Wies at UAF last taught *Electrical Engineering 693: Renewable and Sustainable Energy Systems* in the Fall 2013. This also proved a popular class, but has not been offered in five years because of the pressing demand on faculty to teach core Electrical Engineering courses.

RECOMMENDATION
Without an increase in the capacity of faculty to teach specialized coursework; renewable engineering degree programs at the University of Alaska seem out of reach. It is worth noting, this instructor staffing challenge is another example of a statewide problem: a *train-the-trainer* shortage; one that hampers the progress of clean energy education within the K-12 and Vocational sectors as well.

Renewable energy degree programs outside of the engineering discipline could be feasible and warrant consideration. A fair proportion of Lower 48 universities with renewable energy programs have established inter- or multidisciplinary degree programs. Interesting examples include MBA, MS and BS programs that draw on economics, public policy, social science departments. Noteworthy examples include programs at: *ASU: School of Sustainability*; *Appalachian State University: Sustainable Technology*; *The Energy Institute at the University of Michigan*; *Columbia University: Earth and Environmental Engineering / Sustainable Energy*; *Syracuse University: Energy and Its Impacts BS*; *University of California at Berkeley: Energy Institute at Haas*. (Links to these and others provided below, in the *Compendium* section of this document).

The University of Alaska seems uniquely positioned to draw on several departments to perhaps fashion an Energy MS, MA or Minor program that could, for example, include coursework within existing departments such as: Alaska Native Studies and Rural Development, Geography, School of Natural Resources and Development, Rural and Community Development and/or courses within the Engineering Department.

A University of Alaska partnership with Alaska Pacific University's Sustainable Energy (BA) Program, could be beneficial to both institutions if the immediate goal is to build a multi-disciplinary degree program. APU's intention to become a Tribal College and its close affiliation with ANTHC, could provide an avenue where student coursework incorporates ANTHC renewable energy fieldwork/projects.

Finding #2:

There is a perception that designating a *Minor* or *Certificate in Renewable Energy*, is essentially an institutional effort on behalf of the student that "signals" prospective graduate programs, or employers, that the student is interested in the clean energy field. Rick Rocheleau, Director of Hawaii National Energy Institute (HNEI) characterized renewable energy certificate programs, of which HNEI offers, as not particularly essential to a renewable/clean energy career path: "An employer can teach any entry level mechanical or electrical engineer everything she needs to know about renewables in a month".

ACEP is in a sense already facilitating this sort of "signaling" through efforts such as the Utility Internship Program and the Microgrid Boot Camp; where undergraduate engineering interns are immersed in a week-long exercise to understand the intricacies and demands of micro-grids in rural Alaska.

Recommendation

Building value and prestige into an ACEP Internship program may achieve exactly the sort of "signaling" value that Director Rocheleau suggests is of value. ACEP could look toward models such as Northeastern University's Energy Engineering program (MS/PhD). This program is built on a co-op foundation where every third trimester is spent working for industry in the chosen field of study. Again, Alaska's many microgrids and engineering firms might benefit from such an exchange – one perhaps facilitated by UAF/ACEP.

Finding #3:

There is abundant opportunity for motivated students to gain practical and theoretical experience in designing and testing renewable energy systems in Alaska, home to nearly 300 microgrids. These opportunities have not yet been converted to degree pathways. The engineering programs at both the University of Alaska, Fairbanks and Anchorage offer robust curricula, with a few elective opportunities for independent study within the field of renewable energy. Exposure to renewable energy coursework or actual projects underway in the state are obvious drivers of Alaskan engineering students seeking work in the renewable energy field. But In Alaska, a career in renewable energy or further study of renewable systems, is likely to be a student-driven outcome for most graduates from either UAA or UAF's Engineering programs. ACEP offers an exceptional experience where a handful of BS or MS engineering students find assignments within projects that complement a capstone or thesis project.

Recommendation

Alaska's nearly unrivaled renewable energy resources make the state an obvious and enviable proving ground for renewable technologies. This rich renewable landscape and the University of Alaska's long history as a major contributor of intellectual capital in the field of renewable energy could be leveraged to the benefit of the UA in forming strategic relationships with established graduate and undergraduate renewable energy programs around the nation, and world.

Attached below is a ***Compendium of University Renewable/Sustainable/Clean Energy Education Degree Programs and Research Facilities in the United States.*** One could plausibly comb through each program description on this list and find a point of intersection with either a renewable resource in Alaska, pilot projects in Alaska, completed or working projects in Alaska, and scholarship or technical expertise that has been drawn from research based in Alaska. ACEP has already found common ground and collaborated or formed partnerships with several universities and institutes around the nation. ACEP seems uniquely positioned to perform a deliberate inventory of what other renewable energy programs might need in terms of capstone or theses projects. One could imagine a variety of functions UA/ACEP might perform in facilitating the enrichment of these outside programs by providing access to Alaska's renewable landscape both in terms of resources, contacts, relationships, institutional knowledge and intellectual capital. The mechanics of these strategic partnerships could take many shapes. Models might include: Fellowships, Visiting Scholars, Scholar Exchanges or something along the lines of Western University Exchange (WUE) or the Medical School exchange program WWAMI (Washington, Wyoming, Alaska, Montana, Idaho) might be appropriate.

Attached below is an informal attempt to inventory all of the energy/renewable energy related coursework within both the University of Alaska and APU (*Higher Education Opportunities in Alaska: Clean Energy Studies/Energy Related Studies*). A more rigorous investigation could prove instructive in what exactly Alaska's universities already have on offer; and then compare these findings against the needs of the outside programs.

The success of any university program depends most heavily on the caliber of the students in manages to recruit. Selective and collaborative partnerships with outside programs has the potential for Alaska to gain access to some of the best minds working at other institutions. The wager is that by granting access to the vast resources of Alaska – they will come.

Higher Education Opportunities in Alaska: Clean Energy Studies/Energy Related Studies

*Red font entries denote coursework, professors or research with a direct relationship to Alaska clean energy concerns.

I. University of Alaska, Fairbanks

a. College of Mines and Engineering

i. Electrical Engineering: BS/MS/PhD
ii. Civil Engineering BS/MS/PhD
iii. Computer Engineering: BS/PhD
iv. Mechanical Engineering: BS/MS/PhD
v. Mining Engineering: BS/MS/PhD
vi. Geological Engineering: BS/MS/PhD
vii. Computer Science BS and MS
viii. Petroleum Engineering: BS/MS/PhD
ix. Water and Environmental: M.S.

b. Alaska Center for Energy and Power (ACEP) – Undergrad Internship

i. Alaska Hydrokinetic Energy Research Center (AHERC)
ii. Power Systems Integration (PSI)
iii. Data Collection & Analysis (DC&A)

c. Institute of Northern Engineering – Research

d. Department of Geography

i. F302 UX1 - Geography of Alaska **(Natural and Renewable Resources)**
ii. **F420 - Geopolitics of Energy**

e. School of Management

i. F439 & F639 Energy Economics

f. School of Natural Resources and Extension

i. NRM F101 Natural Resources Conservation Policy
ii. NRM F240 Natural Resources Measurement and Inventory
iii. NRM F430 Natural Resource Management Planning

g. College of Rural and Community Development

i. Community Research Toolbox
ii. Strategic Planning and Decision Making
iii. Rural Business Planning and Proposal Development
iv. Managing Rural Projects and Programs

II. University of Alaska, Anchorage

a. College of Engineering

i. Mechanical Engineering – BS/MS
   1. Getu Halu - ME A453 Renewable Energy Systems Engineering
   2. Jifeng Peng – Vertical Axis + Hydro research in Igiugig

ii. Computer Science and Engineering - BA/BS/Minor

iii. Engineering Civil Engineering – BS/MS

iv. Electrical Engineering – BS/Minor
   1. EE Professor Ahmed Abuhussein – Renewables / Power Systems

v. Project Management – MS/Professional Short Courses

vi. Geomatics – BS/MS

b. College of Business and Public Policy

i. **ISER**
   1. Energy and the Environment – Research
   2. Alaska Energy Data Gateway

ii. Department of Economics and Public Policy
   1. Economics of Energy

III. University of Alaska, Southeast

a. Environmental Science – BA

i. GEO S313 Sustainable Resource Management

IV. Alaska Pacific University

a. Sustainability - BA

i. Sustainable Communities

b. Alaska Native Executive Leadership Program (Certificate)

Compendium of Renewable/Sustainable/Clean Energy Education Degree Programs and Research Facilities in the Lower 48

BS Degree Programs

Oregon Institute of Technology: Renewable Energy Engineering

The degree program is geared toward readying students for occupations in: "energy efficiency and "green" buildings, solar thermal systems, photovoltaics, hydropower, wave and tidal energy, biomass and biofuels resources, wind energy, energy storage, geothermal systems, and alternative transportation systems."

ASU: School of Sustainability

The Bachelor of Science (BS) program introduces students to the concept of sustainability in the context of real-world problems, exploring the interaction of environmental, economic, and social systems. Priority placed on gaining a deep understanding of the concepts and methods of environmental economics, ecology, environmental biology, hydrology, environmental chemistry, engineering, earth-systems management, and other disciplines relevant to the sustainable use of environmental resources. Students can pursue the following tracks within the BS in Sustainability:

Sustainable Energy, Materials, and Technology
The Economics of Sustainability
Ecosystems Sustainability

Appalachian State University: Sustainable Technology

The program requires 28 semester hours in introductory technology and environmental design courses, 12-14 hours of interdisciplinary coursework, 27 hours in technical specialization (i.e., wind, hydropower, photovoltaic systems, solar thermal energy, building science, biofuels, etc.) and a capstone course or internship.

The Energy Institute at the University of Michigan

In addition to the MS in Energy Engineering, UM offers degree programs in: Electrical and Computer Engineering – Power and Energy. The School for Environment and Sustainability (SEAS) offers dual degrees in Engineering, Business, Urban and Regional Planning, and Law. The school also offers a Minor degree with a focus on Energy.

Northeastern University's College of Engineering: Energy Systems

In keeping with Northeastern's co-op model where "curriculum is firmly rooted in energy technology and includes exposure to the interface with business and financial decision processes. Students are exposed to business educators and practicing professionals."

SUNY Canton:
Renewable and Alternative Energy Systems

Stated goals for graduates of the program are: Ability to formulate solutions to the needs of the public for alternative and renewable sources of energy. Emerge as effective project planners and managers of alternative and renewable energy projects. Prepared to respond to the dynamic needs of the alternative energy market. Are able to communicate in an organized manner through technical reports in written, oral, and other formats appropriate to alternative and renewable energy issues. Develop skills to function in and lead a team-based effort.

Syracuse University:
Energy and Its Impacts BS

The Integrated Learning Major on Energy and its Impacts gives students the interdisciplinary background required to understand the origin of our current problems and the ability to seek solutions to them. Students from a broad range of primary majors (in the Natural Sciences, Social Sciences, Engineering, or Management) will come together to confront some of the most important challenges that confront the world. A team-based capstone project will enhance interdisciplinary learning while building problem-solving skills.

MS/PhD Degree Programs

Oregon Institution of Technology

The Master of Science in Renewable Energy Engineering (MSREE) program is offered at Oregon Tech's Portland-Metro Campus (in Wilsonville). The MSREE program has been structured to accommodate both full-time students and working professionals. The MSREE program is designed to prepare graduates to be energy engineering professionals who have advanced knowledge and skills that enable them to assume a broad range of technical leadership roles in nascent and established industries, government entities and NGOs.

Washington State University:
Electrical Power Systems Engineering

The Electrical Power Engineering PSM provides core technical education in power systems analysis, transmission and distribution systems and power system economics and electricity markets. Core technical work can be supplemented with elective courses in areas ranging from power electronics to power system protection to smart grid communication.

University of Colorado:
Master of the Environment

The Masters of the Environment (MENV) is a 17-month, cohort-based, on-campus professional degree program designed for new and early career professionals. The program focuses on applications and problem-solving and has four parts: (1) the core curriculum, (2) a choice of topical specializations that are supported by (3) electives, and (4) a Capstone Project.

The University of Michigan:
The Energy Institute

The Master of Energy Systems Engineering (ESE) program is a 30-credit graduate degree designed for students who are motivated to take on the challenges facing society in the areas of sustainable energy generation, storage, and conversion. In this program, you will learn about alternative and conventional energy technologies, the societal and environmental impact of technology developments, and the economic benefits of those developments. The curriculum takes a holistic approach and exposes you to courses from across disciplines, including engineering, natural and social sciences, public policy, environmental science, and business.

University of Illinois:
MS in Engineering with Concentration in Energy Systems

The M.Eng. in Energy Systems degree requires students to complete 32 credit hours of graduate coursework, consisting of courses in the areas listed below. The program structure is designed to provide students a solid foundation in fundamentals of one or more energy-related technical areas as well as broader exposure to the related economic, social, or political context in which energy systems operate.

University of Massachusetts, Lowell

The Energy Engineering Program at the University of Massachusetts Lowell is, along with the Nuclear Engineering Program, one of two ways to earn a graduate degree in Energy Engineering. The program offers both Master's and Doctoral degrees, as well as a Graduate Certificate, in Energy Engineering.

Columbia University:
Earth and Environmental Engineering /
Sustainable Energy

This concentration is aimed at engineers with a minimum background of a BS degree in an engineering discipline. The objective is to gain a better understanding of present day energy infrastructures, their strength and weaknesses and to scope out future technology developments for a world with seemingly insatiable demand for energy. The master degree aims at preparing a new generation of engineering professionals who will be involved with the rebuilding of a world energy infrastructure that today is stretched nearly beyond the limits of its capacity.

BS/MS/PhD Degrees with Specialty Focus

University of Hawaii, Manoa
School of Ocean and Earth Science and Technology (SOEST):

GeoSciences

The MGeo is for individuals, including working professionals, who have completed a bachelor's degree in the natural sciences, math, or engineering. The MGeo is intended to prepare students to pursue a career in a variety of fields such as geological, geotechnical, and environmental consulting, hydrology, natural hazard mitigation, climate change adaption, natural resource exploration, renewable energy development, and more.

Ocean Resources and Engineering

The engineering systems needed to develop the ocean's energy, mineral, and living resources, the potential use of the ocean for waste disposal, and the environmental and economic aspects of such activities.

Texas Tech University:
National Wind Institute

Wind Energy is the premiere multidisciplinary program developing transformational experts who apply knowledge, skills, and conviction to lead in the advancement of sustainable renewable power solutions with positive regional, national, and global impact.

Wind Science & Engineering Doctoral Program
Bachelor of Science in Wind Energy
Wind Energy Graduate Certificate Program

Cornell University:
Earth Energy Systems – Geothermal PhD

The Earth Energy Systems graduate educational program brings together students seeking degrees in engineering and in geosciences in a unique program designed to provide both communities with skills, knowledge, and a common language to address our energy challenges.

Stanford University:
MS/PhD Geothermal

The program undertakes studies in a number of significant areas, including well test analysis of fractured and multiphase reservoirs, design and interpretation of tracer tests in fractured reservoirs, adsorption in vapor-dominated reservoirs, experimental measurements of fluid flow parameters, and optimization of production and reinjection strategies.

University of Maine :
The Forest Operations, Bioproducts, and Bioenergy Program

This BS program has been designed to address a major challenge to the industry: the efficient and environmentally acceptable growth, management, extraction and transportation of timber for the manufacture of forest products. The interdisciplinary program combines coursework, fieldwork and faculty expertise in forest ecology, forest management and wood science, with an emphasis in business administration. Training in a forest setting begins the first semester.

University of California at Berkeley:
Energy Institute at Haas

A broad ranging energy curriculum is based out of the and includes a variety of MBA programs. The stated goal of the Institute is "to bridge the gap between the frontiers of economic and scientific energy research
and the marketplace.

Penn State University:
MS Professional Studies Renewable Energy and Sustainability Systems

Corporations, government entities, and organizations in the growing fields of renewable energy, energy trading, and systems management will need professionals with a balanced perspective of technical understanding and the advanced project management skills that this Master of Professional Studies in Renewable Energy and Sustainability Systems (MPS-RESS) with an option in Sustainability Management and Policy (SMP). Learn to analyze market and nonmarket strategies, communicate effectively about facility energy policy development, and use systems thinking approaches to unify project development tactics.

Microgrid Program Exec MBA from US Green Building Council

This is a 6-week, comprehensive, data-driven course on microgrid project development for professionals developed by RenewableEnergyWorld.com, Dr. Mahesh Bhave, and HeatSpring. Students will learn to evaluate project economics of microgrid projects in a variety of markets using case studies, financial models, and templates. The student capstone project is a microgrid investment proposal, including pro forma financials.

Graduate Certificates

University of Massachusetts Amherst:
Wind Energy Center- Wind Power Engineering

The Graduate Certificate/Concentration in Wind Power Engineering offers graduate students the opportunity to have their work and interest in wind energy formally acknowledged as an important part of their graduate training, providing certification of relevant knowledge for those seeking academic positions and careers in industry. The program of study is designed to meet the needs of students who are interested in either pursuing further academic studies in wind power or joining the burgeoning wind power industry. This Certificate/Concentration program responds to these professional currents, providing a clear but flexible curriculum for graduate students interested in wind energy, and preparing them with in depth skills and knowledge of all aspects of wind energy.

University of Hawaii, Manoa:
The Renewable Energy and Island Sustainability

A graduate certificate program that provides students with an opportunity to get both breadth and depth in energy and sustainability curriculum. Students will take classes in different colleges to get a broad perspective on energy sustainability. In addition to taking courses and attending a REIS seminar class, students will conduct a capstone project to obtain greater depth in an energy research area.

UC San Diego Extension:
Power Systems Engineering - Microgrids

This certificate program teaches the building blocks of the power system, its control and management. Designed for those with minimal experience with electric power, participants will be able to speak the language and perform substantial tasks within the electric grid and power system network including microgrids. Any engineering degree, preferably BSEE, is required for entrance.

Stanford:
Energy Innovation and Emerging Technologies Professional Program

Online Professional Certificate for working professionals. Eight Courses for completion include:
Solar Cells / Past, Present and Future of Fossil Fuels /
Smart Grid: Sensing, Data Analytics and Control / Energy Storage
Nuclear Energy - Why, How and Prospects
Planning for a Sustainable Future with Wind, Water and the Sun
Economics of Competing Energy Technologies
Behaviorally Informed Design on Energy Conservation

UC Boulder

Renewable and Sustainable Energy Institute (RASEI) Certificate

Energy science and technology. How traditional and renewable energy systems work, how energy technologies function, energy conversion processes, and the status and potential of renewable technologies.

Energy policy. How stakeholders interact to accomplish policy decisions, the impacts and potential of policies to promote renewable energy, and congressional and governmental process.

Energy industry. Finance, project development, economic analysis, and other components of building a viable business around renewable energy.

Bioenergy and Sustainable Technology Graduate Certificate –

South Dakota State U/Kansas State U/Oklahoma State U/U of Arkansas

The certificate may be suitable for individuals who are place-bound in the target industries and need additional knowledge in their disciplines while requiring distance education options. With a rising interest in green chemistry and sustainability, and escalating crude oil prices, bio refinery industry now actively recruits individuals with specific training in bioprocessing and bio based materials. SDSU's Bioenergy and Sustainable Technology Graduate Certificate program is designed to serve the needs of these emerging industries and provide post-baccalaureate educational opportunities for industry practitioners who do not require a full graduate degree program. Students develop an interdisciplinary background and can tailor the program of study to specific interests.

Labs and Centers of Excellence

Hawaii Natural Energy Institute (HNEI University of Hawai'i at Manoa (UHM)

Conducts research of state and national importance to develop, test and evaluate novel renewable energy technologies. The Institute leverages its in-house work with public-private partnerships to demonstrate real-world operations and enable integration of emerging technologies into the energy mix. HNEI was established in statute in 2007 to address critical State energy needs. Our research focuses on sustainable energy production (wave, wind, PV), energy efficiency in transportation (Hybrid, PHEV and EV), large-scale energy management (smart grid, complex system optimization), design morphology, energy policy, new technology adaptation and education.

OSU Center for High Performance Power Engineering

CHPPE is a multi-million dollar world-class power electronics laboratory, located at the Ohio State University, specifically designed to exploit the high temperature, high frequency operation and efficiency advantages of silicon carbide (SiC)-based power electronics. It was established through a $3 M Ohio Third Frontier grant to be the host for a new generation of technologies in power electronics and systems.

*UC San Diego Sustainable Power and Energy Center

Theoretical, computational, and experimental approaches to study, improve, invent, characterize and troubleshoot materials, devices, and systems for energy storage. The mission is to *collaborate* and test our devices on UC San Diego's sought-after microgrid. Cost and performance bottlenecks with a focus on materials science and nano and atomic-scale engineering research. The team includes nanoengineers, materials scientists, chemists and micro-grid experts. Leaders in electrical, structural and chemical engineering as well as the economics of renewable energy. Professors, students and research scientists. Partnerships with companies large and small, U.S. national labs and other universities.

UC San Diego Center for Energy Research

An internationally recognized center of excellence built by fostering interdisciplinary research, developing visibility for UCSD as a leading institution in energy studies, and creating educational programs in energy technologies. The Center welcomes participation as a student, researcher, outreach partner, or in other capacities.

University of Pennsylvania: "PENNERGY"

The Penn center for energy innovation or "Pennergy" is the University's newest research center. Pennergy seeks to harness the collaborative efforts of energy researchers across campus to create innovative technologies and materials aimed at meeting the worlds growing energy demand and achieving environmental and economic sustainability. Pennergy brings together world-class researchers to solve scientific and technological problems enabling the efficient use of current energy sources, the practical use of more sustainable energy, and the facile conversion of energy to different forms.

University of Maryland Energy Research Center

The University of Maryland Energy research center is a multidisciplinary university initiative dedicated to advancing the frontiers of energy science and technology, with a focus on energy storage, efficiency, and clean energy generation. The Center researchers and educators integrate and share their knowledge through energy research, educational, and outreach activities that impact researchers, students, and our community. Research areas include:
Electrochemical Energy / Micro Power Systems /Energy Efficiency / Smart Grid / Power Electronics / Renewable Energy / Nuclear Energy / Chemical Energy Conversion / Carbon Capture & Sequestration / Climate Change & Environment/ Energy Policy / Economics / Energy R&D Policy / Energy Security / Renewable Energy & EE Policy / Education / Agency and Organizational Partnerships / Clean Energy Student Opportunities / Sustainability Workshop

SMU Geothermal Laboratory

The SMU Geothermal Lab is an active research facility, with a variety of ongoing geothermal resource projects. Faculty, staff, and students strive to broaden the understanding and use of geothermal energy, from the simplest form - geothermal heat pumps for buildings, to the large-scale deployment of geothermal power plants providing energy for our cities. Research also explores opportunities to integrate renewable geothermal projects in an oil & gas setting.

BA DEGREES

Western Washington U - Energy Policy Management

The goal of the BA in Energy Policy and Management is to give students knowledge and analytic skills in the policy and management aspects of today's diverse energy business, along with broad exposure to the science, environmental, business and policy aspects of the energy system that drive the formation and analysis of energy-related policies.

ASU – Sustainability BA

Understand the concepts and methods of environmental economics, sociology, anthropology, environmental politics, ethics, design, and human geography relevant to the sustainability of environmental resources and social institutions. Apply these concepts and methods to developing sustainable institutions for water, land, air, and urban management at the local to global level. Evaluate the sustainability of environmental institutions, legal frameworks, property rights, and culture.

Syracuse University – Energy and Its Impacts

The Integrated Learning Major on Energy and its Impacts gives students the interdisciplinary background required to understand the origin of our current problems and the ability to seek solutions to them. Students from a broad range of primary majors (in the Natural Sciences, Social Sciences, Engineering, or Management) will come together to confront some of the most important challenges that confront the world. A team-based capstone project will enhance interdisciplinary learning while building problem-solving skills.

Minor/Undergraduate Certificate

M.I.T. - Minor in Energy Studies

A focus on practical applications. MIT: Designed by MITEI, the minor is an undergraduate course of study that encourages students from any department within MIT to expand their knowledge of energy issues across a range of fields, from science and engineering to policy to the humanities.

Duke University – Renewable Energy

Five unique courses and one capstone design course must be completed to earn the Minor in Energy Engineering. The requirements for the minor are below; you can also read course descriptions for the new ENRGYEGR courses and check out our anticipated teaching schedule. Click here for a detailed check list to help you keep track of your progress in the program.

University of Michigan – Energy Science and Policy Minor

Energy underlies all of our modern technological, social, political, economic, and ecological systems. The minor is designed to provide the information and analytic skills necessary to understanding the sustainable production and consumption of energy across a variety of disciplinary perspectives.

Iowa University – Wind Energy Certificate

Undergraduate work for the certificate focuses on energy, environment, and information science and includes core courses and electives. Mechanical engineering students may use the certificate as a tailored engineering focus area by adding an approved math/science elective.

Duke - Pratt School of Engineering: Certificate in Energy and the Environment

This certificate program provides Duke undergraduates with an understanding of the breadth of issues that confront our society in its need for clean, affordable and reliable energy. The goal of the Certificate is to develop innovative thinkers and leaders who understand the energy system as a whole and the important interconnections among policy, markets, technology and the environment. An expertise in energy will expand career options in the private, non-profit, government and academic sectors.

Innovative Partnerships

Brown University
Brown participates in an Exchange Scholar Program that enables advanced graduate students to study for one or two semesters in the graduate school of participating institutions. Energy relevant as it encourages/enables scholars to gain credit at outside institutions in specialty fields.

UC Solar
The University of California Advanced Solar Technologies Institute (UC Solar) is a multi-campus research institute made up of faculty from the University of California's Merced, Berkeley, Santa Barbara, Davis, San Diego, Riverside, Santa Cruz, Irvine and Los Angeles campuses and the Lawrence Berkeley National Laboratory (LBNL). UC Solar was established by a grant from the University of California Office of Research and officially launched in 2010. Headquartered at UC Merced, UC Solar creates technologies that make solar energy systems more efficient, more affordable, and the best choice for the people of California and the world. In addition, UC solar educates and develops tomorrow's solar energy leaders and entrepreneurs.

Interactive Distance Education Alliance (IDEA)
An online partnership between South Dakota State U/Kansas State U/Oklahoma State U/U of Arkansas. The Great Plains Interactive Distance Education Alliance (Great Plains IDEA) is a consortium of reputable universities who offer online, flexible, affordable programs for a virtual community of individuals from diverse backgrounds.