ALASKA
ENERGY AUTHORITY

Alaska Energy Authority
Renewable Energy Grant Recommendation Program

Impact Evaluation Report

Public Review Draft

Prepared by:
Vermont Energy Investment Corporation

In Collaboration With:
Alaska Center for Energy and Power

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Acknowledgements

The Impact Evaluation of the Alaska Renewable Energy Grant Recommendation Program was conducted by **Vermont Energy Investment Corporation (VEIC)** serving as Prime Contractor. VEIC team members participating in the evaluation included: David Hill serving as Project Team Leader; Chris Badger serving as Project Manager; Leslie Badger conducting impact and benefit cost analysis; and Nikki Clace and Molly Taylor providing project administration, editing, and production support.

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This report was written on behalf of the Alaska Energy Authority, but the views expressed in this report are those of the study authors, consistent with the commissioning of this work as an independent study.

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Executive Summary

The Vermont Energy Investment Corporation (VEIC) in partnership with the Alaska Center for Energy and Power (ACEP) was retained in mid-December 2011 by the Alaska Energy Authority (AEA) to conduct an independent program review of the Renewable Energy Grant Recommendation Program (REGRP). This report presents Phase II of the review – an impact evaluation of the REGRP.

The impact evaluation summarizes energy savings, avoided emissions and costs and benefits from REGRP supported projects – highlighting the full range of project types, renewable energy resources and communities that have participated in the program. Our research included:

- A thorough review of program documentation, program databases, authorizing legislation, supporting regulations, program reports, and related literature;
- Telephone and in person interviews with individual REGRP Program Managers, AEA management, program stakeholders and, Institute for Social and Economic Research (ISER) staff;
- Analysis of AEA/ISER program tracking data, and
- Reporting on four core areas of program impacts:
    - Overview and analysis of REGRP program participation and demographics
    - Portfolio Level Cost Benefit Analysis
    - Renewable Energy Resource Sector Sub-analysis
        - Project level Benefit/Cost Results
        - Sector based lessons learned
    - Renewable Energy Market Development in Alaska

Overall, the impact evaluation findings indicate the REGRP is cost effective, and the current portfolio of projects that have reached the construction phase are projected to provide more than $500 million of net present value benefits during their lifetimes. In addition, the REGRP is beginning to provide a resource base of knowledge on the challenges and opportunities for renewable energy development in Alaska that can help inform and improve future projects.

Participation

The Alaska Renewable Energy Grant Recommendation Program (REGRP) was established in 2008 to support the development of renewable energy projects and to reduce the impact of the high cost of energy for rural communities.

Alaska boasts an abundance of fossil and renewable resources that rival many countries, but Alaskan consumers pay among the highest rates for heating and electricity in the country—50% higher than the U.S. average[1]. According to the Energy Information Administration, in 2012, Alaska ranked second in 2012 for high residential electricity costs with an average price of 17.91 cents/kWh as compared to the national average of 11.52 cents/kWh. However many of Alaska's rural villages mirror 1st ranked Hawaii's $37.05 cents/kWh.

The REGRP has now completed five rounds of funding as summarized in Table ES-1.

Table ES.1 REGRP Participation and Funding by Round[2]

Round	I - IV	V	Total
Applications Received	461	97	558
Projects Funded	208	19	227
Grants in Place	180	5	185
Grants Completed	38	0	38
Grants Cancelled	14	0	14
Amount Requested ($M)	$1,094	$133	$1,227
AEA Recommended ($M)	$239	$43	$282
Appropriated ($M)	$177	$26	$202
Cash Disbursed ($M)	$100	$8	$108

The solicitation for the fifth round of program funding was issued in the summer of 2011 and recommendations for $43 million of REGRP projects at two funding levels were presented to the legislature in January, 2012. The governor approved $26 million of appropriations for the REGRP projects in the State's FY 2013 capital budget in May, 2012.

All of the primary renewable energy resources have been represented in the application pool during the 5 rounds of funding. Through the first four rounds approximately 80% of

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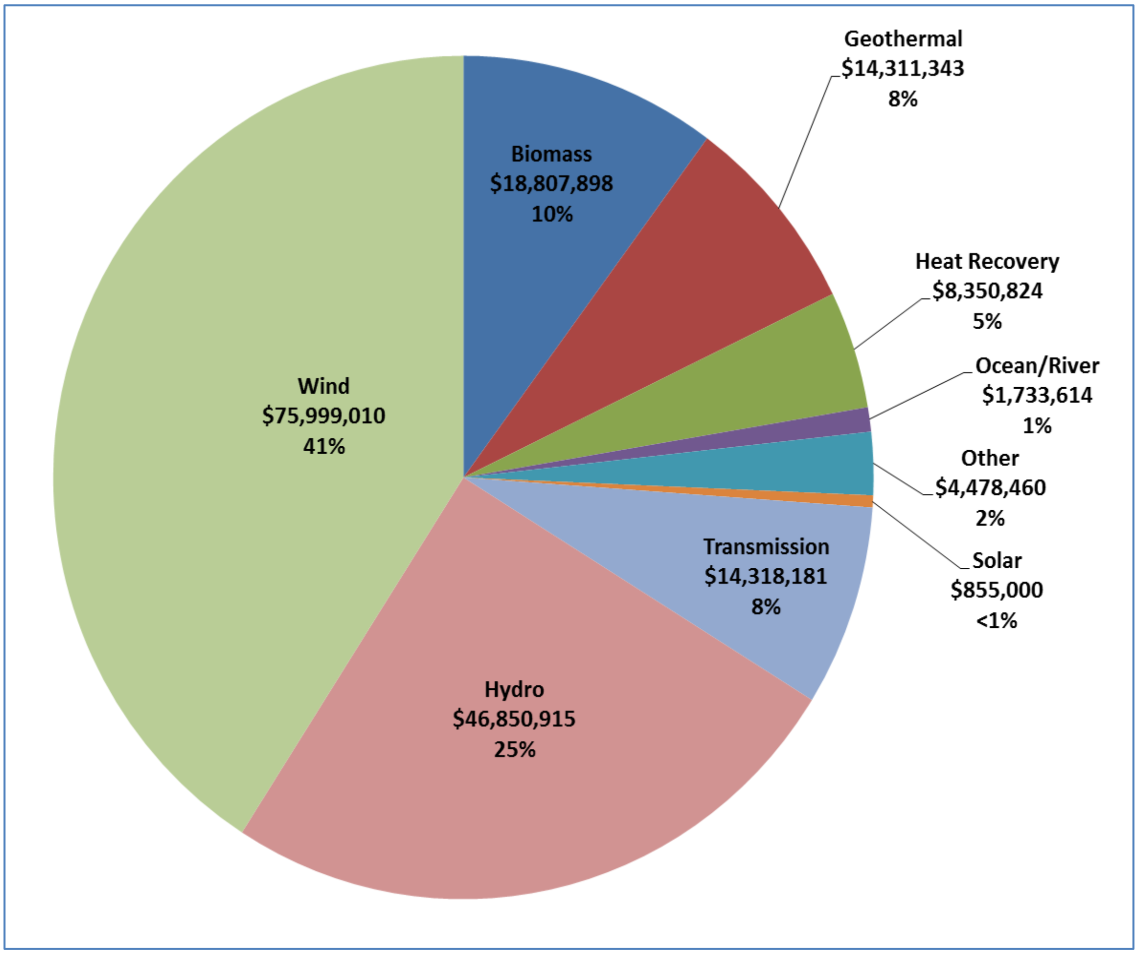
[1] EIA SEDS Database
[2] AEA Renewable Energy Fund Update, October 2012.

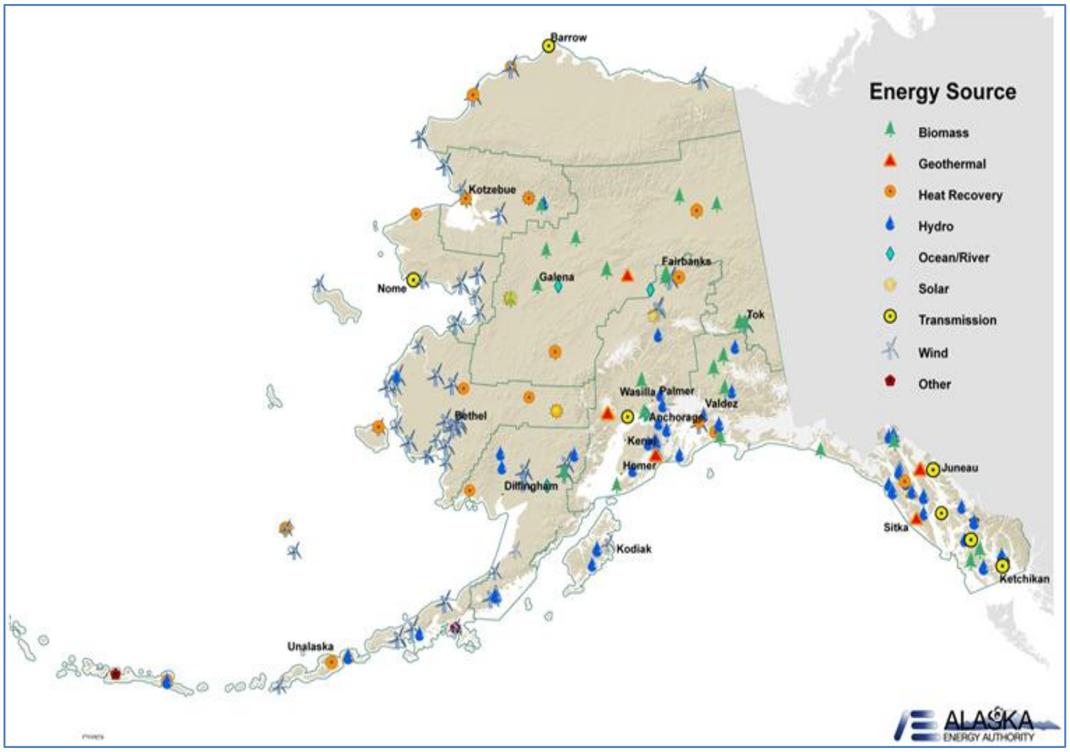
the appropriated funds have been for hydro, wind and biomass projects (Figures ES-1 and 2).

Figure ES.1 Appropriated Funds by Resource (Rounds I-IV)



The funding of REGRP projects during the first four rounds generally reflects the maturity of renewable energy technology sectors coupled with the existing knowledge base for developing cost-effective projects in communities across the state with available renewable resources. More recently additional focus has been given to biomass, geothermal, heat recovery and emerging technologies, with a higher percentage of support for early development (through feasibility studies and design).

Figure ES.2 Geographic Distribution and Type of Projects



The concentration of wind projects in the west and southwest, hydro projects in the south and southeast, and biomass projects in the interior tend to reflect the availability of the renewable resource available in defined regions of the state.

Economic Impacts

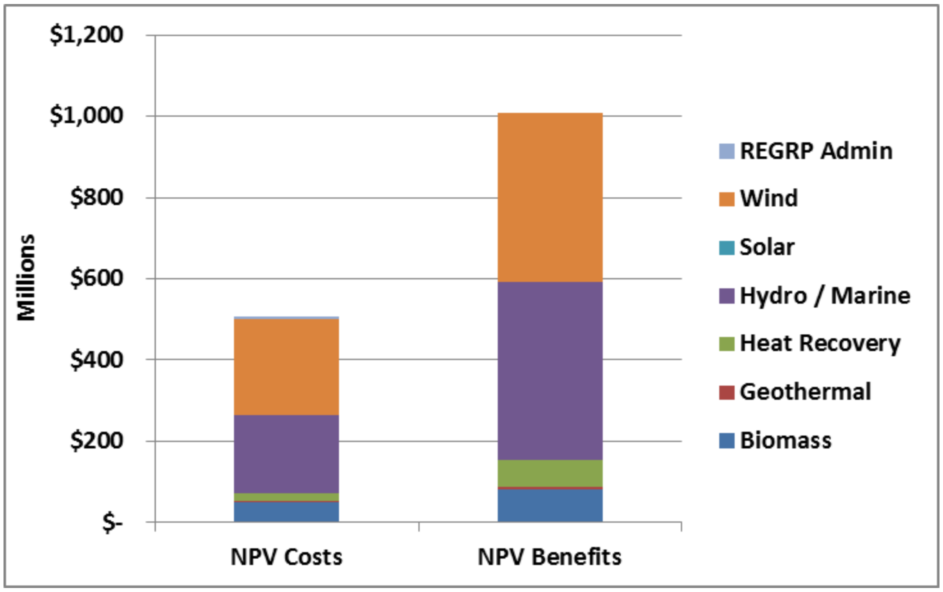
One of the fundamental concerns of policy makers, program administrators, and participants is whether the investment of state funds in the development of renewable energy through the REGRP is providing a net economic benefit. There are a variety of regulatory and economic tests and approaches to assessing the benefits and costs of renewable energy investments – and comparing these to alternative existing or conventional non-renewable supply options.

After review and discussion of various approaches with AEA, we concluded the ***Total Resource Cost (TRC)*** and ***Participant Cost Tests (PCT)*** were most appropriate in addressing the priority questions related to this impact study. The TRC cost test results for the construction portfolio are included in the Executive Summary. The benefit cost analysis methodology is discussed in Section 3 and additional results are presented in Section 4 of this report.

In our analysis we use the term "construction portfolio" to refer to a group of 62 projects. Of these 43 projects were under construction or had construction grants in place during 2011 and 19 are complete and have 2011 operating data.[3] All together, these projects serve 77 unique rural and Railbelt communities (note, some projects serve multiple communities). The program has established grants of $112 million to support these projects, and leveraged $246 million in non-REGRP funds from the state and other sources.

The benefit cost results for the construction portfolio include 2011 operating data from 19 of the 62 projects. The results for the other 43 projects are based on expected operational savings and costs. In some cases early project operations have not met expectations – due to a variety of factors highlighted in the subsector analysis section. However, even when lower than expected project level performance is factored into the cost benefit analysis, the overall portfolio remains cost effective – with total net benefits of more than $500 million (Figure ES 3).

Figure ES.3 2011 Construction Portfolio Benefits and Costs with Operational Data



As indicated in Table ES-2, with the exception of solar, all of the resources are expected to have net positive benefits. Over the course of their operating lifetimes, these projects are expected to return more than $501 million in net benefits to Alaska's economy, returning almost $2 of value for every dollar invested.

[3] Two projects, Kongiganak High Penetration Wind-Diesel Smart Grid project and Wrangell Hydro Based Electric Boilers Construction project, were not included in this count based on absence of descriptive performance data in the 2012 Alaska Renewable Energy Fund Status Report Appendix.

Table ES.2 Construction Portfolio Benefits and Costs With Operational Results

RE Resource Sector	Total Project Cost	Electricity Act/Proj	Diesel Act/Proj	Annual Electricity	Annual Diesel Displaced	Annual Natural Gas	NPV Costs	NPV Benefits	Net Benefits	NPV Benefit to Cost Ratio
	$ Millions	%	%	MWh	gal x 1000	Mmbtu x 1000	$ Millions	$ Millions	$ Millions	
Biomass	$27		34%	27,282	606	319	$49	$82	$33	1.68
Geothermal	$1.5		34%		92		$4.6	$6.6	$2.1	1.46
Heat Recovery	$15	30%	54%	3,318	613		$20	$65	$45	3.23
Hydro / Hydrokinetic	$133	67%	78%	33,550	2,525	24	$192	$438	$246	2.28
Solar	$0.3	0%	38%	42	3.2		$0.3	$0.3	($0)	0.99
Wind	$182	73%	60%	87,556	5,999		$234	$417	$183	1.78
REGRP Admin							$7.4			
Total REGRP Construction Portfolio (Actual)	$358			151,747	9,838	343	$508	$1,009	$501	1.99

Overall, our research confirms that the successful development of renewable energy projects in Alaska is difficult, and is often more costly than elsewhere, but that there are abundant opportunities to benefit the state economy and local communities due to the high costs of providing diesel fuel and other non-renewable energy resources.

The benefits and costs results presented above account for the direct energy and operational costs and savings. In addition, we have estimated the job related impacts, the impact to the state and residents for communities participating the Power Cost Equalization (PCE) Program, and the monetized value of environmental benefits (Tables ES-3 and ES-4).

Table ES.3 Jobs and Avoided Carbon Emission Impacts

RE Resource Sector	Jobs		Avoided Carbon Emissions	
	Person-Years	# of Jobs	Tonnes/Year	Project Lifetime Savings ($ Millions)
Biomass	180	9	23,083	$2.4
Geothermal	18	0.9	930	$0.1
Heat Recovery	71	3.6	6,225	$0.7
Hydro / Marine	445	9	25,117	$6.8
Solar	0.3	0.0	33	$0.0
Wind	294	15	60,139	$6.4
Totals for REGRP in Construction Portfolio	1009	37	115,527	$16.4

The development of renewable energy projects in communities participating in the PCE program creates direct savings for residential customers and eligible public buildings that participate in the PCE program, a reduction in the expenditures by the state to off-set fossil fuel costs for these customers, and also savings for those customers who are not eligible for the PCE program (primarily private, non-residential buildings) who benefit directly from the lower levels of fossil fuel consumption.[4]

Table ES.4 Power Cost Equalization Impacts

	Annual Residential Customer Savings		Annual Non-Residential Building Savings		Annual State PCE Program Savings		Total Annual Project Savings	Total Annual Project Savings
	MWh(s)	$ Millions	MWh(s)	$ Millions	MWh(s)	$ Millions	MWh(s)	$ Millions
2011 Operational REGRP Projects (Actual)	421	$0.1	15,993	$8.2	6,233	$2.8	22,647	$11.2
2011 Operational and Projects in Construction (Projected)	354	$0.3	35,739	$12.6	16,812	$5.1	52,905	$18

The job, environmental and PCE benefits further enhance the program's overall value to the state economy and communities participation in the REGRP. Section IV of this report provides more detail on these analyses.

Lessons Learned

The development of each renewable energy resource sector in Alaska faces unique challenges and opportunities. Section 5 of this report presents greater details – with benefit cost ratios at the project level – for each resource sector. The studies and projects funded to date through the REGRP, and the ongoing collection and monitoring of project data – will provide a valuable resource to assist and inform future policy, project investments and development.

[4] An analysis of the impacts of REGRP projects on public buildings was not performed based on the limited visibility of the energy usage of this customer class in the 2010 Alaska Power Statistics Tables. Including the benefits for public buildings in this analysis would be reflected largely as an increase in the Annual State PCE Program Savings and a proportional decrease in the Annual Non-Residential Building Savings.

Table ES.5 Renewable Resources

Renewable Resource	Lessons Learned and Sector Analysis
Wind	Pages 52 – 58
Hydro Power and Hydrokinetic Energy	Pages 59 – 65
Biomass and Landfill Gas	Pages 66 – 71
Geothermal	Pages 72 – 76
Heat Recovery	Pages 77 – 81

Alaska's Renewable Energy Market Development

Finally, the last section of this report discusses the REGRP in the broader context of renewable energy market development conditions and trends in Alaska. The REGRP has been a critical catalyst for activity across resources and stages of project development. Section 6 provides insights into the job and market growth that the REGRP and other policy and market actors have helped to foster. As the market continues to grow the human resource and knowledge base that helps Alaska to successfully develop renewable energy projects and resources will become an increasingly valuable asset and driver of economic development.

Conclusions

The REGRP has played an important role in supporting the development of renewable energy systems in Alaska, serving both remote and Railbelt communities with significant financial assistance. There is great potential for continued REGRP support to help reduce energy costs in rural Alaska and to help the state tap more of its substantial renewable energy resources. Looking forward, the REGRP has already created a solid foundation for accelerating the development of renewable energy markets and infrastructure in Alaska – and created a robust pipeline for near term project development.

This evaluation has two primary areas of focus: 1) To characterize the economic benefits as estimated by the applicants for projects in the REGRP construction portfolio in 2011 and compare against the actual performance reported in 2011 and 2) Assess the REGRP's progress in meeting the stated priorities of the legislature in supporting cost-effective projects on an equitable geographic basis and prioritizing projects in the communities experiencing the highest energy costs.

In conclusion, despite the high costs and challenges associated with developing renewable energy across the state, the REGRP is found to be cost-effective at both the program and individual renewable resource sector level providing a significant net benefit to the state. Underperformance, or alternatively, overestimation of the energy savings in the application process, is relatively broad based and although this can be attributed in part to the early startup performance of many projects in 2010 and 2011, is a recommended area of continued focus by AEA. Improving the tracking of total system costs and performance will contribute to future evaluation efforts, as well as assisting in ongoing communications by program staff with industry stakeholders in establishing best practices for project development.

The benefits of the renewable energy development in the state were characterized as having primary economic benefits – avoided fuel, operation and maintenance costs, as well as reducing expenditures through the Power Cost Equalization program – and secondary benefits including avoided carbon emissions and increased employment in the state. As the secondary benefits have direct implications to the state in creating jobs, as well as improving air quality in Alaskan communities, creating discrete metrics for capturing these benefits going forward will increase the value of the REGRP to the state and the cost-effectiveness of individual projects.

The wide array of renewable resources, applicant types and geographic regions supported by the REGRP represents an ongoing challenge to AEA in appropriately balancing equitable distribution of funds and prioritizing projects in the communities experiencing the highest energy costs. However, in this area as well, the REGRP is found to be successful with two-thirds of funding being appropriated to communities with higher costs of energy and a generally consistent funding success rate across different regions in the state.

The AEA is well positioned to continue providing support through the REGRP and to serve as an increasing knowledge base for lessons learned that will help improve future project development and operations.

1. Introduction

Alaska is home to an abundance of renewable and non-renewable resources, but harsh climate, limited infrastructure, a distributed population, and a short construction season are common barriers to resource development. The costs and performance of renewable energy systems are often impacted by local factors, with rural communities disproportionately effected. However, even in the more populated regions of the state, the delivery to market of renewable services will often differ from those suited to urban, grid connected environments typical of most areas of the U.S.

Context and Background

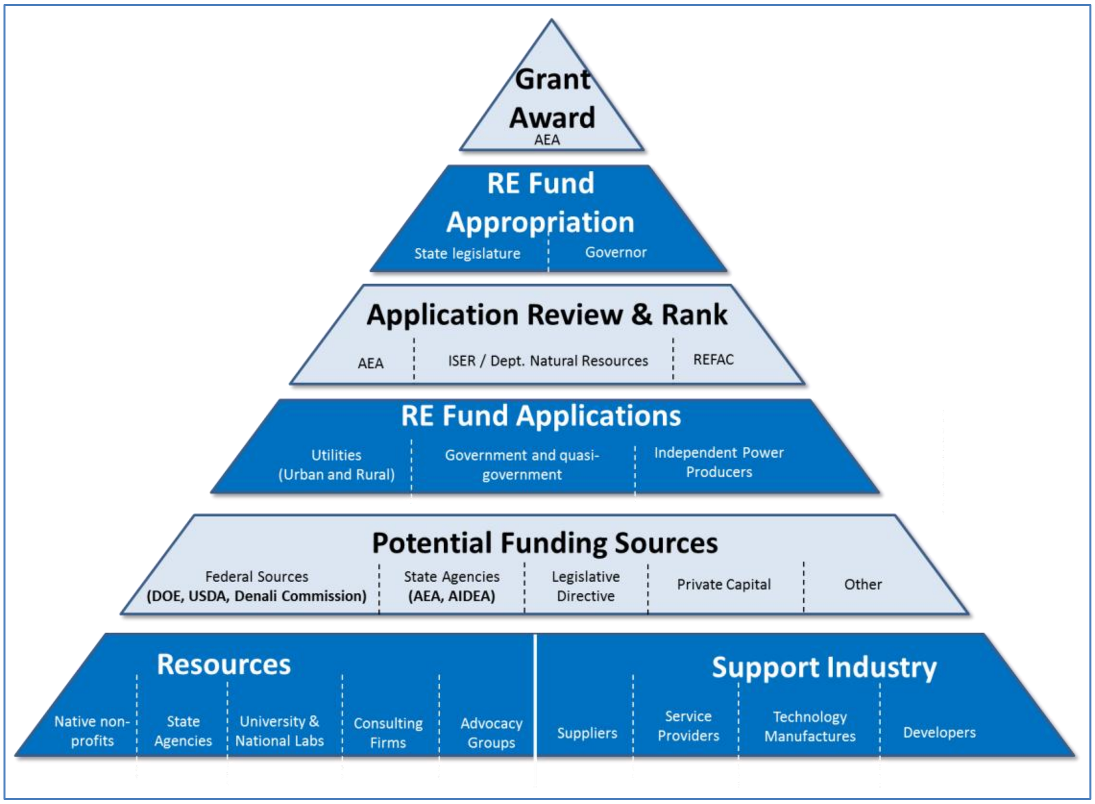
Since 2008, the Alaska Renewable Energy Grant Recommendation Program (REGRP) has provided support to utilities, independent power producers, and local governments, including tribal councils and housing authorities for the development of renewable energy projects. Administered by the Alaska Energy Authority (AEA), to date the program has issued five solicitations, reviewed 558 grant applications, and received appropriations totaling $177 million for 208 projects in the first four rounds, and reimbursed grant recipients for $82 million in project costs.[5] The solicitation for the fifth round of program funding was issued in the summer of 2011 and recommendations for $43 million of REGRP projects at two funding levels were presented to the legislature in January, 2012. The governor approved $26 million of appropriations for the REGRP projects in the State's FY 2013 capital budget in May, 2012.

Alaska boasts an abundance of fossil and renewable resources that rival many countries, but Alaskan consumers pay among the highest rates for heating and electricity in the country—50% higher than the U.S. average[6]. According to the Energy Information Administration, in 2012, Alaska ranked second in 2012 for high residential electricity costs with an average price of 17.91 cents/kWh as compared to the national average of 11.52 cents/kWh. However, 159 rural villages or 85% of Alaska's communities surpass 1st ranked Hawaii's $37.05 cents/kWh, highlighting the wide disparity of rates across the state.[7]

Figure 1 illustrates the types of stakeholders and infrastructure that participate in and support the REGRP. The applicants in the REGRP, as well as AEA staff, are the two stakeholder groups with the most experience at all levels of the program, but clearly with very different and important perspectives on its internal processes.

[5] REGRP results presented by AEA at the Business of Clean Energy in Alaska Conference, April 2012.
[6] Energy Information Administration, State Energy Data System (SEDS) Database
[7] 2010 Alaska Power Statistics Tables

Figure 1.1 Alaska Renewable Energy Stakeholders and Program Infrastructure



As illustrated, the REGRP depends on a broad foundation of human resources and industries to identify candidate projects and the potential funding sources. Funding sources include the grants offered by AEA through the REGRP as well as other sources of public and private capital.

RE Fund applications are generated by utilities, community, tribal and government organizations, and from independent power producers or developers working with communities. The REGRP differs from many other renewable energy incentive programs in that it does not directly support or receive applications for individual customer-sited projects.

Report Objectives

The objective of this report is to document the outcomes of the REGRP in terms of quantifiable as well as qualitative metrics. These include energy production, project benefits and costs (including offset fuel use), environmental impacts, operations and maintenance issues and costs, job impacts, performance issues and other more difficult to measure impacts such as increased awareness of and education about renewable energy, and ancillary economic benefits to communities.

As a compliment to the REGRP Process Evaluations completed in March, 2012, the Impact Evaluation is intended to be useful in helping program managers, planners, and policy makers assess how well the program is functioning, and how effective and efficient it is in meeting its stated objectives.

In general, process and impact evaluations help to foster and support a culture of ongoing program improvement. As programs and initiatives mature and market conditions shift there are always lessons that can be learned from measuring the program's success and applying these insights to future program planning.

Study Schedule and Team

AEA retained the Vermont Energy Investment Corporation (VEIC) in late 2011 to conduct an independent program review for the REGRP with assistance from the Alaska Center for Energy and Power (ACEP). This work is divided into a process evaluation, and an impact evaluation. The process evaluation was started in mid-December of 2011 and was presented to AEA on March 23rd, 2012. The impact evaluation of the program was started in March 2012, with a presentation of preliminary results to the Renewable Energy Advisory Committee (REFAC) in June, and delivery of this report in August.

VEIC has a staff of 200 energy efficiency, conservation, demand response, smart grid, and renewable energy professionals, and operates on an annual budget of approximately $60 million. VEIC maintains an active Consulting Division staffed by 25 program design, planning, review, analysis, and implementation experts. Our Consulting Division serves a wide variety of public and private sector clients in 35 states, 6 Canadian provinces, and 5 European and Asian countries. Over the last 20 years, VEIC has been hired to design programs from the ground up, to critique existing programs, and to recommend improvements to literally hundreds of electric and gas efficiency programs. VEIC staff have developed and critiqued regulatory filings, and filed and defended expert witness testimony in more than 10 states on behalf of consumer advocates, regulators, utilities, and environmental groups.

VEIC also has extensive direct experience with the implementation of efficiency and renewable energy programs - through our successful operation of Efficiency Vermont (the first statewide energy efficiency utility in the nation operated by VEIC by since 2000), and through the more recently launched Efficiency Smart Power Plant portfolio of programs (on behalf AMP-Ohio and a collaboration of more than 40 of their member municipal utilities), and as the implementation contractor for the Washington, D.C. Sustainable Energy Utility (DCSEU).

VEIC has worked with regulators and utilities on renewable energy programs to define eligibility requirements, solicitation mechanics, standard contract terms and conditions, and project evaluation criteria. VEIC has written and reviewed grid supply competitive solicitations and evaluated responses using detailed and quantitative scoring criteria. We have recommended procurement design and implementation changes, in response to changing regulatory and market conditions, and are considered to be among the most experienced nationally in Renewable Energy Credit and Solar Renewable Energy Credit (SREC) market design. Currently, VEIC implements renewable energy programs in New Jersey, Vermont, and the District of Columbia.

The Alaska Center for Energy and Power (ACEP) is an applied energy research program at the University of Alaska Fairbanks, located within the Institute of Northern Engineering and the College of Engineering and Mines. ACEP was formed in January, 2008 with the goal of meeting state and local needs for applied energy research by working toward developing, refining, demonstrating, and ultimately helping commercialize marketable technologies. ACEP has developed key partnerships with over 75 private companies, utilities, and native organizations throughout Alaska, as well as national laboratories and research centers world-wide. In addition, ACEP leverages resources from throughout the University of Alaska system through its model of building integrated, interdisciplinary teams to meet the research needs of our clients. ACEP currently manages over $15M in competitive research grants and contracts and has 20 active research projects.

VEIC and ACEP Team Roles

The Impact Evaluation was led by VEIC with significant technical, stakeholder outreach and advisory support from ACEP.

The VEIC team, led by David Hill and Chris Badger, was responsible for the overall direction, management and final results of the Process and Impact Evaluations. Leslie Badger contributed to the impact evaluation cost effectiveness analysis.

The ACEP team, led by Gwen Holdmann and Julie Estey, provided the necessary context for understanding the breadth of the Alaska renewable energy industry and have contributed significant portions to the Market Development section of the impact evaluation. The ACEP team was complemented by Dennis Witmer, who was responsible for managing and reviewing the REGRP data and conducting analysis for impact evaluation.

Organization of the Report

This report is organized into seven sections, including this Introduction. In the next section, we describe our methodology. This includes both the development of a structured set of evaluation criteria and results-oriented questions used to guide our analysis, an analytical framework for processing program data, and input from AEA program managers and industry stakeholders involved in the REGRP.

The third section, titled the 'Program Participation and Demographics', reviews the success of the program in supporting a broad spectrum of renewable energy resources and applicants, as well as meeting the stated priorities of the legislature in supporting projects on an equitable geographic basis and prioritizing projects in the communities experiencing the highest energy costs.

The fourth section, titled 'Benefit/Cost Analysis Results', evaluates quantitative performance of the REGRP as it relates to providing a net benefit to the state, as well as in its ability to leverage non-state (match) funding for renewable energy projects. Secondary benefits including PCE program impacts, jobs, and environmental benefits are also reviewed, with an emphasis on the performance of operational projects in 2011.

The fifth section, titled the 'Renewable Energy Resource Subsector Analysis', will review individual renewable resources in the state and identify lessons learned from projects included in the 2011 construction portfolio. Documentation of both the actual performance and sector barriers can help identify areas for improvement for future projects, as well as guide focused improvements in both program and policy design.

The sixth section of this report includes a high level overview of the renewable energy market in the State of Alaska, documenting the progress and ongoing efforts to spur growth in the renewable energy sector. Although many of the market activities cannot be solely attributed to the REGRP, documentation of the program contributions and evolution of the market is key to mapping the progress of renewable energy in the state. Finally, section seven presents our conclusions.

2. Study Methodology

This impact evaluation is the second of two phases in the VEIC team's evaluation of the REGRP. Phase I consisted of the Process Evaluation, which was conducted during the first quarter of 2012. As directed by AEA, our team used the research and results from the Process Evaluation to inform and prioritize the tasks and approach for the Impact Evaluation, which is the subject of this report. For this reason, much of the background research and interviews conducted for the Process Evaluation were used to inform this report.

Our study methodology for both the Impact and Process portions of the evaluation has been designed to meet the twin objectives of conducting a rapid yet thorough assessment of the REGRP program.

The process evaluation included an extensive number of interviews, in person meetings, and on-line surveys with current and potential (future) program stakeholders. The impact evaluation has involved more analysis of program databases, and a limited number of telephone interviews and meetings with AEA program staff. Activities undertaken during the impact evaluation have included:

- Phone conferences with AEA to review process evaluation results and use these to refine and identify priority areas of inquiry for the impact evaluation;
- Review of program reports, databases, and analyses;
- In-person and telephone interviews with select AEA program managers and staff;
- A limited number of clarifying interviews with program participants and stakeholders.
- The development of a spreadsheet-based benefit cost analysis;
- Analysis of the impacts for both construction and operational projects within the REGRP portfolio using both projected and (for operational projects) available data on actual performance;
- Secondary research and interviews to provide information on renewable energy market development in Alaska and to place the REGRP in a broader context of statewide activity;
- Drafting and reviewing preliminary impact evaluation results with the Renewable Energy Advisory Committee; and
- Preparation of the written Impact Evaluation Report (this document).

The remainder of this section provides detail on critical elements of the impact study methodology.

Evaluation Priorities & Research Questions

When conducting any evaluation, it is critical to define both clear objectives as well as a defined set of related research questions. For each area of inquiry, the VEIC team worked with AEA staff to refine the impact evaluation priorities, the available data, the approach to answering key questions, and reviewing the analysis that has already been conducted. As a result of this process, the team identified the following key questions:

- What are the societal- and participant- perspective benefits and costs of the REGRP?
- Who has participated?
  - What has been the technology and geographic mix?
  - What has been the mix between funded projects in rural and urban communities?
  - To what degree have high cost of energy communities been served?
- What are the projected and actual energy savings, and how well have these matched? How much impact has any discrepancy had on overall program cost-effectiveness?
- How much total external (match) funding has the state's investment in the REGRP leveraged?
- What are the impacts of the REGRP on the Power Cost Equalization (PCE) program?
- What are the environmental and job related impacts of the REGRP?
- How many projects have moved successfully from assessment to construction (is a good pipeline being built?)
- Have there been resource assessment projects that have helped identify and avert the construction of non-cost effective projects?
- What are the lessons learned in each renewable resource category as they relate to the barriers and opportunities for project development – giving special attention the unique obstacles and market conditions faced in much of the state?

Using these questions as a guide, our team focused on review of datasets, existing analyses, select interviews, and the building of a benefit cost analysis spreadsheet with the goal of providing useful insights on program and project performance to date for both program managers as well as current and future participants.

Data Sets and Previous Analyses

Our team worked closely with AEA to identify existing data sets and prior analyses, including the important and valuable work that has been conducted by the Institute of Social and Economic Research (ISER) to support program data tracking, reporting and analysis. The databases and analyses we reviewed include the following. Unless otherwise noted, those appearing in bold represent the primary data sources for the benefit cost analyses presented in this report.

Resources:

- **2012 RE Fund Status Report & Appendix**
- ***Alaska Renewable Energy Fund Grant Program: How it Works and Lessons We've Learned***
- **2009 & 2011 Alaska Renewable Energy Atlas**
- **2010 Alaska Energy Pathway**

- AEA REGRP Database queries
- EIA Energy Data for Alaska

The REGRP encompasses a wide array of types of projects (upgrade, new, expansion, transmission) with multiple funding sources and applicant types. This diversity makes the consistency of the reporting on total project costs (feasibility, transmission, etc), savings and operational performance critical for the accuracy of reporting performance of the program. In this evaluation, efforts were made to balance the need for confirming the reported costs and savings against secondary sources, while managing the scope of the evaluation. Continued efforts on improving the tracking of costs and performance data will provide greater accuracy in reporting, as well as insights in to improving the cost-effectiveness of the projects and the program.

Interviews

Although analyzing objective performance metrics is an important aspect of conducting a comprehensive impact evaluation, engaging primary stakeholders, including program managers, project developers and other key parties, provides a better framework for understanding the REGRP and the broader context of renewable energy development in Alaska. For the REGRP impact evaluation, interviews were conducted with:

- Individual interviews with AEA Program Managers to review relevant project performance, solicit insights related to corresponding market challenges and opportunities, and to catalogue ongoing program efforts to improve the performance of existing and future projects within their respective technology areas.
- Additional interviews with other AEA staff centered on obtaining program documentation, including both data for REGRP applications through the first five rounds and cost and performance data for projects in AEA's construction portfolio outside the REGRP. Since the initiation of the Process and Impact evaluation, there have been continued efforts by AEA to enhance consistency of data management within and between programs, focused on more streamlined and compatible processes to enhance tracking at both the individual and overall program level. However, for the purpose of the analysis described in this report, we were limited to data pulled from a number of existing sources including the REGRP application database, the AEA/ISER RE Fund Performance Report, the 2012 RE Fund Status Report and individual program manager performance tracking.
- A smaller subset of industry stakeholders, including project developers. These supplementary interviews were pooled with the extensive stakeholder interviews conducted for the Process evaluation and described in that report.

In addition to direct interviews and conversations, significant indirect support was provided by the prior work completed by ISER on behalf of AEA. Key inputs for the evaluation of both the costs and benefits of individual projects were directly supported through their existing database, supplemented by additional industry research.

Benefit Cost Analyses

One of the fundamental concerns of policy makers, program administrators, and participants is whether the investment of state funds in the development of renewable energy through the REGRP is providing a net economic benefit. There are a variety of regulatory and economic tests and approaches to assessing the benefits and costs of renewable energy investments – and comparing these to alternative existing or conventional non-renewable supply options.

After review and discussion of various approaches with AEA, we concluded the ***Total Resource Cost (TRC)*** and ***Participant Cost Tests (PCT)*** were most appropriate in addressing the priority questions related to this impact study. The TRC test compares the societal level benefits and costs of the projects and helps to answer the question of whether the REGRP is making investments that serve the general best interests of the state's economy. The PCT results are helpful in illustrating how attractive participation in the program is for current and potential future applicants.

These tests provide good insight to the fundamental questions of the nature (positive or negative) and magnitude of the economic benefits to the state and to program participants. The following table summarizes the elements included in each of these cost tests, followed by two illustrative examples.

Table 2.1 Summary of Costs an d Benefit Tests Applied to Impact Evaluation

	Total Resource Cost Test	Participant Cost Test	Notes:
Benefits:			
Electric Savings	✓	✓	Value of electric savings for remote communities based on the avoided local diesel fuel costs as estimated by ISER. For Railbelt communities the value of electric savings is based on avoided electric costs. Note for this analysis the PTC uses total offset local fuel costs – in many cases differ from local retail rates due to the Power Cost Equalization (PCE). See discussion of the PCE impacts in the Benefit/Cost Analysis results section for further details.
Diesel Fuel Savings	✓	✓	
Other Fuel Savings	✓	✓	Example: Anchorage landfill project benefits offset natural gas
Non-Energy Benefits	NA	NA	In this analysis non-energy benefits (such as improved community services, jobs or environmental impacts) are not included in the benefit cost ratios. We do estimate - and report separately from the benefit cost tests – the job, avoided carbon emission, and PCE program impacts of the REGRP.
Costs:			
Total Project Capital Costs	✓	-	Based on available program database information on project construction costs. In some cases these include pre-construction (e.g. feasibility or design costs) and in other cases only construction phase costs are captured.
REGRP Program Funds	-	✓	For participant test reduce local costs
Other Federal, State or Non-Local Funds	-	✓	Although federal tax credits, including both the Performance Tax Credit and the Investment Tax Credit are applicable in the participant test, they were not included in this analysis due to the absence of clear documentation at an individual project level.
Local Funds	-	✓	For the PCT, the total capital costs minus all other known sources is equal to local funds invested in the project.
REGRP Program Administration Costs	✓	-	Included in the portfolio level analysis for the TRC.
Operations and Maintenance	✓	✓	Includes gross operations and maintenance costs for RE systems – at this time does not capture off-set of O&M for alternative systems. O&M estimates also include increase in biomass fuel consumption.

The TRC and the PCT both estimate the discounted present value of the projects over their expected operating lifetimes.[8] This means that the anticipated stream of costs and benefits are discounted to present values to account for the time value of money – and also to permit for escalation of costs for offset fuels or for operations and maintenance costs. The TRC and PCT project level benefit cost ratios are calculated as follows.

$$\textbf{TRC Benefit/Cost Ratio} = \frac{\sum_0^{\text{project life}} \text{Present Value Annual Energy Savings}}{\text{Total Project Capital Costs} + \sum_0^{\text{project life}} \text{Present Value Annual Operations and Maintenance}}$$

[8] A discount rate of 3% is assumed for both the Total Resource Cost Test and the Participant Test.

The PCT is similar in structure, but as indicated above, costs are limited to the local portion of the project development costs – subtracting the REGRP and other non-local funds from the total project capital cost.

$$\textbf{PCT Benefit/Cost Ratio} = \frac{\sum_0^{\text{project life}} \text{Present Value Annual Energy Savings}}{\text{Local Project Capital Costs} + \sum_0^{\text{project life}} \text{Present Value Annual Operations and Maintenance}}$$

An example of the TRC and PCT project level benefit cost analysis is presented in the following text box.

Unalakleet Wind Farm Construction Project:

TRC Benefit/Cost Ratio $= \frac{\$7.8\ \textit{Million}\ (\textit{NPV Fuel and O\&M Savings})}{\$4.1\ \textit{Million}\ (\textit{NPV Total Project Installed Cost} + \$0.7\ \textit{Million}\ (\textit{NPV of O\&M})} = 1.64$

PCT Benefit/Cost Ratio $= \frac{\$7.8\ \textit{Million}\ (\textit{NPV Fuel and O\&M Savings})}{\$0.9\ \textit{Million}\ (\textit{NPV Local Share of Installed Cost} + \$0.7\ \textit{Million}\ (\textit{NPV of O\&M})} = 8.83$

Our impact evaluation includes a portfolio (as well as project) level analysis. The TRC test for the portfolio includes program administration costs for the REGRP. The included program administration costs represent all of the AEA's program administration costs for the REGRP, including projects that are in the feasibility or design stages as well as those receiving construction funding.

Although not included in this impact evaluation, the levelized cost of energy is another metric that we recommend AEA begin to track and report, in addition to maintaining information on the benefit/cost ratios that we have included in this analysis.

The levelized cost is based upon the initial capital costs, operating costs, and the total expected output of a system over its lifetime. In its simplest form:

$$\textbf{Levelized Cost of Energy} = \frac{\sum_0^{\text{project life}} \text{Present Value of Capital and Operating Costs}}{\sum_0^{\text{project life}} \text{Present Value Annual Energy Savings}}$$

The levelized cost of energy is most commonly presented in $/kWh or $/gallon of avoided fuel, and for this reason it can easily and directly be compared to the cost of existing or projected alternatives. In many instances, this simple comparison of the cost of renewable energy to alternative provides an easily understood metric for judging project cost effectiveness.

The drawback is that, in contrast the to the TRC and PCT tests that we have applied, the levelized cost of energy does not capture the relative scale of benefits and costs associated with each project, and therefore is less helpful in assessing the total net economic impacts.

Federal incentives for renewable energy projects were not included in the cost benefit analysis due to the lack of visibility in the reporting documentation from individual projects. Although federal grants and incentives are treated as a transfer payment and not included in the TRC, they can be applied in the Participant Test in reducing the effective cost of the project. As few of the projects are for private utilities or independent power producers, who have an effective tax basis, the impact on the overall results of the REGRP are limited. However, federal incentives for applicants paying federal taxes (e.g. independent power producers and private utilities) can be a significant factor in increasing cost-effectiveness of associated projects. Two incentives are currently applicable to qualifying REGRP projects:

- The federal renewable electricity production tax credit (PTC) is a per-kilowatt-hour tax credit for electricity generated by qualified energy resources, including wind, biomass and geothermal (¢2.2/kWh) and landfill gas, municipal solid waste, hydro, hydrokinetic, tidal, wave and ocean thermal energy (¢1.1/kWh).

  Renewable energy projects under construction prior to December 31, 2011 and qualifying for the PTC, could opt to receive a federal business investment tax credit or grant in lieu of the tax credit for 30% of the total installed cost of the system.[9] The expiration of the PTC for wind already appears to have had a chilling effect on the market in the United States resulting in approximately 50% reduction in the expected annual increase in installed wind capacity between 2009 and 2010.[10] Industry advocacy groups like the American Wind Energy Association (AWEA) indicate that creating long-term stability for project developers is critical for sustainable growth of the renewable industry.

- Solar electric (PV) and solar thermal qualify for the federal business investment tax credit (ITC) of 30% of the total installed cost of the system until December 31, 2016. Similar to the PTC, solar energy projects that were under construction prior to December 31, 2011 and qualified for the ITC, could opt to receive a federal grant in lieu of the tax credit.

An additional metric used in this analysis to track REGRP project performance is their system *Capacity Factor* (CF). The net capacity factor of a project is the ratio of the actual output of a power plant over a period of time and its potential output if it had operated at full nameplate capacity during that same time period. Although not tracked uniformly across programs, capacity factor can be an effective measurement of an individual project's success in meeting its predicted performance, as well as provide a universal metric for comparing multiple projects of different scale both within an individual renewable sector, and across sectors.

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[9] Database of State Incentives for Renewables and Efficiency (DSIRE), *Renewable Electricity Production Tax Credit (PTC)*, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US13F&re=1&ee=1
[10] American Wind Energy Association (AWEA), *Production Tax Credit*, April, 2011.

3. Program Participation and Demographics

Summary

The Alaska Renewable Energy Grant Recommendation Program (REGRP) was established in 2008 to support the development of renewable energy projects and to reduce the impact of the high cost of energy for rural communities. In this section we will review the diversity of the 558 REGRP applications evaluated by AEA during the five rounds, as well as the 208 renewable energy projects that received funding appropriations of $177 million through the first four rounds. These projects have impacted 77 unique Alaskan communities, and helped develop renewable energy resources across the state with $135 million in state funding granted under the REGRP and other state funding.

Table 3.1 REGRP Participation and Funding by Round

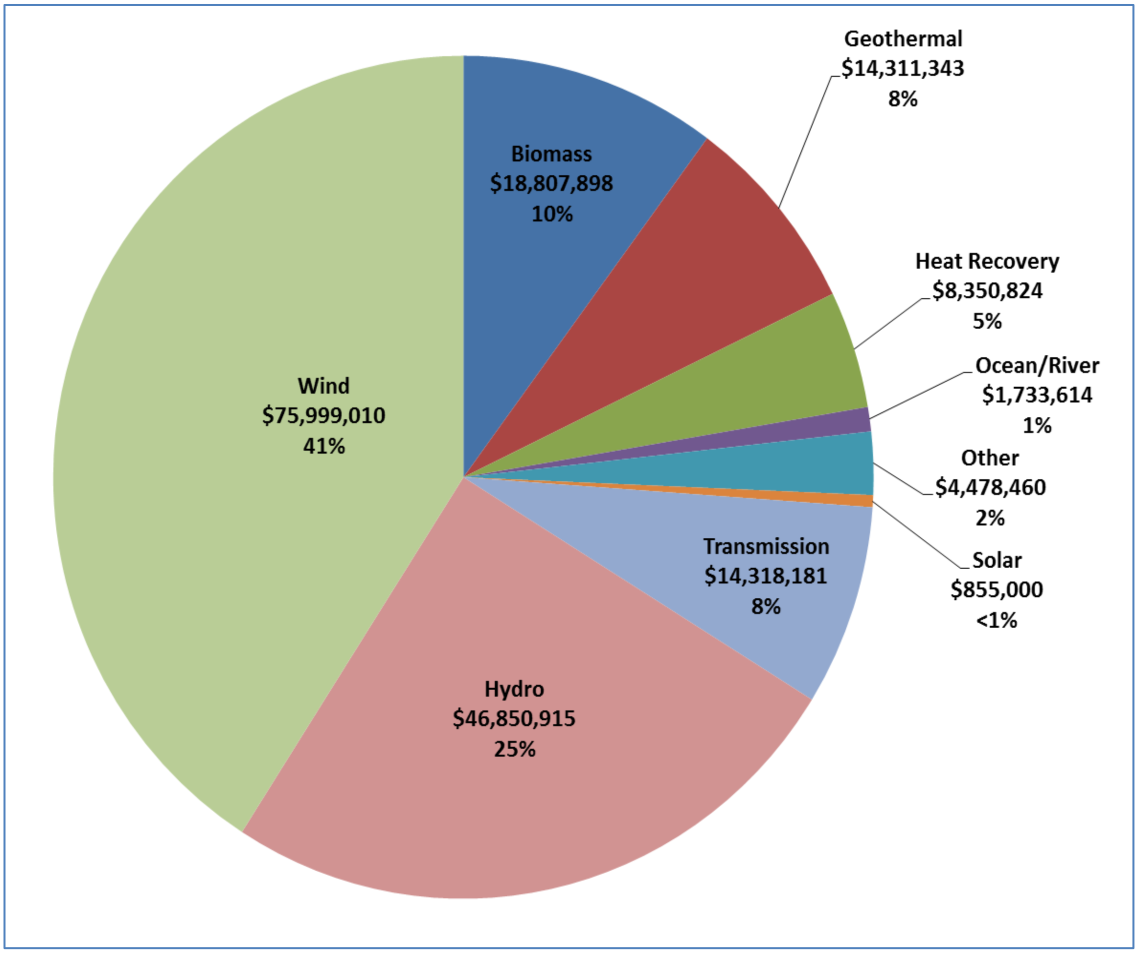
Round	I - IV	V	Total
Applications Received	461	97	558
Projects Funded	208	19	227
Grants in Place	180	5	185
Grants Completed	38	0	38
Grants Cancelled	14	0	14
Amount Requested ($M)	$1,094	$133	$1,227
AEA Recommended ($M)	$239	$43	$282
Appropriated ($M)	$177	$26	$202
Cash Disbursed ($M)	$100	$8	$108

As part of the analysis we will:

- Review performance of the REGRP in meeting its primary goals of supporting high cost of energy communities and achieving an equitable distribution of funds across the state.
- Assess the funding success of applicants, tracking awards by type of applicants, statewide regions, and type of resource.
- Analyze and discuss the different stages of renewable energy project development.

Although all of the primary renewable energy resources were represented in the application pool during the 5 rounds of funding, approximately 80% were for hydro, wind and biomass (Figure 33.1).

Figure 3.1 Appropriated Funds by Resource (Rounds I-IV)



Applicants requested over $1.2 billion in funding support through the REGRP, ranging from the largest individual request of $79 million in Round 1 of the REGRP[11], to the smallest request of $15,000.This wide disparity in project funding level and corresponding scope also highlights the capacity of larger, better capitalized applicants to obtain alternative funding sources for projects despite the funding limitations set for individual projects. [12]

Supporting High Cost of Energy Communities and Projects in Alaska

During the first four rounds of the REGRP, a wide mix of renewable energy projects ranging in both resource type and stage of development (feasibility, design and

[11] The largest request was for GVEA's Eva Creek wind farm, which ultimately received $2 million in Round 1 and capitalized the balance through financing.

[12] Construction projects on the Railbelt, Juneau, Sitka, Ketchikan, Wrangell, and Petersburg electrical grids are limited to $4 million in grant funding and other areas of the state to $8 million.

construction) have been supported across the state. The heavy concentrations of wind in the west and southwest, hydro in the south and southeast, and biomass in the interior tend to reflect the availability of the renewable resource available in defined regions of the state.

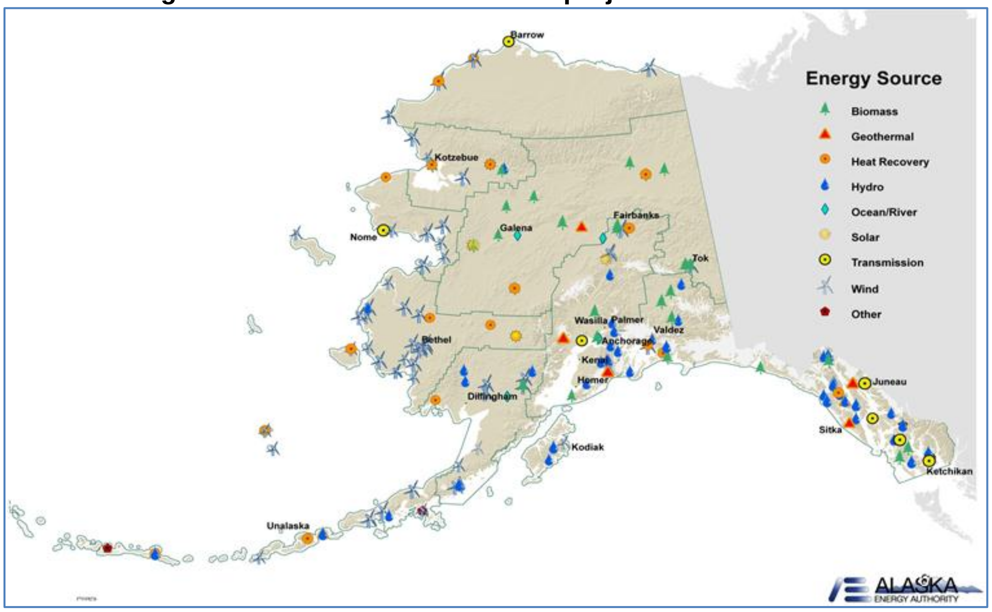


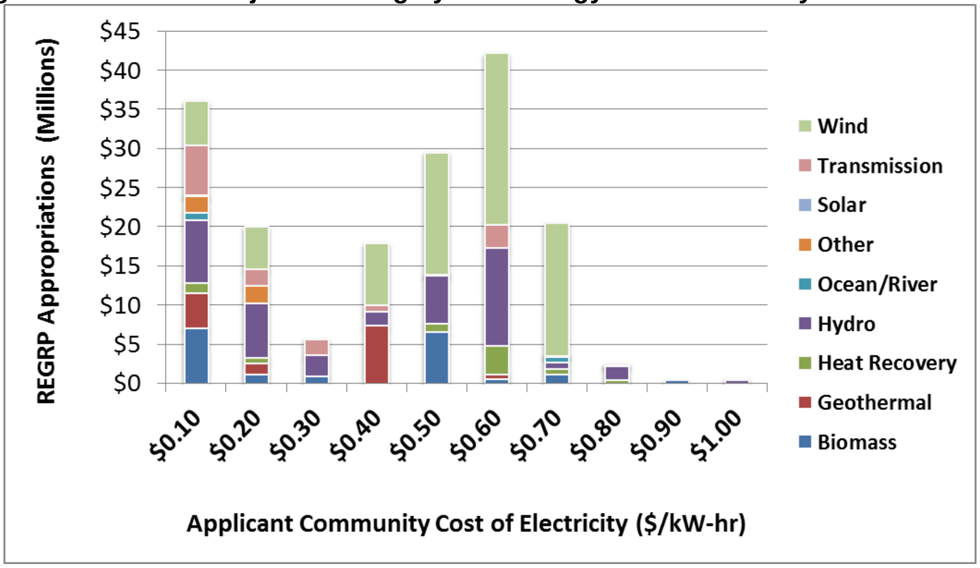
Figure 3.2 Distribution of REGRP projects across Alaska

The REGRP's rule of thumb of obligating 20% of available funding to support the reconnaissance, feasibility and design of renewable energy projects has complemented a broader effort by AEA, the Denali Commission, the University of Alaska and other organizations to map the state's options for meeting the goal of generating 50% of its electric power from renewable resources by 2025. Individual feasibility studies – notably AEA's MET tower loan program for wind, as well as broader renewable resource analyses completed for the AEA Alaska Energy Pathway report have contributed to the opportunities for individual communities to identify and invest in the development of local renewable energy resources to reduce dependence on more expensive, non-renewable sources of energy.

Approximately two thirds of projects appropriated funding in the first four rounds of the REGRP were in communities with reported energy costs above $0.30 per kWh. The highest percentage of funding was for wind energy projects, with 85% of total REGRP appropriations for wind projects in the state invested in higher cost of energy communities. The investment in prior feasibility studies for wind applications, leading to "shovel ready" construction projects likely led to the strength of this sector in the early rounds of the REGRP.[13]

[13] Interviews with AVEC highlighted the immediate opportunity created for early wind projects with the establishment of the REGRP in 2008.

Figure 3.3 REGRP Project Funding by Technology and Community Cost of Energy

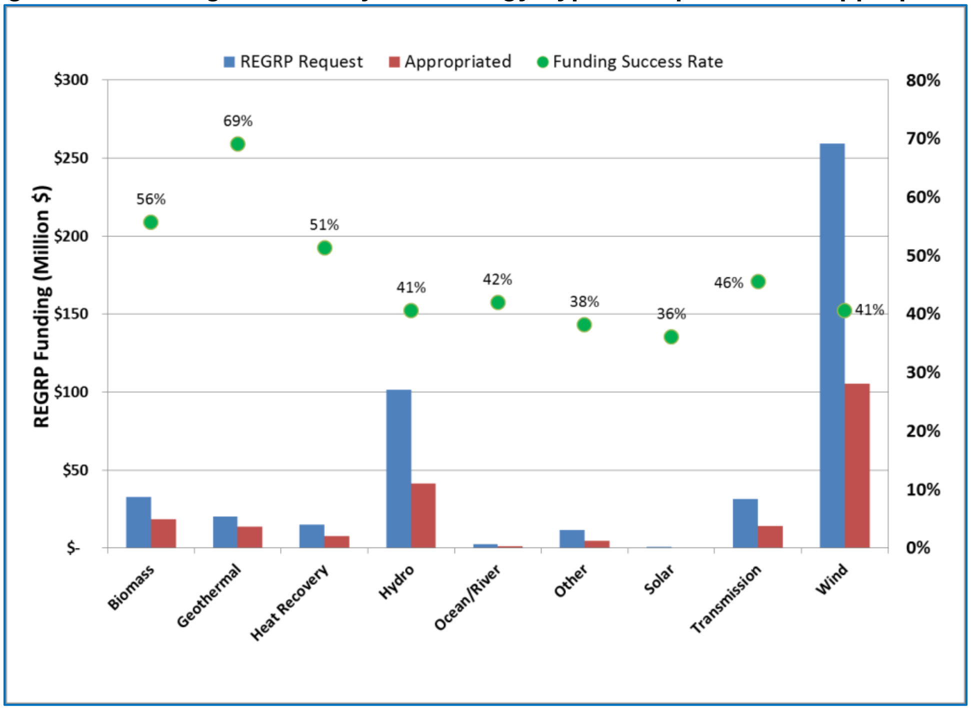


REGRP Support for a Broad Mix of Applicants and Renewable Resources

The funding of REGRP projects during the first four rounds generally reflects the maturity of renewable energy technology sectors coupled with the existing knowledge base for developing cost-effective projects in communities across the state with available renewable resources. More recently additional focus has been given to biomass, geothermal, heat recovery and emerging technologies, with a higher percentage of support for early development (through feasibility studies and design).

In the figures below, a comparison is made between the amount of funds requested versus the funds ultimately appropriated for the various renewable resources, as well as for applicant types. Based on these values, a funding success rate is the ratio between these two funding levels. Although there is a significant funding disparity between the various renewable resources, which generally reflects the percentage of projects types applying for construction funding, there is a relatively even distribution of funding success for individual applicants within the same group.

Figure 3.4 Funding Success by Technology Type – Requested vs. Appropriated



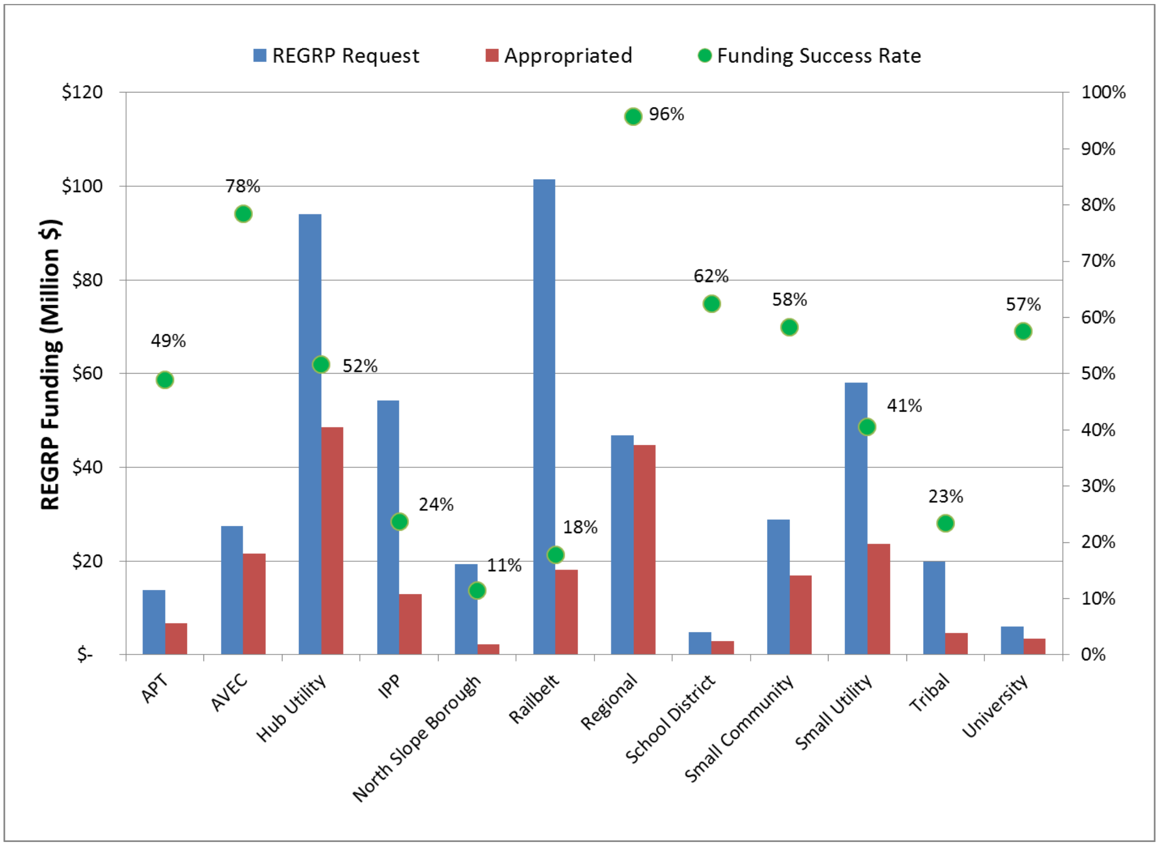
More notable is the success of different applicant types in moving from an application to the REGRP to an appropriation through the state legislature. The various stages of the REGRP process was discussed in greater detail in the Process Evaluation, but at the highest level reflects four general stages:

1. AEA evaluation and ranking
2. AEA & Renewable Energy Fund Advisory Committee recommendations to the state legislature
3. Appropriation by the legislature
4. Final budget approval by Governor

The ranking of projects by AEA generally reflects the final appropriations, but changes in budget, regional distribution of funding, and other factors has occasionally impacted the final prioritization of funding and awards by the legislature.

Some applicants have navigated this process better than others, based primarily on experience of the applicant, as well as the cost-effectiveness of the proposed project. Below are the results of a comparison of the total amount of REGRP funding received by applicant types against the funding requested in its original applications. Although this review of applicant success is not comprehensive, it highlights the wide disparity in funding success rates and the particular success of AVEC, as an individual applicant, in receiving REGRP support for 78% of its funding requests.

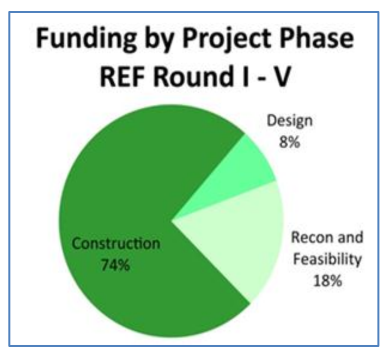
Figure 3.5 Funding Success by Applicant Type – Requested vs. Appropriated



Tracking Projects through Stages of Development

Guidance established for the REGRP recommends that 20% of the funding be allocated to reconnaissance, feasibility and resource studies and 80% be awarded to final design, permitting and construction projects. This funding allocation is designed to support the early development of renewable energy projects across Alaska, creating a pipeline of projects for future construction. Although individual projects move from recommendations to final appropriations by the legislature and approval of the budget by the Governor, the REGRP has largely succeeded in balancing the mix of projects funded, with 18% for reconnaissance and feasibility, 8% for design and 74% for construction.[14]

Figure 3.6 Funding by Phase



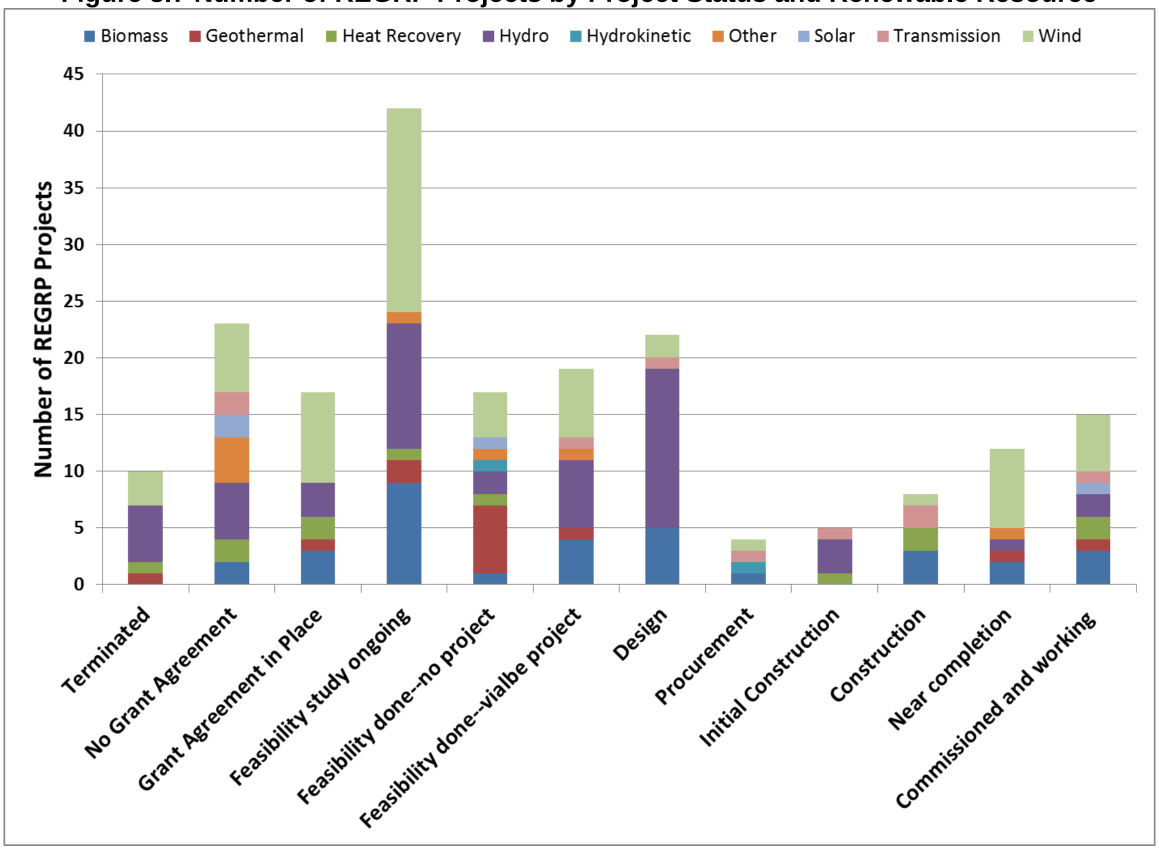
Projects typically proceed from the grant award process, through the feasibility phase, to design, procurement, construction, completion, and commissioning. However, as the

[14] REGRP results presented by AEA at the Business of Clean Energy in Alaska Conference, April 2012.

application process does not restrict funding for specific phases, the identification of the project phase and status is tracked by AEA through its grant administration process.

In an effort to characterize the performance of the funded projects by phase, each project was given a specific status value reflected in the figure below. Based on a review of the most recent reporting by AEA in the annual RE Fund status report[15] and AEA REGRP program documentation, wind projects represent the largest portion of projects completed or nearing completion, while hydro projects encompass the greatest share of projects in the design phase (due to the typical length of a hydropower project development cycle).

Figure 3.7 Number of REGRP Projects by Project Status and Renewable Resource



Although only 35% of REGRP projects are categorized within the design to construction phase, they represent nearly 60% of the total project funding appropriated during the first four rounds (82% of the first five rounds). This can be expected, as construction is almost always the most costly phase for an individual project.

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[15] Grant status for individual projects was last reported in the 2012 Alaska Renewable Energy Fund Status Report in January, 2012 and is the basis for this analysis. It should be noted that Figure 3.7 reflects the current status of projects and not the cumulative funding for specific project types noted in Figure 3.6.

Table 3.2 Multi-phase REGRP Projects

Biomass	4
Geothermal	2
Hydro	2
Transmission	1
Wind	6
Grand Total	**15**

Because some projects completed one or more phases of development outside of the REGRP process, it can be difficult to develop a comprehensive picture that includes all of the true project costs from resource evaluation through completion. In this case, the benefit to cost analysis as presented in the following section may be skewed, representing lower than actual total project costs.

A review of the 208 funded projects in the first four rounds found 15 individual projects moved from pre-construction phases to the construction phase. This total, representing approximately 8% of the REGRP projects, does not reflect non-REGRP support for project construction received through AEA, the Denali Commission or other external funding sources. Increasing the ability to track and report on projects across the various phases of project development should be a priority for future project and program tracking metrics.

A significant finding is that there are a total of 17 feasibility projects that resulted in a determination of no viable/cost-effective project. Nonetheless, the resultant insights from mapping renewable resources across the state while simultaneously avoiding more costly investment of investing construction funding in non-viable projects has been well balanced. The value of the information generated from the projects that did not progress to construction may be underestimated. These results are key to insuring that continued improvements to project designs or siting can be made, raising the cost-effectiveness of future proposals if lessons learned are applied prudently.

4. Benefit/Cost Analysis Results

Summary

Through the first four rounds of funding 62 projects have moved to the construction or operational phase. In this section we review the benefit cost analysis results for this cohort of projects. The analyses and results include the following:

- The benefit cost results for all 62 projects based upon the costs and projected energy savings contained in the program data base and project applications.

- The benefit cost results for 19 operational projects reflecting 2011 calendar year operational costs and savings. In many cases, the energy savings and operations during 2011 are less than projected and consequently the benefit cost ratios are reduced. Note also that the operational benefit cost results assume that the operational and energy savings achieved in 2011 will be maintained throughout the project lifetime. In many cases it is reasonable to expect that operations and energy savings will improve – coming closer to the projected energy savings – as operational and start up issues are resolved.

- The Benefit/Cost test results are presented for the Total Resource Cost (TRC) test and for the Participant Test (PCT). The TRC test compares the societal level benefits and costs of the projects and helps to answer the question of whether the REGRP is making investments that help to serve the general best interests of the state's economy. The Participant Test results are helpful to illustrate how attractive participation in the program is for current and potential future applicants. The technical details for each test are addressed more specifically in the methods section of this report.

- An analysis and discussion of the total investments leveraged by the State's investment of funds in the REGRP program.

- A discussion and analysis of the aggregate impact of the program on the power cost equalization (PCE) program.

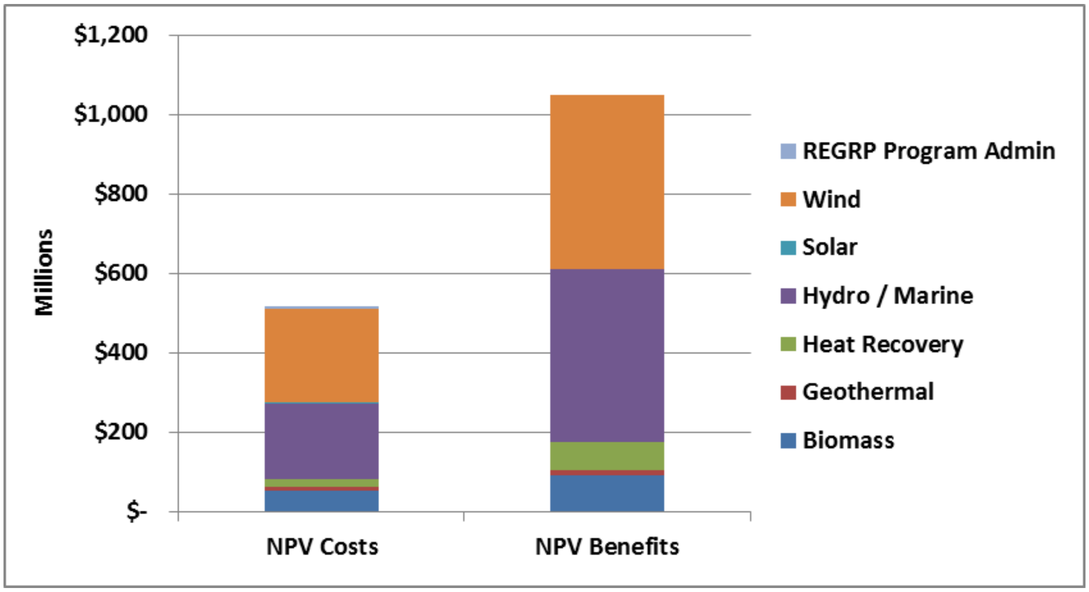
- Discussion of the aggregate portfolio level job and environmental impacts from the REGRP's construction and operational projects.

The REGRP encompasses a wide array of types of projects (upgrade, new, expansion, transmission) with multiple funding sources and applicant types. This diversity makes the consistency of the reporting on total project costs (feasibility, transmission, etc), savings and operational performance critical for the accuracy of reporting performance of the program. In this evaluation, efforts were made to balance the need for confirming the reported costs and savings against secondary sources, while managing the scope of the evaluation. Continued efforts on improving the tracking of costs and performance data will provide greater accuracy in reporting, as well as insights in to improving the cost-effectiveness of the projects and the program.

Construction Portfolio – Projected Benefit Cost Results

Based on the projected costs and benefits – the construction portfolio for the REGRP (which includes 19 projects that have been operational in 2011, and 43 that have received construction grants) – originally was expected to provide more than $531 million in present value net benefits for Alaskans over the life of the projects.

Figure 4.1 2011 Construction Portfolio Benefits and Costs for REGRP Projects



The projects are primarily rural based offsetting the extremely high cost of diesel generation and represent the broad spectrum of renewable energy resources in the state. The $7.4 million in REGRP administration costs are a small fraction, slightly over 1%, of the cumulative costs of the project installed and operation and maintenance costs.

Table 4.1 Benefits and Costs for the REGRP 2011 Construction Portfolio

RE Resource Sector	Total Project Cost	Annual Electricity	Annual Diesel Displaced	Annual Natural Gas	NPV Costs	NPV Benefits	Net Benefits	NPV Benefit to Cost Ratio
	($ Millions)	(MWh)	(gal x 1000)	(Mmbtu x 1000)	($ Millions)	($ Millions)	($ Millions)	
Biomass	**$27**	**27,282**	**718**	**319**	**$52**	**$92**	**$40**	**1.77**
Geothermal	**$2.4**		**164**		**$9.7**	**$12.5**	**$2.8**	**1.29**
Heat Recovery	**$15**	**4,352**	**681**		**$22**	**$71**	**$49**	**3.21**
Hydro / Hydrokinetic	**$131**	**35,093**	**2,618**	**24**	**$190**	**$435**	**$245**	**2.29**
Solar	**$0.3**	**42**	**4.8**		**$0.3**	**$0.3**	**($0.0)**	**0.99**
Wind	**$182**	**90,102**	**6,371**		**$236**	**$438**	**$202**	**1.85**
REGRP Program Admin					**$7.4**			
REGRP Construction Portfolio (Est)	**$357**	**156,870**	**10,556**	**343**	**$518**	**$1,049**	**$531**	**2.03**

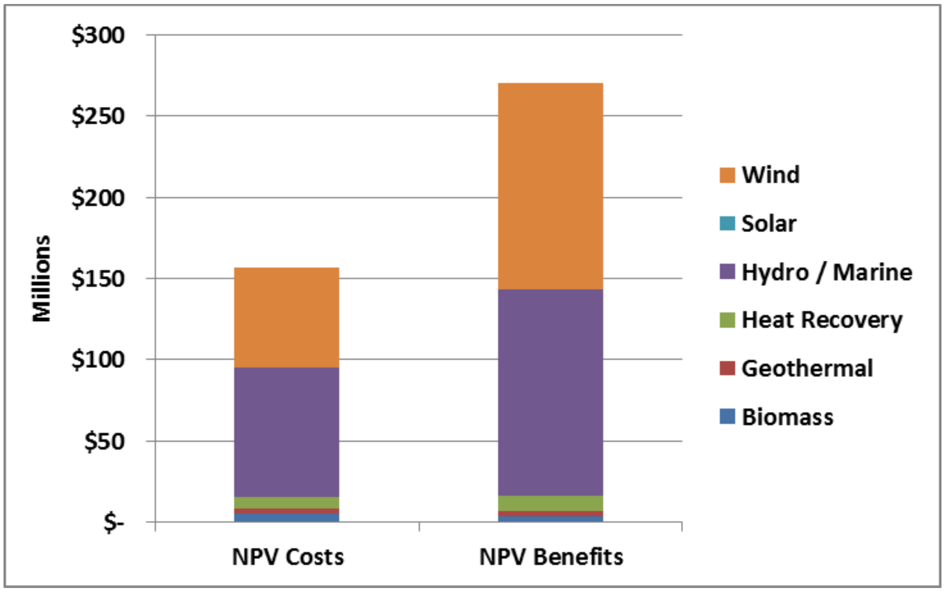
Operating Portfolio – Benefit Cost Results Reflecting Early Operational Data

Of the construction portfolio, 19 projects now have early operational experience and data. Therefore, we also conducted a benefit cost analysis for this sub-set of operational projects including available reported data on energy savings and costs.

The benefit cost results based on the early experience of the operating projects is less favorable than the construction portfolio results based on projected costs and savings. This clearly indicates, that at least in the early phases of project operations and startup – the projects have “under-performed” compared to the expectations in the project application and in the program database.

When the actual savings and costs for operational projects are analyzed the total present value benefits are greater than the total present value costs by a factor of 1.7 – with the portfolio expected to provide more than $114 million in present value net benefits for Alaskans over the life of the projects.

Figure 4.2 Benefits and Costs of the 2011 Operating Portfolio of REGRP Projects



It should be noted that performance for many projects can be expected to improve after the initial commissioning, as the projects develop more operational experience, reduce downtime and in some cases fully bring an individual system up to operational capacity. During interviews and in reviewing RE industry presentations and evaluations, it was apparent that AEA Program Managers and project operators were aware of specific cases of underperformance and working to address many of the issues that have led to lower than expected performance numbers. Ongoing tracking of project performance, ideally even beyond the stipulated requirement of up to 5 years after commissioning, will provide insights for continued improvements on renewable energy project design, development and deployment.

Below is an example of a REGRP wind project that has underperformed in electricity generation, but also installed under budget. The significant value placed on the benefits of offsetting diesel generation outweighs the project savings associated with a lower installed cost, affecting both economic impacts to both the program as well as to the community.

Table 4.2 As Built Versus Projected Costs and Operating Project Performance

Quinhagak Wind Farm Construction		
	Total Project Cost	Annual Electricity
	($ Millions)	(MWh)
Estimated	$4.8	649
Actual	$3.8	409
Difference	-22%	-37%

Table 4.3 Total Resource Cost Versus Participant Cost Test

Quinhagak Wind Farm Construction	Total Resource Cost Test			Participant Cost Test		
	NPV Costs $ Millions	NPV Benefits $ Millions	TRC Benefit to Cost Ratio	NPV Costs $ Millions	NPV Benefits $ Millions	TRC Benefit to Cost Ratio
Estimated	($5.2)	$5.1	0.98	($0.5)	$5.1	11.17
Actual	($3.9)	$3.2	0.81	($0.8)	$3.2	3.92
Difference	-24%	-37%	-18%	79%	-37%	-65%

Table 4.4 Benefits and Costs for the REGRP 2011 Operating Portfolio

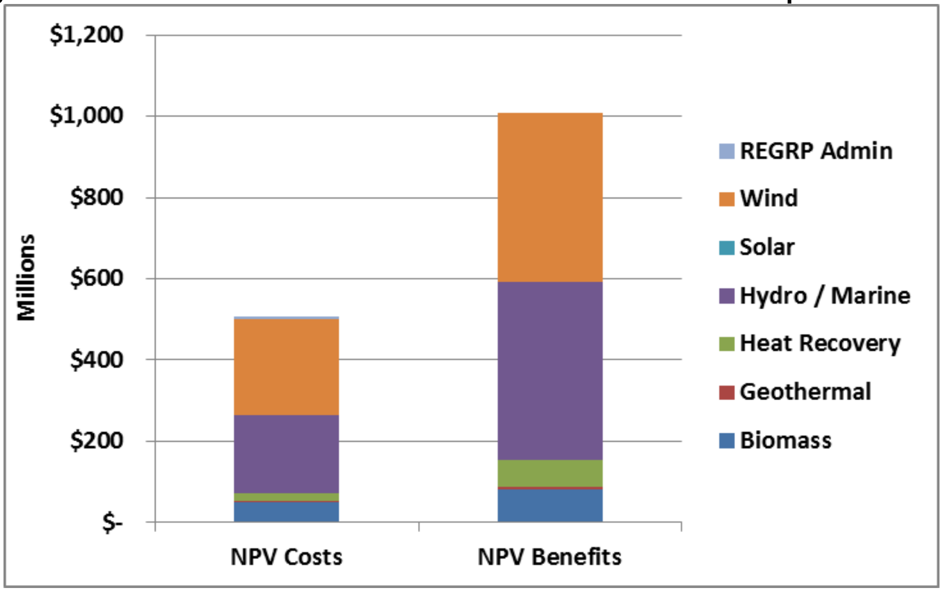
RE Resource Sector	Total Project Cost	Electricity Act/Proj%	Diesel Act/Proj%	Annual Electricity	Annual Diesel Displaced	Annual Natural Gas	NPV Costs	NPV Benefits	Net Benefits	NPV Benefit to Cost Ratio
	($ Millions)	%	%	(MWh)	(gal x 1000)	(Mmbtu x 1000)	($ Millions)	($ Millions)	($ Millions)	
Biomass	**$ 3,898,109**		**34%**		**42**		**$5.6**	**$3.9**	**$10**	**0.70**
Geothermal	**$ 1,026,000**		**34%**		**37**		**$3.1**	**$3.2**	**$6.4**	**1.03**
Heat Recovery	**$ 2,004,225**	**30%**	**54%**	**442**	**57**		**$7.1**	**$9.2**	**$16**	**1.31**
Hydro / Hydrokinetic	**$ 37,633,019**	**67%**	**78%**	**5,344**	**437**		**$79**	**$127**	**$206**	**1.61**
Solar	**$ 193,600**	**0%**	**38%**		**0.9**		**$0.2**	**$0.2**	**$0.4**	**1.14**
Wind	**$ 51,248,202**	**73%**	**60%**	**17,472**	**1,183**		**$62**	**$127**	**$188**	**2.06**
REGRP Operational Projects	**$ 96,003,155**	**68%**	**56%**	**23,089**	**1,756**		**$157**	**$270**	**$114**	**1.73**

Construction Portfolio – Including Operating Data

The first set of Construction Portfolio benefit cost results presented in this section were based on projected savings and costs. In this sub-section we investigate the impact on the portfolio's benefit cost results if the early results from operating projects are included, and assumed to be representative of the operations and savings over the life of this sub-set of projects.

As expected, the benefit cost results for the construction portfolio that reflects the early under-performance of operating projects is less favorable than the construction portfolio results based on projected costs and savings.

Figure 4.3 2011 Construction Portfolio Benefits and Costs with Operational Data



When the actual savings and costs for operational projects are included in the analysis the overall construction portfolio remains cost effective with total present value benefits of $1,009 million and total present value costs of $508 million. Understanding which project types and applications have the greatest potential risks of underperformance improves the program's ability to track specific areas of project development and operations, as well tailoring assistance to assure performance is met moving forward. These early efforts in evaluating program and sector level performance can help in avoiding more broad based underperformance of the construction and preconstruction projects.

Table 4.5 Benefits and Costs for the 2011 Construction Portfolio with Operating Data

RE Resource Sector	Total Project Cost	Electricity Act/Proj	Diesel Act/Proj	Annual Electricity	Annual Diesel Displaced	Annual Natural Gas	NPV Costs	NPV Benefits	Net Benefits	NPV Benefit to Cost Ratio
	($ Millions)	%	%	(MWh)	(gal x 1000)	(Mmbtu x 1000)	($ Millions)	($ Millions)	($ Millions)	
Biomass	$27		34%	27,282	606	319	$49	$82	$33	1.68
Geothermal	$1.5		34%		92		$4.6	$6.6	$2.1	1.46
Heat Recovery	$15	30%	54%	3,318	613		$20	$65	$45	3.23
Hydro / Hydrokinetic	$133	67%	78%	33,550	2,525	24	$192	$438	$246	2.28
Solar	$0.3	0%	38%	42	3.2		$0.3	$0.3	($0)	0.99
Wind	$182	73%	60%	87,556	5,999		$234	$417	$183	1.78
REGRP Admin							$7.4			
REGRP Construction Portfolio (Actual)	$358			151,747	9,838	343	$508	$1,009	$501	1.99

Operating Portfolio - Participant Test – Benefit Cost Results

The results presented above are based on the societal perspective and use the total resource cost test as described in the methods section of the report. This section reviews the participant test benefit costs results for the Operational Portfolio – accounting for both the initially projected savings and costs, and based on the early operational data.

It is important to consider the participant test results – since this provides insights into how attractive the program appears to current and potential applicants. It also provides an indicator of whether the program may have opportunities to support a greater number of projects by reducing the grant dollars given to individual applicants – while still maintaining very favorable participant perspective economics – and thereby allowing a greater number of grants in each funding cycle.

As REGRP projects often receive funding from multiple sources, including REGRP, federal, external organizations (e.g. native non-profits), consistency of reporting on total project costs is critical for the accuracy of reporting performance of the program. In this evaluation, efforts were made to balance the need for confirming the reported costs and savings against secondary sources, while managing the scope of the evaluation.

Figure 4.4 Participant Cost Test for 2011 Operating Portfolio

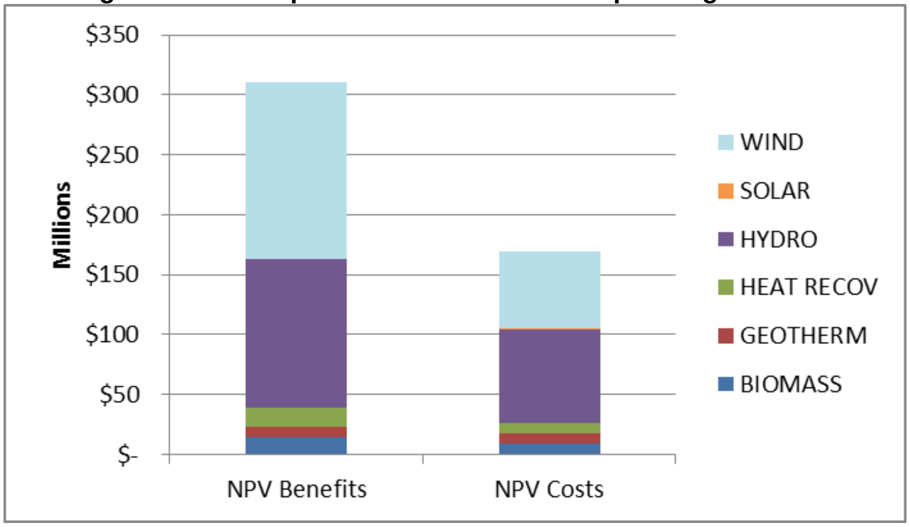


Table 4.6 Participant Cost Test Results for 2011 Operating Projects

RE Resource Sector	NPV Costs	NPV Benefits	Net Benefits	NPV Benefit to Cost Ratio
	($ Millions)	($ Millions)	($ Millions)	
Biomass	**$1.8**	**$3.9**	**$2.1**	**2.12**
Geothermal	**$2.6**	**$3.2**	**$0.6**	**1.22**
Heat Recovery	**$5.6**	**$9.2**	**$3.7**	**1.66**
Hydro / Hydrokinetic	**$64**	**$127**	**$63**	**1.98**
Solar	**$0.0**	**$0.2**	**$0.2**	
Wind	**$35**	**$127**	**$92**	**3.64**
REGRP Operational Projects	**$109**	**$270**	**$161**	**2.48**

Although the overall operational projects participant benefit to costs ratio is 50% higher, this is dominated by the larger projects that have significantly more non-state funds invested versus the smaller, less capitalized rural projects. Individual project performance can range up to 8.83 in the case of the Unalakleet wind project, where the REGRP funding covered over 90% of the project cost.

Construction Portfolio – Leveraged Investment

Through five rounds the REGRP has recommended $282 million in funding, with $202 million appropriated. Of the projects in construction, the $112 million in REGRP appropriations and $23 million in other state funds has leveraged a further $223 million of investments.

The non-state investments encompass a wide variety of sources including federal grants – most notably through the Denali Commission, individual utility funded investments through debt and equity, and regional contributions through either community in-kind funding matches, as well as grants from regional tribal organizations.

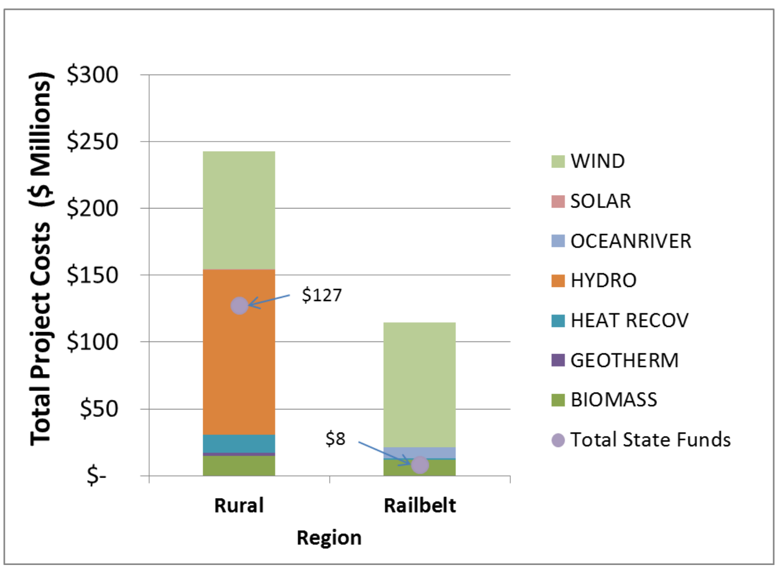
Investments in these renewable energy projects reflect deliberate efforts by organizations and communities to spur project development with goals of reducing the high cost of energy for communities, creating jobs and reducing the flow of money out of communities and the state from non-renewable energy sources.

Table 4.7 REGRP Funding Sources – State and Leveraged Funds

RE Resource Sector	REGRP Funding	Other State Funding	Non-State Funds	Ratio of Non-State to State Funds	State Funding to Total Project Cost (Rural)
	($ Millions)	($ Millions)	($ Millions)		%
Biomass	$16	$0.9	$10	0.60	87%
Geothermal	$0.9		$0.6	0.60	63%
Heat Recovery	$7.0		$7.8	1.12	45%
Hydro / Hydrokinetic	$31.2	$17	$85	1.75	37%
Solar	$0.3		$0.01	0.04	97%
Wind	$56	$4.8	$121	1.97	67%
REGRP Construction Portfolio	$112	$23	$223	1.66	52%

State investment, including both REGRP appropriations and other state funding, represented nearly 52% of the total project costs in rural areas during Rounds 1-4, whereas only 7% of project costs in Railbelt projects were supported through state funding.[16]

Figure 4.5 Rural and Railbelt REGRP Appropriations



[16] GVEA's Eva Creek $93M Wind Project represents a major portion of the Railbelt total project costs, but received only $3.4M in two rounds (1 & 4) of REGRP funding.

There are a number of factors affecting the ability of individual regions of Alaska to develop successful, cost-effective projects. Although a suitable renewable resource is a critical element, access to project funding is also vitally important. The figures below highlight the wide disparity of individual regions in providing non-state “match funding”, though this funding may be from a variety of sources, including in-kind, federal grants, local or utility debt and equity financing and other organizational grants. Identifying sources for non-state leveraged funds is a key area of support, that AEA and other organizations have and continue to provide.

In the figure the total state funds invested in the REGRP projects in regions across the state is represented by the dot, while the stacked bar chart is the cumulative project costs. The higher the dot is on the stacked bars, the greater the share of the state’s investment in the RE projects in the region.

Figure 4.6 Breakdown of State and Leveraged Funds for the 2011 Construction Portfolio

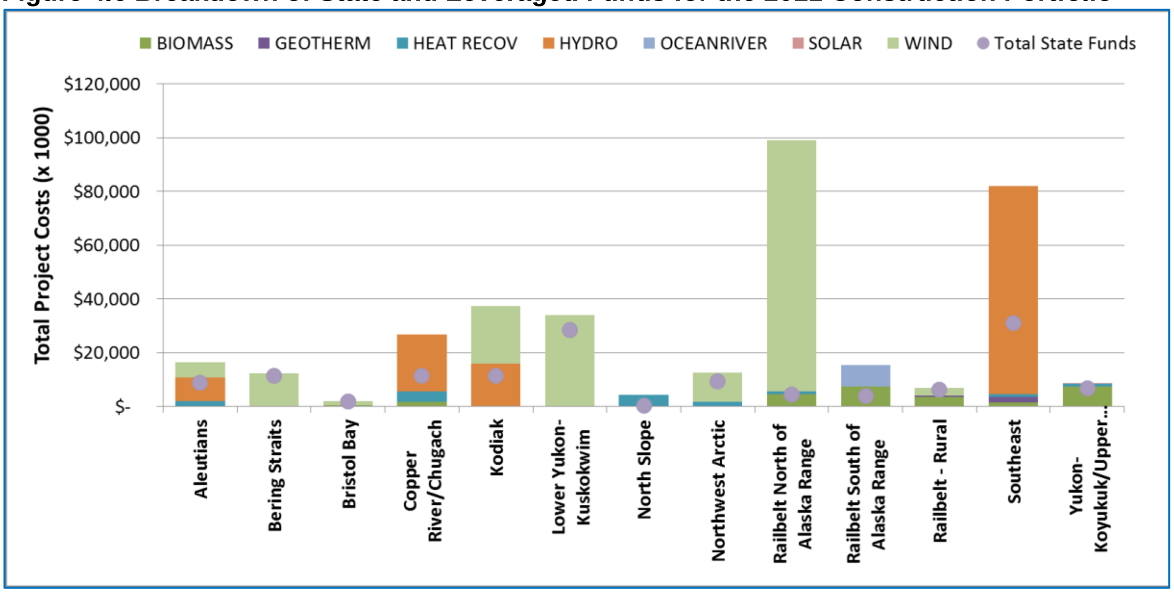
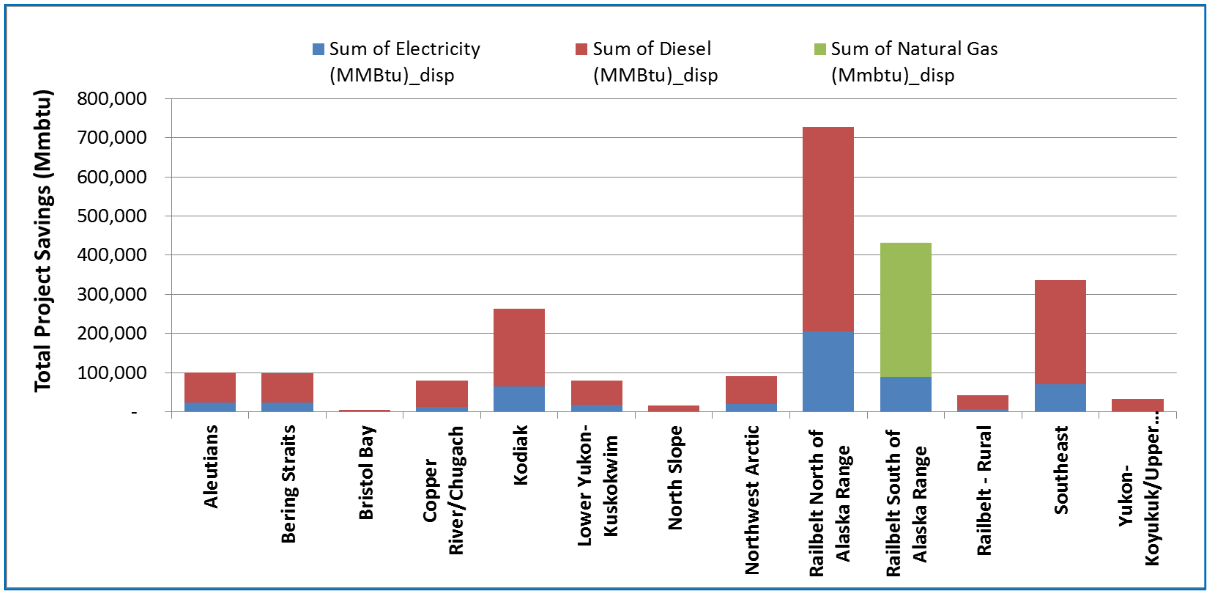


Figure 4.7 Breakdown of Energy Savings for the 2011 Construction Portfolio



Power Cost Equalization Impacts

The Power Cost Equalization (PCE) program, originally established in 1984 to address significant increases in the cost of electric rates in rural Alaska, aims to normalize the high costs of electricity in rural communities with the lower costs in more urban areas through direct-rate reductions. The PCE program provides important support to communities and households that struggle with meeting the challenge of high energy costs in most of Alaska's remote communities.

Currently, the PCE program allows eligible utilities to provide a monthly PCE credit to residential customers up to the first 500 kWhs and to community facilities up to a maximum of 70 kWh per month per community member. Businesses, schools and state and federal customers are not eligible for the program.

The Regulatory Commission of Alaska determines the PCE level for each utility based on the fuel and applicable non-fuel costs of generating electricity in an individual community. The specific PCE rate for a community is computed on a kWh basis and reflects:

- 95% of a utility's costs between 14.12¢/kWh and $1.00/kWh
- Maximum PCE level is 81.59¢/kWh

In 2011 the PCE program reported supporting 183 Alaskan communities with over 434 GWh of total kWh sold, including 93 GWh of eligible residential electricity and 33 GWh of eligible community electricity or approximately 29% of total electricity sold in these communities is eligible for a PCE credit. Legislative funds appropriated for the PCE program in 2011 were $36 million.

Impacts of the REGRP

The renewable energy projects supported by the REGRP can have several types of impacts on the PCE program and PCE participants. For example:

- An REGRP project developed and owned by a community utility may directly off-set the fossil fuel costs borne by that utility. Increased operations and maintenance costs will off-set some of the avoided fossil fuel costs – but usually the net result will be to lower the utility's costs. These lower overall costs will provide some direct benefits to the utilities' customers, and will also provide benefits to the state – by lowering the PCE payments to the community.

- An REGRP project developed and owned by an independent power producer – could provide a local utility with a lower power purchase cost than existing fossil fuel options (that are provided by the community or by an IPP). Presumably, the renewable power purchase agreement will lower the utilities total costs (in comparison to an existing or new fossil alternative) – and therefore will again result in a decrease to utilities total costs. As in the previous case, these lower costs will benefit local ratepayers, and also provide benefits to the state – by lowering PCE payments.

- In both cases, the greatest share of the PCE related benefits will go to local ratepayers who are not eligible for the PCE program – and therefore are directly off-setting their current non-PCE supported electric rates.

Our approach to estimate the PCE impacts of the REGRP is to allocate the benefits associated with the total projected (or actual for operating) MWh production to:

1. The PCE Program (Reduced State PCE payments)
2. PCE in-eligible local ratepayers (Reduction in the non-PCE supported rate for electricity they must pay), and
3. PCE eligible local ratepayers (May see relatively small change to their PCE supported rate – and therefore a smaller share of the PCE impact benefit than the other two groups).

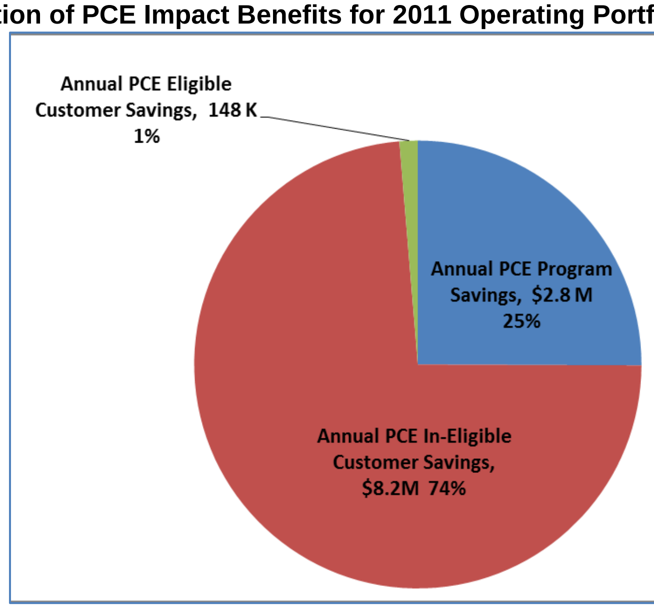
Estimated PCE impacts are presented in Table 6.6 and the following figures. The first row in table 6.6 contains the estimated impacts for 10 communities with operation REGRP projects in 2011. The second row represents projected impacts for 26 communities that have projects that are operational or that have received REGRP construction grants.

Table 4.8 PCE Impacts

	Total Annual Project Savings	Total Annual Project Savings	Annual PCE Eligible	Annual PCE Program Savings	Annual PCE In-Eligible	Annual PCE In-Eligible Savings	Annual PCE Eligible Savings
	MWh(s)	$ Millions	MWh(s)	$ Millions	MWh(s)	$ Millions	$ Millions
2011 Operational REGRP Projects (Actual)	22,647	$11.2	6,233	$2.8	15,993	$8.2	$0.1
2011 Operational and Projects in Construction (Projected)	52,905	$18	16,812	$5.1	35,739	$12.6	$0.3

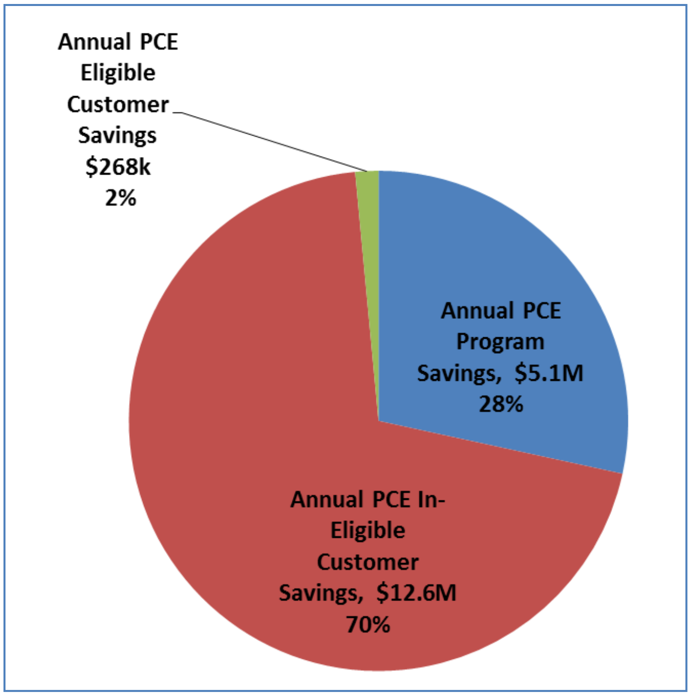
As illustrated in the Figure 6.8 pie chart, for the operational projects roughly one quarter - $2.8 million annually out of $11.2 million - of the estimated PCE benefits go the state as Program Savings, and three-quarters of the benefits (approximately $8.2 million annually) going to the non-PCE eligible ratepayers in the participating communities. Only 1% of the PCE benefit is realized by the PCE eligible ratepayers in these same communities.

Figure 4.8 Distribution of PCE Impact Benefits for 2011 Operating Portfolio



Similarly, Figure 6.9 illustrates the estimated distribution for PCE benefits for the Construction and Operational Portfolio. The largest share of the benefits are realized by the non-PCE eligible ratepayers (70%), followed by the State through lower PCE program payments (28%), and then by PCE eligible ratepayers (2%).

Figure 4.9 Distribution of PCE Impact Benefits for 2011 Operating and Construction Portfolio



Due to limitations on the available data our PCE impact analysis excluded 5 projects that were identified as operated by independent power producers (IPP) due to a lack of information on power purchase agreement terms. As noted above, a the cost of renewable electricity offered by the IPP to the local utility will likely be at lower rates than the diesel generated electricity, this should in effect also reduce the PCE program costs incurred for that community to a lesser degree.

Also note, that while renewable project operation and maintenance costs may be included in PCE cost calculations they are not included in this analysis due to inconsistency of reporting.

Job Impacts

In order to develop a high level assessment of job impacts for the 62 projects in the REGRP Construction Portfolio, industry averages for individual renewable energy resource sectors were applied against the 19 projects currently in operation and the 43 in the construction phase (post-grant).

The industry averages for job impacts were the result of a compilation by the University of California – Berkeley of existing studies on renewable energy projects.[17] The study

[17] Max Wei, Shana Patadia, Daniel Kammen, "Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US?", Energy Policy, November 14, 2009.

proposes a generation based (GWh) factor for each renewable energy sector including boththe shorter term employment in construction, installation and manufacturing (CIM) and the longer term employment in operation and maintenance (O&M). The resultant average allows for calculating both the total person-years of employment, as well as jobs if the result is divided by the operating life of the project.[18] (See Appendix A for additional background on the Univ. California – Berkley study)

The equations listed below were developed to equate an average employment per unit energy produced over a project's lifetime.

$$\textbf{Job Impacts}_{\textbf{Electric}} = Electric\ Savings * RE\ Resource\ Job\ Factor\ \left(in\ \frac{Person-years}{GWh}\right) * Project\ Life$$

$$\textbf{Job Impacts}_{\textbf{Heating}} = Heat\ Savings * RE\ Resource\ Job\ \ Factor\ \left(in\ \frac{Person-years}{GWh}\right) * Project\ Life$$

Employing this model for the RE Fund program suggested a creation of 37 jobs based on the amount of energy being displaced (or projected displacement) by the projects. During the early stages of renewable development in the state, skilled labor was often needed from outside the state to assist in the feasibility, design, construction and maintenance of the renewable energy projects. For this reason, it should be noted that not all of these jobs should be equated with Alaska employment, but that with continued growth in the Alaska renewable industry, this balance will continue to shift.

Table 4.9 Job and Environmental Benefits of REGRP 2011 Construction Portfolio

RE Resource Sector	Sector Job Impact Factor	Jobs	
	Person-years per GWh [19]	Person-Years	# of Jobs
Biomass	0.21	180	9
Geothermal	0.25	18	0.9
Heat Recovery	0.25	71	3.6
Hydro / Hydrokinetic	0.27	445	9
Solar	0.23	0.3	0.0
Wind	0.17	294	15
REGRP in Construction Portfolio		1009	37

[18] Most renewable sectors have a 20 year project life, but hydro has a longer 50 year life.
[19] Due to a significantly higher estimate for landfill gas projects, the lower estimate of 0.32 referenced from the EPRI 2001 evaluation was utilized. As heat recovery was not included in the study, the job impact factor for geothermal was assumed due to the lower O&M.

Due to the unique challenges of installing renewables in Alaska and associated costs, it is very likely that these employment factors from other areas of the United States underestimate the benefits to the state.

Environmental Impacts

Although not included in either the TRC or PCT, reducing diesel and natural gas emissions from offsetting fuel usage offers both benefits to the air quality in Alaskan communities, as well as a monetized benefit to the state. For this evaluation, we solely calculated the monetized avoided carbon emissions, though the additional particulate of generated emissions are monitored by the Alaska Department of Environmental Conservation – Division of Air Quality.

The monetized avoided emissions for the 62 projects in the REGRP Construction Portfolio are 115 thousand metric tonnes of carbon dioxide with a monetized value of over $16 million during the lifetime of the projects.

Table 4.10 Avoided Carbon Emissions

RE Resource Sector	Avoided Fuel		Avoided Carbon Emissions	
	Diesel (x1000 Gal)	Natural Gas (MMBTU)	Tonnes/Year	Project Lifetime Savings ($ Millions)
Biomass	606	319,162	23,083	$2.4
Geothermal	92		930	$0.1
Heat Recovery	620		6,225	$0.7
Hydro / Hydrokinetic	2,419	24,071	25,117	$6.8
Solar	1.7		33	$0.0
Wind	5,822		60,139	$6.4
REGRP in Construction Portfolio	9,560	343,233	115,527	$16.4

Avoided emissions are calculated as part of the individual project evaluations conducted by ISER during the REGRP applications and included in this analysis. The avoided emissions for the two primary generation sources are:

Table 4.11 Avoided Emissions Factors for Diesel and Natural Gas Generation[20]

	Avoided Metric Tonne CO_2	Carbon Price 2011$ (Low)	Carbon Price 2011$
Diesel	0.010 per gal	$5.42 per Tonne	0.05 per gal
Natural Gas	0.053 per Mcf		$0.29 per Mcf

[20] Carbon pricing and avoided emissions are based on ISER analysis of National Bureau of Economic Research, "*Estimating the Social Cost of Carbon for Use in the U.S. Federal Rulemakings: A summary and Interpretations"* and US Energy Information Administration, Voluntary Reporting of Greenhouse Gases Program, *Table1. Carbon Dioxide Emission Factors for Stationary Combustion.*

5. Renewable Energy Resource Subsector Analysis

Overview

This section will present a closer review of the REGRP construction portfolio for the individual primary RE resources of Wind, Hydro, Biomass, Geothermal and Heat Recovery. In addition, we review the operational portfolio for these resource subsectors to identify lessons learned that may help guide future management of the Program, and provide valuable input to industry stakeholders and future participants related to the relative performance of individual systems and designs.

Included in this section are:

- A review of the resource potential for individual renewable energy resources in the State of Alaska, as well as the development of the related industry sub-sector since the inception of the REGRP.
- A project level Benefit/Cost analysis based on the best available data. This includes present value of savings in fuel, as well as capital and O&M over the expected life of the project versus cost. For operational projects, the estimated performance of projects is compared against the operational performance in 2011.
- A high level discussion of secondary benefits associated with the employment, infrastructure development and environmental benefits associated with specific renewable energy resources.

It is important to note that our analysis is limited by the quality of the available data, since VEIC is not familiar with most individual projects operating in the state. In some cases, especially when projects are only partially funded through the REGRP and rely on prior infrastructure or earlier phases of development funded outside the REGRP program, the Benefit/Cost analysis for a given project may not accurately capture the full costs.

This is most evident in the wind energy section, since AEA was a relative late comer in funding projects in this technology sector. By the time the first AEA project was completed (in Unalakleet), a number of other projects had been operational around the state for several years. These projects were originally constructed using other sources of funding and/or financing, but later submitted applications to the REGRP to expand or upgrade their systems. For this reason, the full capital costs are not necessarily reflected in the Benefit/Cost analysis. When possible, we note this probable discrepancy for individual projects. We expect as the program matures and fewer projects are funded entirely outside of the REGRP, the costs reported through the program will better reflect the actual costs for the project in its entirety. In addition, this finding highlights the continued need for a robust and consistent data collection and management plan across programs and technology sectors.

Wind

There is significant potential for wind energy in the State of Alaska with more than 134 rural communities identified as having potentially viable wind resource.[21] In addition, there are opportunities for larger commercial and industrial sized systems along the Railbelt and offshore applications. However, to achieve appropriate economies of scale for cost-effective offshore applications, siting may be restricted to areas in the southeast with access to the larger BC Hydro electrical transmission system in Canada.[22] A map of the wind energy resource at 50 meters above the surface of the earth highlights the significant potential in the coastal and western parts of the state, as well as elevated areas of the interior. However, in order to take full advantage of the potential wind energy available to larger population centers, continued investments in transmission infrastructure will be required as many of the best resources are not co-located with population centers and existing transmission lines have limited capacity to carry additional wind power.

Wind generation capacity has grown significantly since the inception of the REGRP in 2008 with more than 15 MW of installed generation capacity currently operational and an additional 24.6 MW (Golden Valley Electric Association - Eva Creek Wind Project) and

Figure 5.2 50 Meter Wind Map of Alaska

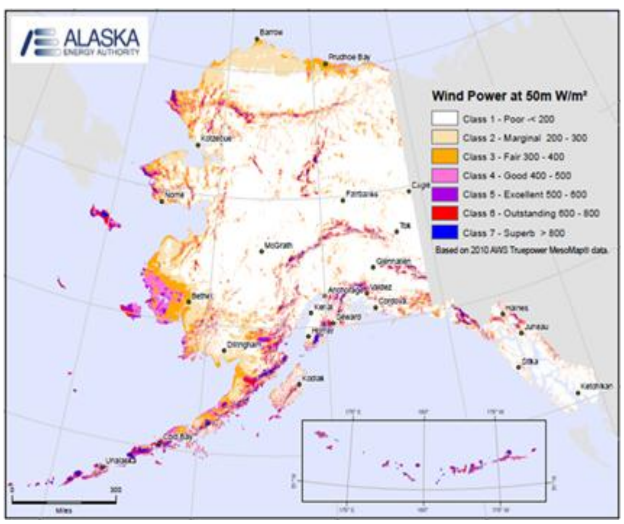
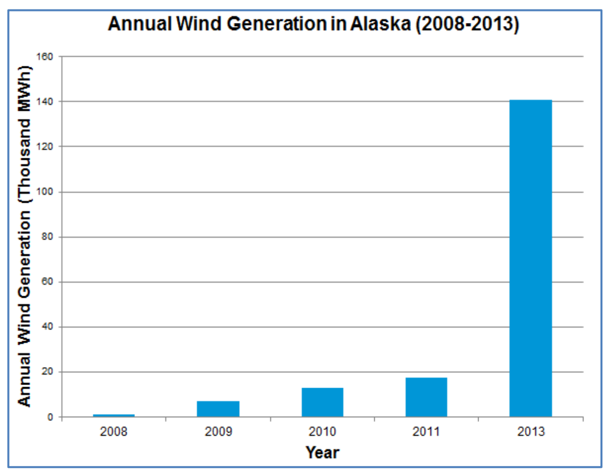


Figure 5.1 Wind Generation in Alaska



17.6 MW (Fire Island Wind LLC) expected to come online by 2013.[23]

The REGRP has provided grant funding to 9 of the 20 wind systems in the state that were operational in 2011. An additional 12 systems are currently in the construction phase and

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[21] Alaska Energy Authority & Alaska Center for Energy and Power, Alaska Energy: A First Step Toward Energy Independence (January 2009) www.akenergyauthority.org/PDF%20files/AK%20Energy%20Final.pdf
[22] Comments attributed to AEA Wind Program Manager Rich Stromberg
[23] Data provided by Rich Stromberg, AEA Wind Program Manager, June 2012.

41 in the pre-construction phase including reconnaissance, feasibility, and design. Of the 11 systems operating in Alaska in 2011 that were not originally funded through the REGRP, several have been awarded funds to expand or update their systems.

The 62 wind projects funded through the REGRP have had a total of $73.7M in funding appropriated through Round 4 of the REGRP.[24] Of the total funding for this sector, $56M is for the 21 REGRP projects operational or in construction as of 2011, and in sum will leverage over $125M of external federal, state, local match including utility debt and equity sources.

Based on the reported performance of the operational systems in 2011[25], the projected cost-effectiveness of the operational REGRP wind systems ranged from 4.66 (Nome Banner Peak[26]) to 0.36 (Emmonak)[27] with an average of 2.39.

However, as previously noted, several REGRP awards capture only a subset of total infrastructure costs, and costs not funded through the REGRP program or reported as match often difficult to reconstruct. The Nome Banner Peak project is an example, as the only cost for the project funded through the REGRP was a transmission line upgrade. This means that none or few of the capital or O&M costs for the project are captured in the Cost/Benefit analysis. It is tempting for this reason to exclude the Nome Banner Peak project from the analysis, however since anecdotal evidence suggests similar circumstances exist to varying degrees in relation to other projects, we have chosen to report values based on the best available data provided to AEA for each project. We leave it to the discretion of the program manager and the reader to use caution in interpreting the output, particularly for very high or low values.

The graph represents the cost-effectiveness of the REGRP funded wind projects that were either operational or in construction in 2011. Projects operational in 2011 have two spheres – one in red representing actual performance and the other in blue for the originally estimated performance. Projects in construction phase have a single sphere representing their estimated performance.

The scale of the individual bubbles that represent projects are relative to the total wind sector annual energy generation with the largest project, GVEA's Eva Creek, projected to generate 35% more energy than the combined total of all of the other projects. However, due to the relatively low avoided cost of energy for GVEA ($0.17/kWh in 2013)[28], the

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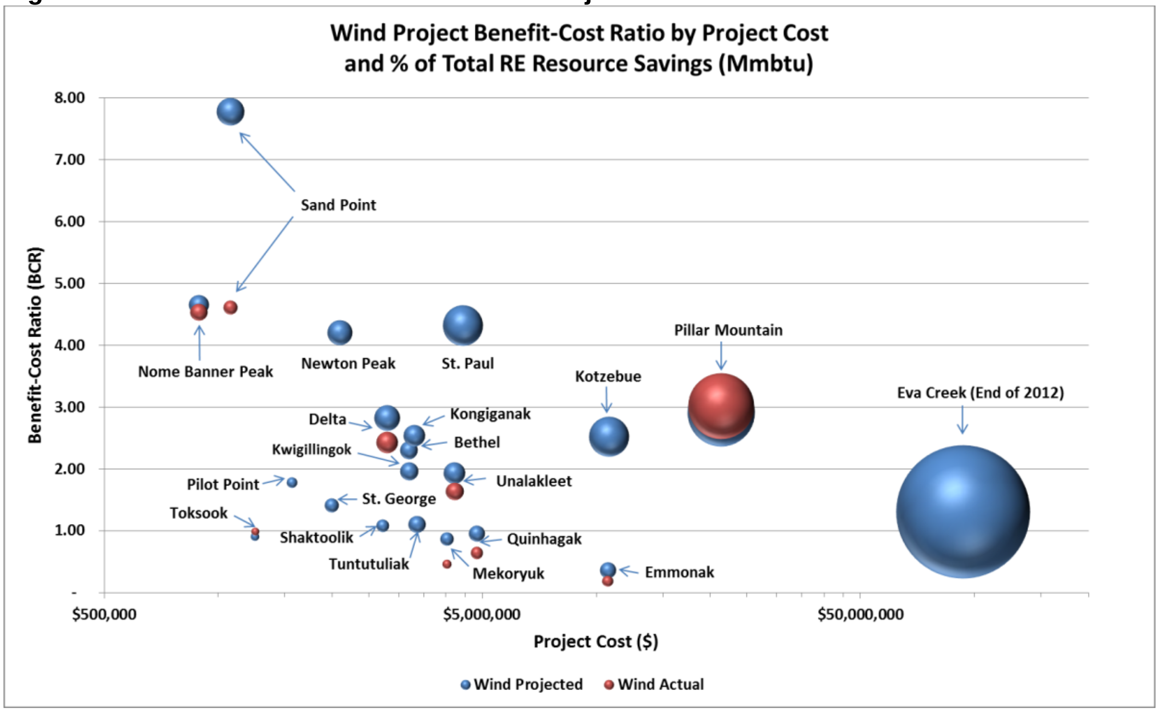
[24] Fifty-two of the wind systems funded through Round 4 are for separate community applications, representing nearly 40% of communities in the State of Alaska with viable wind.
[25] Reported performance was based on the Alaska Renewable Energy Fund 2011 Status Report
[26] The Nome Banner Peak project is for a transmission intertie for a wind project and the relatively high BCR of 4.66 does not reflect the cost of the installation and operation of the wind turbines.
[27] Based on feedback from AEA Program Manager Rich Stromberg, the Emmonak project is anticipated to increase in performance with additional operational experience.
[28] ISER avoided fuel costs included in individual project analysis for Eva Creek.

overall project cost-effectiveness is lower than many of the rural wind projects that are offsetting extremely high diesel-based generation costs averaging $0.44/kWh.[29]

Figure 5.3 Benefit to Cost of REGRP Wind Projects in Construction Portfolio[30]



* Note a logarithmic scale was used for the Project Cost due to the wide spread in scale of the projects.

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[29] Based on 2010 Alaska Power Statistics Table and an average diesel generation efficiency of 13 kWh/gal.

[30] The bubble chart represents the cost-effectiveness of the REGRP funded wind systems that were either operational (actual - red) or in construction (estimated - blue) in 2011.

Table 5.1 Costs and Benefits of REGRP Wind Projects in the Construction Portfolio

Project Name	Total Project Cost_est	Electricity Act/Proj%	Diesel Act/Proj%	Annual Electricity (kWh)	Annual Diesel Displaced (gal)	Annual Natural Gas (Mmbtu)	NPV Costs	NPV Benefits	NPV BCR_TRC
Bethel Wind Power Project Times Four	$ 3,197,986			817,000	62,846		($3,626,531)	$8,560,035	2.36
Delta Area Wind Turbines-Construction	$ 2,801,500	81%	62%	1,424,640	109,588		($3,676,956)	$9,144,260	2.49
Emmonak/Alakanuk Wind Design and Construction	$ 10,733,179	49%	45%	338,526	26,040		($10,649,890)	$1,983,686	0.19
GVEA Eva Creek Wind Turbine Purchase	$ 93,300,000			55,510,204	3,469,388		($127,091,567)	$170,298,889	1.34
Kotzebue High Penetration Wind-Battery-Diesel Hybrid	$ 10,808,919			4,266,667	328,205		($13,300,282)	$34,405,418	2.59
Kongiganak High Penetration Wind-Diesel Smart Grid	$ 3,300,000			1,167,000	89,769		($3,971,419)	$10,331,581	2.60
Kwigillingok High Penetration Wind-Diesel Smart Grid	$ 3,200,000			742,636	69,305		($3,595,228)	$7,248,665	2.02
Mekoryuk Wind Farm Construction	$ 4,031,406	50%	37%	238,706	18,362		($4,075,693)	$1,889,693	0.46
Nome Newton Peak Wind Farm	$ 4,444,444			4,266,667	328,205		($7,121,180)	$31,348,510	4.40
Nikolski Wind Integration Construction	$ 450,930			84,054	10,255		($496,106)	$1,278,698	2.58
Nome Banner Peak Wind Farm Transmission Construction	$ 890,000	93%	68%	955,148	73,473		($1,505,733)	$6,833,906	4.54
Pillar Mountain Wind Project - Construction	$ 21,400,000	102%	93%	12,448,474	957,575		($29,139,412)	$87,996,435	3.02
Pilot Point Wind Power & Heat	$ 1,571,240			240,000	22,644		($1,683,324)	$3,083,221	1.83
Quinhagak Wind Farm Construction	$ 4,838,603	63%	58%	409,240	31,480		($4,983,221)	$3,190,343	0.64
Sand Point Wind Construction	$ 1,077,706	28%	24%	522,085	55,460		($1,410,603)	$6,516,122	4.62
Shaktoolik Wind Construction	$ 2,727,960			360,289	32,715		($2,892,576)	$3,208,497	1.11
St. George Wind Farm Construction	$ 2,000,000			511,221	39,325		($2,268,184)	$3,280,739	1.45
St. Paul Wind Diesel Project	$ 2,100,000			1,600,000	123,077		($3,091,154)	$13,251,063	4.29
Toksook Wind Farm Construction	$ 1,253,056	107%	93%	176,834	13,603		($1,339,945)	$1,322,312	0.99
Tuntutuliak High Penetration Wind-Diesel Smart Grid	$ 3,360,000			517,878	63,496		($3,602,744)	$4,087,939	1.13
Unalakleet Wind Farm Construction	$ 4,222,752	80%	63%	958,350	73,719		($4,768,451)	$7,810,497	1.64
Wind Program Summary	**$ 181,709,681**	**73%**	**60%**	**87,555,619**	**5,998,529**		**($234,290,199)**	**$417,070,508**	**1.78**

Wind Costs, Performance and Lessons Learned

Of the 20 operational wind turbine sites AEA currently monitors for performance, the REGRP has supported the development of 9 systems that are functioning today. Once the additional 12 projects currently in the construction portfolio are brought on-line, a more comprehensive picture will emerge of the value in wind-diesel hybrid systems in reducing energy costs. In addition, since numerous technologies and strategies have been employed in the construction of the systems, additional data will continue to expand the industry's knowledge about developing reliable, cost-effective projects in Alaska. This is especially true because the range of funded projects represents a broad spectrum, including both smaller, rural wind diesel systems and several larger multi-Megawatt projects.

Generally, larger utility-scale wind power systems (e.g. Pillar Mountain - 9MW and Eva Creek - 24MW) offer lower installed costs compared to the smaller distributed wind turbine systems in rural Alaska. However, no systems in Alaska have been installed for capital costs approaching those in other, more developed parts of the country. This is not surprising based on the climate and infrastructure challenges experienced to varying degrees for all construction projects in the state.

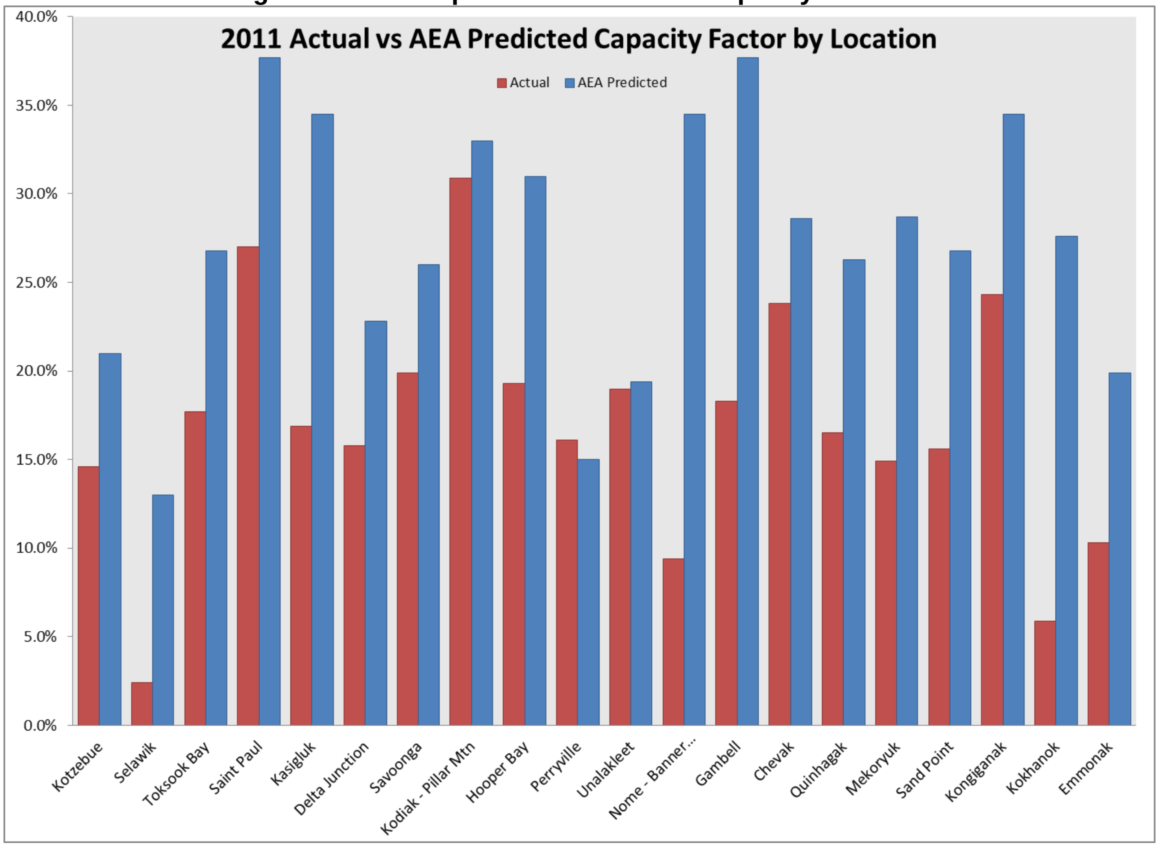
Table 5.2 Installed Cost of Wind Projects by Capacity

Wind Type	NREL ($/kW)	REGRP ($/kW) Operational/Construction Phase in 2011		
	Average	Average	Max	Min
Utility >1MW	$1,631	$3,133	$3,888	$2,378
Distributed <1MW	$2,500	$10,579	$26,833	$1,078

Because wind is variable in speed and availability, a turbine normally operates at less than its rated maximum output power. The average output of the turbine, as compared to its maximum rated nameplate power, is expressed as the *Capacity Factor*. Turbines in Alaska were found to have capacity factors in 2011 ranging from approximately 10% to greater than 30% for the year 2011.[31] The overall average capacity factor for Alaska wind turbines, calculated by comparing the total wind energy generated in 2011 with the installed nameplate wind capacity was 28.5%.

[31] Wind performance data provided by AEA Wind Program Manager, Rich Stromberg. Two wind systems not funded through the REGRP – Selawik and Kokhanok - performed at or below 5% capacity in 2011.

Figure 5.4 AEA reported wind turbine capacity factors[32]



A recent study of wind diesel systems documented the trend of improvements in wind capacity factors[33], but also noted the significant investments that are required to allow higher penetration of wind as a percentage of the total electric load.

Demonstrations of high penetration wind-diesel systems are incorporating the use of active load dumps for heating, as well as other strategies such as the use of battery storage systems, synchronous condensers, and grid forming inverters to achieve higher levels of wind penetration. None of these strategies are without challenges, and as a result AEA has focused on funding low and medium penetration systems in Round 5 of the REGRP until earlier high penetration systems are operational. The recently established Emerging Energy Technology Fund has provided an alternative option for state research towards developing high penetration systems using energy storage and other non-commercial ready technologies.

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[32] Note this includes capacity factors for projects not funded under the REGRP – which can help to provide broader view of projected and actual installed wind capacity factors. The wind sites - Quinhagak, Mekoryuk, Sand Point, Kongiganak, Kokhanok and Emmonak – are all currently completing commissioning and data does not yet reflect full year performance.

[33] Ginny Fay, Institute of Social and Economic Research (UAA) and Kat Keith, Alaska center for Energy and Power (UAF). University of Alaska, *Alaska Isolated Wind-Diesel Systems: Performance and Economic Analysis*, June 2010

Looking forward, operation and maintenance (O&M) for the installed systems was reported by AVEC as one of the largest unknowns for wind turbine projects, as the operational projects may begin to require more substantial repairs, especially in light of Alaska's harsh environment.[34] Continuing to collect information both on performance and additional incurred costs should be a priority, particularly as systems begin to age.

Barriers

There are significant challenges to integrating wind energy into the State's electric grid, especially in regard to rural Alaska:

- Variable resource – The variability of both the wind and the electric load during the year requires appropriate system design to insure the electric energy supply matches the demand. Absent energy storage or a strong baseline source of generation (hydro or diesel), higher penetration as a percentage of total load can present challenges to utilities, who must be sure demand and supply always match in order to maintain grid stability.
- Stranded resource - The places where wind is most abundant are not necessarily where most electricity usage takes place, requiring investments in the transmission or storage of wind energy.
- Turbine Siting – Significant improvements have been made in the siting of turbines both at the national level and in Alaska. Developers are learning to avoid areas with excessive wind speeds or turbulence, and have improved foundation designs suitable for geotechnical and/or permafrost conditions.
- Due to the relatively high capital costs associated with wind energy, funding support including the Federal Production Tax Credit (PTC) can be critical for project development. In other parts of the United States, the continuation of the PTC program is probably the most critical factor to ensure the continued growth of wind energy. However, because many of the utilities investing in wind energy in Alaska are organized as cooperatives, the PTC is less of a driver to development in this state than elsewhere.[35]

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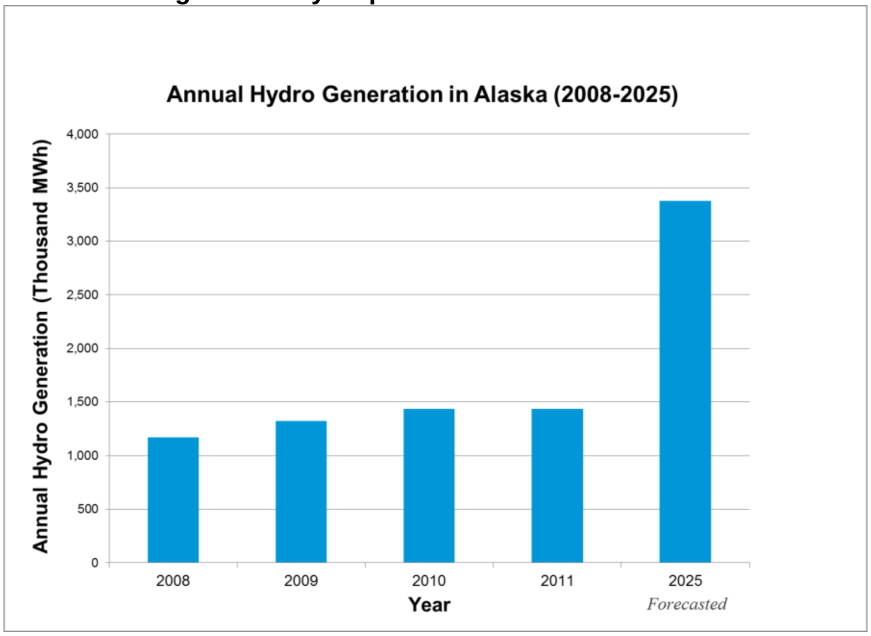
[34] Interview with Meera Kohler and Brent Petrie of AVEC regarding the REGRP impacts on their efforts to replace 25% of the diesel fuel within the 52 communities they serve.

[35] Currently, the Fire Island Wind Project is the only project in the state affected by the PTC.

Hydropower and Hydroelectric Energy

Hydropower is the most mature renewable energy resource in Alaska with over 442MW of installed capacity reported in 2010 distributed across 34 individual power plants. The plants range from 550kW (10 Mile) to 126MW (Bradley Lake).[36] The majority of the current large hydro installations are located in the population dense areas of southeast and southcentral Alaska.

Figure 5.5 Hydropower Generation in Alaska



The additional proposed development of large hydro projects to serve the Railbelt region, notably the proposed 600 MW Susitna-Watana hydroelectric project in 2025, was cited as necessary to achieve the goals set forth in the 2010 state energy plan of achieving 50% of the state's electrical generation from renewable and alternative energy sources by 2025.[37] However, this project would cost many billions of dollars to construct and would not be funded through the REGRP program as it is currently structured.

Including all potential resources, there is significant potential for both conventional hydro and hydrokinetic energy. Hydrokinetic energy takes direct advantage of the energy in moving water in a river or tidal environment without the use of a dam or diversion channel, but is a much less mature technology than conventional hydropower. In total, hydropower energy potential in Alaska totals an estimated 45,000 MW. Traditional hydropower generation has continued to increase under the REGRP, producing over 1,466 GWh of electricity in 2011. Emerging technologies in the hydropower sector for

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[36] *Power Statistics Tables 2010*
[37] *Railbelt Large Hydro Evaluation - Preliminary Decision Document*, Alaska Energy Authority, November 2010.

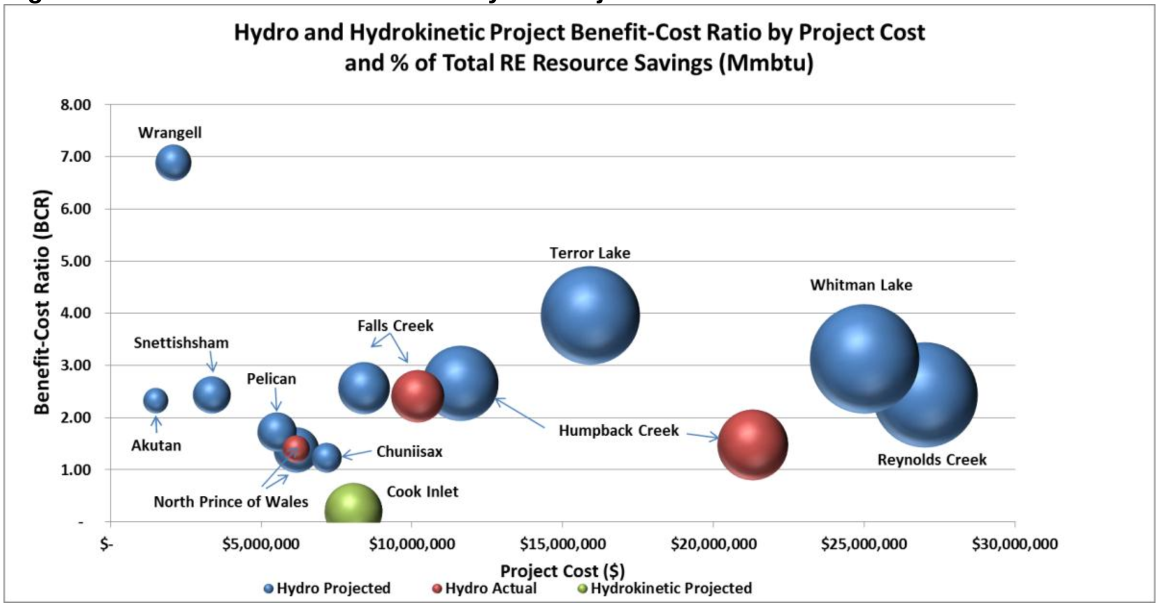
Alaska are tidal, river and wave energy. While there is significant interest by communities and developers, there are currently no active grid-connected marine or wave energy projects installed in the state and no projects funded through the REGRP after Round 1, when two resource assessment projects were funded. Two pilot projects installed in Ruby and Eagle were discontinued due to challenges with debris.

The REGRP has provided grant funding to 2 of the 34 operational hydroelectric sites in the state in 2011, as well as a transmission intertie to expand the service territory of an existing dam. An additional 9 systems are currently in the construction phase, including 2 project infrastructure upgrades and 2 transmission intertie projects. Finally, 43 projects are in the pre-construction phase including reconnaissance, feasibility and design.

The state has provided REGRP appropriations through Round 4 of $42.9M for hydroelectric and other river and marine energy projects. Of the total funding for this sector, $31M has been allocated to the 11 REGRP projects currently operational or in construction as of 2011. These projects will leverage over $100M of external federal, state, local match and utility debt and equity sources.

The graph represents the cost-effectiveness of the REGRP funded hydro projects that were either operational or in construction in 2011. Projects operational in 2011 have two spheres – one in red representing actual performance and the other in blue for the originally estimated performance. Projects in construction phase have a single sphere representing their estimated performance. The scale of the individual projects in the figure below is relative to the total hydroelectric and hydrokinetic energy sector annual energy generation.

Figure 5.6 Benefit to Cost of REGRP Hydro Projects in Construction Portfolio[38]



[38] The graph represents the cost-effectiveness of the REGRP funded hydro and hydrokinetic projects that were either operational (actual - red) or in construction (estimated - blue) in 2011. The scale of the individual projects in the figure is relative to the total hydro sector annual energy generation. In the case of Falls Creek and Humpback Creek project costs in original estimates did not capture total project costs.

Table 5.3 Costs and Benefits of REGRP Hydro Projects in Construction Portfolio

Project Name	Total Project Cost_est	Electricity Act/Proj%	Diesel Act/Proj%	Annual Electricity (kWh)	Annual Diesel Displaced (gal)	Annual Natural Gas (Mmbtu)	NPV Costs	NPV Benefits	NPV BCR_TRC
Akutan Hydroelectric System Repair and Upgrade	$ 1,491,000			420,000	32,308		($2,068,929)	$4,920,503	2.38
Chuniisax Creek Hydroelectric Construction	$ 7,167,332			567,870	43,682		($7,982,849)	$10,148,359	1.27
Falls Creek Hydroelectric Construction	$ 10,178,000	109%	102%	1,933,407	148,724		($11,416,849)	$27,609,838	2.42
Humpback Creek Hydroelectric Construction	$ 21,300,000	91%	87%	3,764,000	289,538		($54,032,617)	$80,180,891	1.48
North Prince of Wales Island Intertie Project	$ 6,155,019	0%	46%	1,356,224	104,325		($13,687,394)	$19,289,315	1.41
Pelican Hydroelectric Upgrade Project	$ 5,520,836			1,000,000	76,923		($6,298,714)	$11,168,957	1.77
Reynolds Creek Hydroelectric Project	$ 27,000,000			7,351,000	565,462		($29,779,235)	$74,667,786	2.51
Snettishsham Transmission Line Avalanche Mitigation	$ 3,344,260			935,606	71,970		($4,311,064)	$10,772,945	2.50
Terror Lake Unit 3 Hydroelectric Project	$ 15,907,950			6,456,150	496,627		($21,525,370)	$87,239,685	4.05
Whitman Lake Project	$ 25,000,000			7,926,000	609,692		($29,758,380)	$95,523,739	3.21
Wrangell Hydro Based Electric Boilers Construction	$ 2,082,000				85,821		($2,021,359)	$14,356,170	7.10
Cook Inlet TidGen Project	$ 8,050,538			1,839,600		24,071	($9,142,488)	$1,956,160	0.21
Hydro / Hydrokinetic Program Summary	**$ 133,196,935**	**67%**	**78%**	**33,549,857**	**2,525,072**	**24,071**	**($192,025,246)**	**$437,834,347**	**2.28**

Based on the reported performance of the operational systems in 2011[39], the projected cost-effectiveness of the operational REGRP hydroelectric projects of Falls Creek and Humpback Creek were 2.18 and 1.47 respectively, with an average of 1.83. Although included in the construction portfolio, it was noted that the Cook Inlet Tidal Generation project is not currently a construction project and does not reflect the total anticipated costs of development of the project.

Hydro Costs, Performance and Lessons Learned

The two operational hydro projects with available performance data[40] were within 10% of the estimated performance in 2011. This can in large part be attributed to the maturity of the technology in Alaska and the relatively consistent nature of the resource. However, the inability to consistently predict the installed cost based on the lengthy pre-construction and permitting phase of the projects, as well as the site specific conditions for individual hydroelectric projects, can lead to significant variances from the estimated project costs.

Both operational projects (at Falls Creek and Humpback Creek) originally proposed lower installed costs in their applications to the REGRP, but ultimately revised costs upward with increases of 21% and 81% respectively documented in the final installed cost. For Falls Creek, the increase was in part attributed to the project cost not originally capturing the cost of prior feasibility studies. In the case of Humpback Creek, two separate applications were submitted in Rounds 1 and 3 and the project received two appropriations of $4M each for a total of $8M in REGRP funding.

Table 5.4 Total Installed Cost of Hydro Projects

Hydroelectric Project	REGRP Hydro Installed Costs Operational Projects in 2011 ($ Million)		
	Original	Final	% Variance
Falls Creek	$8.4M	$10.2M	21%
Humpback Creek	$11.6M	$21M	81%

In an analysis of the installed costs of operational and projects in construction in 2011, the conventional hydropower projects included dam and run-of-river systems, covering a full spectrum of upgrades, new construction, transmission interties and the installation of new electric boilers to reduce diesel heating costs. The table below reflects projects identified as new construction.

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[39] Reported performance was based on the Alaska Renewable Energy Fund 2011 Status Report
[40] The third operational project is an intertie to the Reynolds Creek hydro project.

Table 5.5 Installed Cost of Hydro Projects by Capacity

Hydroelectric Project	NREL ($/kW)	REGRP ($/kW) Operational/Construction Phase in 2011		
	Average	Average	Max	Min
Hydro – New	$2,240	$8,534	$16,800	$4,536

The two operational projects in Alaska, Falls Creek and Humpback Creek, were found to have capacity factors of 0.28 and 0.31, respectively,[41] for the year 2011. The overall average capacity factor for the hydro projects Alaska, calculated by comparing the projected total hydro energy generation with the installed nameplate capacity, was 0.22. Oversizing of hydro projects for future increases in electric load, as in the case of Falls Creek,[42] affects these first year calculations of capacity factors.

Lower capacity factors in Alaska for hydro projects are typically attributed to the lower flow rates during winter months. In some cases, as the generated energy is utilized to offset high cost diesel generation, specific efforts are made to increase head levels of the dam prior to low flow periods on rivers to insure a minimum generation capacity is retained year round. [43] The relatively predictable nature of this seasonality and storage capability of the energy capacity in dam applications allows hydro projects to serve as base loads for other non-dispatchable renewable resources (e.g. wind turbines).

Although hydropower is the most mature developed renewable resource in Alaska and most project funded through the REGRP are conventional systems, more emerging applications of hydrokinetic and tidal energy have also been funded. Ongoing efforts at resource assessment (conducted through both the University of Alaska Fairbanks and the University of Alaska Anchorage), as well as a tidal energy feasibility study for Cook Inlet led by ORPC will improve the understanding of the potential of hydrokinetic and marine energy applications in the state.

Barriers

Broad adoption of hydropower isimpacted by several market and technology barriers including:

- Scale vs. Cost-effectiveness – As with other technologies, the most cost-effective applications of hydro are often tied to conventional hydro at a larger utility scale (>1MW). However, efforts in supporting emerging technologies to allow for more community scale projects may see significant cost reductions with the development of an early industry adoption.

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[41] NREL analysis of new hydro construction projects estimates capacity factors between 0.34 and 0.53. http://www.nrel.gov/analysis/tech_cap_factor.html
[42] In its grant application, Gustuvus Electric estimated 2,000 MWh for first year generation, but suggested the site was capable of 6,300 MWh annually with increased customer electric loads.
[43] Comments from Doug Ott, the AEA Hydro Program Manager.

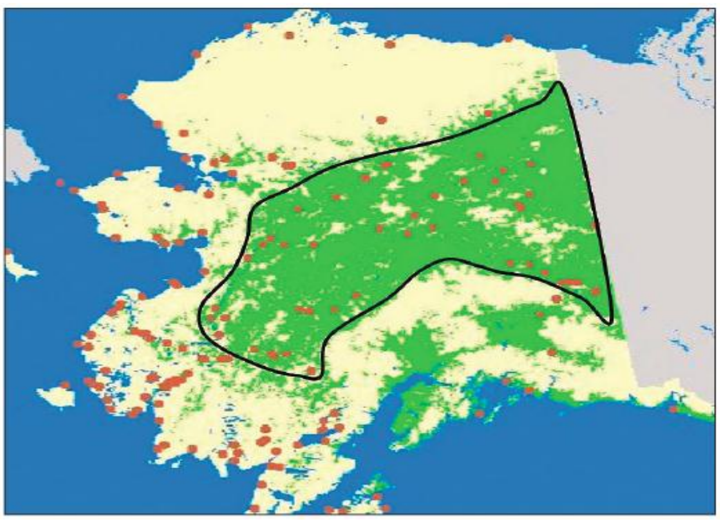
- Limited sites – Although Alaska has a significant untapped hydropower potential in the state, assessing the viability of individual sites, as well as balancing the development of a hydropower project on a river against competing interests (environmental impacts, fishing, etc.) limits the number of suitable sites. Equipping existing non-powered dams with turbines and repowering existing dams with new turbines is often considered a preferred path to reducing the permitting and development costs per kW for installations.
- Stranded resources - Significant investments in transmission are often required to allow for the utilization of a hydropower resource, whether centered on a river system, lake tap hydro, or in the ocean.
- Permitting remains as one of the biggest barriers to expediting the hydro development timeline, as multiple organizations at the state and federal level, notably the Federal Energy Regulatory Commission (FERC), have jurisdiction over proposed hydro projects.[44]
- Assessing the potential of smaller community-sized or microhydro run-of-river conventional hydropower installations having 100 kW average power output or less, as well as addressing technical barriers, could lower the costs and complexity of hydropower projects going forward.

[44] Legislation currently being proposed in the US legislature (H.R. 5892 - Hydropower Regulatory Efficiency Act) is targeted to streamline the efficiency of the process and expand FERC's ability to grant exemptions to their review process.

Biomass and Landfill Gas

Biomass represents one of the broadest spectrums of energy generation in Alaska, ranging from residential space heating applications to community scale combined heat and power plants and utility scale landfill gas applications. Several community scale wood boiler projects are currently operational in Alaska with a total capacity of 1.75 MWth[45]. Chena Power's waste to energy CHP system (400kWe) and Anchorage's landfill gas-to-energy project (3.2MWe) will add 3.6MWe of biomass electric power generation in 2012, becoming the state's first commercial and utility scale projects generating electricity. Not included in this estimate is the existing UniSea 2MWe generator that utilizes processed fish oil for over 70% of its blended fuel, as well as other examples of the use of fish oil by fish processors in the state.

Figure 5.7 Alaska Forested Regions



Biomass potential is widely distributed, with Alaska's forests capable of growing over 3.5 million cords of wood a year, the fishing industry generating over 21 million gallons of fish oil, and 7 class 1 landfills.[46] A recent evaluation by the USDA Forest Service identified a significant opportunity for biomass development, especially in Interior Alaska, where approximately half of the communities bordered by forested regions are located.[47] This study also identified the natural fit of biomass boilers with the more than 50 communities that currently have combined heat and power (CHP) systems in place with the necessary infrastructure for distribution of the generated heat and power.

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[45] Total installed capacity estimated based on installed wood boilers in the communities of Dot Lake, Craig, Gulkana, Tanana and Tok, as well as the Sealaska Plaza.

[46] Renewable Energy Alaska Project (REAP) website - http://alaskarenewableenergy.org/alaskas-resources/types-renewable-energy/biomass/

[47] *Assessing the Potential for Conversion to Biomass Fuels in Interior Alaska*, United States Department of Agriculture – Forest Service, Nancy Fresco and Stuart Chapin, June 2009.

The Alaska Energy Authority, in partnership with the US Forest Service and NREL, established funding for a Wood Energy Pre-Feasibility Grant initiative to provide feasibility funding for "community heating projects of individual facility, community and district heating projects with high efficiency, low-emission, wood-fired systems." Twenty-six applications were received and currently being processed for design/permitting support through USDA grants.[48]

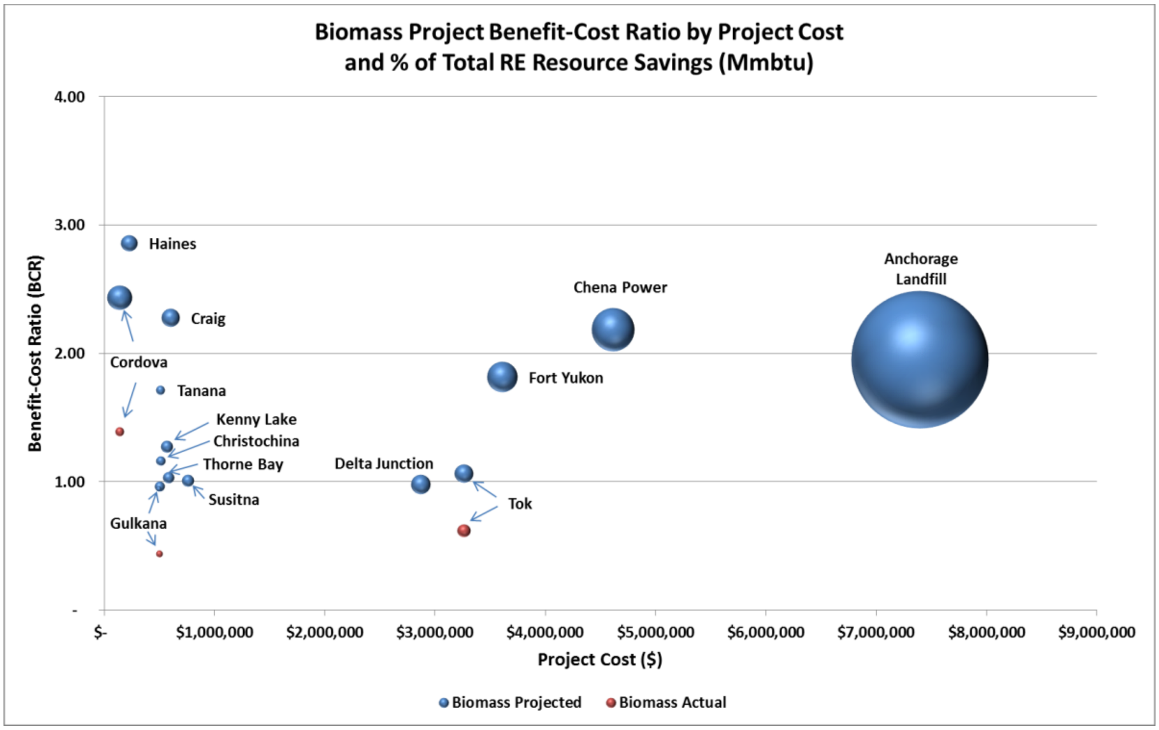
The REGRP has provided grant funding to 3 of the operational biomass projects in the state in 2011, including 2 wood boilers and 1 wood processing facility. An additional 12 systems are currently in the construction phase, including both wood boilers and processing facilities. An additional18 projects are in the pre-construction phase including reconnaissance, feasibility, and design.

The state has provided REGRP appropriations through Round 4 of $18.3M for biomass energy projects. Of the total funding for this sector, $15.8M was designated for the 15 REGRP projects currently operational or in construction as of 2011. These projects leverage over $10.8M of external federal, state, local match and utility debt and equity sources.

The graph represents the cost-effectiveness of the REGRP funded biomass projects that were either operational or in construction in 2011. Projects operational in 2011 have two spheres – one in red representing actual performance and the other in blue for the originally estimated performance. Projects in construction phase have a single sphere representing their estimated performance. The individual scale of the projects is relative to the total biomass energy sector annual energy generation.

[48] AEA Biomass Program Update 2011, Presentation by Devany Plentovich.

Figure 5.8 Benefit to Cost of REGRP Biomass Projects in Construction Portfolio [49]



Based on the reported performance of the operational systems in 2011[50], the projected cost-effectiveness of the operational REGRP biomass projects in Cordova, Gulkana and Tok were 0.98, 0.59 and 0.61 respectively with an average of 0.73. The consistent spread between actual and estimated performance for all three of the operational biomass projects is more prominent than other sectors. Continuing to track performance of these systems will be an important area of focus for the biomass sector of the program.

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[49] The graph represents the cost-effectiveness of the REGRP funded biomass projects that were either operational (actual - red) or in construction (estimated - blue) in 2011. The scale of the individual projects in the figure is relative to the total biomass sector annual energy generation.

[50] Reported performance was based on the Alaska Renewable Energy Fund 2011 Status Report

Table 5.6 Costs and Benefits of REGRP Biomass Projects in Construction Portfolio

Project Name	Total Project Cost_est	Electricity Act/Proj%	Diesel Act/Proj%	Annual Electricity (kWh)	Annual Diesel Displaced (gal)	Annual Natural Gas (Mmbtu)	NPV Costs	NPV Benefits	NPV BCR_TRC
Anchorage Landfill	$ 7,395,200			24,183,132	0	319,162	($16,799,890)	$33,281,086	1.98
Biomass Fuel Dryer Project	$ 600,000				47,742		($1,470,769)	$3,392,415	2.31
Biomass-fired Organic Rankine Cycle System	$ 4,612,900			3,098,413	201,114		($4,478,544)	$10,097,555	2.25
Chistochina Central Wood Heating Construction	$ 512,000				13,210		($1,051,954)	$1,243,319	1.18
City-Tribe Biomass Energy Conservation	$ 508,365				11,600		($684,978)	$1,201,843	1.75
Cordova Wood Processing Plant-Purchase and setup	$ 137,760		13%		11,400		($819,275)	$1,140,501	1.39
Delta Junction Wood Chip Heating	$ 2,868,000				52,508		($4,523,082)	$4,528,145	1.00
District Wood Heating in Fort Yukon	$ 3,606,255				137,282		($8,264,591)	$15,217,666	1.84
Gulkana Central Wood Heating Construction	$ 500,000		40%		5,900		($1,199,462)	$530,388	0.44
Haines Central Wood Heating Construction	$ 225,120				38,362		($1,419,394)	$4,080,735	2.87
Kenny Lake School Wood Fired Boiler	$ 565,485				20,000		($1,183,546)	$1,534,031	1.30
Lake and Peninsula Wood Boilers	$ 493,200				3,902		($594,879)	$578,053	0.97
Susitna Valley High School Wood Heat	$ 755,500				20,800		($1,575,785)	$1,617,165	1.03
Thorne Bay Wood Boiler	$ 580,179				17,500		($1,255,155)	$1,318,104	1.05
Tok Wood Heating Construction	$ 3,260,349		48%		24,400		($3,588,610)	$2,228,822	0.62
Biomass Program Summary	**$26,620,313**		**34%**	**27,281,545**	**605,720**	**319,162**	**($48,909,916)**	**$81,989,829**	**1.68**

Biomass Costs, Performance and Lessons Learned

With three projects providing operational data for 2011, and a further 12 biomass projects approved through the construction phase, the REGRP is starting to develop a useful base of knowledge on the projected and actual costs, as well as the performance of individual systems. This will provide valuable lessons for future program management, industry project development, and ongoing operation and maintenance of existing projects.

All of the operational biomass projects significantly underperformed in comparison to initial estimates. This variance was accredited to the relative immaturity of the industry in Alaska with limited standardization of system designs, as well as lack of full system hookups and need for trained operation and maintenance staff. AEA is working with industry groups to standardize biomass system designs, particularly around wood boilers, to improve performance and reduce costs.[51]

Table 5.7 2011 Performance of Biomass Projects

Biomass Project	REGRP Biomass 2011 Performance Against Goal (PAG) (Diesel gallons offset for heating)		
	Estimated	Actual	% Variance
Cordova	88,700	11,400	13%
Gulkana	14,643	5,900	40%
Tok	50,400	24,400	48%

Table 5.8 Installed Cost of Biomass Projects by Capacity

Biomass Project	NREL ($/kW)	REGRP ($/kW) Operational/Construction Phase in 2011		
	Average	Average	Max	Min
Biomass CHP	$3,000/$5,500	$11,532	n/a	n/a
Landfill Gas	$2,360	$2,311	n/a	n/a
Wood Boiler	$1,000	$2,503	$3,826	$1,072

Not included in this analysis are any secondary benefits associated with biomass energy projects. The illustration to the right from a 2009 USDA study[52] identifies the myriad societal benefits associated with the harvesting of biomass fuels and the influx of payments associated with potential carbon credits from reduced diesel emissions. As forestry fire management is a critical effort in Alaska, the parallel benefits to removing hazardous wood fuels and providing a fuel source to community biomass projects are specifically noteworthy.

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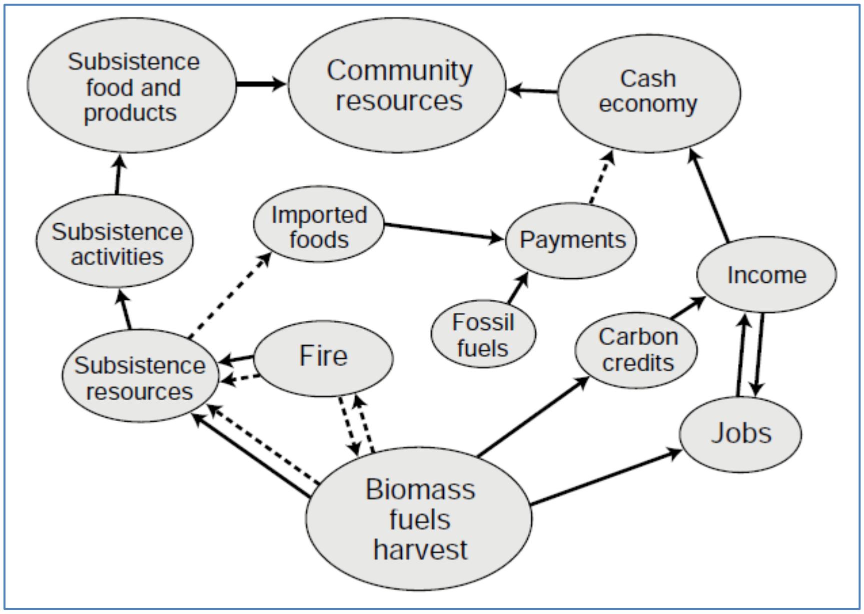
[51] Interview with AEA Biomass Program Manager, Devany Plentovich.
[52] United States Department of Agriculture, *Assessing the Potential for Conversion to Biomass Fuels in Interior Alaska*, June 2009.

Figure 5.9 Biomass Fuel Harvest Benefits



Barriers

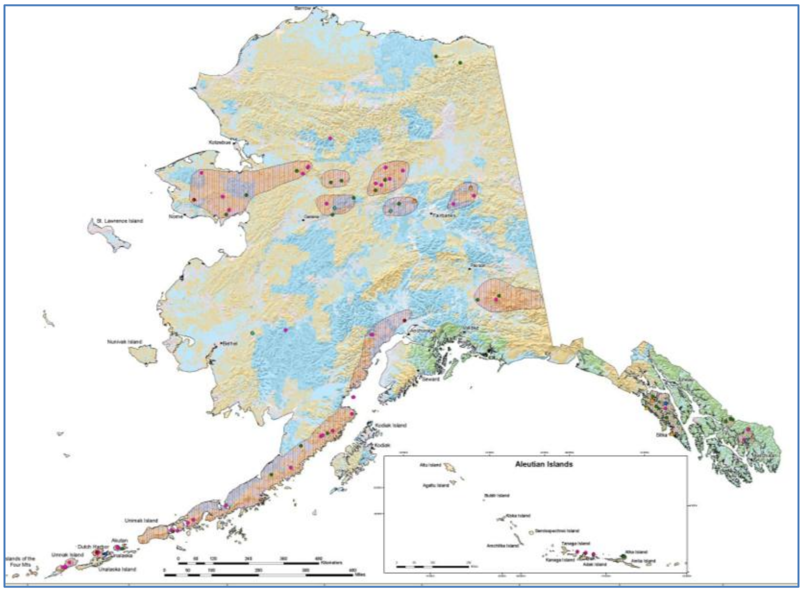
Challenges for developing a more robust biomass energy industry in Alaska include:

- Maturity of the technology and market infrastructure development – The necessary support functions such as availability of spare parts and trained operator and maintenance personnel can increase O&M costs, as well as lead to lengthy downtimes. Additionally, fuel processing of both woody biomass and biofuels require investments in pellet manufacturing plants, fuel dryers for cord wood, wood harvesting equipment, and (potentially) fish oil processing plants.
- Transportation – The cost and difficulty of delivering biomass fuels depending on the source and processing location can be a limiting factor for biomass energy project development.
- Environmental – Recent advances in biomass technology have significantly improved the emissions of wood boilers to meet and exceed federal standards. Proper forestry management practices are also critical to insure a sustainable source of biomass fuel without impacting the surrounding environment.

Geothermal

Alaska is home to almost every major type of geothermal resource, but in most cases these resources are not located near major population centers where the energy could be used. Alaska has three distinct geothermal regions: the interior hot springs belt including Chena Hot Springs, the Aleutians and Alaska Peninsula with world-class high temperature geothermal resources associated with active volcanoes, and hot springs in southeast Alaska that are caused by deep circulation of water along open faults.

Figure 5.10 Geothermal Resource Map for Alaska



Currently, Alaska has one geothermal power plant located at Chena Hot Springs, which has been operating since 2006 with a rated capacity of 400 kW and notable as the first combined heat and power (CHP) application in the state.

The state has provided REGRP appropriations through Round 4 of $13.9 million for geothermal energy projects. Of the total funding for this sector, approximately $0.9 million is for the 3 REGRP projects currently operational or in construction in 2011. These projects will leverage over $0.5 million of external federal, state, local match and utility debt and equity sources.

Several exploration projects have been funded through the REGRP in areas with known geothermal resources, as evidenced by hot springs and/or fumeroles. In fact, with the exception of Chena Hot Springs, no significant geothermal resource assessment work has occurred in Alaska since the early 1980's prior to the development of the REGRP.

In addition to traditional geothermal energy, heat pumps and enhanced geothermal projects are included in the geothermal energy category under the REGRP.

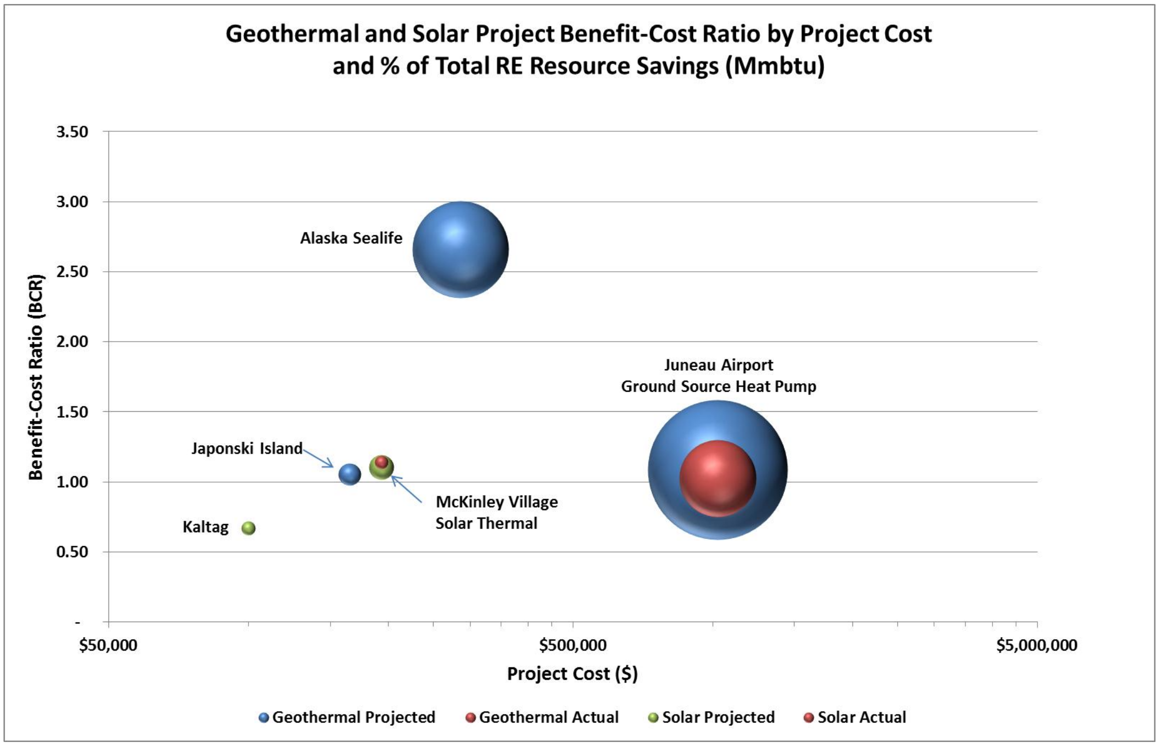
Three heat pump projects have been funded through the REGRP, located in the communities of Juneau, Seward, and Sitka. Although none are strictly using geothermal energy they are categorized under the broad category of 'geothermal energy' by the Alaska Energy Authority. The project in Juneau is installed at the airport and is a ground source heat pump system, utilizing heat stored in the near-surface ground through horizontal loops rather than vertical wells. Both the Seward Sealife Center and Japonski Island Boathouse use seawater-source heat pump systems. The Seward Sealife Center also received funding under the Emerging Energy Technology Fund (funded through the Denali Commission and managed by the Alaska Center for Energy and Power at UAF) to fund Phase I of the project, which is not reflected in the Benefit-Cost ratio reported for the project.

The graph represents the cost-effectiveness of the REGRP funded geothermal projects that were either operational or in construction in 2011. Projects operational in 2011 have two spheres – one in red representing actual performance and the other in blue for the originally estimated performance. Projects in construction phase have a single sphere representing their estimated performance. The scale of the individual projects in the figure below is relative to the total geothermal energy sector annual energy generation.

The Juneau Airport Ground Source Heat Pump project was the only reported operational system in 2011[53], with a projected cost-effectiveness of 1.03. The Alaska Sealife Center is being completed in two phases, with the capital costs for the first phase only included in this analysis. It is expected that if all costs associated with the project were included in this analysis the actual project Benefit-Cost ratio would be similar to the one reported for the Japonski Island project in Sitka.

[53] Reported performance was based on the Alaska Renewable Energy Fund 2011 Status Report. Although the Juneau Aquatic Center was operational in 2011, no performance data was available for the 2012 annual report.

Figure 5.11 Geothermal REGRP Projects Cost-Benefit Analysis[54]



* Note a logarithmic scale was used for the Project Cost due to the wide spread in scale of the projects.

[54] The scale of the individual projects in the figure is relative to the total biomass sector annual energy generation.

Table 5.9 Costs and Benefits of REGRP Geothermal and Solar Projects (combined) in Construction Portfolio

Project Name	Total Project Cost_est	Electricity Act/Proj%	Diesel Act/Proj%	Annual Electricity (kWh)	Annual Diesel Displaced (gal)	Annual Natural Gas (Mmbtu)	NPV Costs	NPV Benefits	NPV BCR_TRC
Seward Alaska Sealife Center Ph II Seawater Heat Pump Project	$ 286,580				51,888		($1,197,804)	$3,189,232	2.68
Japonski Island Boathouse Heat Pump in Sitka	$ 165,000				2,700		($212,427)	$224,369	1.08
Juneau Airport Ground Source Heat Pump Constr	$ 1,026,000		34%		37,082		($3,140,700)	$3,226,815	1.03
Geothermal Program Summary	**$ 1,477,580**		**34%**		**91,670**		**($4,550,931)**	**$6,640,416**	**1.46**
Kaltag Solar Construction	$ 100,000			10,096	777		($98,503)	$68,315	0.69
McKinley Village Solar Thermal Construction	$ 193,600		38%	32,000	2,462		($187,961)	$214,560	1.14
Solar Program Summary	**$ 293,600**		**38%**	**42,096**	**3,238**		**($286,464)**	**$282,875**	**0.99**

Geothermal Costs, Performance and Lessons Learned

Absent the addition of additional operational projects in the geothermal sector, limited cost and performance information is available.

Feasibility and reconnaissance projects funded through the REGRP for geothermal projects include Mount Spurr, Akutan, Pilgrim Hot Springs, Manley Hot Springs, and Tenakee Inlet. The fact that none of these projects have progressed beyond the exploration phase highlights the challenges associated with geothermal development anywhere, but especially in remote regions of the state. Resource assessment is often a multi-year undertaking, and results are slow to become available. When compared to all other renewable resources, geothermal energy has the highest risk and costs associated with the exploration phase. However, where economic to develop, geothermal energy is highly desirable because it can supply base load heat and power whereas most renewable resources are intermittent.

Barriers

- Heat pumps require low cost electricity to be cost-effective, which limits their usefulness in rural Alaska. In addition, the cold average ground temperatures in most regions of the state reduce the efficiency of traditional ground source heat pumps compared to other, more temperate regions. Nonetheless, in regions and where low cost electricity is available and ground temperatures are moderate, heat pumps can be used to decrease local heating costs. The challenge for the REGRP is that the areas where heat pumps are generally most economical to install are in areas that have relatively low overall electricity costs, but high heating fuel costs. This situation describes certain areas of the state, such as Kodiak and parts of Southeast Alaska, but much of the state with high heating fuel costs also derive their electrical energy from diesel power systems, thereby making the electrical costs too high for heat pumps to be cost-effective.

- Costs associated with geothermal exploration are very high compared to exploration costs for other renewable resources. This makes geothermal energy a risky proposition for private investment at the exploration phase. For this reason, funding the evaluation of these resources through the REGRP increases the chances that any economically developable projects will move forward.

Heat Recovery

Space heating is a significant energy load for many Alaskan communities, residences, and businesses. For this reason, offsetting a portion of the heat energy ‘wasted’ as a byproduct of diesel electric power generation can result in significant savings. Heat recovery has long been a priority of AEA’s Rural Power Systems Upgrade program and as a result many powerhouses in Alaska have some type of installed heat recovery system, although not all are fully functional. The most efficient use of waste heat is to use it directly as heat. This avoids efficiency losses that occur when heat is transformed to another kind of energy, such as electricity. Typical uses for the recovered heat in rural communities include space heating, domestic hot water, and tempering municipal water supplies to prevent freezing and facilitate treatment.

Figure 5.12 Alaska Fuel Distribution Map

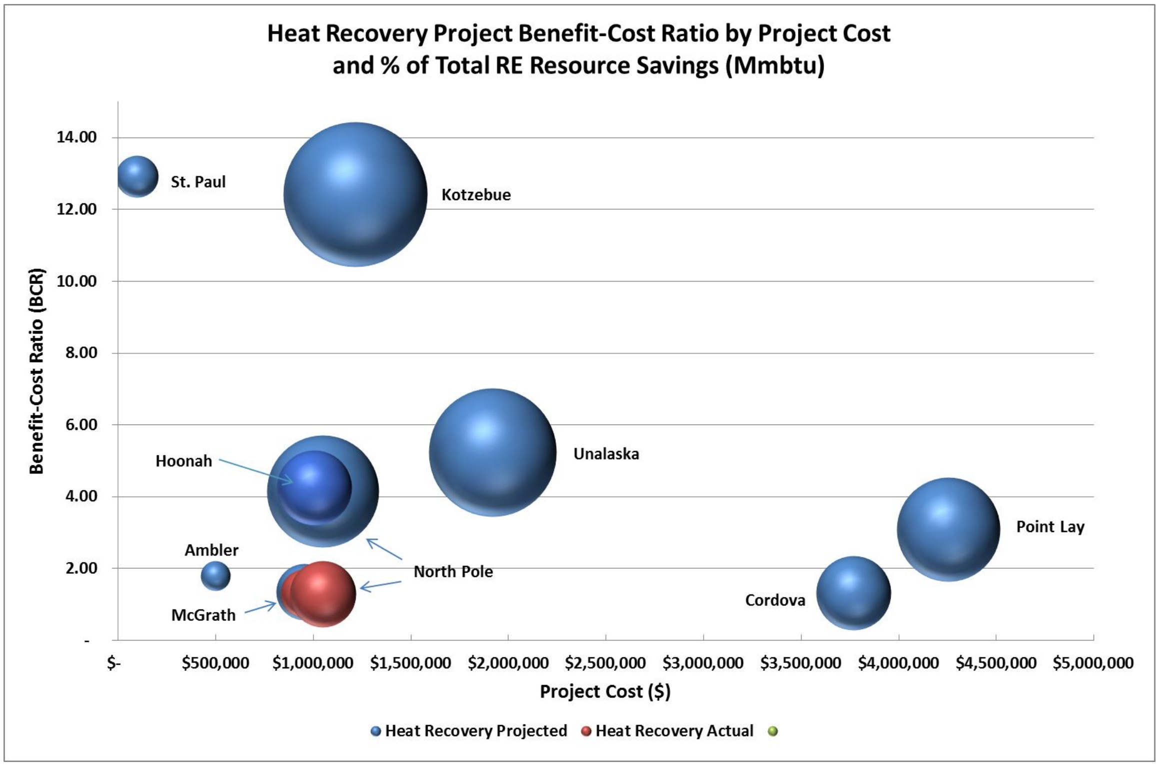
The limited and high-cost modes of transport for delivering fuel to rural Alaskan communities places a premium on the efficient use of diesel fuel for electrical generation, as well as space heating and highlights the needs for well organized community planning. With over a quarter of rural village diesel generators already equipped with jacket water heat recovery systems, the value of the efficiency gains and reduction in fuel costs is widely recognized.

The efficiency of recovering waste heat for augmenting electrical power production is lower than that for heating; however, it can be attractive and economical in some places since electrical power is needed year round as opposed to space heating, which is required at varying levels throughout the year.

The REGRP has appropriated over of $7.8 million through Round 4 for 12 heat recovery projects. Of the total funding for this sector, approximately $6.9 million is for the 9 REGRP projects in the 2011 construction portfolio, 3 of which were operational as of that time. These projects leverage over $7.8 million of external federal, state, local match and utility debt and equity sources.

The graph represents the cost-effectiveness of the REGRP funded heat recovery projects that were either operational or in construction in 2011. Projects operational in 2011 have two spheres – one in red representing actual performance and the other in blue for the originally estimated performance. Projects in construction phase have a single sphere representing their estimated performance. The scale of the individual projects in the figure below is relative to the total heat recovery energy sector annual energy generation.

Figure 5.13 Heat Recovery REGRP Projects Cost-Benefit Analysis[55]



In the program documentation, the Cordova Heat Recovery project was noted to not have any electrical savings estimated for the project despite being a CHP application with an organic Rankine cycle similar to Kotzebue. This would affect both the magnitude of the savings, as well as the cost-effectiveness of the overall project for Cordova.

[55] The scale of the individual projects in the figure is relative to the total biomass sector annual energy generation.

Table 5.10 Costs and Benefits of REGRP Heat Recovery Projects in the Construction Portfolio

Project Name	Total Project Cost_est	Electricity Act/Proj%	Diesel Act/Proj%	Annual Electricity (kWh)	Annual Diesel Displaced (gal)	Annual Natural Gas (Mmbtu)	NPV Costs	NPV Benefits	NPV BCR_TRC
Ambler Heat Recovery Construction	$500,000				8,864		($513,250)	$945,824	1.84
Cordova Heat Recovery Construction	$3,770,000				56,773		($3,660,194)	$4,964,185	1.36
Hoonah Heat Recovery Project	$1,005,000				57,000		($975,728)	$4,273,896	4.38
Kotzebue Electric Heat Recovery Construction	$1,215,627			1,213,348	184,537		($1,520,527)	$19,332,088	12.71
McGrath Heat Recovery Construction	$954,225		72%		22,975		($6,047,269)	$7,941,943	1.31
North Pole Heat Recovery Construction	$1,050,000	30%	37%	442,117	27,632		($1,019,417)	$1,303,351	1.28
Point Lay Heat Recovery Construction	$4,257,116				109,588		($4,295,172)	$13,634,081	3.17
Saint Paul Fuel Economy Upgrade	$98,149				18,030		($152,169)	$2,001,880	13.16
Unalaska Heat Recovery Construction	$1,919,807			1,662,400	127,877		($1,977,591)	$10,629,471	5.37
Heat Recovery Program Summary	$14,769,924	**30%**	**54%**	**3,317,865**	**613,277**		**($20,161,319)**	**$65,026,720**	**3.23**

As noted earlier, the costs and the resulting cost-effectiveness highlighted in the graph can range widely based on the application. The REGRP funded heat recovery projects include both additions to new diesel powerhouses as well as retrofits of existing generators and expansions to existing heat recovery systems. Based on our analysis, expansion of existing systems results in the best opportunity for communities and the REGRP to lower energy costs.

Heat Recovery Costs, Performance and Lessons Learned

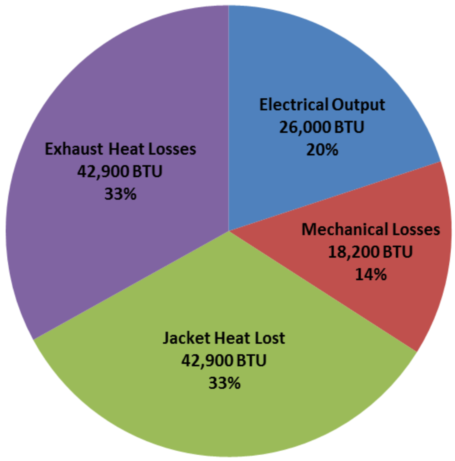
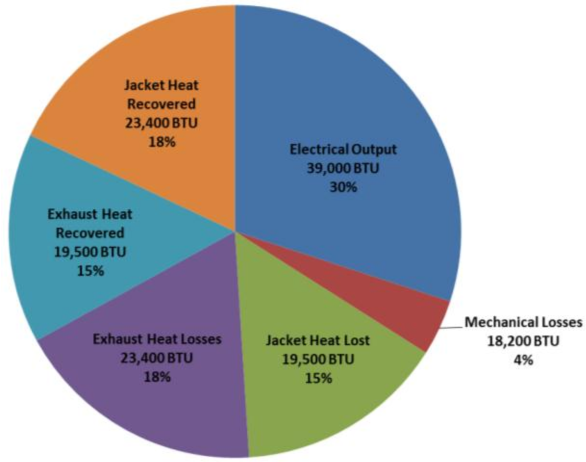
It is difficult to compare the economics of the heat recovery systems installed under the REGRP program because each project is unique to an individual community and very local conditions and circumstances. Most involve the direct use of recovered heat, although the size of the project varies considerably. Two projects, including the Cordova and Kotzebue heat recovery construction projects involve the installation of heat to electric power systems. Cordova is in the final stages of commissioning a Pratt and Whitney organic Rankine cycle 280 kW system, while Kotzebue has proposed the installation of a smaller ammonia-cycle system designed by Energy Concepts.

Because few of these systems have operated long enough to provide quantitative data, the true impact is difficult to assess through projects funded under the REGRP alone. However, through both pre-construction cost-benefit ratio estimates as well as data from operational systems funded outside the REGRP, the potential positive impact per dollar spent is quite high. This is because heat recovery is in essence an efficiency improvement, taking maximum advantage of fuel already shipped into a community for the purpose of generating electric power.

Both through in field performance monitoring by AVEC, as well as a research project conducted by the University of Alaska Fairbanks, significant efficiency gains were reported as the graphic below highlighting the performance of older diesel gensets against newer equipment with installed heat recovery.[56]

[56] Alaska Energy Wiki, Alaska Center for Energy and Power

Figure 5.14 Efficiency Gains from New Diesel Gensets with Heat Recovery

<table>
<tr><th>Old Technology</th><th>New Technology</th></tr>
<tr><td>
</td>
<td>
</td></tr>
<tr><td>80% Wasted, 20% Utilized</td><td>37% Wasted, 63% Utilized</td></tr>
</table>

Barriers

- Standardization of system design for both diesel generators and heat recovery systems has been a priority for the PowerHouse Upgrade Program at AEA. This is an important factor for both reducing cost and fostering consistency in the performance of systems.

- Operation and maintenance of the heat recovery system is also a critical factor as the particulate emissions from the generator exhaust can have significantly reduce the heat recovery system performance if not well maintained. It has been reported that some systems installed in communities are not operational.

6. Market Development

Overview

In this section we review the Alaska renewable energy market development from the REGRP inception in 2008 to the end of 2011, drawing upon input from state energy data, resource working group reports, a subset of individual interviews with industry stakeholders and other existing reports on renewable energy in Alaska.

Although the direct costs and savings of the program are critical for understanding the impact of a renewable energy program, longer term goals for developing a sustainable industry for renewable energy projects is equally important. In this section we will review:

- *A high level overview of the REGRP performance within the overall context of energy in Alaska*
- *Job statistics for RE in Alaska from 2008-2012, including training for renewable energy jobs.*
- *Impacts of the renewable energy projects on PCE communities and the funding for the state program.*
- *Development of conferences, organizations, reports and resources developed around the REGRP*

Alaska boasts an abundance of fossil and renewable resources that rival many countries, but Alaskan consumers pay among the highest rates for heating and electricity in the country—50% higher than the U.S. average[57]. According to the Energy Information Administration, in 2012, Alaska ranked second in 2012 for high residential electricity costs with an average price of $17.91 cents/kWh as compared to the national average of 11.52 cents/kWh. However many of Alaska's rural villages mirror 1st ranked Hawaii's $37.05 cents/kWh.

The most recent numbers published in 2009 indicate that Alaska receives the majority of its electrical generation from natural gas (39.5%), petroleum (15%), hydroelectric (14.6%) and coal (6.1%) with no discernible generation coming from non-hydro renewables.[58] Alaska ranks 48th of all states in non-hydro renewables, largely due to the absence of a transmission system capable of transporting the remote renewable energy resources to population centers.[59]

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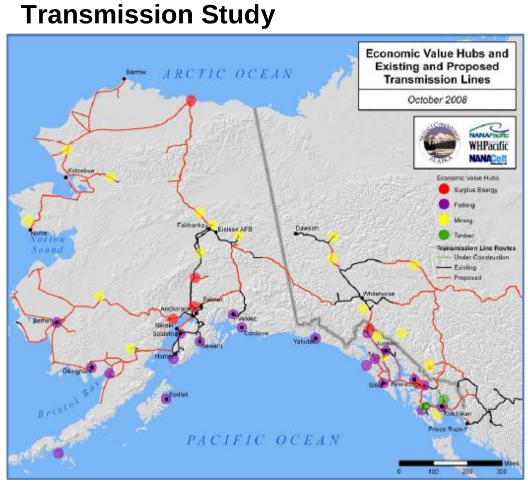
[57] EIA SEDS Database
[58] Based on 2010 Alaska Power Statistics Tables wind power has increased its share of the generation to 0.3% and projected by AEA to represent 2% of Alaska's electrical generation by 2012.
[59] EIA SEDS Database

Forces at work for Alaska's energy challenges:

- Harsh climate, including long, dark and cold winters and corresponding high energy needs.
- High cost of fuel for generation, due to export of the majority of crude and import of almost all refined fuels aside from some transportation fuel refined at two local refineries. In addition, due to limited interconnections of transmission and distribution systems between rural communities in Alaska, the majority of the fuel is transported significant distances.
- Lack of economies of scale due to fewer ratepayers. Nevertheless, electricity consumption is growing much faster in Alaska than in the rest of the US with an estimated consumption of 55 barrels of oil per year per person (25 barrels per year in rural AK) .[60] Alaska ranks 2nd nationally in energy consumption per capita[61], though this may be attributed largely to increased commercial and industrial activity and jet fuel usage associated with travel within the state.[62]
- Most electricity consumers outside of the major cities are not linked to utility scale electric power grid via transmission and distribution lines. Rural communities rely primarily on mini-grids supplied by diesel-electric generators.

In rural Alaska nearly 80% of communities are dependent on imported diesel for their primary energy needs[63] to run generators and heat their homes with fuel oil, leaving them vulnerable to fluctuating prices and victim to significant delivery surcharges. Since 2006, the percentage of individual household income the average rural Alaskan spends on energy shifted from 20% to 50% due to increasing costs.[64]

Figure 6.1 2008 Denali Commission Transmission Study



One additional struggle facing Alaska despite impressive renewable resources is that many of these resources are stranded away from customers, rendering them uneconomic to develop due to high transmission costs and/or a low customer base. In 2008, the Denali Commission funded a study of potential transmission line extensions and interties to build out the electrical infrastructure enjoyed by the rest of the developed world. With recent innovations in technology and connecting with these stranded resources through

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[60] Energy for a Sustainable Alaska: The Rural Conundrum. Commonwealth North, February 2012.
[61] EIA Database.
[62] Reporting from Railbelt utilities suggests a downward trend of 5-9% of residential electricity usage during the period from 2000 to 2011. Source: AEA September 2012.
[63] Energy for a Sustainable Alaska: The Rural Conundrum. Commonwealth North, February 2012.
[64] Energy for a Sustainable Alaska: The Rural Conundrum. Commonwealth North, February 2012.

transmission or potentially co-locating processing industries in the vicinity of resources has been investigated as an opportunity for Alaska. Striking this balance of investing in transmission infrastructure will be important to further support development of RE resources in both rural and Railbelt areas of the state.

In addition to economic challenges, integrating renewables on small village microgrids presents integration and power quality issues that limit the level of penetration the renewable system can achieve, resulting in lower displaced fuel. Even Alaska's road system-based 'Railbelt grid', is considered a micro-grid in relation to the large integrated grid systems in the lower 48 and Europe. This infrastructure presents interesting and unique challenges for implementing energy solutions to maximize the penetration of renewables.

One silver lining of high energy prices is that products and technologies not considered economically viable options elsewhere in the country, pencil out in Alaska, making it an excellent place to demonstrate new technologies and a potential launching place for global solutions to other remote or rural villages and industrial locations.

Framing the Renewable Energy Fund

The Renewable Energy Fund was identified by Chris Rose, Executive Director of the Renewable Energy Alaska Project (REAP), as one of his fledgling organization's top priorities in 2006. Renewable energy in the form of conventional hydropower plants had been a mainstay of southeast Alaska and as a percentage of the Railbelt generation with the state-owned Bradley Lake hydro project for decades, however, other renewable energy solutions - most visibly wind - were just being reintroduced with mixed success after a series of failures in the 1980's. According to EIS database, in 2006, the energy mix for Alaska was 18% renewable (99% hydro) with the remainder as fossil fuels. Fossil fuel generation had seen a slight decline, primarily due to a reduction in natural gas usage with oil and coal remaining fairly stable.

At that point in Alaskan energy history, prices were climbing and in 2006/2007, the worldwide oil price spike hit Alaska at an exponential level. Although the higher per barrel price resulted in increased oil revenues for the state operating fund, energy prices, specifically in rural Alaska, hit unsustainable levels, compounding the already high prices with additional costs associated with transporting the fuel across the rural landscape by barge and air freight. The impact was felt in urban communities as well, especially Fairbanks which utilizes heating oil as its primary heating source, instead of the locally extracted/natural gas infrastructure surrounding Anchorage.

This crises combined with the budget surplus from higher oil prices provided the political capital necessary to enact change. In 2008, Governor Sarah Palin announced a state goal of 50% electrical generation from renewable energy sources by 2025. This target mapped closely with the passage HB 152 in 2008 which created the Renewable Energy Grant Fund and positioned Alaska as a national leader in funding for renewable energy.

The RE Fund was created with the goal of funding projects to install commercialized technology that could make an immediate difference for Alaskans.

While the RE Fund was approved by the legislature over 4 years ago, the state is just starting to see the first years of actual production data due to the application, contracting processes, permitting and construction. The exact impact of the RE Fund on the Alaska Renewables market is difficult to empirically discern due to a lack of granularity in the data reported at the state level on organizations specifically focused on renewable energy.

A look at the evolution of renewables development in Alaska can identify correlative examples of growth since the inception of the program, but not necessarily causation.

State Leadership and Policy Action

Affirming the Goal:

- Former Governor Sarah Palin's initial energy production goal was reaffirmed by Governor Sean Parnell in the July 2010, *Alaska Energy Pathway Toward Energy Independence.* The document also added an increase in energy efficiency by 20% by 2020.[65]
- This pledge was adopted by the legislature in 2010 through House Bill 306 which established a 50% by 2025 renewable electricity goal for the state through legislative intent. One of the most aggressive in the country, it is not currently backed up with any codified policies or interim performance metrics to gauge progress and also sets a goal to reduce per capita electricity use in the state by 15% by 2020.

Setting a State Energy Policy:

- SB220 was designed as an 'omnibus energy bill', and declared the need for a statewide energy policy. It included a number of components including providing the Alaska Housing Finance Corporation bonding power to create a $250 million revolving loan fund to help finance energy-efficiency retrofits in public buildings across the state.

Program Creation:

- **Emerging Energy Technology Fund** – Once the RE Fund was passed and the $100M authorized under Round 1, it rendered $5M set aside by the Denali Commission to support of renewable energy projects in 2006 unnecessary. The Denali Commission chose to invest the funding in a pilot program called the

[65] Alaska Energy Pathway Towards Energy Independence. Alaska Energy Authority, July 2010.

Emerging Energy Technology Fund to provide a funding mechanism for demonstration projects not eligible for the RE Fund. Based on the success of that program, in 2011, the State of Alaska created the Emerging Energy Technology program under SB220, and provided funding in the amount of $4.8M which was matched by the Denali Commission with $4.1M for a total of $8.9M.

- **Weatherization** - Since 2008, the State of Alaska has authorized $511M in expenditures to support weatherization efforts. This program was developed in tandem with the RE Fund, as it was recognized that energy efficiency improvements were critical to an effective overall management strategy to stabilize energy costs, particularly for rural Alaska where weatherization is the clearest path to reducing energy costs for an individual home owner.
- **RE Fund -** HB250, signed by Governor Parnell on May 2nd, 2012, reauthorized the Renewable Energy Grant Fund Program through 2023 with the intent of continued funding at a level of $50M per year.

Other Financing Mechanisms:

- **SB 25 - Alaska's Sustainable Energy Transmission and Supply Development Fund (SETS):** It has been recognized that the RE Fund is a grant only program and is not an adequate funding vehicle to fund very large projects appropriate to applications such as the Railbelt. Therefore, SB25, passed in 2012, authorizes the fund to be capitalized in the amount of $125M in FY13 with the goal of enabling a revolving loan program through the Alaska Industrial Development and Export Authority for energy projects (renewable and non-renewable).

Resource Specific Policy:

- **Geothermal Regulatory Changes** - One of the consequences of increased interest in geothermal energy spurred in part by the RE Fund is a change in regulatory statutes for geothermal energy. Prior to 2009, geothermal resources under 150°C were regulated by DNR as water resources. This was primarily because resources below this temperature were not considered to be developable for power generation purposes. With the development of the Chena Hot Springs 400 kW geothermal plant using geothermal fluid under 75°C and the subsequent submission of several RE Fund applications for additional low temerature resource exploration and development projects, it was apparent that the threshold of 150°C was not necessarily a barrier to power generation given modern equipment. For this reason, jurisdiction over geothermal exploration and development was moved to the Alaska Oil and Gas Conservation Commission for all geothermal exploration and development projects over 150°C, or for projects below 150°C intended for commercial power or heat sales.

Regional Planning

In July of 2010, the Alaska Energy Authority created the Alaska Energy Pathway Toward Energy Independence which provided Alaskans with a road map that each community could use to make energy decisions to help the state reach the 50% by 2025 goal.

Utilizing a regional approach, it provided detailed data for each community including generation capacity, costs of energy, potential resources, etc and utilized them in case scenarios that could be used as guidelines for action.

The Pathway estimated that Alaska would spend approximately $5B in diesel fuel over the next 20 years in rural Alaska and $60B along the Railbelt.[66] When compared against their total estimated investment statewide to develop all renewable projects that were economically viable ($7.3B for Railbelt) it made the case that investment in these technologies now may make economic sense in the long run.

A key priority of the Energy Pathway to achieve these goals was to continue to fund the Renewable Energy Fund. However, it also recognized the limitation of the grant fund in the long term and recommend adding loans to the project financing options available from the state. [67]

Motivated by energy security, economic development, and AEA's mission to lower the cost of energy in Alaska, the Pathway also detailed plans to decrease electric non-Railbelt renewables from the current 63% (primarily hydro) to 91% at an approximate cost of $2.8B following a regional planning model.

Since 2008, AEA has used this model to create two large scale regional plans starting with the Integrated Railbelt Resources Plan in 2009 and Southeast Integrated Resources Plan which was completed in 2011 as a direct outcome of the Pathway's focus.

In addition, AEA has started to further develop a regional planning model around these goals. In the past year, they have funded Regional Planning efforts throughout the state and hired a Regional Planning Coordinator and two technical advisors to assist with this effort.

Business Indicators of Market Development

Business Licenses

A review of business licenses reveals a marked increase in the number of construction and engineering organizations in the state over the past 5 years, it is unclear what part of that growth can be linked to the influx of renewable energy spending by the state. This lack of detail is compounded by the fact that the fossil energy extraction industry is significantly larger and likely obscures any clarity in shared job sectors like engineering and construction.

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[66] Alaska Energy Pathway July 2010 Alaska Energy Authority
[67] Alaska Energy Pathway Toward Energy Independence. Alaska Energy Authority, July 2010.

Cost Stabilization

The RE Fund insulates small Alaska communities from potential future price increases in diesel fuel. In others words, the Renewable Energy fund, can be viewed as a hedge against future price increases, rather than a significant reduction in energy costs to the individual home owner. This is in contrast to the Weatherization and Efficiency programs, also managed by the state, which can and often do show an immediate savings for residents who participate in those programs.

There is anecdotal information that in some cases local energy costs can actually increase certain segments of a community if a renewable energy system is installed. For example, if a biomass project that uses cordwood sets a going rate for delivered wood at $250/ton in the interest of providing well-paying employment opportunities during the winter months when most harvesting is completed, that rate will drive rates for delivered wood throughout the community. If the previously established rate was much lower, it could force an increase in heating costs for community members dependent on the purchase of delivered cord wood.

Local Business Support

There are examples where energy projects funded through state or other funding sources have had a substantial positive impact on a small, niche market within a community often centered upon a single business enterprise or cluster or businesses that benefit the community through an increase in revenue, or reduced costs for operation.

One example is a 20-Ton absorption chiller installed in Kotzebue, Alaska. This unit, custom designed for Kotzebue Electric Association, was originally funded by AEA in 1995, prior to the development of the REF. However, KEA was awarded REF funds to repair and upgrade the unit under Round 2. The system uses recovered heat from the diesel power plant to produce 10 tons of flake ice per day during the fishing season.

By making low-cost ice available to local fisherman, commercially caught salmon can be placed on ice shortly after they are caught, increasing both the quality of the product and the corresponding market value. The increase in market value will provide increased revenue to the local fisherman over the 17 year operating lifetime of the project.

Impact on Jobs

One key indicator of economic impact is job growth. The Alaska Green Jobs Report, published in June 2011 by the Department of Labor estimated that during 2010, there were 145 green occupations or 4973 green jobs in Alaska, representing 1.7% of the state's private and local government employment. Of this number, renewable energy accounted for 13% of those jobs, and primarily existed among utilities and local government.

These numbers are influenced by a somewhat subjective scoring multiplier according to the percentage of time an employee spends doing renewable focused tasks. With very few jobs receiving scores over 6 or 7 one could assume that many of these jobs were not necessarily created by the RE industry, but instead indicates that much of this work was added on to existing positions to support a broader energy industry focused on fossil extraction and generation as well as renewables. The level of data we found did not support this second level of analysis.

The report did uncover some growth trends based on direct employer questioning. Around 22% of the green employers surveyed reported they had added additional jobs due to increased demand for green goods and services and 14% of firms across industries said they were adding jobs in response to green demand. In addition, 36% indicated sending workers for additional green jobs training, however as with all of these figures, it is not reported how renewable-specific jobs. With this baseline data available in the future, this may be a more worthwhile exercise to conduct every few years, perhaps with an increased level of granularity for renewables.

RE Fund Job Analysis

While the greater renewable energy industry job determination was somewhat incomplete, we utilized a basic economic model with common multipliers to gain information about the projects the RE Fund supports.

For the RE Fund, we used a standard economic model which utilizes job data to average employment per unit energy produced over a project's lifetime. While the model is based on plant operations, it can be tailored to fit any position involving fuel offsets.

Based on performance data or, if not available, proposal projections, the model allows for the estimation of specific factors (here Mmbtu's displaced) that then interact with standard multiplier assumptions to estimate the average number of jobs that will be produced by the project over its lifetime (see Appendix A).

One time employment factors such as construction and installation can be averaged over plant lifetime to obtain an average employment number that can be directly added to ongoing employment factors such as operations and maintenance. Key variables include capacity factor, type of resource/technology. One job is full time employment for one person for a duration of 1 year.

Employing this model for the RE Fund program estimated a creation of 197 jobs based on the amount of energy being displaced (or projected displacement).

Organizational Growth in the Energy Sector

While there was a lack of statewide data reflecting the growth of the renewable energy related organizations, anecdotal evidence provided by individual companies highlights the evolution of the industry.

Renewable Energy Alaska Project (REAP)[68]

REAP was formed in 2004 by Executive Director Chris Rose with the goal of promoting the use of renewable energy in Alaska. It has since grown to include more than 70 organizational and contributing members representing a diverse coalition of small and large Alaska electric utilities, environmental groups, consumer groups, businesses, Alaska Native organizations, and municipal, state and federal entities. REAP was Alaska's first and remains its only education and advocacy group focused solely on renewable energy.

Director Chris Rose and the Board of Directors of REAP representing a variety of key energy stakeholders are credited for laying much of the groundwork to draft and pass the legislation which enabled the creation of the RE Fund

Since 2004 REAP has grown from a $110,000 budget with one staff member to an $800,000 organization with 5 staff. In 2007, REAP reported 48 members. By 2012, REAP membership had grown to 83. The largest growth was in their Business and Consumer Organization categories.

Table 6.1 Renewable Energy Alaska Project Membership Categories

Category	2007	2012
Total Members	**48**	**83**
Large Utilities	5	6
Small Utilities	11	10
Businesses	13	36
Conservation	4	7
Consumer Groups	5	14
Native Organizations	4	6
Advisory Members	6	7

Director Chris Rose reports that they have seen an increase in out of state players and local consulting firms focused on energy projects. While he does not link this growth directly to the RE Fund, he does believe it reflects the strength of the industry and believes the RE Fund reinforces that. He points to Alaska's recognized global leadership in Wind-diesel technologies as a direct result of the RE Fund investment.

[68] Interview Chris Rose 7.13.12, Interview Stephanie Nowers 7.10.12, email Erin Jones 7.10.12

Alaska Village Electric Cooperative[69]

AVEC began integrating renewable energy into their 52 rural power systems in 2003 as part of an ambitious goal of displacing 25% of their diesel fuel   Since these projects were constructed before the Renewable Energy Fund, they were financed through a variety of other means including the Denali Commission, Rural Utility Services and other state support, some bond sales, AVEC cash match through long term loan. Through this process, AVEC installed renewable-diesel hybrid systems (all wind) in 5 of their 52 villages.

Since the inception of the Renewable Energy Fund, AVEC has used this opportunity to finance an additional 7 wind systems with others in the planning stages. AVEC credits the RE Fund with supporting the development of their renewable projects more quickly than in absence of the program. This reflects the barrier communities face in justifying the capital investment required for financing projects.

AVEC has not added any additional permanent jobs due to the RE Fund, instead they have trained their existing village technicians to handle O&M needs of the turbines, although they have created additional temporary jobs for the construction of the wind turbines including temporary project managers and construction technicians.

Impact to the State

They do feel that the RE Fund has benefited the state by creating enough of a market to produce in-state experts on design, engineering and construction of wind projects. Before the fund was in place, they had to bring in experts from the lower 48 to assist with those tasks. Now, they can turn to in state companies like STG, V3, BBFM, Golder, etc. It has also resulted in more in-house expertise within AVEC employees.

In order to increase the impact to their organization and the 52 communities they serve, AVEC believes more projects need to become operational. They believe the RE Fund can improve its impact by increasing the dollars available for construction projects which would provide bigger paybacks for state investment.

WHPacific[70]

WHPacific is an engineering services company wholly owned and operated by the NANA Regional Corporation, the regional corporation for northwest arctic Alaska, including Kotzebue. The majority of their $65-70M in sales are based in the lower 48, however, they do offer quite a few services to the resource extraction industry in Alaska. In 2008, WHPacific initiated an energy strategic plan to gain involvement in the state of Alaska's energy solutions focused on remote power solutions in the NANA region and beyond, including distributed generation, O&M, energy audits, and some additional

[69] Interview Meera Kohler and Brent Petrie, AVEC. 6.29.12
[70] Interview Jay Hermanson and Kat Keith, WH Pacific 7.3.12

North Slope services. They indicated that this new focus was due to the Renewable Energy Fund.

Impact to the Organization

The energy group was approximately $300K in revenues in 2009 and it has grown to over $6.7M for FY12 with an estimated $9M for FY13. WHPacific attributes a significant amount of that growth to the RE Fund. Due to this growth, WHPacific believes they have added approximately 15-20 jobs.

In addition to direct revenue to the bottom line, WHPacific indicates their involvement in RE Fund projects has strengthened their resume with customers outside of Alaska. It has served as a springboard, further building their business due to their credible experience gain through the RE Fund.

Similar to AVEC, WHPacific credits the RE Fund for building key capacity within the organization and throughout the state. "Four years ago, we didn't know a lot, but through these projects we have built capacity and better understand the resources as well as understanding how to manage a successful project to completion.' He also listed the value of understanding how AEA manages a project as a positive area of growth thanks to the fund.

Impact to the State

From a statewide perspective, they too pointed at the growth in installed capacity of wind to make the point that the RE Fund has had significant impact on Alaska. In 2012, the state went from 15.3MW to an anticipated 63.8MW[71] by the end of this year in rural Alaska and throughout the Railbelt.

WHPacific believes that Alaska should be doing what we can to foster this potential market by rewarding and fostering collaboration between potential applicants to make their funding go much farther. Alaska will be left with expertise project developers in state and can then step up as a global leader.

Alaska Center for Energy and Power[72]

ACEP is an applied energy research group at the University of Alaska Fairbanks under the Institute of Northern Engineering. It was formed in 2008 by INE Director Dan White and Gwen Holdmann as a vehicle to provide critical data and analysis to make informed decisions on energy.

ACEP started in Jan 2008 with a small amount of start up support from the university to fund the director's salary and their funding was vetoed by Governor Palin during the 2008 legislative session for FY09. From $0 general fund dollars and a few limited projects in 2008, ACEP has grown to a $750,000 annual general fund budget with over

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[71] AEA projection based on RE Fund project status reporting.
[72] Gwen Holdmann, ACEP 6.12

$16M currently in competitively-awarded projects and has grown from a 3 person organization to 12 full time staff and 30+ affiliated faculty.

RE Fund Support and Communication: conferences, workshops, working groups and publications

Alaska has several mechanisms to bring experts, practitioners and interested stakeholders together to support renewable energy projects in the state. While many of these resources existed before the Renewable Energy Fund, many have experienced significant growth and relevance since 2008.

Rural Energy Conference

The largest conference that addresses renewable energy projects in Alaska is the Rural Energy Conference which is run by the Alaska Energy Authority and the Alaska Center for Energy and Power. This conference is scheduled every 18 months and while the primary purpose of the Rural Energy Conference was - and remains - to discuss ways to optimize diesel power houses, through the years, this conference has also become the primary vehicle to discuss the integration of renewables onto small grid systems and provide updates on performance data.

The first conference was in 2002 in Fairbanks with an attendance of 250[73]. Since the inception of the RE Fund, this conference has grown significantly larger. By 2007 the conference had grown to 362 then saw a major jump to over 500 participants in 2008, 2009 and 2010 with over 600 expected in 2013. [74]

This conference also provides an opportunity for vendors to connect with rural Alaskans, project managers and funders. The 2012 conference saw over 30 vendor tables and since 2008, the conference has run out of space for vendor (non-sponsor) tables.

During interviews for the RE Fund process evaluation, many interviewees listed this conference as one of the primary means to hear information about the RE Fund projects and their performance. Ike Towerak, General Manager of Unalakleet Village Electric Cooperative, indicated that his RE Fund project would not have happened without the opportunity to meet with project developers at the Rural Energy Conference.[75]

Business of Clean Energy Alaska Conference[76]

Since the inception of the RE Fund, a new conference called the Business of Clean Energy was created and is now in its 4th year. It is an annual conference focused on building and supporting a clean energy economy in the state around renewables and energy efficiency. This conference typically focuses on teaming in state and out of state

[73] Rebecca Garrett, AEA.
[74] Rural Energy Conference Registration Statistics
[75] Interview Ike Towerak, UVEC 1.24.12
[76] Chris Rose, Stephanie Nowers, Erin Jones, REAP interviews and emails July 2012.

experts on panels to discuss success stories from the lower 48 and around the world and the potential here in Alaska. When the conference cycles dictate that BCEA and the REC occur 6 months away from each other, BCEA add project updates, typically from the RE Fund projects.

It has enjoyed a relatively stable attendance of around 300 with an increasing number of vendors, maxing out at 48 this year.

Workshops

In addition to these major conferences covering broad range of topics, over the past 3 years there have been a variety of technology specific workshops focused on renewable topics, many led by either AEA and/or ACEP. The first of these conferences took place in the summer of 2009 around geothermal energy. Since then Alaska hosted the International Wind Diesel Workshop in Spring 2011, the Biomass conference later that year, a hydrokinetic workshop in the fall of 2011, the Energy Storage workshop June 2012 and a second Biomass workshop summer 2012. These workshops typically allow for deeper investigations into Alaska specific applications than the major conferences can provide. These focused sessions bring together 75-100 people in the single day conferences to 200-300 at some of the more popular technologies like wind and biomass.

Working Groups

In addition to conferences, there are six working groups focused on renewable resources or related topics that support the energy industry in Alaska. Program managers from AEA manage the majority of the working groups (hydropower, biomass, geothermal, hydrokinetics, and energy efficiency). The Wind working group is run by Renewable Energy Alaska Project through a national grant from Wind Powering America and advised by wind program staff from AEA, NREL and ACEP.

While these working groups were in existence before the Renewable Energy Fund, the number of participants and activity level of meeting groups has increased in almost all cases aside from the geothermal working group, which has seen a decline in successful projects. The majority of working groups now meet at least 3 times each year with active members ranging from 20-40 participants and total group sizes between 100-200 names. Wind Working Group manager, Stephanie Nowers indicates that their last remote meeting in Kotzebue saw over 70 people attend in person with 8 additional over the phone. She also noted an increasing number of participants from outside of Alaska.[77]

Renewable Energy Atlas

AEA published an inventory of energy infrastructure and resources called the Renewable Energy Atlas in 2007, one year before the RE Fund was created. The Atlas was later revised in 2009 and again in 2011 as new resource information became available. While the versions are similar, revisions to the narrative adding project examples from every

[77] Stephanie Nowers, REAP emails July 2012

renewable energy subsector, reflecting the diversity and reach of the RE Fund by that stage. In the 2011 Atlas, a specific section summarizing the RE Fund and its performance in supporting the development of renewable energy resources in the state. An appreciable change to the wind resource maps in 2011 reflects the addition of statewide high-resolution wind data, especially in regards to the resolution of the data over Kodiak, the North Slope, and through the Aleutians. The impact of the RE Fund is highlighted by the significant increase in the number of wind projects either under construction or operational in 2009 and 2011. The 2007 Atlas registered 2 MW of wind energy and by 2009, the map was adjusted to show that the wind capacity had doubled to 4MW. At the end of the 5th year, if all goes according to plan, that number will increase to potentially 57MW largely due to two Railbelt wind projects – Eva Creek (24.6MW) and Fire Island (17.6MW)[78] which should be online by the fall of 2012 thanks, in part, to grants from the RE Fund.[79]

Alaska Energy Wiki

The Alaska Energy Wiki is designed to make information about energy in Alaska accessible for a wide audience to quickly find relevant information. It includes information about energy resources and the technology developed to utilize those resources as well as some of the challenges that these resources and technologies present. In addition, the Alaska Energy Wiki contains information about many of the energy related projects across the state and their current status. Additionally, the Alaska Energy Wiki provides information and links to energy events in Alaska, as well as state, local, and federal organizations that focus on energy related issues.

Wind Community Toolkit

This hands-on, action-oriented booklet was published in 2011 by REAP to help communities identify tangible next steps, questions and resources if they were interested in bringing a wind project to their community.

Wind Best-Practices Guide

Currently in peer review, the guide acts as a technical textbook for best practices in implementing wind with diesel-hybrid systems.

Many other reports, presentations and general information brochures exist to provide additional information to organizations or communities interested in renewable energy. Links can be generally be found through REAP's website or ACEP's publication database.

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[78] Fire Island is currently being developed to 17.6MW, but has the ability to be expanded to 52.8MW in supplemental phases.
[79] Renewable Energy Atlas 2007 and 2009.

7. Conclusions

The REGRP has played an important role in supporting the development of renewable energy systems in Alaska, serving both remote and Railbelt communities with significant financial assistance. There is great potential for continued REGRP support to help reduce energy costs in rural Alaska and to help the state tap more of its substantial renewable energy resources. Looking forward, the REGRP has already created a solid foundation for accelerating the development of renewable energy markets and infrastructure in Alaska – and created a robust pipeline for near term project development.

This evaluation has two primary areas of focus: 1) To characterize the economic benefits as estimated by the applicants for projects in the REGRP construction portfolio in 2011 and compare against the actual performance reported in 2011 and 2) Assess the REGRP's progress in meeting the stated priorities of the legislature in supporting cost-effective projects on an equitable geographic basis and prioritizing projects in the communities experiencing the highest energy costs.

In conclusion, despite the high costs and challenges associated with developing renewable energy across the state, the REGRP is found to be cost-effective at both the program and individual renewable resource sector level providing a significant net benefit to the state. Underperformance, or alternatively, overestimation of the energy savings in the application process, is relatively broad based. Although this can be attributed in part to the early startup performance of many projects in 2010 and 2011, it is a recommended area of continued focus for AEA. Improving the tracking of total system costs and performance will contribute to future evaluation efforts, as well as assisting in ongoing communications by program staff with industry stakeholders in establishing best practices for project development.

The benefits of the renewable energy development in the state were characterized as having primary economic benefits – avoided fuel, operation and maintenance costs, as well as reducing expenditures through the Power Cost Equalization program – and secondary benefits including avoided carbon emissions and increased employment in the state. As the secondary benefits have direct implications to the state in creating jobs, as well as improving air quality in Alaskan communities, creating discrete metrics for capturing these benefits going forward will increase the value of the REGRP to the state and the cost-effectiveness of individual projects.

The wide array of renewable resources, applicant types and geographic regions supported by the REGRP represents an ongoing challenge to AEA in appropriately balancing equitable distribution of funds and prioritizing projects in the communities experiencing the highest energy costs. However, in this area as well, the REGRP is found to be successful with two-thirds of funding being appropriated to communities with higher costs of energy and a generally consistent funding success rate across different regions in the state.

The AEA is well positioned to continue providing support through the REGRP and to serve as an increasing knowledge base for lessons learned that will help improve future project development and operations.

Appendix A: RE Jobs in Alaska

In order to develop a high level assessment of job impacts from the REGRP, estimates for individual renewable energy resource sectors were utilized from an evaluation from the University of California – Berkeley, which compiled averages from previous RE job impact evaluations. The averages are applied against REGRP projects currently in operation or in the construction phase (post-grant) to develop an estimate for an aggregate of total employment in person-years, as well as job estimates based on the estimated project lifetime. As noted in the table below the average for job impacts is based on both the shorter term employment in construction, installation and maintenance (CIM) and the longer term employment in operation and maintenance (O&M).

Work-hrs per year	2000	Capacity Factor	Equipment lifetime (years)	Employment Components			Average Employment Over Life of Facility							
							Total jobs/MWp		Total jobs/MWa		Total person-yrs/GWh			
Energy Technology	Source of Numbers			CIM (person-years/ MWp)	O&M (jobs/ MWp)	Fuel extraction & processing (person-yrs/GWh)	CIM	O&M and fuel process-ing	CIM	O&M and fuel process-ing	CIM	O&M and fuel process-ing	Total	Avg
Biomass 1	EPRI 2001	85%	40	4.29	1.53	0.00	0.11	1.53	0.13	1.80	0.01	0.21	0.22	0.21
Biomass 2	REPP2001	85%	40	8.50	0.24	0.13	0.21	1.21	0.25	1.42	0.03	0.16	0.19	
Geothermal 1	WGA 2005	90%	40	6.43	1.79	0.00	0.16	1.79	0.18	1.98	0.02	0.23	0.25	
Geothermal 2	CALPIRG 2002	90%	40	17.50	1.70	0.00	0.44	1.70	0.49	1.89	0.06	0.22	0.27	0.25
Geothermal 3	EPRI 2001	90%	40	4.00	1.67	0.00	0.10	1.67	0.11	1.86	0.01	0.21	0.22	
Landfill Gas 1	CALPIRG 2002	85%	40	21.30	7.80	0.00	0.53	7.80	0.63	9.18	0.07	1.05	1.12	0.72
Landfill Gas 2	EPRI 2001	85%	40	3.71	2.28	0.00	0.09	2.28	0.11	2.68	0.01	0.31	0.32	
Small Hydro	EPRI 2001	55%	40	5.71	1.14	0.00	0.14	1.14	0.26	2.07	0.03	0.24	0.27	0.27
Solar PV 1	EPIA 2006	20%	25	37.00	1.00	0.00	1.48	1.00	7.40	5.00	0.84	0.57	1.42	
Solar PV 2	REPP 2006	20%	25	32.34	0.37	0.00	1.29	0.37	6.47	1.85	0.74	0.21	0.95	0.87
Solar PV 3	EPRI 2001	20%	25	7.14	0.12	0.00	0.29	0.12	1.43	0.60	0.16	0.07	0.23	
Solar Thermal 1	NREL 2008	40%	25	10.31	1.00	0.00	0.41	1.00	1.03	2.50	0.12	0.29	0.40	
Solar Thermal 2	NREL 2006	40%	25	4.50	0.38	0.00	0.18	0.38	0.45	0.95	0.05	0.11	0.16	0.23
Solar Thermal 3	EPRI 2001	40%	25	5.71	0.22	0.00	0.23	0.22	0.57	0.55	0.07	0.06	0.13	
Wind 1	EWEA 2008	35%	25	10.10	0.40	0.00	0.40	0.40	1.15	1.14	0.13	0.13	0.26	
Wind 2	REPP 2006	35%	25	3.80	0.14	0.00	0.15	0.14	0.43	0.41	0.05	0.05	0.10	
Wind 3	McKinsey 2006	35%	25	10.96	0.18	0.00	0.44	0.18	1.25	0.50	0.14	0.06	0.20	0.17
Wind 4	CALPIRG 2002	35%	25	7.40	0.20	0.00	0.30	0.20	0.85	0.57	0.10	0.07	0.16	
Wind 5	EPRI 2001	35%	25	2.57	0.29	0.00	0.10	0.29	0.29	0.83	0.03	0.09	0.13	
Carbon Capture & Storage	J. Friedmann, 2009	80%	40	20.48	0.31	0.06	0.51	0.73	0.64	0.91	0.07	0.10	0.18	0.18
Nuclear	INEEL 2004	90%	40	15.20	0.70	0.00	0.38	0.70	0.42	0.78	0.05	0.09	0.14	0.14
Coal	REPP, 2001	80%	40	8.50	0.18	0.06	0.21	0.59	0.27	0.74	0.03	0.08	0.11	0.11
Natural Gas	CALPIRG 2002	85%	40	1.02	0.10	0.09	0.03	0.77	0.03	0.91	0.00	0.10	0.11	0.11
Energy Efficiency 1	ACEEE 2008	100%	20										0.17	0.38
Energy Efficiency 2	J. Goldemberg 2009	100%	20										0.59	

Source: Max Wei, Shana Patadia, Daniel Kammen, *"Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US?"*, Energy Policy, November 14, 2009.

Appendix B: List of Impact Evaluation Interviewees

The list of phone interviews, both in-person and phone, were chosen to reflect the breadth of stakeholders affiliated with the REGRP and the diversity of perspectives and input that they could provide a balanced evaluation of the program.

LAST	FIRST	TITLE	ORGANIZATION	TYPE	REGION
Crimp	Peter	Deputy Director - AEEE	AEA	Current AEA	ANC
Fay	Ginny	Project Manager, Economic Analysis	ISER	ISER	ANC
Hermanson	Jay	Program Manager – Energy	WH Pacific/NANA	Advocate	ANC/NW
Keith	Kat	Engineer – Distributed Generation	WH Pacific/NANA, Former WiDAC Coordinator	Advocate	ANC/NW
Kohler	Meera	CEO	Alaska Village Electric Cooperative	Applicant	ANC/Rural
Ott	Douglas	Hydro Program Manager	AEA	Current AEA	ANC
Petrie	Brent	VP community Development	Alaska Village Electric Cooperative	Applicant	ANC/Rural
Plentovich	Devany	Biomass Program Manager	AEA	Current AEA	ANC
Rose	Chris	Executive Director, Business/Organization involved in renewable energy	Renewable Energy Alaska Project	REFAC	ANC
Stromberg	Rich	Wind Program Manager	AEA	Current AEA	ANC
White	Clinton		STG	Project Developer	ANC

Appendix C: Operational, Construction and Pre-Construction Projects

Project ID	Project Name	RE Resource Type	Portfolio
68	Anchorage Landfill	Biomass	Construction
605	Biomass Fuel Dryer Project	Biomass	Construction
53	Biomass-fired Organic Rankine Cycle System	Biomass	Construction
15	Chistochina Central Wood Heating Construction	Biomass	Construction
476	City-Tribe Biomass Energy Conservation	Biomass	Construction
26	Cordova Wood Processing Plant-Purchase and setup	Biomass	Operational
112	Delta Junction Wood Chip Heating	Biomass	Construction
445	District Wood Heating in Fort Yukon	Biomass	Construction
2	Gulkana Central Wood Heating Construction	Biomass	Operational
33	Haines Central Wood Heating Construction	Biomass	Construction
649	Kenny Lake School Wood Fired Boiler	Biomass	Construction
681	Lake and Peninsula Wood Boilers	Biomass	Construction
623	Susitna Valley High School Wood Heat	Biomass	Construction
211-636	Thorne Bay Wood Boiler	Biomass	Construction
49	Tok Wood Heating Construction	Biomass	Operational
453	Alaska Sealife Center Ph II Seawater Heat Pump Project	Geothermal	Construction
705	Japonski Island Boathouse Heat Pump	Geothermal	Construction
999	Juneau Airport Ground Source Heat Pump Constr	Geothermal	Operational
307	Ambler Heat Recovery Construction	Heat Recovery	Construction
22	Cordova Heat Recovery Construction	Heat Recovery	Construction
687	Hoonah Heat Recovery Project	Heat Recovery	Construction

235	Kotzebue Electric Heat Recovery Construction	Heat Recovery	Construction
61	McGrath Heat Recovery Construction	Heat Recovery	Operational
105	North Pole Heat Recovery Construction	Heat Recovery	Operational
244	Point Lay Heat Recovery Construction	Heat Recovery	Construction
448	Saint Paul Fuel Economy Upgrade	Heat Recovery	Construction
271	Unalaska Heat Recovery Construction	Heat Recovery	Construction
469	Akutan Hydroelectric System Repair and Upgrade	Hydro	Construction
58	Chuniisax Creek Hydroelectric Construction	Hydro	Construction
10	Falls Creek Hydroelectric Construction	Hydro	Operational
21-407	Humpback Creek Hydroelectric Construction	Hydro	Operational
23	North Prince of Wales Island Intertie Project	Hydro	Operational
688	Pelican Hydroelectric Upgrade Project	Hydro	Construction
629	Reynolds Creek Hydroelectric Project	Hydro	Construction
672	Snettisham Transmission Line Avalanche Mitigation	Hydro	Construction
653	Terror Lake Unit 3 Hydroelectric Project	Hydro	Construction
37-620	Whitman Lake Project	Hydro	Construction
9	Wrangell Hydro Based Electric Boilers Construction	Hydro	Construction
660	Cook Inlet TidGen Project	Hydrokinetic	Construction
641	Kaltag Solar Construction	Solar	Construction
108	McKinley Village Solar Thermal Construction	Solar	Operational
122-604	Bethel Wind Power Project Times Four	Wind	Construction
102	Delta Area Wind Turbines-Construction	Wind	Operational
302	Emmonak/Alakanuk Wind Design and Construction	Wind	Operational
616	GVEA Eva Creek Wind Turbine Purchase	Wind	Construction
85-518	High Penetration Wind-Battery-Diesel Hybrid	Wind	Construction

110	Kongiganak High Penetration Wind-Diesel Smart Grid	Wind	Construction
107	Kwigillingok High Penetration Wind-Diesel Smart Grid	Wind	Construction
72	Mekoryuk Wind Farm Construction	Wind	Operational
52	Newton Peak Wind Farm	Wind	Construction
89	Nikolski Wind Integration Construction	Wind	Construction
47	Nome Banner Peak Wind Farm Transmission Construction	Wind	Operational
103	Pillar Mountain Wind Project - Construction	Wind	Operational
486	Pilot Point Wind Power & Heat	Wind	Construction
70	Quinhagak Wind Farm Construction	Wind	Operational
317	Sand Point Wind Construction	Wind	Operational
303	Shaktoolik Wind Construction	Wind	Construction
90	St. George Wind Farm Construction	Wind	Construction
503	St. Paul Wind Diesel Project	Wind	Construction
71	Toksook Wind Farm Construction	Wind	Operational
273	Tuntutuliak High Penetration Wind-Diesel Smart Grid	Wind	Construction
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