ALASKA ENERGY AUTHORITY

Renewable Energy Projects Best Practices Guide

Renewable Energy Fund Application

Introduction

This guide contains information that is critical to the success of a Renewable Energy Fund (REF) grant application and project. The intent of this guide is to aid applicants in the submission of a comprehensive project proposal, and to provide additional details specific to renewable energy technologies (solar, wind, hydro, biomass, heat recovery, and heat pumps). Smaller and simpler projects, or those applying for pre-construction phase efforts, may not need to address all the items below. Larger and more complex systems, and projects requesting construction funding are expected to provide a more thorough analysis of the respective systems.

Since the inception of the Rural Energy Fund, Alaska Energy Authority (AEA) has managed dozens of grants for renewable energy projects across the state. Over time, several common planning issues have been identified. Recognizing that each project is unique, this best practice guide does not prescribe a one-size-fits-all approach for project development. Instead, the guide poses a series of questions and prompts to assist an applicant and/or project developer work through the process of developing a successful application and project. A well-planned project is more likely to be a strong proposal, increasing the chance of being selected for funding, while also providing greater benefit(s) for the community in which the project would be located.

Disclaimer: this guide does not cover every element of the REF application requirements as stated in a Request for Applications (RFA) published by AEA for a particular funding round. To ensure compliance with all current application requirements, please read thoroughly and follow the instructions as stated in the RFA under which an application is being submitted. Additionally, the provision of all information stated herein, in an application, does in no way constitute a guarantee of selection and/or funding for the submitted application. Only the execution of an official grant agreement by and between an applicant and AEA constitutes a contractual agreement whereby terms and conditions of funding are thus established.

This guide is intended to address the following components of an REF application and project:

(1) Site selection,
(2) Understanding the existing system,
(3) Proposed system design,
(4) Economic analysis & optimization,
(5) Financing and operations planning, and
(6) Common planning risks.

Project design and optimization is not a straight line, but an iterative process where additional information will require that plans be reevaluated. An applicant is expected to have performed

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the data collection and analysis appropriate for all phase(s) that precede the proposed phase. The applicant should likewise use this guide to help develop the scope of work for the subsequent proposed phase(s).

Each phase of project development investigates two main questions: “Can the project be built?” and “Should the project be built?” Answering these questions requires investigating the technical, economic, environmental, and business aspects of the project. Every project has inherent risks as part of its development; a thorough plan will identify the pertinent risks as early as possible, investigate possible ways to mitigate these risks, and determine if the expected benefits outweigh such risks. Where possible, the guide provides information on the detail and content for each phase (reconnaissance to construction).

A short summary of REF project phases is provided below:

1. **Reconnaissance** is a “desktop” study that should use resource, economic, and operational data that is readily and/or publicly available for the analysis. The study should be sufficient to identify high-level flaws in the use and integration of the resource.

2. **Feasibility and Conceptual Design** studies should include site specific data collection and analysis. The conceptual design (also called a 35% design) will not be sufficient to give to a construction company but will include sufficient detail that a thorough economic and feasibility analysis can be completed. This phase also includes planning for the business and financial aspects of operating the project.

3. **Final Design and Permitting** will make the project “shovel-ready.” The conceptual design will be refined and improved. The specific operational conditions and parameters will be finalized. All business, operational, and financial plans will be finalized.

4. **Construction and commissioning** activities are not specifically addressed in this document.

Contents

1 Site Selection & Assessment

A renewable energy project begins with selecting and understanding a project site: the available resources, the potential restrictions in accessing and controlling the site, and any environmental or other permits that may be needed for project activities.

1.1 Resource assessment

1.1.1 Data to collect & how to collect

All data collection should be done to industry standards, the specifics of which are beyond the scope of this guide. While a reconnaissance project may be a "desktop" study using existing data, a Feasibility study and Conceptual Design is expected to collect robust data. Depending on the amount of investment needed and the uncertainty associated with the resource, longer monitoring may be required and be continued into Final Design and Permitting. The below sections outline the information needed for each type of resource.

1.1.1.1 Biomass

- ☐ A "Large Project" (L) is assumed to be of a size that would require a permit from state forestry (such as under the Forest Resources and Practices Act), or another proper permitting agency. A "Small Project" (S) would not be required to get a permit. "S/L" denotes application for both large and small projects.
    - Long-term harvest sustainability assessment that shows allowable harvest for the life of the project (S/L)
    - All landownership involved in the project (S/L)
    - Detailed 5-year harvest schedule with identified plots (S/L)
    - Assessment of anadromous streams if required (L)
    - Verify timber volumes with field sampling (L)
    - Required harvest equipment (S/L)
    - Access/transportation plan (S/L)
    - Harvest assessment should use high resolution classified systems – 10-m or less resolution (S/L)
    - Requirements of the Forest Practices Act are considered in the wood harvest plan. A plan of operations should be submitted to The State of Alaska Department of Natural Resources – Division of Forestry. (S/L)

1.1.1.2 Heat Pumps

- ☐ Air Source Heat Pumps (ASHP)
- ☐ Ground Source Heat Pumps (GSHP)
- ☐ Seawater – Temperature of input over year (seawater)

1.1.1.3 Heat Recovery

- ☐ Current configuration and condition of power generation system
    - What is the make, model, nameplate kW rating and hours of each diesel genset?
    - Supply and return temperatures required for diesel engines.
    - What are the fuel curves for each unit?
    - What is the heat output for each unit?
    - Do the engines have marine jackets?

- What are the actual reported kWhs per gallon of fuel for this facility?
- Are upgrades or replacements planned for any key system components?

- ☐ Load analysis and growth projections
  - Load profile by month (peak, minimum, average) and/or 15-minute interval load profile for one year.
  - What generation is used by the community to meet the current load?
  - Is there sufficient existing generation to meet the future needs of the community? Or if the load is declining, can the existing generation run efficiently at lower loads?
  - Are there additional potential electrical loads in the community that are not currently being met? Are any new electrical loads being planned?

1.1.1.4 Hydro

- ☐ *Reconnaissance* and *feasibility* applications should address all of these factors. Design and construction grants should have already addressed these topics.
- ☐ Detailed mapping of all boundaries, features, and topographic data covering river, reservoir, proposed project and alternate project extents using LIDAR or similar surveying and 1-meter or better aerial imagery collected within last 3 years, and a reservoir area-volume based on topographic and bathymetric data.
- ☐ Understanding of basin hydrological and climate characteristics with a minimum of 3 years of 15-minute interval or daily average, median, and peak flows reported by qualified hydrologist or civil engineer along with other pertinent hydrological analysis data (comparative analysis, flow duration curves and exceedance tables (10% increments) at dam, powerhouse, and other critical locations.
- ☐ Geomorphological considerations including Probable Maximum Precipitation, Probable Maximum Flood, flood hazards, estimated sediment loads, and snow and ice considerations and impacts.
- ☐ Geotechnical evaluations as appropriate:
  - surficial geology, stratigraphy to competent bedrock and along tunnels and dam locations,
  - slide or rock stability analysis, bedding characteristics and fracture locations,
  - tunnel boring, finishing, and rock bolting recommendations,
  - packer testing with recommendations for grouting,
  - cut and fill recommendations, locally sourced structural fill analysis and recommendations,
  - material testing including analysis and recommendations for strength and use of local materials for locally batched concrete.
- ☐ Project parameters – design flow, detailed 3D location and materials description of all proposed and existing features in maps, drawings, tables, and text, detailed concept designs for all project features including temporary diversions or coffer dams, construction extents and work areas, proposed project boundary with legal and all existing land rights and restrictions, proposed turbine and generator configuration, operational efficiency over full range of flows, proposed design criteria for all project features, quantities for proposed features and work.
- ☐ A draft and final report stamped by an Alaska licensed Professional Civil Engineer presenting all of the above information, including permitting requirements, and results of assessment.

1.1.1.5 Solar

- ☐ The National Renewable Energy Laboratory's (NREL) PVWatts website (pvwatts.nrel.gov) is a web-based solar PV tool that estimates the power production from a grid-connected solar PV system based on a few simple inputs. This method is sufficient for most Alaska solar assessments but should be adjusted if there is significant shading or other site-specific impacts.

- ☐ Has a shading analysis been completed? What is the impact on expected insolation from shade at the site? Shading analysis is critical. Most Alaska solar projects experience some degree of shading and related performance impacts.
- ☐ Any other data sources that can be used to correlate data.

1.1.1.6 Wind

- ☐ Wind resource report is based on a local met tower with a minimum of 12 months of valid data.
- ☐ How reliable is the overall data? Are there gaps? Did any sensors or datalogger fail? Was a log sheet filled out during tower erection?
- ☐ How fast is the wind? Average speed, maximum, std. dev.?
- ☐ Are there general trends of how the wind speed varies throughout the day, or month to month?
- ☐ What is the air temperature and density?
- ☐ Are there other data sources, such as a nearby airport, that can be used to correlate data?

1.2 Site Control

The applicant must be able to have legal right to use and access the site(s) for the solar panels, distribution, roads, etc. Applicants should identify potential issues as soon as possible. Legal and/or financial agreements may be required to resolve site control issues. Site control must be finalized before construction funds are committed. Do not underestimate the complexity of land ownership in Alaska.

- ☐ The grantee shall be responsible for resolving any landownership disputes between state and/or federal entities, local landowners, native corporations, municipalities, boroughs and community organizations, or other entities.
- ☐ Proof of valid title to the land and/or written documentation of any private agreements is required.
- ☐ The landowner must guarantee that there are no liens or encumbrances on the property.
- ☐ Final proof of ownership shall be the certificate to plat.
- ☐ Site control for transmission or distribution power lines may be established using easements or utility right-of-ways so long as the period of the agreement meets or exceeds the intended life of the project.
- ☐ If the project expects secondary loads to be placed in non-utility facilities, ownership and access of infrastructure must be agreed to by all parties.
- ☐ If the project site is adjacent to or near an airport or runway, the grantee must research FAA permit requirements, existing or pending leases and easements, and DOT expansion or relocation plans
- ☐ Land transfers required for project development shall be recorded with the appropriate District Recording office and a copy of the recordation provided to the AEA grant manager
- ☐ Site control drawing including:
    - Recorded document list for properties, leases, easements.
    - Horizontal and vertical control basis and monuments.
    - Complete legal description
    - Plat references

1.3 Environmental and Permitting Risks

Permitting, environmental or otherwise, may stop projects or require change in size, location, or operations. It is important that any potential permitting issues are identified early so that the scope of the project can be changed, mitigation measures are taken, or the project can be ended before significant funds have been spent.

- ☐ In addition to understanding which permits are required, and the studies and/or modifications (either in infrastructure or operations) required for the permits, the amount of time required to do the necessary work must be included in the project plan.
- ☐ Document communications and approval from US Fish & Wildlife Service, FAA, Army Corp of Engineers, DNR, local government and any other appropriate agencies.
    - Contaminated sites database
    - Threatened or endangered species
    - Habitat issues
    - Wetlands and other protected areas
    - Archaeological and historical resources
    - Land development constraints
    - Telecommunications interference
    - Aviation considerations
    - Visual, aesthetics impacts
    - Identify and describe other potential barriers
- ☐ Fire Marshal Plan Review
- ☐ National Electric Code
- ☐ National Electrical Safety Code
- ☐ Local construction permit
- ☐ Electric utility interconnection permit (if project not proposed by the local utility)
- ☐ *For hydro:*
    - As applicable, permits required under the State of Alaska DNR Dam Safety Program; and/or federal permits required by the Federal Energy Regulatory Commission (FERC).
- ☐ *For solar:*
    - Solar Energy Code 8 AAC 63.010
- ☐ *For wind:*
    - Additional information for permitting wind projects is made available via the U.S. Department of Energy via its WINDExchange program here.

2 Understanding the existing system

Having a detailed understanding of the existing system (also called the base case) is key to knowing if the proposed system will be beneficial. The base case will be used both to understand the economics and the feasibility of integrating the solar system.

The level and type of detail required will be based on the proposed phase and the proposed system's complexity. If secondary loads and energy storage systems (ESS) are proposed, additional information is needed to do the integration and economic analysis.

This section is also a good time for the applicant to see if fixing or upgrading the current infrastructure is the best option for the community. This is not required for the REF process, but is a good idea nonetheless.

The following sections are divided into *configuration* and *operation*. The configuration is the infrastructure that is currently in place. The operation is how that infrastructure is used.

2.1 Configuration of existing system

2.1.1 Power—Info & data

- ☐ Current configuration and condition of power generation system (gensets, switchgear, controls, heat recovery)
  - What is the make, model, kW rating and hours of each diesel genset?
  - What are the fuel curves for each unit?
  - What type of mechanical or electronic throttle controls exist?
  - What are the actual reported kWhs per gallon of fuel for this facility?
  - What kind of switchgear and/or other controls exist – make, model, manual/automatic? Can the existing system be expanded for the proposed renewable energy system and secondary loads?
  - What kind of SCADA currently exists?
  - Are upgrades or replacements planned for any key system components?
- ☐ Transmission and distribution
  - What is the condition of the distribution lines, transformers and poles?
  - Provide a map showing single versus three-phase power lines and varying voltage levels
  - How are the phases balanced through the grid?
  - How are the transformers in the community loaded or overloaded? Where is there transformer capacity to add additional loads?
  - Where are the major electrical loads located in the community from a geospatial perspective?

2.1.2 Heat – Info & Data (generally related to projects involving biomass heating, heat pumps, and/or heat recovery projects)

- ☐ The type, design and components of the existing heating system(s) is clearly described including the operating temperature range in every proposed building/system.
- ☐ What is the design load (the maximum Btu/hr of heat needed) of building(s) and/or facility?
  - Pull heating fuel consumption/purchase records (minimum one year) for the buildings being considered and provide annual estimates (high/low) for each.
- ☐ Is there a heat recovery system on the diesel engines? What loads does it feed?
- ☐ If there is a heat recovery system, how are those heat loads monitored/quantified? What is the annual heating fuel purchased for each of those loads?

2.2 Operations of existing system

2.2.1 Power—Data

- ☐ Load analysis and growth projections
  - Load profile by month (peak, minimum, average) and/or 15-minute interval load profile for one year
  - What generation is used by the community to meet the current load?
  - Is there sufficient existing generation to meet the future needs of the community? Or if the load is declining, can the existing generation run efficiently at lower loads?
  - How much spinning reserve is needed and how is it met?
  - What are the parasitic and other system losses?

- Are there additional potential electrical loads in the community that are not currently being met? Are any new electrical loads being planned?

- ☐ Power quality
  - Have there been issues with
    - Outages,
    - High/low voltage incidents,
    - Phase imbalances,
    - Power factor, or
    - Frequency deviations
- ☐ Operational
  - Describe the controls strategy with existing electrical system
  - Are there existing diversion electrical loads in the community? Are there electrical loads that could be converted to interruptible loads if needed?
  - If you participate in the PCE program, how much line loss does the utility experience? Has there been an investigation of if the line loss is from physical losses or metering and accounting issues?

2.2.2 Heat – Data

- ☐ Monthly heating data is available for each proposed building (Indicate if these are actual or modeled data)
  - Pull heating fuel consumption/purchase records (minimum one year) for the buildings being considered and provide annual estimates (high/low) for each.
- ☐ What is the operational thermal efficiency of the existing system? Note if this information is based on tested, manufacturer, or estimate.
- ☐ Is the existing heating system at or near the end of its design life?
- ☐ Will the existing heating system(s) be removed or maintained for backup or peaking?
- ☐ Supply and return temperatures needed in existing systems
- ☐ Design of the existing system is clearly described including the operating temperature range
- ☐ Describe the existing heating control system(s) and if it will be useful for the proposed system
- ☐ What is the heat recovery percentage of each diesel genset? How much heat is lost in the system? What additional capacity is available?
- ☐ Where are the major heat loads located in the community? Which could connect to an existing or planned heat recovery loop if excess hydro generation could be available? Which could be clustered together for a remote electric boiler?
- ☐ Are there additional potential heat loads in the community that are not currently being met? Are any new heat loads being planned? Where are they located relative to the powerhouse?
- ☐ What is the operational thermal efficiency (tested, manufacturer, or estimate) of the existing system?
- ☐ Energy Efficiency improvements have been completed on the proposed buildings.
  - Air infiltration: Caulk doors & windows, rim joist, weatherstrip doors & windows, use foam gaskets on outlets and switches.
  - Insulation: Attic, floor, basement, walls
  - Upgrade windows

3 Proposed System Design

Designs should consider the site-specific requirements of the energy resource, the physical environment, and the system into which it will be integrated. The design should aim to reduce costs for customers, while maintaining or improving service to customers. Care should be taken that the solar project does not adversely impact the operations of the utility or customer service.

The level of design required is based on the phase. The proposed system design should include a description of any civil infrastructure (buildings, towers, etc.) that will be built or changed, the power system, and/or heating system as appropriate for the application. In all cases, designs should meet or exceed state and federal standards and regulations and be performed by people with proper credentials (such as a licensed Professional Engineer) for the design.

All appropriate building permits must be received prior to construction. What follows are a selection of common considerations that will need to be incorporated into the final design of the project prior to construction.

3.1 Proposed Renewable System (Hydro, Wind, & Solar)

The proposed electrical system must be described in sufficient detail consistent with the phase of development. The configuration of the proposed system are the specific components that will be built or installed for the project; the operations will explain how all the components will be designed to work together in the system.

Some of the important questions and ideas to consider while evaluating and designing the power generation system, as specific to certain technologies, include:

- ☐ Physical location(s)
- ☐ Total economically optimal installed kW based on current and reasonable future load estimates and the evaluation of the available resource. Include model as appropriate.
- ☐ Make, model, capacity of each proposed unit.
- ☐ Upgrades needed before RE project
    - Transmission/distribution—phase balance, transformers, wires, etc.
    - Supervisory controls for RE to interface with diesel powerhouse
    - Controls for diesel engines
    - What metering will be included to track performance for the utility and reporting to AEA?
- ☐ Controls on renewable energy system for each generator and between generators (fossil fuel and renewable system)

3.1.1 Proposed Biomass System

- ☐ Fuel supply—how will it be delivered
- ☐ Type of system—cordwood, chip, or pellet
- ☐ Biomass storage—silo for pellets, shed for cordwood or chips
- ☐ What is the optimally sized biomass system, including thermal storage, needed to meet the design load of the system most economically?
    - Are heat loads better served by connecting a biomass system to the existing heat recovery loop or placing biomass boilers in other community buildings?

- Make/model, size (Btu/hr)
    - How is the system sized relative to average and peak loads? Would a hybrid system improve the project economics?

- ☐ The existing or proposed mechanical room has ample room to access the boiler components for operations and maintenance.
- ☐ Piping—what type, size, where will it be routed? What is the plan for leak detection, how will it be protected? Will heat trace be used?
- ☐ Will infrastructure upgrades be required due to psi increase, temp (gasket changes), bolt/ fit up requirements, and/or support structures?
- ☐ Fire suppression (if needed)
- ☐ BTU meters are required for heat sales agreements and for performance reporting of total heat produced by the system.

3.1.2 Proposed Heat Pump or Heat Recovery System

- ☐ What is the optimally sized heat pump / heat recovery system, including thermal storage, needed to meet the design load of the system most economically?
    - Heat exchanger sizes
    - How is the system sized relative to average and peak loads? Would a hybrid system improve the project economics?
    - Make/model, size (Btu/hr): How is the system sized relative to average and peak loads? Would a hybrid system improve the project economics?
    - The integration of the heat recovery system into the existing heating system(s) is discussed
- ☐ The mechanical room has ample room to access the boiler components for operations and maintenance.
- ☐ Are there non-grandfathered codes present that need to be dealt with properly?
- ☐ If piping is necessary—what type and size, where will it be routed, how will it be protected?
- ☐ What types (VSD) and size(s) of pumps will be needed within the system? How much power will these pumps require? How will that use of energy impact the end user?
- ☐ Are there structural changes needed to accommodate the new infrastructure?
- ☐ Are changes to existing diesel engines' cooling system needed?
- ☐ Fire suppression (if needed)
- ☐ BTU meters are required for heat sales agreements and for performance reporting of total heat produced by the system.

3.2 Proposed Secondary Load System and/or Energy Storage System (ESS)

- ☐ The proposed heating system must be described in sufficient detail consistent with the phase of development. The configuration of the proposed system are the specific components that will be built or installed for the project; the operations will explain how all of the components will be designed to work together in the system.
- ☐ Integrating complex secondary loads and/or energy storage into a system is not trivial. The upfront capital costs and ongoing operational costs can be significant, and complexity increases risk to the system. More training, employees, and expenses should

be expected, all which should be accounted for in the appropriate areas of the REF application.

- ☐ Some of the important questions and ideas to consider while evaluating and designing the secondary load and/or energy storage system include:
- ☐ What is the optimally sized secondary load and/or energy storage system, including thermal storage, needed to meet the design load of the system most economically?
- ☐ What are the trade-offs between a few large electric boilers versus many small heaters throughout the community?
- ☐ Are heat loads better served by connecting an electric boiler to the existing heat recovery loop or placing electric boilers in other community buildings?
- ☐ Make/model, size (Btu/hr)
- ☐ How is the system sized relative to average and peak loads? Would a hybrid system improve the project economics?
- ☐ The mechanical room has ample room to access the boiler components for operations and maintenance.
- ☐ If piping is necessary—what type, where will it be routed, how will it be protected?
- ☐ Fire suppression (if needed)
- ☐ BTU meters are required for heat sales agreements and for performance reporting of total heat produced by the system.

3.2.1 Proposed Energy Storage System (ESS)

The proposed renewable system must be described in sufficient detail consistent with the phase of development. The *configuration* of the proposed system are the specific components that will be built or installed for the project; the *operations* will explain how all of the components will be designed to work together in the system.

Integrating complex energy storage into a system is not trivial. The upfront capital costs and ongoing operational costs can be significant, and the complexity increases risk to the system. More training, employees, and expenses should be expected, all which should be accounted for in the appropriate areas of the REF application.

Some of the important questions and ideas to consider while evaluating and designing the energy storage system include:

- ☐ What is the optimally sized energy storage system needed to meet the design load of the system most economically?
    - Make/model, size in both kWh of storage and kW of power output
        - How is the system sized relative to average and peak loads?
- ☐ The mechanical room has ample room to access the ESS components for operations and maintenance.

3.3 Proposed Electrical System Design – Integration with Renewable System

- ☐ The applicant should include a description of the electrical infrastructure that will be built in support of the project. The infrastructure must be built to perform as expected for the life of the project in the particular environment of the preferred site and within the context of the existing generation system.
- ☐ Total optimal installed kW based on current and reasonable future load estimates and the evaluation of the available resource. Include model as appropriate
- ☐ Make, model, capacity of each unit. Include why chosen generating systems were selected based on the system's expected load and environmental conditions.
- ☐ Controls on renewable energy system for each generator and between generators (fossil fuel and RE)
    - Can the diesel system parallel safely with the renewable system during periods of maximum renewable output and minimum electric loads?
    - Will the renewable power output adversely affect three-phase balance, i.e. is it a single-phase system that may significantly unbalance the phase amperages?
    - Can the proposed power system handle the ramp rate resulting from intermittent character of the renewable energy output?
- ☐ Will there be excess electricity generated or excess resource available? What components will be included to maintain system reliability and stability?
    - Load regulator(s), energy storage
    - Are there existing diversion electrical loads in the community? Are there electrical loads that could be converted to interruptible loads if needed?
    - Are there additional potential electrical loads in the community that are not currently being met? Are any new electrical loads being planned?
- ☐ Physical location(s) - resource
- ☐ Upgrades needed before RE project
    - Transmission/distribution—phases, phase balance, voltage, transformers, wires, etc.
    - Controls for RE to interface with diesel powerhouse
    - Controls for diesel engines
    - What metering will be included to track performance for the utility and reporting to AEA?

3.4 Perform Stability Analysis of Options

To ensure that the proposed design will not adversely impact existing or prospective customers' service, it is important that the stability of the proposed system is analyzed. Especially since the renewable resource can change very quickly, it is important to ensure the system will remain stable. With both relatively simple and complex projects, it is important that at a minimum the proposed project is evaluated for:

- ☐ Ramp rates
- ☐ Voltage rise/drops across lines
- ☐ Frequency excursions

3.5 Proposed Civil Infrastructure

The applicant should include a description of the civil infrastructure that will be built in support of the project. The infrastructure must be built to perform as expected for the life of the project in the particular environment of the preferred site. If the application is for a construction project, the applicant's schedule should reflect the seasonal and logistical constraints.

3.5.1 Designs for new or changes to existing buildings, foundations, etc.

Design best practices include preparing logical, readable, and professional drawings and specifications and other documents for construction and operation and maintenance phases of the project. General goals of the design are as follows:

- ☐ That the project is designed and constructed in a safe manner that minimizes the danger to human life and harm to the environment.
- ☐ The design results in a low project cost while serving the project purpose and need for its useful life.
- ☐ The design is sufficiently detailed and adequate to minimize change orders, cost deviation, and reasonably minimizes risk of major repairs or modifications following construction.
- ☐ The design appropriately balances cost of construction with lowered operation and maintenance costs and the potential for expansion is considered.
- ☐ The design incorporates energy efficiency and arctic design best practices.

At a minimum, prior to construction the applicant should expect to have the following things:

- ☐ Project overview map(s) and general information
    - At least one map showing full project extents and a vicinity map
    - A sheet index for all drawings
- ☐ Design Criteria and information
    - Design codes and standards used along with a code analysis
    - Design loadings
    - Structural loads
    - Wind loads
    - Foundation(s)
- ☐ Geotechnical investigations and reports to design for:
    - Permafrost and other geotechnical concerns
    - Earthquakes (seismic tolerance)
- ☐ Design analysis, calculations/report
- ☐ Future maintenance and expansion
- ☐ Drawings showing horizontal and vertical design sufficient for layout and construction of infrastructure. Typical methods include plan and profile drawings with stationing for alignments, standard road cross sections, limits of grading, grades or slopes, and general topography, drawing scale bars and north arrows, point or dimensional data, structural sections showing embedments, equipment layout drawings, electrical and mechanical schematics, and equipment lists, size, and locations
- ☐ Submittal requirements including drawings and basic design data for contractor design build items, fabrications, and procured equipment with requirement for submittal and review of the electrical switchgear engineered and shop drawings.
- ☐ Technical specifications for materials and methods
- ☐ Engineers cost estimate, updated feasibility report, owner's business development and operational plan, and schedule.

3.5.1.1 Construction requirements

Applicants should start planning for construction in the Feasibility phase—only by understanding and preparing for site specific risks and logistics can accurate costs be determined. Final Design and Permitting will end with all of the following logistics and plans must be worked out to make sure the construction is safe, cost effective, and done properly. Earlier stages of development can address the points below generally—that is identifying that a road may need to be designed to handle the load of a crane, but not specifically how the road will be built.

- ☐ Safety plan for construction activities
- ☐ Logistics for getting materials, supplies, machinery, etc. on-site
    - Getting it in place—are new roads or trails needed?
- ☐ Are there seasonal limitations on when materials can be delivered to the community and/or delivered to the site?
- ☐ General specifications governing execution of work
- ☐ When is labor available? Are there sufficient trained workers in the community, or will there need to be contractors brought in from other places?
- ☐ Are there DOL Rate requirements (e.g., Davis-Bacon, Little Davis Bacon)? Use most recent rate publications.

3.6 Proposed Operations

Planning for operations and understanding the expected outcomes should start early.

3.6.1 Operations of Proposed Power Generation System (Biomass)

- ☐ Model proposed system with local resource, load, and control strategy
    - Does the system model verify that the boiler is not oversized?
    - Can the backup boiler system handle peaking requirements?
    - Have the shoulder seasons been modeled to estimate the timing of the start-up and shutdown of the system?
    - Parasitic power (pumps, etc.)
    - Expected thermal efficiency in the operating environment.
    - Amount of biomass consumed on a daily, weekly, monthly, and annual basis.
    - The logistics required to deliver the required amount of biomass to the storage and the boiler are detailed, including if there is sufficient room for equipment (loader, plow, etc.) to maneuver safely.
    - Continued fuel consumption in existing generation infrastructure.
- ☐ Are there conditions—either economic, environmental, or technical—where the project will not be feasible to operate?
- ☐ Summary
    - Anticipated annual BTUs
    - Capacity factor
    - Post-project fuel consumption estimate—both fossil and RE fuels

3.6.2 Operations of Proposed Power Generation System (Hydro, Wind, Solar)

- ☐ Controls strategy
  - o Describe control strategy for the multiple components within the system (Diesel, hydro, solar, wind, load regulator(s), energy storage, secondary loads)
- ☐ A robust and reproducible model should be used to understand the system. The applicant should provide the model's results of the proposed system with solar resource, load, and control strategy and be prepared to provide the model at request.
  - o Generation by 15-minute increments
    - ▪ Are there conditions that create instability?
    - ▪ Generation to primary load vs. secondary loads vs. voltage regulator vs. storage
  - o Parasitic power
  - o What number of spinning reserves will be required? How will these spinning reserves impact the expected fuel savings?
  - o Continued fuel consumption in existing generation infrastructure
  - o Summary
    - ▪ Anticipated annual generation
      - • Include any excess generation that would not be usefully consumed
    - ▪ % available
    - ▪ Capacity factor
    - ▪ Post-project fuel consumption estimate—both fossil and RE fuels

3.6.3 Operations of Proposed Power Generation System (Heat Pumps / Heat Recovery)

- ☐ Model proposed system with local resource, load, and control strategy
  - o Does the system model verify that the heat exchangers are not oversized?
  - o Can the backup boiler system handle peaking requirements?
  - o Will the boiler size elevate the inspection requirements if state DOL registered?
  - o Parasitic power (pumps, etc.)
  - o Expected thermal efficiency in the operating environment
  - o Continued fuel consumption in existing generation infrastructure
- ☐ Are there conditions—either economic, environmental, or technical—where the project will not be feasible to operate?

4 Perform Economic Analysis & Optimization

Planning and designing a renewable energy project should be an iterative process, as new information is learned the design is refined and improved, progressively more tailored to the site and system. A project that receives REF funding must be both technically possible and economically viable. A proposed system may be technically possible but cost prohibitive by increasing costs to customers or the costs outweigh the benefits.

AEA will perform an economic analysis for all applications. In all cases, AEA compares the proposed system against the base case (the current system configuration). The proposed costs must be outweighed by the expected savings. For renewable energy projects, most of the economic savings are in displaced fossil fuels, but it can also see savings in the O&M of the diesel system if the diesels can be turned off. However it should be noted that if a heat recovery system is integrated with the existing diesel genset units, a loss of recovered heat will result should the diesel generation units be turned off, even if for short periods of time, and thus considerations will need to be made in terms of how such losses will be recovered, perhaps in the form of electric boilers which generate heat using available excess renewable energy from the proposed renewable project, or otherwise. Communities may have additional values that are important—increased local employment, decreased imported diesel, or reduced greenhouse gases.

Ideally an applicant will investigate multiple options, including improving the base case.

The economic evaluation assesses the economic viability of a project. The entire project proposal is assessed, not each individual component. If the costs for the project are greater than the expected benefits, then the project would not be economically viable. If the total benefits to all parties outweigh the costs incurred by all parties, then the project is considered to be economically viable. The economic analysis is indifferent to who receives benefits and who pays costs.

- **Benefits**: Savings to utility customers, non-utility customers, Power Cost Equalization, and others
- **Costs**: Expenses paid by utility customers, grants from state, federal, and regional governments; non-profits, non-utility

AEA uses an Excel-based economic model to provide the underlying assumptions (such as expected fuel costs), calculations and analysis. The model is made available to all applicants. Please ensure that when applying under a particular RFA grant round that the most recent version of the model is utilized. A copy of the most recent version will be made available along with the RFA supporting documents. While AEA encourages applicants to perform and submit an economic analysis, AEA's analysis is used in the scoring process. Ideally, applicants would use the model to maximize the project's benefits and minimize the costs.

4.1 Costs for the existing system

Before analyzing the benefits of the proposed project, it is important to understand the existing system (the base case). Any savings that can be realized by the project will come from displacing costs from the base case. Keep in mind, there may be a number of costs that will not be displaced, even with the best designed renewable project.

4.1.1 Power (Hydro, Solar, and Wind)

- Capital costs: any current depreciation and/or loans?
- Operational costs
  - Efficiencies of the existing energy (electricity and heating, as appropriate) systems
  - Cost of diesel at the utility
    - AEA has forecasts available for the price of diesel in most communities
  - Annual O&M
  - Expected (Repair & Replacement) R&R and/or amortized R&R

4.1.2 Heat

- Capital costs (current depreciation/loans?)
- Operational costs
  - Efficiencies of the existing heating systems
  - Cost of heating oil at the proposed customers
  - Operations and Maintenance (O&M)
  - Repair and Replacement (R&R) reserve fund considerations

4.2 Economic optimization

Even if an applicant expects to receive grant funds for their project, the proposed project should be designed to get the best economic return on the investment. By maximizing the savings from the projects and keeping the cost as low as practical, the application will maximize those points possible as awarded as part of the economic cost-benefit criteria and will thus result in a higher score, increasing the likelihood of being selected for award, relative to other, lower-scoring applications. This may mean that a proposed project may not end up displacing the maximum amount of diesel or heating oil, owing to the law of diminishing marginal returns whereby the marginal savings realized from every additional dollar of marginal cost needed to realize such savings falls with every additional dollar, because the systems needed to realize such savings may be complex and costly, when considering both the initial capital cost and the recurring O&M costs.

4.2.1 Develop options based on generic assumptions

It is encouraged that applicants use industry-standard modeling programs, such as HOMER. Just note that AEA's economic assumption may be different from the models, and the economic results may be different. AEA does not require applicants to provide an analysis of all options that were analyzed, but the applicant will need to be able to justify why the preferred alternative was chosen.

Using generic, or low-cost, readily available and industry-standard equipment in conjunction with high-level, less accurate modeling programs are sufficient for early phase development, but it is likely that more robust modeling will be needed for Final Design, prior to construction to ensure the highest-degree of accuracy when presenting project economics.

- ☐ HOMER model with accurate renewable resource, electrical load, thermal load, renewable power curves, shading values (solar), turbine availability (hydro), turbine blade power curves (wind), diesel power curves and diversion loads. Pay special attention to the excess power in the system: this number must be subtracted from your total kilowatt-hours to accurately estimate diesel fuel savings, unless this excess power is to be consumed via a secondary load source or ESS. Bear in mind that the economic benefit of offsetting a heat load is less than offsetting diesel electric generation.
- ☐ If excess electricity is being proposed to be sold, and/or utilized for heating requirements, model (through HOMER or some other model) excess renewable energy throughout the year to the heat load profile(s). Expect that not all excess energy will be usable by customers, especially excess energy produced during the summer. In many instances, battery storage and other dynamic storage systems can provide greater benefits than a simple load control system diverting excess power to an electric boiler or furnace, as they can provide additional resiliency and back-up power benefits, and prevent the need for additional diesel-fueled spinning reserve during times of high system load, and can allow for more gradual ramp-rates of diesel gensets in response to intermittent renewable generation.

Such storage systems, however, can be quite costly depending on the size and integration requirements.

- ☐ Annual modeling, including variables of demand and fuel price, financing and O&M projections, and climate projections for both the existing/alternate and proposed generation system. Note that these assumptions may differ from AEA's assumptions. Please check AEA's economic model for additional guidance.
- ☐ Investigate how the economies of scale are affected by using different types and quantities of panels. How do these options vary the overall system cost and unusable excess power?
- ☐ If the project involves, or could involve, the intertie of two or more communities, analysis becomes more complex to determine where diesel and renewable power generation are located relative to community loads. Cost and efficiency of reliable communication between the renewable fuel source (i.e., most optimal wind/solar site, optimum head for hydro, etc…) and the powerhouse should be considered.

4.2.2 Costs for the preferred alternative

Any savings that can be realized by the project will come from displacing costs from the base case. Savings are expected to be found in displacing fuel and the potential of reduced O&M if diesel can be turned off. Expect that the renewable energy project will increase some costs.

4.2.2.1 Power (Hydro, Solar, and Wind)

- ☐ Capital costs (hydro):
  - Estimates based on phase-appropriate cost estimates for hydro infrastructure, integration, controls for hydro and/or diesel generation, batteries/flywheels/capacitors, etc.
- ☐ Capital costs (solar):
  - Estimates based on phase-appropriate cost estimates for panels, integration, controls for solar panels and/or diesel generation, batteries/flywheels/capacitors, etc.
- ☐ Capital costs (wind):
  - Estimates based on phase-appropriate cost estimates for turbines, integration, controls for wind turbines and/or diesel generation, batteries/flywheels/capacitors, etc.
- ☐ Operational costs
  - Annual O&M
  - Expected (Repair & Replacement) R&R and/or amortized R&R

4.2.2.2 Heat

- ☐ Capital costs (current depreciation/loans?)
  - Estimates based on phase-appropriate cost estimates for boilers, heat exchangers, heaters, heating control systems, new metering, etc.
  - Fuel storage
- ☐ Operational costs
  - Annual O&M
  - New account management and billing
  - Expected R&R and/or amortized R&R
  - Include positive or negative impacts, if any, on an existing heat recovery system
  - Biomass fuel
  - Operator salaries and training

4.3 Benefit-Cost Analysis

The Renewable Energy Fund evaluation process uses the benefit-cost ratio as its primary metric for economic viability. The **benefit-cost ratio** (B/C ratio) summarizes all the project's benefits and costs into a single number.

The total benefits of the project are found by taking the present value of all the annual cost savings. The cost is the present value of the project's capital costs.

$$\text{B/C ratio} = \frac{\text{Project Benefits}}{\text{Capital Costs}}$$

Understanding the B/C ratio

B/C ratios communicate the economic viability of a project as a single number making it ideal for communicating the benefits and costs concisely.

- A B/C ratio greater than 1 means that the benefits are greater than the capital costs. Even without grant funds, the project should be cost effective and save the utility and customers money.
- A B/C ratio of 1 means that the benefits equal the Capital costs—the project just breaks even.
- A B/C ratio less than 1 means that the costs are greater than the benefits—economically things would be worse than before the project was built. Without grant funds, the project would not be cost effective and the utility and/or customers would lose money.

Since many projects will lead to savings for utilities and customers, even projects with B/C ratios below 1, it can be confusing why AEA would use the benefit-cost ratio to rate projects. The state wants to maximize its return on investment, its "bang for the buck", and wants to promote cost effective designs.

5 Financial and Operational Planning

Planning for the eventual operation of the energy system is too frequently overlooked. The training and skills needed to successfully operate and maintain the renewable project and the complex control systems are different than what is needed for a simple diesel power house. The additional need to track and pay for the parts, maintenance, and other necessary things can stress an owner if adequate preparation is not made. With proper planning, training, and management, a renewable project can be a long-term benefit to a community.

Below are selected aspects of a business plan that should be included in the REF application. Please see the phase appropriate business plan template for a complete version of what should be included.

5.1 Financial Management

Since grant funds cannot be used to operate the renewable project, an applicant must know how the maintenance and operations of the infrastructure is going to be paid for over its useful life. Renewable projects face failure without a plan for paying for needed training, personnel, contractors, materials, and supplies.

Additionally, most renewable project developers are also utilities. The utility must be able to have a financially viable project that shares expenses fairly across all rate classes. A utility should not build a project that will require some customers to pay more so that other customers may benefit. At the very least, a utility should understand how the costs for renewable power should be fairly divided between customers. For a more thorough explanation, please see AEA's white paper on the economic and financial analysis of excess renewable energy sold for heat. It is available on the Round 19 application page. What follows is a short list of aspects that the applicant should address.

- ☐ How will the applicant pay costs including expected capital costs and operations and maintenance
    - What are the expected rates ($/kWh) for each rate class?
- ☐ Explain how O&M activities will be tracked for required performance reporting to AEA
- ☐ Heat sales agreement(s), if applicable – required for construction
- ☐ Accounting system to track revenue and expenses

5.2 Operational Management

- ☐ The business plan should identify who will have overall responsibility for all components.
- ☐ Inspections & Maintenance—include checklists for responsible personnel, estimated time to completion, parts and supplies to keep in inventory, etc.
- ☐ Employees—including a back-up operator, training

6 Common Planning Risks

- ☐ Not having a plan should costs exceed estimates (i.e., cost overrun coverage)
- ☐ Not maintaining adequate insurance in the event of material damage to renewable energy project assets.
- ☐ Not engaging agency stakeholders early on and throughout project development
- ☐ Making major changes without consulting agency stakeholders
- ☐ Not receiving support and authorization from landowners prior to project development (i.e., site control)
- ☐ Intentionally or inadvertently not including all infrastructure required during economic analysis (i.e., cherry-picking capital costs)
- ☐ Placing all focus of the design at the renewable project site - Much of the needed design activity deals with integrating renewable power with the existing power plant, distribution system and community heat loads.
- ☐ Ignoring the excess kilowatt-hours reported by HOMER – This number must be subtracted from your total kilowatt-hours to accurately estimate diesel fuel savings. Proposed projects should find a dispatchable load that can use this excess energy. Bear in mind that the economic benefit of offsetting a heat load is less than offsetting diesel electric generation.
- ☐ Oversized diesel generators may negate some assumed benefits from renewable power – Unless the renewable generation infrastructure produces all of the needed community load, inclusive of peak load, which thus provides for times that the diesel gensets can be turned off, hybrid renewable-diesel systems require small, medium and large gensets so that as renewable power comes online, smaller diesel generators can be selected based on which generator is currently in the optimum part of the fuel efficiency curve for the net system load. Particularly given the intermittent nature of solar and wind power, the system must be able to respond to still, shearing, shading-events and be able to provide sufficient spinning reserve in sufficient time so as not to cause system disturbances. Battery energy storage systems, depending on sizing and intended function, are also generally able to

provide virtual spinning reserve functionality, in the absence of optimally sized generators. However, the large capital costs of such BESS systems must be taken into consideration.

- ☐ Proposing unproven storage or controls technology to the Renewable Energy Fund – New technology falls outside of the scope of the Renewable Energy Fund and should be proven out in a more accessible location than remote Alaska. This is especially true for construction-phase projects. In some instances, more nascent technologies have been awarded grant funds for pre-construction phase activities, to assist in proving out more 'conceptual' technologies.
- ☐ Building a hybrid renewable-diesel project without a remote SCADA system that allows for performance data collection and offsite troubleshooting.
- ☐ The grant applicant has not verified that the electric utility will allow interconnection of a renewable energy resource. This should be verified by Memorandum of Agreement, copy of utility tariff and policies, or other written proof. These documents should be included with the grant application.
- ☐ The grant applicant assumes that the renewable system can operate in a net metering mode, but has not verified that the electric utility will allow that type of metering
- ☐ The project site is sited in an area of high risk for natural disaster events (i.e., floodplain, seismically active area, avalanche / landslide area, etc…)
- ☐ The project is single phase and will result in imbalance of the three-phase distribution system during periods of high renewable energy output.
- ☐ Oversizing the proposed renewable system. Simply adding battery storage and a DC-AC inverter may sound like a trivial solution, but it can prove technically complex and challenging when performing the actual integration and interconnection with the existing system.