ALASKA ENERGY AUTHORITY

# Wind Power Best Practices Guide

Renewable Energy Fund Application

## Introduction

The following guide contains items that are critical to the success of a Renewable Energy Fund (REF) application and project. The intent of the guide is to aid applicants in the submission of a comprehensive project proposal, and is meant to add additional details specific to wind projects. Smaller and simpler projects may not have to address all of the items below. Larger systems, more complex, and Combined Heat and Power (CHP) systems will be expected to have a more thorough analysis of the system.

Since the inception of REF, the Alaska Energy Authority (AEA) has managed dozens of grants for wind projects across the state. Over time, a number of 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 help an applicant and 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 and benefit the community.

The guide does not follow the REF application precisely, but the application provides references to this document. The power produced from a wind resource is based on multiple factors: the quality of the resource, the type and number of turbines, the system's load profile, how other generation sources can respond and/or interact with the wind generation, the effectiveness of secondary loads and energy storage systems, etc. The guide is organized to address these factors:

(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 generally a straight line, but an iterative process where new information will require that plans be reevaluated. An applicant is expected to have performed 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 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 an investigation of the technical, economic, environmental, and business aspects of the project. Every project has development risks; a thorough plan will identify these risks as early as possible, investigate possible ways to mitigate the risks, and ultimately determine if the expected benefits outweigh the risks. Where possible, the guide provides information on the detail and content for each phase (reconnaissance to construction).


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1. **Reconnaissance** studies are a “desktop” study and the analysis should use resource, economic, and operational data that is readily and/or publicly available. 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 be of sufficient detail that a thorough economic and feasibility analysis can be accomplished. Planning for the business and financial aspects of operating the project will be started.

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 wind project begins with selecting and understanding a site: the available resource, 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 and Conceptual Design project 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.

- ☐ 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?

### 1.1.2 How to analyze data

Data analysis should aim to answer two main questions: (1) What is the quality of the wind resource (sufficient for modeling and design)? And (2) What type of infrastructure will be needed to use the resource effectively?

- ☐ What does the wind speed distribution look like? Weibull K? Is it bi-modal with periods of calm, then severe storms? Is the distribution more continuous?
- ☐ How does the wind shear change with elevation (power law exponent)? How turbulent is the wind? What are the predicted maximum speeds over 20 and 50 years?
- ☐ How much icing is experienced at the site? How thick is the icing and how long does it last?
- ☐ How consistent is the wind data from one year to the next? How does it compare with long-term trends?
- ☐ How closely will wind turbines be placed near the met tower site?
- ☐ How does the wind rose affect siting for multiple turbines?

## 1.2 Site control

The applicant must be able to have legal right to use and access the site(s) for the wind turbines, transmission, 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 land ownership 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

### 1.3 Environmental and Permitting Risks

Permitting, environmental or otherwise, may stop projects or require change in size, location, or operations. It 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.

Additional information for permitting wind projects can be found at: [www.ak-ea.org/portals/0/programs/wind/reports/2009windbestpracticesguide.pdf?ver=2019-06-20-132327-170](www.ak-ea.org/portals/0/programs/wind/reports/2009windbestpracticesguide.pdf?ver=2019-06-20-132327-170)

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.

## 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 wind 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

- ☐ 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?
- ☐ Will the existing heating system(s) be removed or maintained for backup or peaking?
- ☐ Describe the existing control system(s) and if it will be useful for the proposed system
- ☐ Is the existing heating system at or near the end of its design life?
- ☐ Is there a heat recovery system on the diesel engines? What loads does it feed?
    - 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 wind 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?

## 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 (tested, manufacturer, or estimate) of the existing system?

☐ Describe how the heating control system(s) is used for the existing system

☐ 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?

☐ 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
- Install a heat recovery ventilation system

# 3 Proposed System Design

Designs should take into account 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 to customers, while maintaining or improving service to customers. Care should be taken that the wind project does not adversely impact the operations of the utility or customer service.

The level of design required is based on the phase. A Reconnaissance project may end with a design based on a generic turbine, while a Feasibility & Conceptual Design will have a design with actual turbines, and a Final Design project will end with plans sufficient to give to a construction firm to build the project.

The proposed system design should include a description of any civil infrastructure (buildings, roads, 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 Wind System

### 3.1.1 Proposed Power Generation System

**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 of 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 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.
- ☐ Explain why chosen turbines systems, including power curves, were selected based on the system's expected load and environmental conditions, and the applicant's operational and financial capabilities.
- ☐ 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 wind)

### 3.1.2 Proposed Secondary Load and/or Energy Storage

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 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 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.

### 3.1.3 Perform Stability Analysis of Options

To ensure that the proposed design will not adversely impact customers' service, it is important that the stability of the proposed system is analyzed. 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

### 3.1.4 Proposed Electrical System Design

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.

- ☐ Proposed electrical system line drawings showing wind turbines, transmission lines, distribution system and powerhouse. Label voltage and phase of lines, plus conductor type, size and resistance factor at 0 degrees Celsius.
- ☐ Proposed and existing SCADA system drawing and description.
- ☐ One line electrical and communication drawing.
- ☐ Proposed and existing diversion load drawing and description.

### 3.1.5 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.

#### 3.1.5.1 Designs for new or changes to existing buildings, towers, 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
        - Foundation(s)
    - Geotechnical investigations and reports to design for:
        - Permafrost and other geotechnical concerns
        - Earthquake
    - 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 embedment's, 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.

#### 3.1.5.2 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?

## 3.2 Proposed Operations

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

### 3.2.1 Operations of Proposed Power Generation System

- ☐ Controls strategy
    - Describe control strategy for the multiple components within the system (Diesel, 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 wind resource, load, and control strategy and be prepared to provide the model at request.
    - Generation by 15-minute increments
        - Are there conditions that create instability?
        - Generation to primary load vs. secondary loads vs. voltage regulator vs. storage
    - Expect percentage and conditions for turbine curtailment
    - Parasitic power
    - What amount of spinning reserves will be required? How will these spinning reserves impact the expected fuel savings?
    - Continued fuel consumption in existing generation infrastructure
    - Summary
        - Anticipated annual generation
            - Include any excess generation that would be not be usefully consumed
        - % available
        - Capacity factor
        - Post-project fuel consumption estimate—both fossil and RE fuels

### 3.2.2 Operations of Proposed Secondary Load System

- ☐ Model proposed system with local wind resource, load, and control strategy
    - Does the system model verify that the secondary boiler is not oversized?
    - Can the backup boiler system handle peaking requirements?
    - Parasitic power (pumps, etc.)
    - % available
    - Expected thermal efficiency in the operating environment

- 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 generation
  - Capacity factor
  - Post-project fuel consumption estimate—both fossil and RE fuels

# 4 Perform Economic Analysis & Optimization

Planning and designing a wind 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—it will increase 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 wind projects, most of the economic savings is in displaced fossil fuels, but it can also see savings in the Operations and Maintenance (O&M) of the diesel system if the diesels can be turned off. 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 for 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 available to all applicants. 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 wind project.

### 4.1.1 Power

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

### 4.1.2 Heat

- ☐ Capital costs (current depreciation/loans?)
- ☐ Operational costs
  - o Efficiencies of the existing heating systems
  - o Cost of heating oil at the proposed secondary load customers
  - o O&M
  - o R&R

## 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 applicant will be more likely to get an REF grant. This may mean that a proposed project may not end up displacing the maximum amount of diesel or heating oil, because the extra cost might not be worth it.

### 4.2.1 Develop options based on generic or common turbines

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 turbines and high-level modeling programs are sufficient for early phase development, but it is likely that more robust modeling with be needed for Final Design.

- ☐ HOMER model with accurate wind resource, electrical load, thermal load, wind turbine power curves, turbine availability, diesel power curves and diversion loads. Pay special attention to the excess power in the system and how that can be put to value-added use. (Include the electronic HOMER file in your submission, but limit the printed report to HOMER output from the proposed system.)
- ☐ If excess electricity is being proposed to be sold for heat, model (through HOMER or some other model) excess wind 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.
- ☐ 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 effected by using different types and quantities of turbines. 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 wind power generation are located relative to community loads. Cost and efficiency of reliable communication between the wind site 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 diesels can be turned off. Expect that the wind project will increase some costs. Customers expect that there will be a massive rate savings from a wind project. Fuel is only a portion of the cost of producing electricity, and a wind project is unlikely to displace all of the diesel used by the utility.

### 4.2.3 Power

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

### 4.2.4 Heat

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

## 4.3 Benefit-Cost Analysis

The REF evaluation process uses the benefit-cost ratio as its primary metric for economic viability. The **benefit-cost ratio** (B/C ratio) summarizes the all of 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 of 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 wind project is too frequently overlooked. The training and skills needed to successfully operate and maintain a wind turbine and the complex control systems are different than what is needed for a 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 wind 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 wind project, an applicant must know how the maintenance and operations of the infrastructure is going to be paid for over its useful life. Wind projects face failure without a plan for paying for needed training, personnel, contractors, materials, and supplies.

Additionally, most wind power 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 wind power—both for electricity and for heat—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 through AEA's website. 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, including electricity sold specifically for heat?
- ☐ 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
- ☐ Not engaging agency stakeholders early-on and throughout project development
- ☐ Making major changes without consulting agency stakeholders
- ☐ Not receiving support and authorization from land owners prior to project development
- ☐ Not including all infrastructure required during economic analysis
- ☐ Placing all focus of the design at the wind turbine site - Much of the needed design activity deals with integrating wind power with the existing power plant, distribution system and community heat loads.
- ☐ Ignoring the excess kilowatt-hours reported by HOMER (or other modeling program) – This number must be subtracted from your total kilowatt-hours to accurately estimate diesel fuel savings. Proposed projects should find an interruptible 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 wind power – wind-diesel systems require small, medium and large gensets so that as wind 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, just so as to maintain sufficient spinning reserves.
- ☐ Proposing unproven storage or controls technology to REF – New technology falls outside of the scope of the REF.
- ☐ Proposing turbines that are not certified by an independent third party – Turbine manufacturers make optimistic claims on the performance of their product. AEA requires wind turbines that have been verified by a certified test facility. These turbines also need cold weather packages.
- ☐ Ignoring the O&M challenges of a wind system – Communities who have personnel that are trained on wind systems and are comfortable climbing exposed towers to perform maintenance have a better chance at meeting the output projections of your design. Major impacts to production are seen the more remote a community is if there is no local trained support.
- ☐ Building a wind-diesel project without a remote SCADA system that allows for performance data collection and offsite troubleshooting.
- ☐ The project site is in a floodplain
- ☐ Small (<400kW) 1200-RPM generators do not respond quickly enough to variable wind power to maintain frequency control on the system. 1800-RPM engines in this size range

have proven to be more effective in wind-diesel systems - preferably with electronic controls. Larger (500kW and up) 1200-RPM generators have not been an issue to date.

- ☐ Oversizing the proposed wind system
- ☐ Building a wind project without performing a structured wind resource analysis.
- ☐ Building a wind project when the wind resource analysis indicates poor wind conditions.