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List of Acronyms

AED	Automated External Defibrillator
AWEA	American Wind Energy Association
CBT	Computer-Based Training
CE	Competency Exemption
CIP	Certified Instructor Program
CPR	Cardio-Pulmonary Resuscitation
CSE	Confined Space Entry
ESD	Electrostatic Discharge
FA	First Aid
GW	Gigawatts
HV	High Voltage
JSA	Jobsite Safety Analysis
LOTO	Lockout/Tagout
MCC	Mechanical Completion Checklist
MW	Megawatts
NFPA	National Fire Protection Association
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
OJT	On-the-Job Training
OSHA	Occupational Health and Safety Administration
PPE	Personal Protective Equipment
PQS	Personal Qualification Standard
STRR	Safety Topic Requirement Ranking
WTG	Wind Turbine Generator

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Executive Summary

Wind has provided energy for thousands of years: some of the earliest windmill engineering designs date back to ancient Babylonia and India where wind would be used as a source of irrigation. Today, wind is the quickest growing resource in America's expanding energy infrastructure. However, to continue to positively diversify America's energy portfolio and further reduce the country's reliance of foreign oil, the industry must grow substantially over the next two decades in both turbine installations and skilled industrial manpower to support.

The wind sector is still an emergent industry requiring maturation and development of its labor force: dedicated training is needed to provide the hard and soft skills to support the increasingly complex wind turbine generators as the technology evolves. Furthermore, the American workforce is facing a steep decline in available labor resources as the baby boomer generation enters retirement age. It is therefore vital that a process is quickly created for supporting the next generation of wind technicians.

However, the manpower growth must incorporate three key components. First, the safety and technical training curriculum must be standardized across the industry - current wind educational programs are disparate and dedicated standardization programs must be further refined and implemented. Second, it is essential that the wind sector avoid disrupting other energy production industries by cannibalizing workers, which would indirectly affect the rest of America's energy portfolio. The future wind workforce must be created organically utilizing either young people entering the workforce or train personnel emerging from careers outside of energy production. Third, the training must be quick and efficient as large amounts of wind turbines are being erected each year and this growth is expected to continue until at least 2035.

One source that matches these three requirements is personnel transitioning from military service to the civilian sector. Utilizing the labor pool of transitioning military personnel and a dedicated training program specifically tailored to military hard and soft skills, the wind workforce can rapidly expand with highly skilled personnel. A tailored training program also provides career opportunities to an underutilized labor force as the personnel return from active military duty.

This project's goal was to create a Wind Workforce Development Program that streamlines the wind technician training process using industry-leading safety programs and building on existing military experience. The approach used was to gather data from the wind industry, develop the curriculum and test the process to ensure it provides adequate training to equip the technicians as they transition from the military into wind.

The platform for the curriculum development is called Personal Qualification Standards (PQS), which is based on the program of the same name from the United States Navy. Not only would the program provide multiple delivery methods of training (including classroom, computer-based training and on-the-job training), but it also is a familiar style of training to many military men and women. By incorporating a familiar method of

training, it encourages active participation in the training and reduces the time for personnel to grasp the concept and flow of the training requirements. The basic overview of the PQS is found below in Table 1.

Table 1: PQS Overview

PQS Level Overview	
Level 0	New hire training, includes: <ul style="list-style-type: none"> • History of company • Policies/Procedures • Timesheets • Expectations • Customer Service • Company Paperwork
Level 1	Entry-level turbine technician. Focus on basic turbine electrical and mechanical fundamentals, overall turbine operation, familiarization of turbine components, site personnel introduction (including contractors, manufacturers, owner/operator), and site safety.
Level 2	Intermediate turbine technician. Focus on electrical and mechanical intermediate training, solid understanding of site personnel hierarchy, familiarity with WTG maintenance cycles, familiarity with major component change-outs, and familiarity with troubleshooting techniques. Includes both core and specialized modules.
Level 3	Advanced turbine technician. Advanced understanding of all major maintenances and major component change-outs, capable of site deployment without supervision, mastery of site and turbine paperwork, advanced troubleshooter. Includes core, specialized and platform-specific modules.
Level 4	Supervisor training. Capable of leading crew of up to 10 personnel on site projects (including major component change-out, maintenances, and troubleshooting), capable of instructing Level 0-3 technicians, capable of mentoring entry-level technicians in site, customer, and company policies and procedures. Has authority to sign off on Level 0-3 PQS, unless otherwise indicated.

The program was tested for thoroughness, schedule and efficacy using a 5-person pilot phase during the last two years. The results of the training were a reduction in time to complete training and increased customer satisfaction on client project sites. However, there were obstacles that surfaced and required adaptation throughout the project including method of delivery, curriculum development and project schedules and are discussed in detail throughout the report.

There are several key recommendations in the report that discuss additional training infrastructure, scalability within additional alternative energy markets and organizational certification through standardization committees.

Introduction

According to the US Department of Energy, for America to derive 20% of its total energy usage from wind, the industry must create 500,000 new “green jobs” by 2030 (8). The US is ahead of schedule to meet the “20% by 2030” goal as it increased new wind energy capacity by 13,124 MW in 2012, bringing the total installations to over 60 GW representing more than 45,100 wind turbine generators (1). Analysts project total wind capacity to dramatically increase from its current level to over 100 GW of installed capacity brought online by 2035 (NRC, Emerging Workforce Trends). To support every 100 MW of installed wind capacity, it is estimated that 310 FTE manufacturing, 67 construction/installation and 9.5 O&M positions are created (6). Current estimates of wind energy sector employment include 75,000 skilled workers at the end of 2010; therefore, there is substantial employment growth potential to reach industry sustainability as the market expands through 2030 (9).

As an industry, because employment within wind is relatively nascent, wind will require an expansion of skilled labor through training and education of a new workforce (5). Compounding this issue, a large section of the wind workforce will retire within the next 10 years as the baby boomers reach retirement age (5). The National Academy of Sciences states “the direct job skills required in the wind power industry are, to a significant degree, the same as skills in other large sectors of the workforce” (5). However to avoid cannibalization of other energy industrial employment by hiring workers out of oil, gas, nuclear or similar jobs, the workforce should be sourced from other industries when feasible.

As a result of the growth of the industry, retirement of experienced workers and restraints on cannibalizing the existing energy workforce, the wind industry must organically create skilled workers through training and education. Community colleges and trade schools are only just beginning to offer associate’s or certification programs, therefore occupations that offer similar training and experience (unlinked to energy production) are preferred to bridge the employment gap as the industry expands.

During the June 2008 AWEA Windpower Conference, a round table discussion among multiple industry CEOs and Senior VPs highlighted significant problems facing the wind industry. A key talking point was the need for skilled employees as the industry rapidly expands. Florida Power and Light (now known as NextEra Energy) senior vice president Michael O’Sullivan remarked, “[The problems in the industry are]...about the human capital. It’s about the staff, the operations people, whatever part of the food chain you’re talking about. And I don’t see it going away any time soon, in the short, medium, or long term.” (7)

In that same discussion, Vic Abate, vice president of renewable energy for GE Energy, exhorted everyone to “think creatively.” He then suggested that companies look toward gas turbine engineers and aircraft engineers for help with wind turbine product development, manufacturing and maintenance (7). In other words, to meet significant energy milestones and see continued progress, wind energy must rely heavily on

translatable skill sets from established industries; one such established industry is the United States military.

From a “potential employee” standpoint, more than 250,000 military personnel with highly technical backgrounds transition into the private sector each year (4). Without a known job as they leave the military, many veterans are at risk for unemployment, or at the very least, are unable to find employment in a relevant field of expertise. In fact, a survey of military veterans in November of 2007 found that a staggering 81% did not feel fully prepared to enter the civilian work force, and 76% felt they were unable to translate their military skills to work in the civilian world (3). Furthermore, because of a lack of training and education for military personnel, a gap is developing between recently transitioned veterans (of the Iraq and Afghanistan conflicts) and nonveterans of 9.4% and 7.9% respectively (2).

Military veterans placed in wind companies come already equipped with highly technical backgrounds; they include aviation electricians, fire controlmen and electronics technicians. Former military technicians make ideal wind candidates because of similarities in their technical backgrounds, including component-level electronic and mechanical troubleshooting, to actual equipment within the industry. These skill sets are applicable because of the increasingly advanced equipment being installed as wind technology evolves. However, with no consistent training pipeline to translate their skills directly to the wind industry, many veterans do not know how to “get their foot in the door” or even that their unique skill sets are similar to and highly desirable within the industry.

Overall, two primary problems must be solved: first, America’s military veterans must find adequate training and employment as they transition from the military to the civilian world. Second, it is critical for the wind industry to establish a skilled training pipeline in order to continue to support its predicted growth. Both problems can be solved through the development of a veteran training pipeline focused on safety and wind technology.

Background

STATE OF THE ART

Currently, multiple educational organizations have developed and implemented curriculum focused on wind technology and basic wind technician training. However, the industry is relatively young and the core curriculum varies greatly between organizations, resulting in various skill levels as technicians enter the industry. The differences are primarily due to length of training (which varies between 3 weeks and 2 years), type of organization (trade school, community college, computer-based training), and even geography. As the industry evolves, the fragmentation of education and inconsistency of the curriculum has created confusion for employers because of the disparate skill sets of entry-level technicians. The result is increased training time upon technician hire, costly repairs to damaged equipment and lost revenue due to availability problems resulting from maintenance delays.

To support standardization of wind curriculum, the AWEA developed the “Wind Turbine Service Technician Seal of Approval” in 2009 to evaluate programs and ensure employees are adequately equipped for support as they begin their careers. Although the Seal of Approval program does standardize training curriculum, the program is still in its infancy with only 7 institutions across the US certified over its current three-year implementation. The standardized curriculum is necessary to systematically ensure technicians are adequately equipped for the various turbine maintenance and repair tasks, however no programs offer a streamlined process for military veterans. Currently, all programs treat entry-level technicians as starting at “ground zero.”

PROJECT OBJECTIVES

The end goal of the project was to create a *Wind Workforce Development Program* catering to former military technicians and veterans as they transition from active duty military to the civilian sector. In addition to serving as an aid to transitioning veterans, the program would harness and hone the established skills of the veterans for use within private wind industry.

The project had two primary objectives:

- 1. Employee Training.** The project would develop a training curriculum and standardize the requirements for former military personnel shifting into wind energy employment. While in the military, personnel are rigorously trained for combat, technical support/repair and military bearing/professionalism in order to prepare them for their tenure in the service. Building on this background, the employee training would be optimized for wind: the primary training would centered on wind-specific safety and technical curriculum while skill sets already honed within the military would be recognized but less emphasized.

2. **Increased Industry Proficiency.** The project was focused on raising the proficiency level of the average technician within the wind industry. Over the past decade, wind technician salaries have increased to match the level of skill required to operate and maintain the increasingly complex machinery in a turbine. Likewise, the level of technician must also rise in order to maintain optimum operations within the industry. The project would harness the technical knowledge of the military personnel for use within the wind industry and verify this knowledge through empirical evidence gathered from actual wind industry clients.

PROJECT APPROACH

The project approach was based on the following core tasks:

1. *Develop the safety and training curriculum through survey of industry companies and personnel. The resultant multi-phase training program would be optimized to the individual skill sets that military personnel have acquired during their time in the service.*
 - a. **Level 1 Training** would consist of basic safety requirements for the wind industry.
 - b. **Level 2 Training** would consist of general turbine troubleshooting and schematic training to transition military skills to wind industry skills.
 - c. **Level 3 Training** would focus on OEM-specific platforms to create an exceptionally knowledgeable technician on individual turbines within the industry.
2. *Enroll and train former military technicians ensuring comprehension and understanding through formal classroom sessions and testing. Each level of training will required specific tools and safety equipment for the required job and training event.*
3. *Deploy technicians to wind farms for actual project support in the industry and receive feedback from industry clients on proficiency, safety and expertise.*

QUALIFICATIONS AND EXPERIENCE

Our organization's core business is to provide technicians for service support within the wind industry. We hire and deploy former military men and women for a career beyond their military service. With a management board completed comprised of former military, we strive to provide a service to the transitioning military personnel of America; perhaps it can be described as a sense of obligation mixed with patriotic *esprit de corps*. The members of the management team have been in the exact same position as the transitioning veterans: excited to see what is beyond the military, yet fearful of an unknown future.

Our managers and trainers have over 40 years of combined experience in wind, training and military support. Their backgrounds include wind industry original equipment manufacturers, service providers, training providers and the US military. Our combined

management experience is uniquely positioned to develop a training program focused on former military personnel transitioning into wind. Similarly, our parent company has over 22 years of military recruiting history, helping over 25,000 military men and women make successful transitions into the civilian sector. The support and oversight provided from our parent company was essential in establishing the program and contributing to its successful implementation.

The trainer we utilized for the curriculum development and actual training has nearly a decade of wind experience including 5 years as a wind industry trainer. He has provided thousands of training hours to personnel within the wind sector and has authored curriculum for a variety of courses for major industry manufacturers. His certifications exceed the minimum requirements that we established when we initiated a search for qualified personnel and he has worked on all major platforms of manufacturer's turbines.

Results & Discussion

There are three primary methods of delivery on which we could build the wind workforce training framework: classroom training, computer-based training (CBT) and on-the-job training (OJT). All three delivery methods have bona fide advantages but also sacrifice key components provided by the other methods. Classroom training offers structured, documented training and certification in a controlled environment but lacks real world experience. CBT is capable of reaching a broader audience spread throughout the nation, but lacks face-to-face interaction to ensure thorough understanding by the students. OJT provides applied, hands-on training in a real world environment, but lacks documentation of the training acquired while in the field.

We utilized a hybrid of all three training methods that offered a comprehensive training solution: the program is called Personal Qualification Standards (PQS) and is based on the program of the same name within the US Navy. Not only does the PQS program incorporate the advantages of all three delivery methods, but it also provides a familiar training structure for personnel transitioning from the US military. All topics within the PQS curriculum have associated presentation slides, written tests, practical tests or formalized key training points (for OJT material).

In practice, PQS is a structured method of qualifying technicians in the performance of assigned professional duties, tracking their training in the field, on the computer and in the classroom, and aiding the trainee in professional development. The PQS program is particularly effective to technicians because it:

- Identifies references where trainees can find information, assigns responsibility for learning to the technician and encourages self-achievement
- Provides the activity with minimum standards to qualify technicians
- Provides the technician with a basic core of knowledge and skills that allows him/her to transfer to a new project or platform of turbine and assume his/her duties with a minimum of requalification effort
- Structures the training program to progressively build on existing knowledge
- Provides supervisors and managers with a record of individual accomplishment to facilitate monitoring progress and performance

Upon hire, a technician is assigned a PQS level, a goal for achievement for relevant PQS training and a provided an electronic PQS packet outlining the tasks to complete the assigned PQS. A technician's PQS packet describes the minimum knowledge and skills an individual must demonstrate to perform his/her duties. Each individual line item is reviewed thoroughly, and signatures captured by authorized PQS Qualifiers upon completion of the training course or individual task. PQS Qualifiers will evaluate whether the technician meets the competency requirements of the required tasks that make up a certification level.

Upon completion, the Qualifier will certify that the technician has met the task competency or performed required task by signing and dating the individual task line

item. Once all the tasks for a particular level are complete a Qualifier will then sign off for the overall level and forward the certification documentation to management. When all the tasks have been demonstrated for a level and validated by a qualifier, the next step is for the manager to:

1. Validate that the technician has completed the required training for that level
2. Validate the authenticity of the qualifiers' signatures
3. Conduct additional oral review, if managers determine it is necessary
4. Approve the certification by signing the certification form

Building on the foundation of the PQS program, we are able to track progress, completion dates and overall efficacy of the Wind Workforce Development Program. The next tasks were to populate the curriculum, tailor it to former military skill sets, test the curriculum through pilot phases and receive customer feedback.

4.1 Create Level 1 Training Program (Task 1)

At the initiation of the project, there were no established safety standards common throughout the wind industry. AWEA announced its "Seal of Approval" in the last quarter of 2009, but the standards were not promulgated until 2010. To date, there remain disparate safety requirements between manufacturers, owners and even between sites with the exact same platform of turbine. Furthermore, federal regulations are yet to be adopted that are specific to the wind industry.

The wind technician occupation is inherently dangerous because of the legion of highly hazardous risks throughout daily tasks. A routine day for a wind technician exposes technicians to hazards that could cause severe injury or death including extreme weather and temperatures (both hot and cold), working at height, working around rotating machinery, working with high voltage, compressed gases, and within confined spaces. To effectively mitigate these hazards, it is imperative for the technicians to master all safety training as it pertains to their occupation prior to mobilizing to a project.

Furthermore, knowledge of specific wind-safety requirements requires the most emphasis for all personnel entering the industry. Because of the dangerous risk factors and the lack of experience of military personnel in wind, it was imperative to focus on safety first and foremost for the PQS training program.

4.1.1 Identify Safety Programs

To determine the safety topics that are a priority throughout the industry, we conducted blind surveys with four primary types of wind companies that provide uptower services: OEMs, construction firms, independent service providers and wind project owners. The purpose was to gather information on their site safety requirements and best practices for wind safety. Participants were asked to rank a variety of safety topics based on the percentage of personnel (internal employees and subcontractors) on a project site that are required to have individual training and/or hold certifications. We termed this ranking "Safety Topic Requirement Ranking" (STRR). Because uptower turbine work is primarily comprised of these four types of companies, the sampling represents the wind

industry as a whole. The larger the STRR number is on a scale of 0-100, the greater the requirement for that particular training throughout the industry. The feedback of the STRR is displayed in Figure 1 below.

Figure 1: STRR Results

Based on the STRR results, we created tiers of safety training for organizational purposes. Tier 1 safety training is considered a core requirement and received over 95 on the STRR. Tier 2 safety training involved coursework that received an STRR of 50 - 94 of surveyed personnel. Tier 3 is considered “specialty” training and was required between 15-49 of surveyed personnel. All other topics received an STRR ranking of < 15 and were not included in the PQS Level-1 curriculum. A summary of Tiers 1-3 can be found in below in Tables 2, 3 and 4.

Table 2: Tier 1 Safety Training (Core)

Course Name	Description/Topics
OSHA-10 Hour	Course work includes: <ul style="list-style-type: none"> • Basic Rigging • Confined Spaces • Electrical Safety • Fall Protection • Hand & Power Tool Safety • Hazard Communication • Health Hazards in Construction • Introduction to OSHA • Ladder Safety • Material Handling & Storage • Personal Protective Equipment (PPE) • Scaffolding • Struck By, Caught Between • Welding, Cutting & Brazing
Tower Rescue/Safe Access	Course work includes: <ul style="list-style-type: none"> • Fall protection • Work positioning systems • Harness induced suspension trauma • Rescue protocol • Ladder pickoff rescue • Over-the-nacelle rescue • Hazard Awareness • Job Site Assessment • PPE Use/Fit/Condition • Practical climb • Emergency Descent/Evacuation
First Aid/CPR	Course work includes: <ul style="list-style-type: none"> • Shock Management • Burns • Diabetic Emergencies • Bleeding Control • Stroke • Heart Attack • AED • Adult CPR
General Wind Safety/Orientation	Course work includes: <ul style="list-style-type: none"> • Site orientation • Common PPE • Safety paperwork (JSAs, work orders, etc) • Turbine component identification • Basic turbine operations • Hazard identification • Risk mitigation • Radio communications

Table 3: Tier 2 Safety Training (Auxiliary)

Course Name	Description/Topics
NFPA 70e/Electrical	Course work includes: <ul style="list-style-type: none"> • Electrical hazards and mitigation • Arc Flash protection boundaries • Electrical Personal Protective Equipment • Safe Work Practices • Compliance and Responsibilities • Electrical Accident Factors • Electrical Metering • Voltage Test Procedures • Electric Static Discharge (ESD)
Confined Space	Course work includes: <ul style="list-style-type: none"> • Responsibility • Personal Protective Equipment (PPE) • Hazard Determination • Safe Work Practices • Permits • Record Keeping • Emergency/Rescue Procedures • Signage & Markings
Lockout/Tagout (LOTO)	Course work includes: <ul style="list-style-type: none"> • What is Lockout/Tagout • Authorized employees • Standards for locks and tags • Procedures for special Lockout/Tagout occasions • Procedures for Lockout/Tagout • Affected employees • Procedures-locks and tags removed • Training of Lockout/Tagout Procedures
Defensive Driving	Course work includes: <ul style="list-style-type: none"> • What is Lockout/Tagout • Authorized employees • Standards for locks and tags • Procedures for special Lockout/Tagout occasions • Procedures for Lockout/Tagout • Affected employees • Procedures-locks and tags removed • Training of Lockout/Tagout Procedures

Table 4: Tier 3 Safety Training (Specialty)

Course Name	Description/Topics
Hydraulic Torque Equipment	Course work includes: <ul style="list-style-type: none"> • Inspection, Maintenance, Operation • PPE/Safety Considerations • Hand safety • Proper positioning and control
Crane Signaling and Rigging	Course work includes: <ul style="list-style-type: none"> • Responsibility • Crane Hazards • Signallerperson Requirements • Differences between signal types • Hand signals • Rigging for lifting • Rigging inspection criteria
High Voltage	Course work includes: <ul style="list-style-type: none"> • Switchgear operations • Proper grounding technique • Bus bars & Breakers • HV cable Inspection criteria

Utilizing a decentralized technician workforce presents numerous logistical and financial constraints to field training. Project schedules (and thus technician availability) were compounded by the high cost of travel to rotate technicians through our training headquarters. In order to facilitate the remote workers, CBT was utilized when feasible, however several courses require hands-on training and practical examples. When required, we were able to move our subcontracted trainer to site locations for hands-on training of individuals.

Based on industry feedback, it was necessary to provide verifiable documentation of technician training including certifications and potentially curriculum review by client personnel. In addition, several certifications have a limited active periodicity and require refresher training annually or bi-annually and must be tracked for ongoing completion. We developed a web-based solution to track training certifications and training periodicity that is utilized for client and technician communication. The web-based solution allows real-time updates to completed training and actual certificate upload so personnel may access training records 24/7.

As a result of the industry research and in coordination with our contracted trainer, we built PQS Level-1 (Table 5). As the wind industry continues to mature, additional safety requirements are implemented and legacy safety requirements are refined. To that end, PQS Level-1 is a combination of both Tier 1 and Tier 2 safety requirements in order to stay ahead of the “bare minimums” and offer industry-leading training for the safety of wind personnel.

Table 5: PQS Level-1 Curriculum Topics

PQS Level-1 Curriculum Topics	
<ul style="list-style-type: none"> • OSHA-10 Hour • NFPA 70e • Tower Rescue • Climb Test • FA/CPR • Confined Space • LOTO • Electrical - Intro 	<ul style="list-style-type: none"> • Safety in the Wind Park • PPE • Turbine Component Identification • Turbine Operations Intro • Hazardous Material Handling • Communications • Proper Tool Use • Hydraulic - Intro

4.1.2 Qualify Trainer

The initial project plan involved training an internal employee/manager to conduct training for all field personnel. However, we determined that the process for certifying an internal trainer would exceed the project budget and have undesirable consequences on our business continuity as a whole. The cost of acquiring instructor certifications, the time and logistics commitment and business operations all contributed to our decision to outsource the training and curriculum development to a third party. Furthermore, the experience level in wind industrial training and O&M support was a value added benefit with the selected contractor.

The contractor was selected based on nearly a decade of wind experience, extensive wind-specific “train-the-trainer” certifications and a history of curriculum development for the wind industry. Although he has many more certifications, his relevant certifications are displayed below in Table 6. His training experience and certifications provide 100% coverage for all required PQS training.

Table 6: Certifications held by Contracted Trainer

Training Certification	Description
CIP Instructor/Safe Access & Rescue	Certified to provide industry standard wind tower rescue training
CIP Instructor / Safe Access & Suspended Platform Rescue	Certified to provide external, temporary platform rescue training
CIP CSE9003 Confined Space Entry & Rescue	Certified to provide specialty training for confined space while at working at height (such as a wind turbine hub)
OSHA 500/510 Certified Instructor	Certified to teach and issue certificates for OSHA-10 Hour and OSHA-40 Hour courses
American Red Cross Instructor/Lay Responder for First Aid, CPR, AED	Certified to teach standard emergency medical training
CSE 2001V Safe Work Confined Space	Certified to teach confined space training
Electrical Safety & Lockout/Tagout	Certified to teach control of hazardous energy (lockout/tagout) to personnel

4.2 Create Level 2 Training Program (Task 2)

4.2.1 Establish Level 2 Curriculum with Subcontractor

PQS Level-2 was developed in coordination with our trainer, feedback from client personnel and our organization's project experience within the industry (Table 7). Initially, it was assumed that all general turbine training could be accomplished in PQS Level-1 and Level-2, and PQS Level-3 would focus solely on specific platforms of turbines. However, as the curriculum for PQS Level-2 was developed, the sheer amount of training required to install, operate, maintain and repair wind turbine generators exceeded our anticipated training pipeline. To accommodate the expanded training scope, we bisected the training requirements into Level-2 and Level-3 training that included both Common Core and Platform Specific sections (PQS Level-3 discussed in Section 4.3 below).

Table 7: PQS Level-2 Curriculum Topics

PQS Level-2: Common Core Curriculum Topics	
<ul style="list-style-type: none"> • Breaker Operation • Hydraulic Line Diagrams • Electrical Schematic Reading • Hydraulic Tool Introduction • Lubricants and Oil Sampling • Accumulator Charging • Service Documentation • Minor Component Replacement • Gearbox Inspections 	<ul style="list-style-type: none"> • Generator Alignments • Yaw Adjustments • Operation of Service Lifts • Hydraulics – Intermediate • Incident Reporting • Service Panels/Controllers • Electrical Terminations • Capacitor Discharge • Hot Work Permits
PQS Level-2: High Voltage I Curriculum Topics	
<ul style="list-style-type: none"> • HV Electrical Safety • Switchgear Operation • Transformer Operation 	<ul style="list-style-type: none"> • Breakers/Bus Bars • HV Cables • Power Electronics Operation
PQS Level-2: Rigging I Curriculum Topics	
<ul style="list-style-type: none"> • Tower Component Rigging • Hub Component Rigging • Ground Controller Rigging • Blade Alignment 	<ul style="list-style-type: none"> • Gearbox Changeouts • Transformer Changeout • Generator Changeout • Hand Signals
PQS Level-2: Turbine Installation I Curriculum Topics	
<ul style="list-style-type: none"> • Rotor Pinning • Damage Inspections • Lightning System Test • New Equipment Transport/Storage • Commissioning • Blade Turning Gear • Tower Base • Switchgear • Foundation Grouting • Nacelle Prep • Internal Hoist System • Tower Cabling 	<ul style="list-style-type: none"> • Rotor Installation • Temporary Storage of Components • Mechanical Walkdowns • Hub Installation • Ground Controller Installation • New Blade Alignment • HV Cable Installation • Tower Paint Repairs • Torqueing Lubricants • Offloading of Turbine Components • Building a Rotor • Top Section/Topout

PQS Level-2 offers an accelerated training pathway for veterans as it is based more on technology common throughout the military. Based on current wind technology, we determined the rates and backgrounds to have the most success in the industry based on project experience and client feedback (Table 8). These backgrounds were successful because they provided a technological overlap with actual wind industrial equipment. Furthermore, the military career development for these specialties include extensive formal training schools that ensured firm understanding of theory and application (Table 9).

In order to satisfy both entry-level veterans and non-veterans, the PQS Level-2 included all relevant training topics required for competency. However, to accommodate the accelerated pathway for veteran hires, Level-2 includes an option to exclude individual topics through a Competency Exemption (CE). The CE process allows veterans to exempt out of qualifications/certifications for specific tasks within PQS levels. For instance, if a veteran technician was an Electronics Technician from the Navy, he may potentially exempt out of the schematics task within the PQS program. Because each military specialty includes specific training, the CE process allows for exemptions can be tailored for individual experience.

Eligibility for a CE on an individual PQS task requires verification by a team consisting of the technician's manager and lead technician. The team will meet with the technician to assess the technician's prior military experience, capability and skills relative to the PQS framework. Based on the completed assessment, the qualifier will then sign off on the PQS tasks that the team has determined that the technician has successfully performed and demonstrated before. The result of the CE process is a comprehensive training program for all personnel, but that allows streamlined completion based on historical experience of military veterans.

Table 8: Ideal Military Backgrounds/Specialties

Rank/MOS	Primary Branch	Relevant Job Description
Fire Controlman	Navy	Repair, operation and maintenance of shipboard weapons system such as Tomahawk missiles and the Close-In Weapons System. This includes all sensor, computer and control packages.
Electronics Technician	Navy	Repair, calibration and maintenance of shipboard electronics equipment including computer systems, radar systems and communication systems.
Aviation Electrician	Navy	Repair and maintenance of aircraft electrical and navigation equipment including power generation and distribution systems, auxiliary sensors and instrumentation.
Avionics Technician	Marine Corps	Repair and maintenance of aircraft electrical and electronic systems including weapons system, component level troubleshooting and auxiliary sensor systems
Machinist Mate (nuclear)	Navy (nuclear)	Repair, operation and maintenance of propulsion plants on nuclear powered surface ships and submarines. Includes reactor control, propulsion, auxiliary equipment and power systems.
Electrician (nuclear)	Navy (nuclear)	Repair, operation and maintenance of reactor controls on nuclear power surface ship and submarines. Includes component level troubleshooting and control system oversight.
Gas Turbine Systems – Electrical	Navy	Repair, operation and maintenance on gas turbine generators and propulsion plants on surface ships. Includes control equipment, component level troubleshooting, schematic reading and circuit repair.
Generator Technician	Marine Corps/Army	Repair, maintenance and overhaul of power generating equipment including motors, engines and auxiliary equipment. Includes both mobile and stationary power production.
Air Flight Engineer	Air Force	Inspection, operation and repair of aircraft control systems, panels, indicators and sensors. Includes helicopter and fixed wing aircraft.

Table 9: Relevant Military Training

School	Description of Relevant Training
"A" School	<ul style="list-style-type: none"> • AC/DC Electrical Theory • Electrical and Electronics Repair • Troubleshooting • Schematics Reading • Power Generation and Theory • Tools and Test Equipment • Advanced Circuits • Hydraulic Theory
"C" School	<ul style="list-style-type: none"> • AC/DC Electrical Theory • Advanced Hydraulics • Advanced Electrical and Electronics Repair • Advanced Troubleshooting • Advanced Schematics Reading • Digital Logic and Control Systems • Isolating/Correcting Faults • Advanced Circuits
Nuclear Pipeline	<ul style="list-style-type: none"> • Applied Electrical Theory • System/Subsystem Interaction • Advanced Mathematics • Safe Nuclear & Power Generation Operations • Advanced Component Level Troubleshooting • Advanced Hydraulics

4.2.2 Purchase Tools/Safety Equipment

Once the PQS curriculum was developed, we established a comprehensive list of tools and equipment requirements to facilitate the training. The requirements included individual personal protective equipment, installed training infrastructure, project/team safety equipment and various tools. Standard technician tool set and PPE list is found below in Table 10 and images of acquired equipment are found in Table 11 below.

Table 10: Standard Technician PPE and Tool Lists

Standard PPE List	Standard Tool List
Climbing Harness	Multimeter, w/ cal certs
Lad Saf, 8mm & 3/8" Cable	Allen Wrench Set, Std/Metric 13 Pc
Fall Arrest Lanyard, 6', Dual Leg	Needle Nose Pliers, Standard
Hard Hat, Climbing	Needle Nose Pliers, Precision
Headlamp	Pliers, Channel lock, 9", 12"
Trauma Straps	Pliers, Side cutter, 8"
Safety Glasses	Insulated Screwdriver Set
Climbing Gloves	Pliers, Vice Grip, locking pliers
Tool Lanyards	Socket set, 1/2" set
High Visibility Vests	Tape measure, metric, 5m/16 ft
PPE Gear Bag	Tool bag, 25"
LOTO Lock & Hasp	Wrench set, Combo 7-24mm
	Wrench, adjustable, 6", 12"
	Precision Screwdriver Set
	Automatic Wire Stripper
	Hammer, Dead Blow
	Hammer, Ball Pein
	Pipe Wrench, 10", aluminum
	Crimper
	Handlamp
	Cordless Drill, 1/2" and Impact Wrench set
	Extension Cord, 25ft

Table 11: Training PPE, equipment and infrastructure

Equipment	Primary Use/Description	Image
Lad Saf	A Lad Saf is required for every technician as a safety precaution during ascending and descending ladders within WTGs. The Lad Saf is used in conjunction with an installed ladder safety cable and attached to the technician's climbing harness at the chest. In the event of a fall, the Lad Saf will catch the cable and arrest the fall.
Full Body Harness	A full body climbing harness is required for every technician and supports the entire body in the event of a fall. When worn, the harness is attached to the Lad Saf on the chest D-Ring and the Fall Arrest Lanyard on the dorsal D-Ring.
Fall Arrest Lanyard	A fall arrest lanyard is a requirement for work at height in accordance with 100% tie-off standards of state and federal regulations. The fall arrest lanyard is attached to the dorsal D-Ring of the full body harness.
Tower Rescue Device	The tower rescue device is used during emergency situations that require immediate turbine evacuation or lowering of injured technicians. The device allows for automated, paced descent from the tower.

Ladder Safety System	The installed ladder safety system within our headquarters is an exact replica of actual turbine ladders and ladder safety systems. This allows actual hands-on training and application that parallel real world scenarios that technicians may face on project sites.
Confined Space System	The confined space trainer replicates the approximate size and enclosure of the wind turbine's hub. This allows for training of emergency procedures in a closed environment and permit-required confined space entry training.
Test Bench	The tool test bench was installed to train on hydraulic and manual torque applications with specialty tools. The bench is equipped with a tension testing unit, a torque testing unit and appropriate electrical connections.

Hand Tools	Hand tools sets are required for all technicians to support all standard O&M duties within the industry. The standard tool list was developed to be functional on multiple platforms of turbines.
Multimeter	Multimeters are part of the standard toolset, and are calibrated electrical measurement equipment for use in wind turbine generators.

4.3 Create Level 3 Training Program (Task 3)

4.3.1 Establish Level 3 Training Plan with OEMs

As discussed previously, the original concept for the Wind Workforce Development program was to complete all required general wind training (Common Core) in Levels 1 and 2, however, substantial training requirements involved in establishing competency resulted in a division of Level 2 training into additional advanced training within Level 3 as part of the Common Core curriculum. The advanced PQS Level 3 Core Curriculum is found below in Table 12. PQS Level-3 training also includes Platform-Specific training focused on OEM-specific WTGs.

Table 12: PQS Level-3 Common Core Curriculum Topics

PQS Level-3: Common Core Curriculum Topics	
<ul style="list-style-type: none"> • Testing Capacitors • Hydraulic Motor Circuits • Wind Sensors • Solenoid Valves • Motor Faults/Diagnosis • Schematics – Advanced • Failures and Root Cause Analysis • Replacing Rotating Union • Megger & Motor Testers • Troubleshooting • Analog/Digital Signals • Motor & Pump Replacement • Hydraulic Line Diagrams – Advanced • Main Seal Replacement • Bearings – Advanced • Coupler Replacement • Pitch Ram Replacement • Operational History/Turbine Logs 	<ul style="list-style-type: none"> • Yaw Drive Replacement • Hydraulic Pump Replacement • Thermal Relay Tests • Sensors • Heating Elements • Circuit Breakers & Fuses - Advanced • Contactors & Relays • Coil Knowledge • Switch Functions • Transformers – Advanced • Thyristors • Accumulators – Advanced • Check Valve Operation & Replacement • Pressure Transmitter • Gearbox Inspection – Advanced • Grid Connections • Internal Generator Cooling Fans • Borescope Introduction
PQS Level-3: High Voltage II Curriculum Topics	
<ul style="list-style-type: none"> • Transformers - Advanced • Switchgear - Advanced • Advanced HV Troubleshooting 	<ul style="list-style-type: none"> • Breakers/Bus Bars - Advanced • HV Cables - Advanced • Power Electronics - Advanced
PQS Level-3: Rigging II Curriculum Topics	
<ul style="list-style-type: none"> • Nacelle Rigging • Offloading Tower Sections - Rigging 	<ul style="list-style-type: none"> • Offloading Blades - Rigging • Offloading Hub - Rigging
PQS Level-3: Turbine Installation II Curriculum Topics	
<ul style="list-style-type: none"> • Arc Detection System Installation • Setting Modules Address • Turbine Counters • Updating/Setting Turbine Parameters • Commissioning – Advanced • Earthing Systems • MCCs 	<ul style="list-style-type: none"> • Phase Rotation Checks • Blade Locking • Crane Basket • Crew Leadership • Switchgear Programming • Common Installation Faults

We approached multiple OEMs to coordinate a platform-specific training program on their wind turbine generators when the project commenced. However, because of the highly confidential intellectual property involved, we initially met much resistance against building an internal program that included specifics on their equipment. Any courses offered were either proprietary and limited only to the OEM's own employees or the cost of the training exceeded our project's budget.

After much dialogue with various OEMs, we were able provide a solution that would involve our technician's attendance at one OEM's proprietary training

course held in their own facility in Minnesota. Although our own internal trainers did not conduct this training, the task was nevertheless accomplished through the highly specific training tailored to a specific OEM platform of WTG. A table of the training conducted by the OEM is found below in Table 13.

Table 13: OEM #1 Platform-Specific Training

PQS Level-3: Platform-Specific (OEM #1)	
All training topics specialized to specific OEM WTG platform:	<ul style="list-style-type: none"> Hydraulic Rotor Lock Turbine Schematic Review Rotor Lock Practical Procedure Lab/Practical OEM Electrical Course Installation Final Test and Practical
<ul style="list-style-type: none"> Project Introduction Turbine Platform Overview Pitch Drive Operation Pitch Drive Practical Detailed Procedural Review 	

Despite the earlier resistance against internal training of proprietary equipment and as a result of the successful training with first OEM, we successfully created a tailored training program with a secondary OEM. The OEM provided detailed training course curriculum that covered wind turbine basics and progressed into turbine operations and advanced troubleshooting. We then worked with the OEM to create a customized training plan for the platform prior to mobilizing to their project site. A table of the training conducted by the OEM is found below in Table 14.

Table 14: OEM #2 Platform-Specific Training

PQS Level-3: Platform-Specific (OEM #1)	
All training topics specialized to specific OEM WTG platform:	<ul style="list-style-type: none"> Main Bearing & Gearbox High-speed Shaft Generator Hydraulic Concepts/Principles Hydraulic Symbols Hydraulic System Functions Hydraulic Maintenance Top Controller Anemometer Maintenance Procedures Alarm Conditions Event/Fault Analysis
<ul style="list-style-type: none"> Company Overview Turbine Overview WTG Electrical Generation Principles Power and Pitch Control Switchgear Ground Controller Service Lift Mid Level Transformer Yaw Deck Hub 	

4.4 Training Pilot Program (Task 4)

The pilot phase was completed successfully for all phases of the project. We surveyed the trainees for schedule and thoroughness of the course and we surveyed the clients for quality, professionalism and knowledge of the technicians on projects on which they worked.

Overall, former military technicians completed the training quicker than non-veteran technicians: PQS Level-1 was completed 8.3% faster and PQS Level-2 was completed 4.22% faster (Figures 2 and 3 in Conclusions section).

At the conclusion of individual projects, we also receive client feedback on technician performance and the results are shown in Figures 4 and 5 (Conclusions section below). The veteran teams received increased satisfaction scores in all categories and the overall satisfaction score that was nearly 11% higher than non-veteran teams.

The CE process was the primary driver of the expedited completion time, although the client feedback on actual projects proves that there was no loss in quality as a result of the exempted modules. Utilizing the CE process effectively controls or even eliminates redundant training and potentially saves companies training funds.

However, throughout the pilot phase, we experienced various challenges that required redesign of the original project plan as a result of our organization's business model and industry market conditions. The pilot phase details are found below with associated lessons learned during the process.

4.4.1 PQS Level-1 Pilot Program

Summary

Five former military technicians identified and enrolled in the PQS Level-1 safety training and accomplished it over the modules over a 3-week period.

Lessons Learned

The initial plan was to coordinate travel for all technicians to our headquarters in San Diego, CA, however due to project schedules, the remote locations of the technicians and the expense of travel, it was more feasible for the technicians to complete various modules via CBT. For the modules that required hands-on/practical training, we mobilized our trainer to a centralized project site on which the technicians were to perform services. This resulted in travel/logistics cost savings yet the result was that the technicians received verifiable training and practical experience.

An additional lesson learned was caused by a delay in the initial pilot phase was due to curriculum development. The curriculum development period was extended because the training contractor was not hired until 2012 and up until that point the management team lacked required certifications to conduct training. Exacerbating the delay was the inexperience of the management team with authorship of training curriculum. However, by utilizing internal training for a portion of the training and CBT, we were able to accomplish the pilot phase of PQS Level-1 in September of 2011.

Another lesson learned involved the curriculum development – once initially finalized, it expanded during the course of the project as additional requirements were added or modified based on client safety programs. An example was the NFPA 70e training requirement – the number of clients that requested NFPA 70e certifications grew over the 24 months of the project indicating that more companies within the industry were emphasizing electrical safety on project sites. It is therefore paramount that the PQS program be adaptable to changing industry requirements to quickly add or modify specific training modules.

4.4.2 PQS Level-2 Pilot Program

Summary

Five former military technicians were identified as having the prerequisites for entering into PQS Level-2. The technicians completed the training over a span of approximately 14 Months.

Lessons Learned

The trainees completed the training, however the time period to complete was extended well beyond our initial expectations for the following reasons:

- The Level-2 curriculum was contingent on hiring a qualified training contractor, which did not happen until the first quarter of 2012 therefore large portions of the curriculum remained unwritten until that time. The Level-2 material as a whole was not completed until September 2012, however the technicians were able to complete portions of the curriculum as they were written.
- Many of the task-based training modules in the PQS Level-2 material is contingent on the availability of projects that involve that particular equipment. If that equipment or those particular tasks are not available, the technicians cannot complete that portion of the PQS until they are deployed to a project site on which those individual modules are available. For instance, one of the task items included in PQS Level-2 is a Generator Alignment – if none of our existing customers currently require Generator Alignments, then our technicians cannot accomplish this task.

Now that the Level-2 curriculum is completed, it is expected that technicians can complete the training within a 12-month window, barring availability of on-the-job training tasks contingent on customer project schedules. Additional recommendations are provided in sections below to overcome task-based project availability.

An additional lesson learned as we moved into the pilot phase of PQS Level-2 was the challenge of technician continuity. Because of the inherent nature of the wind service business and its basis on support for short-term projects, we were experienced turnover of a portion of the original PQS Level-1 trainees. As a result, individual technician tracking of PQS level completion is required to ascertain ongoing effectiveness of the program.

4.4.3 Level 3 Pilot Program:

Summary

Eight technicians participated in the Level-3 training pilot program spanning training with two different OEMs and their proprietary equipment. 5 technicians completed the training in OEM #1's facility utilizing their own trainers and equipment over the span of 2 weeks. 1 technician was removed from the training after 1 week due to insufficient knowledge and personality conflicts.

2 additional technicians were trained through a tailored training program coordinated with OEM #2 using our internal trainers over a span of 2 weeks.

Lessons Learned

Because of the hesitancy of OEMs to offer training to third party service companies due to intellectual property concerns, it was very difficult to negotiate any training with our clients. When we were presented with an opening to participate in training in November 2010, we took advantage of the opportunity, despite it technically being completed prior to the PQS Level-1 and PQS Level-2 training. The technicians that were selected for this position had already accomplished PQS Level-1 and were experienced technicians via the CE process to exempt out of large portions of the PQS Level-2 training. However, with 1 technician being removed for insufficient knowledge from the OEM #1 training program, we redesigned the CE process based on upper management approval in order to catch any knowledge gaps that may have been overlooked at lower levels.

Also as we discussed above, we deviated from the original plan of training curriculum by expanding the Level-2 training into two phases, one of which was incorporated into Level-3 training as a distinct section called Common Core module. The key lesson from this pilot phase is that Level-3 Common Core modules are extensive in nature; due to project schedules and the specialization of the training involved in Level-3 Common Core curriculum, it is anticipated that training for that portion will take approximately 24 months. As a result, our technicians are currently in progress of completing the Common Core section. However, because the original project plan only incorporated OEM-specific training, the overall task was completed ahead of schedule in November 2010 with OEM #1 and then in January 2011 with OEM #2.

4.5 Submit Program Results (Task 5)

Initial program results were promulgated during the Cutting-Edge Preventive Maintenance Strategies in April 2011 after the first PQS Level-1 technicians had completed the modules. Additional results were disseminated to the industry during the annual AWEA Windpower Tradeshow in May 2011 and June 2012.

Although we were able to provide results via multiple web publications, the final results have not been published to date. One opportunity that is forthcoming is a highlighted article in the G.I Jobs magazine and highlighted web article that discusses the program and includes interviews with former military technicians.

Currently, our internal marketing department has approached multiple industry periodicals and publications, but are yet to receive hard publication dates outside of those mentioned below in the Accomplishments section.

Accomplishments

Internet Publications

US Department of Energy. (2012, August 16). Retrieved August 17, 2012, from Wind Powering America:

http://www.windpoweringamerica.gov/filter_detail.asp?itemid=3644

Casey, Tina. (2012, June 2). Retrieved June 3, 2012, from Cleantechnica:

<http://cleantechnica.com/2012/06/02/military-vets-train-for-wind-power-employment/>

Schultheis, Debbie. (2012, May 31). Retrieved March 31, 2013, from Energy.gov:

<http://energy.gov/articles/wind-industry-training-our-military-veterans>

Danko, Pete. (2012, June 20). Retrieved March 31, 2013, from Earth Techling

Homepage: <http://www.earthtechling.com/2012/06/wind-industry-embraces-us-military-veterans/>

Presentation

Cutting-Edge Preventive Maintenance Strategies. (2011, April 14). Developing the Wind Workforce: Former Military

Product Development

Flow Database - proprietary web-accessible database to track training certifications and training periodicity for employees and client companies. Visit

<http://flowtrac.com/flow/gemini-energy/> for more information.

Infrastructure

Developed turnkey training facility within organizational headquarters in San Diego, CA. Training capabilities include facilities for tower rescue, work at height, confined space, OSHA-10 hour, NFPA 70e, LOTO, PPE, Hydraulic torque equipment and additional classroom training.

Training Curriculum

Developed proprietary, multi-tiered training program that includes a streamlined exemption process for fast-tracking former military personnel transitioning military personnel into the wind industry. Curriculum includes hybrid of CBT, OJT, classroom and hands-on training covering all relevant safety and technical topics relevant to the wind industry. Training process is scalable to multiple energy production industries.

Project Completion

Throughout the Wind Workforce Development project, our veterans trained through the pilot phase of the PQS program accomplished projects totaling over 1200MW of installed capacity on 4 of the largest OEMs in the US. Additional technicians trained after the pilot phase are not included in these project statistics but provided services at additional locations.

Projects were accomplished in the following US States:

- New Mexico
- Montana
- New York
- California
- Kansas
- Indiana
- Idaho
- Minnesota
- North Dakota
- Texas
- Iowa
- Oregon
- Wyoming
- Pennsylvania
- Connecticut
- New Hampshire
- Massachusetts
- Maine

Conclusions

- The program successfully created a curriculum for wind training that expedites former military technicians into the wind labor pool. Currently, our facility, infrastructure and training personnel are capable of supporting 12 technicians per month for Level-1 Training.
- Military candidates completed the PQS levels faster compared to nonveterans in similar positions because of the Competency Exemptions available to them as a indirect result of their military training. Furthermore, they received high marks for quality when placed in real-world projects in the field. Figures 2, 3, 4 and 5 display the results of the PQS completion and customer satisfaction surveys.
 - It is estimated that with the refined curriculum, the PQS CE process will produce an 8%-10% reduction of training time, resulting in cost savings estimated over \$104,000 annually in training expenses for an organization of our size and type.
 - The PQS program is scalable to larger organizations that maintain field service teams for wind projects. The resultant cost savings would be scaled accordingly to the size of their field service teams.
 - With tailoring, the PQS model is applicable for conventional and alternative energy sources. However, the training required for the specific industrial equipment must be similar in form and function to take advantage of the training that the military personnel completed previously.

Figure 2: Average Time of Completion for PQS Level-1

Figure 3: Average Time of Completion for PQS Level-2

Figure 4: Weight Projected Feedback from Customers

Figure 5: Overall Satisfaction of Veteran and Non-Veteran Technicians

- For an organization of our size, certifying an internal trainer is not feasible at this time due to cost and time-to-certify. However, for larger organizations, internal training teams would be more cost effective depending on the number of field employees and length of curriculum.
- CBT is the preferred method of training due to logistics, technician availability and project scheduling. When classroom training is required for hands-on and practical applications, it is more feasible to deploy the internal trainer (or contracted trainer) to a local area (relative to the trainees).
- The safety requirements for the wind industry dynamically shift as the industry matures. The PQS program must be modular in order to add/delete/modify particular safety curriculum based on industry requirements and statutory and federal regulations.
- The service sector of wind is project-based and attrition rates are high. It is imperative that the PQS program is streamlined to provide a career path to employees that will document progress and completion in order to ensure consistent training of all personnel.
- The sheer amount of information related to wind turbine operations, maintenance and repair is large. The structure of the PQS program required an even greater division of hard and soft training skills as a result. As increasingly complex equipment is installed with industrial growth, it is anticipated that additional PQS modules are created to further differentiate skill sets.
- OEM-specific training is difficult to acquire due to cost and IP concerns. It is imperative to acquire OEM buy-in to support certification of third party providers on platform-specific equipment.

Recommendations

May include recommendation for commercialization path, need for follow up R&D work or demonstration.

It is recommended that the project is further developed in the following ways:

- Acquire AWEA Seal of Approval for PQS program to legitimize the curriculum to adequately equip technicians for wind project support.
- Acquire Global Wind Organization training certification (similar to AWEA's Seal of Approval)
- Certify our training facility as an ENSA and Gravitec training location for tower rescue. ENSA and Gravitec are two additional wind tower rescue training courses that are open to public enrollment. This would create a southern California training option for additional personnel entering the wind industry.
- Build a standalone training facility big enough to facilitate larger class sizes and hands-on practicals involving real-world turbine components. This infrastructure would replicate turbine conditions and avoid delays in completing technician training based on client project availability.
- Incorporate offshore wind training as that wind market begins in the US. Currently, the PQS curriculum only encompasses onshore wind training.
- Expand the training program into Fuel Cell and Solar markets to test scalability of the PQS training model.
- Create our own online training platform for CBT that would be tailored specific to wind (or relevant alternative energy markets) instead of utilizing generic CBT that exists today.
- Conduct detailed study on the true cost of training technicians for proficiency at other organizations within the wind industry. This would allow immediate cost benefit analysis of the streamlined PQS program as it pertains to former military technicians.

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