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Development of a best practices manual for the U.S. Department of Energy's Wind for Schools Project

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Development of a Best Practices Manual for U.S. Department of Energy's Wind for Schools Project

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Abstract

The Development of a *Best Practices Manual* for the U.S. Department of Energy's Wind for Schools Project is an effort to provide the necessary research and data to make the completion of a *Best Practices Manual* possible. The *Best Practices Manual* will be used to help with the future development of Wind for Schools Projects nationally. The Wind for Schools Project was developed in 2005; currently 11 states are actively participating. As the Wind for Schools Project developed, various approaches and techniques were used to meet the goals of the program. A *Best Practices Manual* will serve as a repository of successful strategies and approaches employed by the program. The development of the *Best Practices Manual* focused on the research needed to understand the Wind for Schools Project; this included background on the U.S. Education System, a comprehensive study of the Wind for Schools Structure, a study of each 11 state programs, defining a *best practice*, the development and dispersion of a survey for the Wind for Schools Facilitators and Wind Application Center Directors, and a final outline for the *Best Practices Manual*. This effort is an attempt to pull together all the necessary research for the *Best Practices Manual*; which will in turn present generally-accepted, informally-standardized methods and techniques that have been developed to accomplish the three main goals of Wind for Schools.

I. Introduction

Wind for Schools (WfS) was initiated in 2005 under the Wind Powering America (WPA) education initiative. Wind Powering America is an initiative by the U.S. Department of Energy Wind Program that aims to educate, engage, and enable critical stakeholders to make informed decisions regarding the contribution of wind energy to U.S. electric supply (U.S. Department of Energy [DOE], 2012a). There are three main goals of the Wind for Schools Project: to equip college students with an education in wind energy applications; to engage American communities in wind energy application, benefits, and challenges; and to introduce teachers and students to wind energy (DOE, 2012a).

The Wind for Schools Project developed in response to the call for new, hands-on science curricula as well as the need to provide for an expanding wind industry within the United States. Specifically there is a collaborative effort to provide 20% of the United States electricity through wind energy by 2030 (Baring-Gould, 2009). Although the United States was once ranked number one in the world in terms of science education, it has recently fallen behind internationally. In a recent study by the Associated Press, the United States ranked 17th out of 34 countries in science (The Associated Press, 2010). There are numerous attempts being made nationally to improve science education in the U.S. including the Wind for Schools Project, Change the Equation, the National Math and Science Initiative, and Educate to Innovate.

The approach taken by the Wind for Schools Project to achieve these goals begins with the installation of small wind turbines at rural K-12 host schools while simultaneously developing Wind Application Centers (WACs) at higher education institutions (DOE, 2012a). The project emphasizes teacher training and development of curricula at the K-12 level, while providing experiences to undergraduates through their engagement in the assessment, design, installation, and analysis of small wind systems. In 2005, the first project was launched in Colorado. At present there are 11 Wind for Schools Projects supported nationally, these reside in Alaska, Arizona, Colorado, Idaho, Kansas, Montana, North Carolina, Nebraska, Pennsylvania, South Dakota, and Virginia. These 11 projects have installed more than 95 small wind systems at host schools (U.S DOE, 2012a).

As the Wind for Schools Project has evolved, a variety of approaches have been developed by the different Wind Application Centers. The diversity of approaches results from the fact that different resources and opportunities are available in each state. Each WAC structure reflects the home institution and department that support it and which will vary from state to state. Each state's WAC also interacts with one or more national laboratories that provide additional resources. There are also a variety of methods being used to identify and involve the K-12 community in the installation of small wind systems at host schools. The methods and approaches used to meet the three goals of the project vary state to state and are extremely important to the future successes of this project.

This effort focuses on the development of a *Best Practices Manual* for the U.S. DOE's Wind for Schools Project. The development of a the *Best Practices Manual* includes a variety of research related to the project, including the justification of the WfS Project, background on U.S. science curriculum, the developing wind industry in the U.S., the original intentions of the WfS Project, roles and responsibilities of WfS participants, structure of each of the 11 state projects, and feedback from each state which provides approaches and methods used in the development of their projects. The objective is to pull together all the necessary research to develop the *Best Practices Manual*. The data and research collected will result in the creation of an outline for the *Best Practices Manual*, in turn making it possible for the creation of the manual.

A *Best Practice Manual* will provide insight into the Wind for Schools Project for states and institutions that are not already engaged and wish to initiate their own project. The manual will provide a library of methodologies and approaches that are already proven to be effective during the development and implementation of a Wind for Schools Project. Thus, it will empower states and institutions by providing a guide of *best practices*. The *Best Practices Manual* will serve as a repository of strategies employed by the past and present Wind for Schools facilitators and will present a comprehensive list and explanation of the different approaches developed by each state. The manual will also describe strategies that are most commonly employed by the individual WACs to promote learning at the undergraduate level and will include specific examples of techniques and programs that have developed through Wind for Schools. The *Best Practices Manual* will also present the various techniques developed by WfS Facilitators to identify and engage the K-12 community, as well as non-traditional learning institutions such as museums where a host school may not be available.

II. United States Education System

Before discussing the specifics pertaining to the Wind for Schools Project, it is important to first discuss the United States Education system. Education in the U.S. has gone through various evolutions, not only pertaining to the development of the current system but also the development of science curriculum. Much of the curriculum development was influenced by events happening around the world, especially those pertaining to science. Recently, U.S. science education has fallen behind internationally.

In recent years, the U.S. education system has seen criticism from various aspects of society. The greatest criticism pertaining to U.S. education comes from their current failings based on international studies, proving that U.S. has lost its spot at the top (The Associated Press, 2010). This is especially true about science education, which as a result of various government reforms, has been put on the back burner in order to focus on other subjects. There are various programs and initiatives aimed at the improvement of science education for K-12 students as well as to create the drive to pursue science education for postsecondary learning. The improvement of science education in the U.S. will directly affect the economy positively by providing a larger knowledge base and adding to the gross domestic product (Symonds, 2004). In order to best understand the current situation of the U.S. education system, it is important to first look at the development of the modern education system.

Development of U.S. Education System

The United States education system has evolved throughout the years, one of the most important changes was the shift from localized schools to common schools. This evolution has been influenced by various aspects of U.S. history, including many world and political events. Once seen as the best in the world, the United States education system now faces numerous challenges and is falling behind much of the world according to education ranking (The Associated Press, 2010). This is especially true regarding science and mathematics rankings, where the U.S. has seen some significant lags in the past few years.

It was not until the 1840s that education in the United States evolved to today's traditional system; previously it was localized and often only available to the wealthy. The movement toward common schooling began during this time in an attempt to enable all children to gain from the benefits of education. Reformers believed that common schooling would create good citizens, unite society, prevent crime, and decrease poverty. As a result of these efforts, free public elementary education was available by the end of the 19th Century (Thatti, 2003). Education in the United States became compulsory in the late 19th Century with the establishment of the National Education Association (NEA) which created school districts, taxations for government schools, curriculum and structure, and compulsory attendance (Clare Boothe Lucy Policy Institution [CBLPI], n.d.). Massachusetts was the first state to pass compulsory attendance in 1852, followed by New York (Thatti, 2003). By the early 20th Century, compulsory elementary attendance was enacted in all states.

The rise in American high school attendance was one of the major developments during the 20th Century, between 1900 and 1996 the percentage of students who graduated from high school increased from 6% to 85% (Thatti, 2003). This is in part due to the expansion of compulsory education during the 20th Century to the age of 16. The 20th Century was shaped by the various world events which directly impacted the development of the education system including the Great Depression, the two World Wars, the Cold War, and numerous political events. In the years following World War II, the U.S. education system was unrivaled, but has since eroded (Dillion, 2010). In 1958, Congress passed the National Defense Education Act, providing federal funds to local public schools for science, math, and foreign language instruction as well as guidance counseling services (CBLPI, n.d.). In recent years, an increasing number of students in other countries are graduating from high school and college and have begun to score higher on achievement tests than U.S. students (Dillion, 2010). In 2002, No Child Left Behind (NCLB) was signed into law to remedy the education crisis in the United States, but has not had the desired effect (CBLPI, n.d.). Ironically, NCLB could actually be making the problem worse. Currently, NCLB requires that students be tested in reading and math, which in turn puts science on the back burners (Symonds, 2004). The education system in the U.S. is failing to provide adequate educations to students.

History of Science Education in the United States

Along with the development of the traditional education system, science curriculum has also evolved. Early science curricula, those taught in localized private and religious schools, developed to serve an agrarian society. The science curriculum involved natural philosophy (physics), astronomy, chemistry, botany, geology, navigation, agriculture, and surveying (Kean University, n.d.). Science curricula underwent a reformation with the shift from localized schooling to the public school system. This evolution was greatly influenced by the Industrial

Revolution and urbanization, leading to a shift toward a more technical/industrial science. At the same time this shift was occurring, many colleges and universities began requiring physics and chemistry for admissions.

One of the major influences on science curriculum was the Industrial Revolution in the late 19th and early 20th Century. The beginning of the Industrial Revolution is characterized by technological advances based almost exclusively on craft and trade skills, as well as experiences. Throughout the Industrial Revolution science played a major part in the development of technology, but the science technology influence is a two-way process (Evans, n.d.). This concept of science and technology working together influenced science education in both positive and negative ways. During this time there was a belief that science was a superior body of knowledge to technology, which in turn led to many negative assertions about the development of a technology-based science curriculum (Evans, n.d.). The important change to science curriculum during this time resulted from research and innovation in almost every scientific field (biology, chemistry, mathematics, and physical science). While the second half of the industrial revolution was driven by chemical, communication, and electrical technologies (Evans, n.d.). As a result of the Industrial Revolution, science curriculum began expanding to include technical education in order to keep up with the expanding technological world.

Reorganizations of science curriculum took place throughout the 20th Century; science became grade-specific – for example, biology was taught in 10th grade, physics in 11th grade, and chemistry in 12th grade. In 1924 the Committee on the Place of Science in Education of the American Association for the Advancement of Science issued a report stressing the importance of scientific thinking as a goal (Kean University, n.d.). General science was added to 7th and 8th grade curriculum between 1930 and 1945, which in turn pushed for more advanced sciences in secondary school. During this time biology also became the basis for 8th grade science curriculum. World War II had a tremendous effect on science curriculum; the focus moved toward practical sciences such as aviation, photography, and electricity. During the post WWII era, between 1945 and 1955, science fairs became very popular and interest in earth sciences, physical sciences, general sciences, and biology increased while interest in chemistry and physics decreased (Kean University, n.d.).

During the post WWII era, the American people recognized the importance of scientists and engineers. Scientists and engineers were recognized for two of the most important contributions;

penicillin and the atomic bomb (National Science Foundation [NSF], n.d.). In order to ensure the progress of science and engineering, the National Science Foundation was established in 1950 (NSF, n.d.). In 1957, the Russian Space Program launched Sputnik, directly influencing U.S. science curriculum. The goal of the new science curriculum was to catch up to and surpass the Russians (Kean University, n.d.). During this time, there was a decrease in the number of Americans entering the science field, which prompted the U.S. to revise the science curriculum (Kean University, n.d.). Sputnik prompted Americans to recognize that science education was falling increasingly behind the rest of the world. In response, Congress passed the National Defense Education Act (NDEA) of 1958 (Dean, 2007). This act was intended to ensure that highly trained individuals were available to help compete against the Soviet Union in the scientific and technical fields. In order to achieve this, NDEA included loans to support college students for aspiring scientists and engineers; improvement of science, mathematics, and foreign language instruction in elementary and secondary schools; graduate fellowships; foreign language and area students, and vocational-technical training (U.S. Department of Education, 2012).

The 1983 report “A Nation at Risk” by the National Commission on Excellence in Education (a bipartisan federal commission) warned that the country was engulfed in a “rising mediocrity” as a result of the decline in science achievement (Dean, 2007). This report was focused primarily on secondary school curricula (Scherer, n.d.). “A Nation at Risk” recommended that secondary school should incorporate three years of science and one half year of computer science; each with specific standards to guide teaching curricula (Schrerer, n.d.). “A Nation at Risk” also emphasized the demand for teachers of mathematics, science, foreign languages, specialists in education for gifted and talented, language minority, and handicapped students. This in turn placed a new emphasis on the teaching preparation curriculum in order to prepare qualified teachers (Scherer, n.d.). “A Nation at Risk” did not solve the science education problems in the U.S., but instead made it a never-ending battle. The U.S. is falling behind globally in science performance which in turn makes Science, Technology, Engineering, and Mathematics (STEM) education a national priority.

The Current Situation: U.S. Education Standing

During the past few years both national and international reports have shown that U.S. education, especially involving mathematics and science, is falling increasingly behind the rest of the world. According to the results of a key international assessment, the 2009 Programme for International Student Assessment (PISA), U.S. students are trailing behind their international peers. This study showed that 15-year-old students in the U.S. are performing at an average level in reading and science and below average in math. Among 34 countries, the U.S. ranked 14th in reading, 17th in science, and 25th in math (The Associated Press, 2010). The highest-scoring countries include South Korea, Finland, Singapore, Hong Kong and Shanghai in China, and Canada. The PISA is considered to be the most comprehensive test of its sort to compare levels of education across nations. The test focuses on how well students are able to apply their knowledge in math, reading, and science to real-life situations. In 2009, approximately 470,000 students took the test in 65 countries. Between 1995 and 2008 the U.S. slipped from ranking second in college graduation to 13th (The Associated Press, 2010). Figure 1 below shows international PISA rankings in descending order of top science performers in 2009, the figure also compares 2009 averages with 2006. The United States shows little to no improvement in average science scores between 2006 and 2009 and is performing significantly behind their peers (Organization for Economic Cooperative and Development [OECD], 2009)

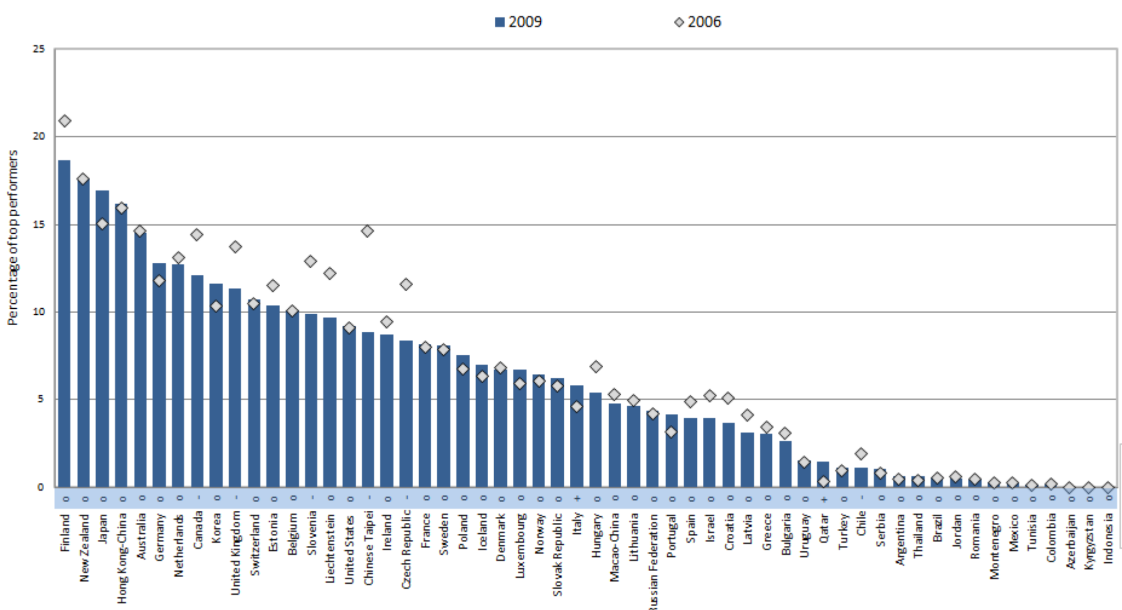

Figure 1: 2009 PISA science performance (OECD, 2009).

The impact of improving math, reading, and science scores in the U.S. could be radical. A recent study by the Organization for Economic Co-operation and Development (OECD) and Stanford University projected that if the U.S. were to boost the average PISA score by 25 points over the next 20 years, there would be a $41 trillion gain in the U.S. economy over the lifetime of the generation born in 2010 (The Associated Press, 2010). Despite recent increases in some measures of scientific and mathematical proficiency, U.S. students lag behind their international counterparts. There are also major gaps in the U.S. between populations at different socio-economic levels (Olson, 2009). Not only is the U.S. lagging behind globally, but there are significant differences in the educations received throughout the country (National Public Radio [NPR], 2011).

Many states are failing to provide adequate science education to public school students. A recent report revealed that California is not providing high quality science education to public elementary students. Approximately 10% of elementary school classrooms provide hands-on science experiments and fewer than half of the surveyed school principals believe their students receive high-quality science instruction in their respective schools (NPR, 2011). California is just one example of inadequate science education; this problem can be seen all over the U.S.

Longitudinal data from 2008 Indicators on the concepts and skills that students master in the early grades shows that 90% of 5th graders are proficient in multiplication and division, but only 40% are proficient in rates and measurements, while less than 10 % are proficient in fractions (Olson, 2009). For mathematics, the overall proficiency for 4th and 8th grade has been growing from 1990 to 2005, but the same is not true about science. Science proficiency has been falling for the 4th, 8th, and 12th grades between 1990 and 2005, this is especially true about 12th grade (Figure 2 below) (Olson, 2009).

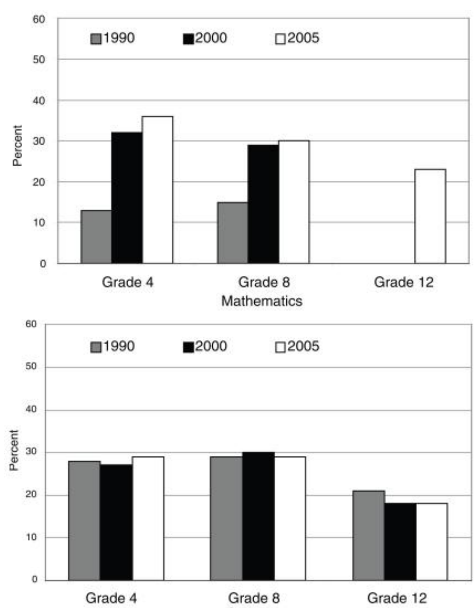

Figure 2: Math and Science Proficiency in fourth, eighth, and twelfth grade (Olson, 2009).

The United States is severely lacking in science education. According to the Third International Mathematics and Science Study, by the time students reach their senior year of high school they are ranking below their counterparts in 17 countries in terms of math and science literacy (Symonds, 2004). In physics alone, U.S. high school seniors scored last. As result of inadequate education, many high school graduates are not prepared for college-level science courses; one report showed that only 26% of 2003 high school graduates score high enough on the ACT science test to have a good change of completing college-level science courses (Symonds, 2004).

There are various consequences associated with this deficiency in science education because the quality of the nation's workforce has an influence on productivity. Education reform could stimulate the economy more than any conventional strategy, such as tax cuts. According to Eric A. Hunushek, a Paul and Jean Hanna Senior Fellow of the Hoover Institution at Stanford University, if we were to raise our science and math performance to that of Western Europe in a decade, U.S. gross domestic product growth would be 4% higher than otherwise in 2025 and 10% higher in 30 years. Clearly, the lack of adequate science and math education is not only hurting our international rankings, but has a direct effect on our national economy.

One of the greatest problems with science and mathematics education in the U.S. is the lack of a national standard such as what exists in much of Europe and parts of Asia. Michigan State University Professor Bill Schmidt found that other countries place greater demands on their students; especially those in middle grades, while in the U.S. students are studying basic arithmetic and doing very basic science (Black & Stewart, 2011). In both national and international tests mathematics and science, U.S. students' performances range from mediocre to extremely poor.

The U.S. Department of Education 2009 National Assessment of Educational Progress (NAEP), informally referred to as the 'The Nation's Report Card', is the largest national representation and assessment of American students' knowledge and ability to perform in various subjects (Atkins, 2011). The NAEP science test was recently revised, thus making comparisons to previous test results impossible. The new framework is a better representation of students' performance and knowledge of science concepts, taking into account scientific advances, and more effectively measures higher-level scientific thinking (Paulson, 2011). Thus, though not comparable with previous tests, the new NAEP science test provides a much more accurate picture of student performance and knowledge.

The study revealed that U.S. students are performing poorly in science, and showed significant gaps between races, income levels, public/private education, and gender (Paulson, 2011). NAEP considered 156,500 4th grade children, 151,100 8th grade children, and 11,000 12th grade students; 46 states were involved along with students from the Department of Defense Education Activity (DoDEA) schools. The test examined the basic scientific concepts at each respective grade with scoring on a 0 to 300 scale (Atkins, 2011). There were various results from the NAEP science report:

- 1 in 3 children in middle school and junior high school show proficiency in science (Atkins, 2011)
- 1 in 5 graduating high-school student showed proficiency in science (Atkins, 2011)
- In 2009 34% of 4th graders, 30% of 8th graders, and 21% of 12th graders performed at or above the proficient science level (Atkins, 2011)
- Between 1% and 2% show strong knowledge of ‘advanced’ scientific concepts (Atkins, 2011)
- Males scored higher than females in all three grade levels (Atkins, 2011)
- There was a 36-point achievement gap between African-American and Caucasian students and a 32-point achievement gap between Hispanic and Caucasian students (Paulson, 2011)
- Private school students outperformed public school students by 14 points (Paulson, 2011)
- At the 4th grade level the top-scoring states were New Hampshire, North Dakota, Virginia, and Kentucky while Mississippi and California had the lowest average scores (Paulson, 2011)

After the report was published, U.S. Secretary of Education Arne Duncan made the following comment: “The results released today show that our nation’s students aren’t learning at a rate that will maintain America’s role as an international leader in the sciences” (Atkins, 2011). President Obama and the Secretary of Education are committed to improving education in the U.S. The American Jobs Act proposed $30 billion to keep teachers in the classroom and off the unemployment line and another $30 billion to repair and modernize schools, in turn upgrading science laboratories to create proper learning environments (U.S. Department of Education, 2011). They hope to remove barriers to reform and support educators who are committed to raising academic achievement. The enhancement of education is the key to the nation's economic prosperity (U.S. Department of Education, 2011).

Reform of U.S. Science Education

The various reports paint a gloomy picture of U.S. science education. Not only is U.S. education itself lacking, but the U.S. is failing to produce a future knowledge base. In turn, the failures of the education system directly affect the already tumultuous economy. Experts agree that the U.S. needs to reform education, especially math and science, in order to retain world competitiveness. Despite general agreement, there continues to be much discussion about how exactly education reform should proceed. There are various opinions about what should be done, from improving teacher quality, to comprehensive reform of standardized testing (Barrett et al, 2011). While various reform options do not always agree on what needs to be done, each recognizes the importance of improving U.S. science curriculum.

One of the reform strategies focuses on improving teacher quality and a national-based curriculum. The U.S. recognizes that the K-12 education system is not doing an effective job; it needs good teachers with content expertise, high expectations, and feedback systems to help struggling students and teachers (Barrett et al, 2011). These three requirements, as stated by Craig R. Barrett, founder of Intel Corporation, are difficult to implement within the public education system. One way to do so is to develop a national expectation level for the K-12 system. Achieve, a non-profit education reform organization, is working on state-driven, internationally benchmarked common-core curriculum to replace the variety of standardized testing (Barrett et al, 2011) with the goal for all students in the U.S. to learn the same material by grade level and subject matter, in alignment with other successful education systems in the world (Barrett et al, 2011).

Another reform strategy focuses on the elimination of standardized testing, as a result of the negative consequences resulting from NCLB. Today's education policies currently reflect No Child Left Behind, promoted by President George W. Bush and with some parts supported by the Obama administration. This law requires every student in Grades three through eight to be tested by the state, and every student must achieve proficiency on these tests (Barrett et al, 2011). Schools that do not meet these standards by 2014 will receive severe sanctions. Thus, today's public schools are focused on teaching children to pass a test. As stated earlier, NCLB tests are aimed at reading and math, this puts science education on the back burner. There is no evidence to prove that teacher quality is reflected by standardized testing scores or that students' ability to perform or retain knowledge is shown through these tests (Barrett et al, 2011). The former U.S. Assistance Secretary of Education Diane Ravitch believes that standardized testing does not encourage innovation, creativity, or imagination. The federal government should move away from mandating standardized testing and punishing teachers and schools for not meeting unreasonable targets. Instead, schools should promote creativity and innovation to enable students to experiment, create, and question while using technology (Barrett et al, 2011).

The next reform strategy looks at the education system as a whole, comparing it to the performances of the top-scoring countries. The public education system is unable to provide all children with the knowledge and skills that are needed for them to succeed. Many policies reinforce the inadequacies of our approach to education – the misuse of standardized testing, the narrowing of the curriculum, emphasis on competition, and ongoing cuts to education (Barrett et al, 2011). A recent study by PISA showed that the highest-achieving countries emphasize ongoing teacher preparation and development, mentoring, and collaboration, without the use of standardized testing. Teacher preparation in the U.S. is often insufficient and turnover is rampant; however, top-performing countries emphasize strong support for struggling teachers and schools (Barrett et al, 2011). It is obvious that the school systems in top-performing countries are successful; the U.S. should consider their example.

A final reform option focuses on a total reformation of the education system and an improvement in teacher quality. One of the biggest problems with the reformation of the U.S. education system is it will take at least the next 15 to 25 years. However, there are immediate efforts being made to revamp education through President Obama's Race to the Top federal education grant contest as well as the multitude of reform efforts nationwide (Barrett et al, 2011). One of the biggest issues is that there are 3.2 million K-12 public school teachers, the largest occupation in the nation aside from retail sales clerks/cashiers. In order to revamp the teaching system, the union needs to be changed in order to allow for teachers to be measured on their performance (Barrett et al, 2011). This reform option would allow for the improvement of teacher quality, in turn directly improving students' education.

The need for educational reform has been apparent for many years, and was recently investigated in depth by the National Academy of Sciences. In 2005 the National Academy of Sciences and

Engineering created a Blue Ribbon Panel comprising 20 distinguished members of business, academia, and government to respond to concerns about STEM and U.S. technology competitiveness. They published the report “Before the Gathering Storm” to answer the question about how the U.S. could be better prepared to compete and prosper in the 21st century (ASM International, n.d.). The report stated:

> “The United States takes a deserved pride in the vitality of its economy, which forms the foundation of our high quality of life, our national security, and our hope that our children and grandchildren will inherit ever greater opportunities…Without a renewed effort to bolster the foundations of our competitiveness, we can expect to lose our privileged position.” (ASM International, n.d.)

The Blue Ribbon Panel was alarmed by the lack of satisfactory science education and feared that the continued decline of science education would lead to the loss of American’s international standing as a world leader (AMS International, n.d.). In order to ensure that the U.S. shares in the prosperity that science and technology are bringing the world, the panel developed four broad recommendations with 20 specific action items (H.R. Science Committee, 2005). The four broad recommendations considered efforts to address the K-12 education system, address the U.S. science research base, increase higher education in the sciences, and incentivize U.S.-based innovation (H.R. Science Committee, 2005). The Blue Ribbon Panel set forth a proclamation that the situation in the U.S. was dire and laid out recommendations for a solution to the problem.

In an attempt to improve the participation and performance of America’s students in science, technology, engineering, and mathematics, President Obama launched the Educate to Innovate campaign. This campaign includes efforts from the Federal Government as well as from leading companies, foundations, non-profits, and science and engineering societies (The White House, 2012). Educate to Innovate is an attempt to increase STEM literacy so that all students can learn and think critically in science, mathematics, and engineering. It also attempts to move U.S. students from mediocrity to the highest levels during the next decade and to expand STEM education and career opportunities for the underrepresented groups, including females and other minorities. As part of Educate to Innovate, five major public-private partnerships are developing media, interactive games, hands-on learning, and community volunteers to reach millions of students. Some of these partnerships include; Time-Warner Cable, Discovery Communications, Sesame Street, National Lab Day, National STEM design competitions, and Change the Equation

(The White House, 2012). Though not a complete reform of the education system, Educate to Innovate is a positive attempt to enhance science in the classroom.

A similar effort is the National Math and Science Initiative (NMSI) which focuses on recommendations put forth by the National Academies of Science in the 2005 blue-ribbon panel report, “Rising above the Gathering Storm”. NMSI was formed to address the nation’s economic and intellectual threats, especially the declining number of students prepared to take rigorous science and mathematics courses (National Math and Science Initiative [NMSI], 2012). It is believed that in order to advance the U.S. must continue to generate intellectual capital to drive research and development to fuel the economic engine of our future.

The National Math and Science Initiative is an attempt to enhance science and technology in the U.S. to dramatically improve K-12 math and science education (NMSI, 2012). In order to accomplish this goal, the panel recommends actions to: produce more effective math and science teachers; strengthen skills of existing teacher through training programs; and enlarge the pipeline of students with the desire and preparation to pursue science, technology, engineering, and mathematics at the undergraduate level and beyond (NMSI, 2012). The key elements of NMSI are clear/strategic goals to address significant issues, do what works (use programs with proven results), ensure long-term sustainability requiring both an increasing financial match and increasing scale, measure results using objective criteria, and provide partners with opportunities for participation and recognition (NMSI, 2012). The NMSI reflects the ideas presented by the Blue Ribbon Panel and is an attempt to rectify the failings of science education in the U.S.

A similar initiative to improve STEM education is Change the Equation. Change the Equation (CTEq) is non-profit formed to mobilize the business community to improve the quality of science, technology, and engineering, and mathematics learning in the U.S (Change the Equation [CTEq], n.d.). This effort is similar to that seen through the National Math and Science Initiative as well as Educate to Innovate, but is completely nonpartisan. CTEq strives to sustain a national movement to improve K-12 STEM learning by focusing on three goals: improving philanthropy, inspiring youth, and advocating change (CTEq, n.d.). The CTEq coalition will continue to influence and lead STEM learning movement for improving teaching and students STEM learning in the classroom by developing tools to promote effective collaboration with stakeholders, thus creating communication channels grounded in data, and speaking as a unified voice. CTEq attempts to foster widespread literacy in science, technology, engineering, and mathematics to prepare students for postsecondary options as well as to add to the knowledge base (CTEq, n.d.).

The U.S. continues to make attempts to improve science education, but it is not something that will happen overnight. These various initiatives and reform efforts are a positive step in the right direction and are just a few examples of a spreading movement. The 2005 Blue Ribbon Panel pointed out some glaring deficiencies in the U.S. education system and brought up some positive reform efforts that can be initiated. A total reform of the education system is a challenging but necessary step that will take years to complete. Innovative programs and initiatives are necessary to drive improvement and quality of science education throughout K-12 education. One such program designed to advance STEM education is the Wind for Schools project which represents not only an attempt to provide for a future workforce, but also a hands-on science curriculum which will significantly enhance STEM learning at K-12 and postsecondary levels.

III. Comprehensive Study: Wind for Schools

The United States is moving toward a vision of expanded renewable energy resources, especially through the implementation of wind energy (Baring-Gould et al, 2009). In 2006, President Bush emphasized the nation's need for greater energy efficiency and a diversified energy portfolio. As a result, a collaborative effort of more than 70 organizations led by the U.S. Department of Energy's (DOE) Wind and Hydropower Technologies Program, the American Wind Energy Association (AWEA), and the national laboratories to explore a modeled scenario where wind provides 20% of U.S. electricity by 2030 (Baring-Gould, 2009). The purpose of that study was to initiate a dialogue regarding issues, costs, and potential outcomes associated with the 20% wind scenario; though achievable there are many hurdles to face (Baring-Gould, 2009).

There has been a dramatic increase in the deployment of wind energy over the past decade. U.S. wind power represents 20% of the world's installed capacity, and during the past 5 years, the U.S. has added over 35% of all new wind generating capacity (American Wind Energy Association [AWEA], 2012). The wind industry represents a large market for wind power capacity installations as well as for the growing market for American manufacturing. There are more than 470 manufacturing facilities in the U.S. that produce components for wind turbines including major components such as towers, blades, and assembled nacelles (AWEA, 2012). These facilities are spread across the U.S. and can be seen below in figure 3. There are two major needs associated with the rapid growth of the wind industry – one is a skilled workforce trained in wind energy technology and the other is addressing local concerns caused by a lack of understanding regarding wind energy developments (Baring-Gould et al, 2009).

Figure 3: Major Wind Component Manufacturing Facilities in the United States (Amos, 2010).

The expansion of the wind industry in the U.S. is hindered by the lack of an appropriately-sized skilled workforce. The 20% by 2030 report estimated that a direct U.S. wind workforce of 180,000 is needed to support the implementation of approximately 16 GW per year of new capacity (Baring-Gould et al, 2009). In addition to the need for a trained workforce, the perception of wind energy in the U.S. needs to be addressed in order to address misconceptions. Wind Powering America developed the Wind for Schools Project (U.S. Department of Energy [DOE], 2012a) to address this. Wind Powering America launched the Wind for Schools Project in 2005 with a pilot project in Colorado (U.S. DOE, 2012a). Following the success of the pilot project, by 2011 Wind for Schools projects had been developed in 11 states Including Alaska, Arizona, Colorado, Idaho, Kansas, Montana, North Carolina, Nebraska, Pennsylvania, South Dakota, and Virginia (U.S. DOE, 2012a). Through these 11 projects, more than 95 wind systems have been installed at K-12 schools. At the university level, more than 60 students graduated in 2011 having had active involvement in a Wind Application Center (WAC) (U.S. DOE, 2012a). Since the development of the WfS program, all 11 states have seen much success through their work with host schools, the development of WACs, as well as by inspiring a future wind energy workforce.

Need for a Wind Energy Work Force

The primary U.S. energy industries, such as oil, coal, and natural gas have an extensive training infrastructure in place, which helps to ensure a steady stream of engineers, scientists, and developers entering each individual field. Although numerous universities and community colleges are developing new wind education and/or training programs, there is not national infrastructure in place. In the short term, there is a significant need for wind technical experts and individuals who can deploy and maintain wind projects (Baring-Gould et al, 2009). While over the long term, educational pathways such as those available for the primary energy industries must be developed in order to ensure that the required workforce is supplied. These educational pathways will also ensure that continued improvements and expansions are made to guarantee the future development of the wind industry (Baring-Gould et al, 2009).

Thus, to develop an expanded workforce, it is imperative that a standard system is developed among all levels of the educational sector. This includes training teachers and professors to expand their knowledge base and develop pathways, thus allowing individuals in the field to obtain support and expertise (Baring-Gould et al, 2009). For the wind industry to receive an educated workforce and the support of the expanded wind energy future, it is important that education be provided at all levels, from primary education through post graduate programs (Baring-Gould et al, 2009). The Wind for School Project is one example in which a valuable hands-on education can be provided at all educational levels in order to advance an expanded workforce for the development and expansion of the U.S. wind industry.

United States Department of Energy's Wind for Schools Project

The Wind for Schools Project is a multi-dimensional attempt to address barriers to U.S. wind energy development associated with education. The Wind for Schools Project is designed to engage local citizens in constructive discussion about wind energy, while developing a knowledge base for wind energy within K-12 schools as well as higher education institutions (Baring-Gould et al, 2009). The project has three primary goals: to educate college juniors and seniors in wind energy applications, to engage American communities in the benefits and challenges of wind energy applications, and to introduce teachers and students to wind energy through hands-on curricula (U.S. DOE, 2012a). The general approach of the Wind for Schools Project is to install small wind turbines at K-12 host schools, while simultaneously developing a WAC at a higher education institution (U.S. DOE, 2012a). By equipping college juniors and seniors with wind energy education, a workforce will be advanced that is knowledgeable and interested in wind energy topics. Likewise, by involving small communities in the deployment of wind energy systems, it is likely that negative perspectives and misconceptions will be corrected. Finally, the engagement of the K-12 community will provide students and teachers with a good base of wind energy education. This is an attempt to continue their interest in the field through K-12 education and into university level education (Baring-Gould et al, 2009).

The Wind for Schools Project installs small wind turbines at elementary, middle, and secondary schools, while simultaneously developing Wind Application Centers at higher education institutions. The Wind for Schools Project implements a wind energy training center or wind application center (WAC) at state-based universities or colleges. As part of university wind energy curriculum activities, college students associated with a WAC assist with the installation of small wind turbines at K-12 schools including the original assessment of a host school site (Baring-Gould et al, 2009). The installation of a wind turbine at a K-12 school is a visible example of a community's involvement in the economic and environmental security of the nation, and also provides a hands-on education opportunity for K-12 students and teachers (Baring-Gould et al, 2009).

Each host schools implements teacher training and hands-on curricula to bring the wind turbine into the classroom through interactive wind-related research tasks (U.S. DOE, 2012a). Undergraduate students who are affiliated with WACs act as wind energy consultants, assisting in assessment, design, and installation of small wind systems at the K-12 host schools. These students also participate in class work and other engineering projects related to wind energy, in preparation for the wind workforce upon graduation (U.S. DOE, 2012a). The implementation of projects also provides experiences for college students which, combined with wind energy coursework, prepare students to enter the wind energy workforce (Baring-Gould, 2009). Thus, not only are college students learning about wind energy in the classroom, but they also receive hands-on experiences through their involvement as "wind energy consultants". The installation of small wind turbines at K-12 schools is a critical element of the Wind for Schools Project because it provides hands-on experiences for college students entering with workforce, and also introduces the younger generation and the community to wind energy applications.

The Wind for Schools project is an attempt to meet the needs of an expanding wind industry, by providing hands-on learning at the K-12 and university level. The main goal of the Wind for Schools Project is the development a Wind Application Center (WAC) which supports the installation of Wind for Schools systems at K-12 host schools as part of a larger educational goal (Baring-Gould et al, 2009). Although the structure of the Wind for Schools Project is not rigidly defined, there are eight entities involved in the implementation of each Wind for Schools project. Those involved in Wind for Schools are usually the school (including a science teacher and school administrator), a WAC, a State Facilitator, Wind Powering American/NREL, a green-energy-sponsoring company, a wind turbine manufacturer, the local utility or electric cooperative, and the state energy office (Baring-Gould et al, 2009). Figure 2 below shows the general Wind for Schools Project structure as well as the various participants. In order for a WfS Project to be successful, participation from various groups is needed. A lot of time and effort goes into the installation of a K-12 small wind system and it is imperative that the various participants take an active role. The roles and responsibilities of each participant will be discussed below.

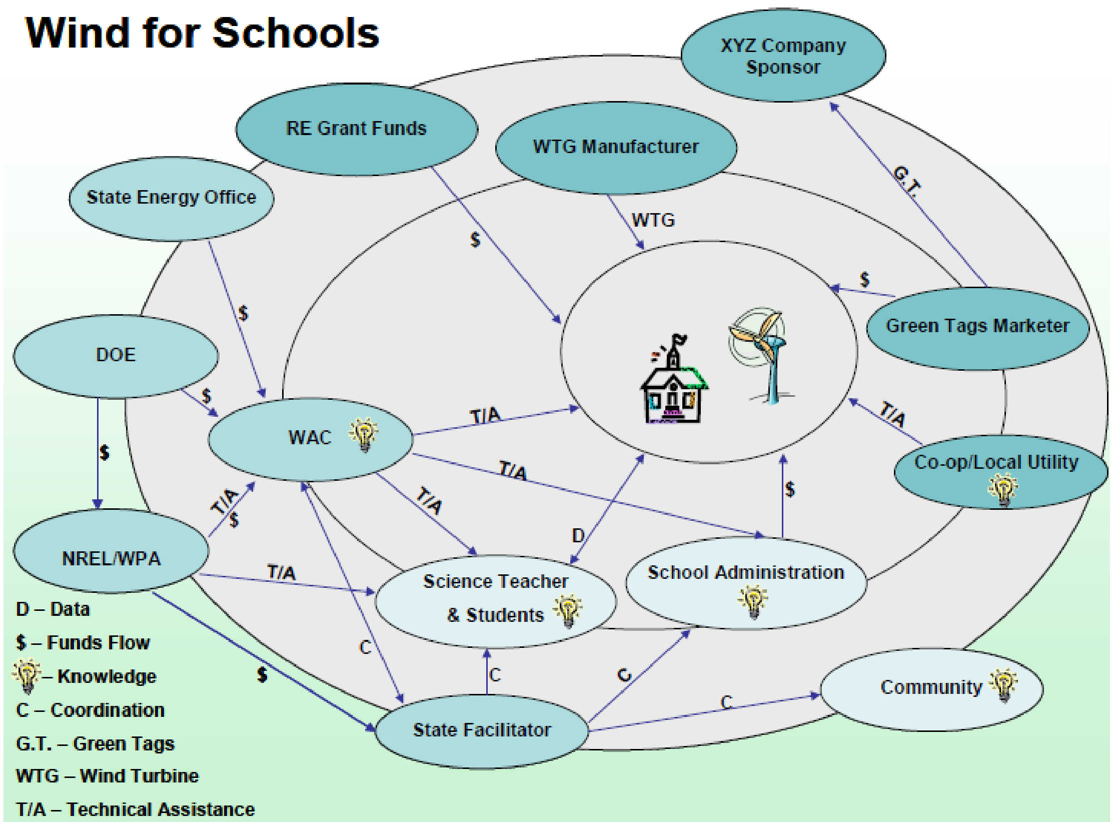

Figure 4: Wind for Schools Program Schematic (Baring-Gould et al, 2009).

Wind for Schools Participants

Each participant in the Wind for Schools Project plays an important role in the development and the success of each project. There are varying roles and responsibilities of each participant, which are critical to the success of the project.

Host School and the Community

For the Wind for Schools Project to succeed, all levels of the school community must support the concept. Those involved in the host school community are the science teachers, the school principal and administration, the district superintendent, and the school board (U.S. DOE, 2012b). The school community is an integral part of the Wind for Schools community because the school provides the land for the project, support for the wind turbine interconnection to the school electrical system, facilities support, financial support, and support for the project in community meetings, as well as other organizational events (Baring-Gould et al, 2009). Following the installation, the wind turbine is used to support classroom curricula related to energy as well as a possible source for science fair concepts. The wind turbine provides hands-on curricula for students at host schools, providing real time wind and energy data. The Wind for Schools Project supplies curricula, educational kits, and training to support teachers, in order to properly implement wind education in the classroom (Baring-Gould et al, 2009). Financial structures for the project vary from state to state, once the project is installed the schools owns and is responsible for the wind turbine system. As a result, the school will offset a minimal amount of money through the turbine power generation (Baring-Gould et al, 2009).

Wind Application Center (WAC)

Under the leadership of an interested university professor, a Wind Application Center is implemented at a state university or college (U.S. DOE, 2012b). The WAC implements a wind energy curriculum which will support future graduates. It is the hope that many of these graduate will choose to pursue a career in wind energy (Baring-Gould et al, 2009). The WAC will also provide technical assistance to K-12 schools hoping to become host schools by analyzing wind resource, energy usage, siting, permitting, land use, and financials as well as overseeing the installation of the power system and analyzing performance data (Baring-Gould et al, 2009). Typically, under the structure of the WAC, candidate schools are identified early in the fall and students from the WAC conduct analysis and system permitting during the fall semester. The turbines are typically installed during the spring or summer, possibly as part of junior or senior academic project (Baring-Gould et al, 2009). Thus, the WAC helps to produce engineers, system analysts, and other kinds of professionals who are knowledgeable about wind power siting and technologies.

Following the 3- to 5-year implementation period, the WAC will assume the role of the state facilitator (discussed below) and become the primary repository of wind application knowledge and expertise (Baring-Gould et al, 2009). It is anticipated that the WAC will be viewed as the primary source of information regarding wind energy applications. It is anticipated that after the implementation period, the WAC will identify independent funding sources, although Wind Powering America/NREL may provide technical and financial support in the development (Baring-Gould et al, 2009). The success of the WAC is a long-term goal of the Wind for Schools Project, creating a future repository of wind knowledge for the state as well as an example for those attempting to develop similar projects.

State Facilitator

This individual is responsible for the development of Wind for Schools Projects in each state in accordance with the Wind Powering America staff (U.S. DOE, 2012b). Their primary responsibility is the identification of K-12 host schools as well as supporting project development by working with local communities and school administrations (Baring-Gould et al, 2009). The state facilitator also has the responsibility to work with Wind Powering America and the WAC to find funding opportunities and implement school projects (U.S. DOE, 2012b). This role is designed to last 3 years, at which point the WAC will assume all responsibilities (Baring-Gould et al, 2009). The role of the state facilitator is critical to the development of the state Wind for Schools Project and becomes an integral part of the WAC.

Wind Powering America/NREL/DOE

Wind Powering America provides technical and financial assistance to the WAC and state facilitator over the first few years of project development. The assistance from Wind Powering American/NREL/DOE includes training programs for annual wind energy applications, assistance for the analysis of Wind for School projects, models and tools to support project development, training for turbine installation and commissioning, wind resource equipment, assistance in the development of K-12 curricula, and finally support for students, professors, and teachers who are hosted at NREL for summer projects (Baring-Gould et al, 2009).

Green Energy Certificate Sponsoring Companies

As a result of the wind turbine installation a modest amount of energy will be offset at the host school. The green attributes for the energy produced by a Wind for Schools turbine can be sold to help decrease the cost of the turbine. The sponsoring company will pre-purchase the environmental attributes (green tag production) from the turbine over the first 10 years of operation for a fixed amount, typically on the order of $2,500 (Baring-Gould et al, 2009).

Wind Turbine Manufacturer

Southwest Windpower joined the Wind for Schools Project as the initial supplier of all Wind for Schools systems. The standard system includes a SkyStream 3.7 wind turbine on a 70-ft guyed tower. This 2.4-kW wind turbine produces approximately 3,600 to 4,000 kWh/year, depending on annual average wind speeds (Baring-Gould et al, 2009). There are several tower options available at an additional cost, including a monopole tower.

Local Utility or Electric Cooperative

One of the most important participants in the Wind for Schools Project is the local utility or electric cooperative. In order to ensure the success of the project, the local electricity provider should be involved (U.S. DOE, 2012b). Technical expertise should be provided by the utility or cooperative, in terms of installation and education. The technical expertise provided by the utility or cooperative includes the installation of the wind turbine and associated hardware (Baring-

Gould et al, 2009). It is the responsibility of the host school and state facilitator to ensure the support of the utility or cooperative in order to proceed with the project development. One of the goals of the Wind for Schools Project is community education, in which the local utility is critical as a partner to help meet this goal. In many rural areas, the utility serves as an integral part of the community. The Wind Powering America program supports an environmentally sustainable energy economy as a way to bring prosperity to communities; this will be assisted by the local electricity provider (Baring-Gould et al, 2009). Though there will be some hesitation from the electricity provider based on their lack of experience with wind energy, the Wind for Schools Project is an attempt to bridge this gap.

State Energy Office

The State Energy or Development Office provides technical, financial, and managerial support for the project (Baring-Gould et al, 2009). They are also responsible for the assistance in funding for projects, either directly or by identifying grants and other opportunities (Baring-Gould et al, 2009).

All of the participants in a Wind for Schools Project play a pivotal role in the development of WAC and K-12 projects. For Wind for Schools to function properly it is imperative that all levels of participants meet their responsibilities. Though there is some flexibility in the roles played by each participant, it is important that they are noted in order to provide for the success of the program. Each participant plays a crucial role, without it the program may not be able to properly develop and function.

The Wind for Schools System

As discussed earlier, the standard Wind for Schools system is based upon the SkyStream 3.7 wind turbine, with the understanding that some schools may be interested in implementing a different but similar turbine model. There are three conditions set by the Wind for Schools Project regarding turbine selection; 1) it must be easy to implement, 2) it must be small enough so that all system generation will be used at the school, and 3) it must have integrated data logging to provide students with real-time data (Baring-Gould et al, 2009).

Wind for Schools System Components

The standard Wind for Schools project system includes:

- SkyStream 3.7, 2.4-kW turbine
- Standard 70-ft guyed (or equivalent monopole) tower

- Turbine electrical box and fused disconnect
- Main foundation for the turbine and tower, includes tower base electrical grounding (specific foundation design is based upon type of tower and soil condition)
- Tower guy wire foundations and electrical grounding (guy wire foundations are not needed for monopole)
- School electrical connection (interconnection between the school and the turbine will be completed with buried electrical cable)
- School disconnect and junction box (typically located where electrical wires enter the school)
- School's electrical power meter or interconnection point, where the turbine is electrically connected to the school's 240-V or 208-V electrical system. This should be connected on the school's side of the electrical meter (Baring-Gould et al, 2009).

Project Costs

Financial support, for the State Facilitator, during the initial project years is provided by NREL/DOE, this does not include direct funding for the purchase of turbine hardware (Baring-Gould et al, 2009). Through the state energy office, potential funding sources for partial purchases of turbine hardware are identified. To install a typical Wind for Schools systems, costs are estimated between $15,000 and $20,000 (depending on what tower type is selected). The equipment costs range between $7,000 and $10,000. Typically, it is expected that the school will provide approximately $1,500 to $2,500; the sale of the turbine's environmental benefits will provide approximately $2,500; state-based grants, local donations, or equipment buy-down will provide the remaining funds (Baring-Gould et al, 2009). Since many of the project participants are working on donated time, it is the hope that the local utility will provide in-kind and material support for an installation. Also, there may be other funding options available from state organizations or local benefactors which will need to be identified. As part of the facilitator's role, potential sources of additional state funding should be identified and applied to the wind project costs (Baring-Gould et al, 2009).

Curricula

The Wind for Schools Project implements wind energy curricula at both the K-12 and the university level. As part of one of the Wind for Schools Project goals, to educate college students in wind energy applications, the development of WACs at a number of colleges and universities is crucial (Baring-Gould et al, 2009). The rationale for implementing university-level curricula is to educate college students in wind energy applications, focusing on hands-on, small wind project development through both classroom and field work (U.S. DOE, 2012a). The primary responsibility of the WAC is to provide technical assistance to schools and to develop and implement university-based wind energy curricula (Baring-Gould et al, 2009). The development and implementation of new curricula by the WACs results in an increase in the numbers of engineers, system analysts, and other majors knowledgeable in the wind industry who may be likely to graduate and pursue careers in wind energy. New wind curricula are developed and shared among the WACs, each focusing on specific technical areas that represent the strengths of the specific faculty or institutions that are engaged (Baring-Gould et al, 2009).

The installation of Wind for Schools systems at K-12 schools plays a pivotal role in the development of wind energy curricula. Project implementation at K-12 host schools allows for WAC students to gain valuable experience through engagement in resource assessment, site selection, permitting, and the installation of the wind turbine system (Baring-Gould et al, 2009). Although on a much smaller scale, the installation experiences of a Wind for School's system mirrors that which is applied on a much larger scale, which are pivotal experiences for university students. To further stimulate interest in the renewable energy sector, the WACs foster relationships between universities and K-12 schools, and these relationships support the mutual benefits gained through the work of university students as "consultants-in-training" and provide young students and teachers with access to university resources for ideas and assistance in applying wind energy to science and mathematics (Baring-Gould et al, 2009). It is the hope that early positive science experiences will lead more students to choose the scientific fields for undergraduate and post-graduate learning.

One of the vital components of the Wind for Schools Project is classroom curricula related to wind energy. The development of age-appropriate curricula is critical, thus the Wind for Schools Project sponsors the National Energy Education Development (NEED) Project and the KidWind Project (U.S. DOE, 2012a). These two projects provide hands-on, interactive curricula supported through teacher training workshops (U.S. DOE, 2012a). Teacher training and science kits are also provided by the projects to enhance successful classroom use. Additional classroom resources are available through the central Wind for School data repository, where all data collected from host schools are uploaded for use by all schools. Along with the data-sharing capabilities, curricula are being developed to allow for expanded science education such as output comparisons among different locations and different wind resource areas. It is expected that various wind-related curricula will be shared among schools through the Wind for Schools network (Baring-Gould et al, 2009). In addition, Wind Powering America provides links to teaching materials (U.S. DOE, 2012a). The NEED Project and the KidWind Project are critical elements of the wind energy curricula at the K-12 level.

The KidWind Project: WindWise

The KidWind Project is represented by a team of teachers, engineers, and scientists who are committed to innovative energy education. They provide information regarding wind energy, lesson plans for various grade levels, ideas for building educational wind turbines, as well as teacher training (KidWind Project Incorporated, 2012). KidWind provides free workshops for teacher training and free WindWise curriculum as well as other resources to help teachers organize wind energy curriculum (KidWind Project Incorporated, 2012). Windwise is a comprehensive interdisciplinary wind energy curriculum, developed with Normandeau Associates for middle and high school (KindWind Project Incorporated, 2012). WindWise takes a larger modular approach to wind energy education, focusing primarily on secondary students. The curriculum modules cover many different aspects, from resource assessment to environmental impacts (U.S. DOE, 2012d).

Another integral element of the KidWind Project is the KidWind Challenge. The KidWind Challenge is a student-oriented wind turbine design contest. Students spend time designing and constructing their own wind turbines with the goal of creating an efficient, elegant, and highly functional device (KidWind Project Incorporated, 2012). To accomplish this task, students perform research to better understand the science of wind, analyze testing protocols, think creatively about solutions to problems, and collaborate to get their project completed (KidWind Project Incorporated, 2012). At the end of this process, student teams convene and teams enter a judging process. The judges are typically made up of professionals from the wind industry. The projects are judged on three main criteria: turbine power performance, turbine construction, and knowledge of wind energy topics (KidWind Project Incorporated, 2012). The goal of the KidWind Challenge is to engage students in an open-ended competition to build small-scale turbines demonstrating knowledge.

National Energy Education Development Project

The mission of the National Energy Education Development (NEED) Project is to promote energy consciousness by creating effective networks of students, educators, business, government, and community leaders to design and deliver objective, multi-sided energy education programs (The NEED Project, n.d.). In order to do this, NEED works with energy companies, agencies, and organization to bring balanced energy programs to the nation's schools; focusing on strong teacher development, timely and balanced curriculum materials, signature program capabilities, and turnkey program management (The NEED Project, n.d.). The curriculum provides comprehensive, objective information and activities for both renewable and non-renewable energy sources. The Wind for Schools Project uses the wind energy NEED curriculum; exploring the history, current events, and the future of the resource, while using hands-on learning activities (The NEED Project, n.d.). The NEED Project provides wind curriculum with lessons correlated to state standards. These lessons include hands-on curriculum, interdisciplinary activities and data-based lessons (U.S. DOE, 2012d).

Wind energy curricula, both at university and K-12 levels, are critical to the success of the Wind for Schools Project. They provide the foundations for educating K-12, undergraduate, and post-graduate students in wind energy. Most importantly, the education provided by Wind for Schools offers hands-on learning experiences at all levels of education through the installation and application of small wind systems as well as myriad other Wind for Schools resources.

Affiliate Projects

As discussed earlier, the Wind for Schools Project is supported in a limited number of states. The affiliate project is an attempt to continue Wind for Schools type projects in each state, but without direct support from the DOE. The affiliate project allows K-12 schools or state-based projects to implement activities on their own (U.S. DOE, 2012c). The affiliate project is modeled after the Wind for Schools Project, but does not receive financial support from the U.S. Department of Energy or the National Renewable Energy Laboratory (NREL) (Baring-Gould et al, 2009). There are two types of affiliate projects: the K-12 project and the statewide project (university or state institution). When an institution becomes an official project affiliate, they are provided with access to project support functions, web sites, and information. The main element of the affiliate project, as well as with Wind for Schools Projects, is to install a small wind turbine to be used in combination with age-appropriate, hands-on, wind-related curricula taught in science classes (U.S. DOE, 2012c). State-based projects, in turn, will support the implementation of a Wind Application Center at a local engineering university or college in order to lead K-12 installation and curricula efforts (U.S. DOE, 2012c). In all cases of affiliate programs, WPA does not provide funding to directly support them, but will provide appropriate levels of technical assistances as well as all project resources and documentation. State projects and individual school projects are thus responsible for all organizational responsibilities associated with implementation (Baring-Gould et al, 2009).

K-12 Wind for Schools Affiliate Projects

The K-12 Wind for Schools Affiliate Project is a way for K-12 schools to be involved in WfS without being directly linked to a state WfS Project. The K-12 affiliate schools act similar to host schools, without the direct guidance of the WAC. As part of the K-12 Wind for Schools Affiliate Projects, schools will have access to many of the resources provided to Wind for Schools host schools. Thus, as an affiliate, the school's staff gains access to:

- Project implementation documents (interconnection specifications and foundation information)
- Hardware and software developed for the Wind for Schools system
- Limited technical assistance during the implementation of the Wind for Schools systems
- Access to project-sponsored teacher-training programs
- Access to Wind for Schools host schools system database to support expanded educational opportunities
- Wind for Schools environmental benefit sales process to obtain outside funding for implementation
- Access to National Energy Education Development (NEED) Project's curricula kit (U.S. DOE, 2012c)

There are various expectations of the K-12 affiliate projects. A school interested in joining the affiliate project is expected to incorporate the NEED Project's wind curricula into science classes and install a Skystream (or equivalent) wind turbine at the school (U.S. DOE, 2012c). As discussed earlier, the expected costs of such system is approximately $20,000 (this price includes turbine, tower, control package, and curricula) (U.S. DOE, 2012c). With the wind turbine system, a compatible data logger must be installed; the data collected will be made available on the Wind for Schools website so that other schools can access it. The expectation is that the affiliate school will obtain all funding necessary to implement the project; however, some support in obtaining funds will be available through the Wind for Schools Project. The school agrees to assume responsibility for all turbine maintenance and to engage all relevant organizations, such as the local utility or energy cooperative that would support such maintenance. The following tasks are expectations of affiliate schools:

- Education and outreach in the local community

- Report on installation and system costs
- Provide turbine operational data
- Sign an indemnity agreement between the school and NREL
- If a school is unable to install a Wind for Schools system (lack of fund, permitting, wind resource), the school may become an affiliate if staff members are interested in implementing the NEED Project's wind curricula with the use of data from other Wind for Schools installations (U.S. DOE, 2012c)

The K-12 Wind for Schools Affiliate Project is structured similar to that of K-12 host schools, with a few expectations. One of the most important features of the K-12 affiliate project is that they gain access to all the data and information given to project host schools.

Statewide Wind for Schools Affiliate Project

The Statewide Wind for Schools Affiliate Project, like the K-12 Wind for Schools Affiliate Project, is designed to mirror Wind for Schools activities in other states. The statewide Wind for Schools Affiliate Project mirrors the university level Wind for School Project. The development of statewide affiliate projects includes the implementation of a Wind Application Center at an appropriate university, the appointment of a state facilitator, and the funding of related project elements (U.S. DOE, 2012c). The project goals reflect the existing Wind for Schools Project: educating at the university level, installing approximately 5 K-12 host schools per year, engaging with the community to convey benefits of wind energy, and offering project support. Thus, by agreeing to establish a statewide affiliate project, they will gain access to the broad array of support services, including:

- Project implementation documents (interconnection and foundation information)
- Wind for Schools publications
- Benefits of lessons learned by other states
- Hardware and software developed for Wind for Schools systems
- Limited technical assistance
- Access to project sponsored meetings, trainings, and informational summits
- Full access to the Wind for Schools system database to support education opportunities
- Wind for Schools environmental benefit sales process to allow affiliate school to obtain funding (U.S. DOE, 2012c)

The statewide affiliate projects are expected to initiate a Wind Application Center, identify funding, implement Wind for Schools systems at K-12 host schools, and integrate state participants into national Wind for Schools Projects (U.S. DOE, 2012c). The state is expected to obtain the necessary funding to implement the project with limited support through the national program on a case-by-case basis. The Statewide Wind for Schools Affiliate Project is also expected to:

- Provide operation support for the Wind Application Center
- Provide funding for a state facilitator to work with the WAC and K-12 host schools
- Engage in education and outreach
- Purchase wind assessment/measurement systems to support resource assessment
- Provide funding and support to Wind for Schools system installations
- Facilitate training and educational opportunities for Wind Application Centers
- Implement NEED based teacher-training
- Purchase NEED curriculum kits for loan to K-12 host schools
- Report installations and share data on system costs
- Provide support and partial funding at host schools
- Ensure that each host school activity meets requirements as defined for K-12 school projects (U.S. DOE, 2012c)

A fully comprehensive Statewide Affiliate Project, which includes the Wind Application Center, state facilitator, and initial equipment funding is approximately $175,000 per year for 3 years (this amount includes the assumption that a small amount of the state funding, $8,000-10,000 per host school, will be applied to wind turbine hardware) (U.S. DOE, 2012c). Funding typically includes the WAC ($60,000/year), the state facilitator ($30,000/year), Host school system funding assuming five systems per year ($50,000/year), project oversight ($10,000/year), meteorological towers ($25,000/year), and wind for schools teach training ($25,000/year) (U.S. DOE, 2012c).

Both the Statewide and K-12 Affiliate Projects are structured and function similar to the Wind for Schools Projects at the state and K-12 level. The Affiliate Project is an extremely important element of the Wind for Schools Project, it allows states that otherwise may not have the opportunity to join the Wind for Schools Project to establish active wind energy educational activities in their state. It also allows for K-12 schools to become actively involved in Wind for Schools in their state by becoming affiliate schools.

IV. State Wind for Schools Programs

As discussed previously, Wind for Schools Projects are supported in 11 states: Alaska, Arizona, Colorado, Idaho, Kansas, Montana, North Carolina, Nebraska, Pennsylvania, South Dakota, and Virginia (U.S. DOE, 2012a). As a result of these 11 projects, more than 95 systems have been installed at host schools, with many more in funding and developing stages. Figure 5 below shows the locations of the installed and planned projects in the U.S. (with the exception of Alaska, which is not on the map). Since WfS was founded in 2005, the 11 projects have been developing on various time scales in accordance with their involvement in the program. Not only have the 11 projects developed each at a different pace during the past 7 years, but each has created a unique structure consistent with the specific needs and resource of its home state. Thus, it was deemed imperative to understand the development and background of each Wind for Schools Project in order to be fully informed before crafting a *Best Practices Manual*. Each Wind Application Center varies in structure, funding opportunities differ, degree of involvement in the installation process varies, etc. But while there are many differences in the structure and development in each state, they each function to meet the three fundamental goals of the national Wind for Schools Project.

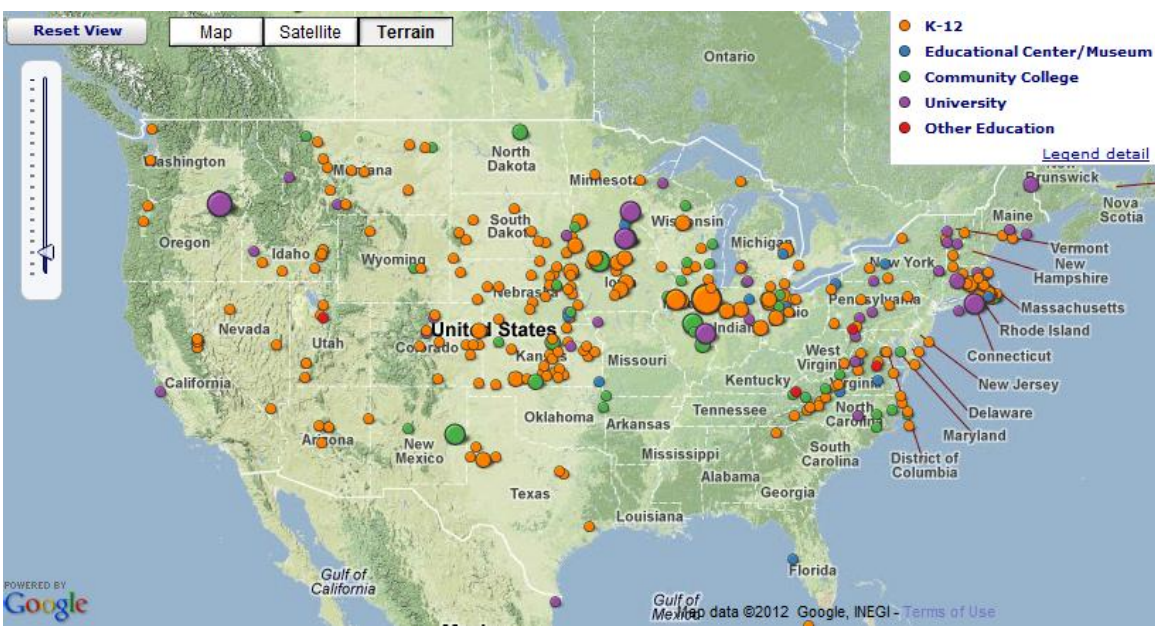

Figure 5: Locations of installed and planned Wind for Schools Projects in the United States (US DOE, 2011).

Alaska

The Alaska Center for Energy and Power (ACEP) with the partners from the Alaska Energy Authority and the National Renewable Energy Laboratory (NREL), established the Alaska Wind-

Diesel Applications Center which is housed at the University of Alaska (The University of Alaska, 2010). This center was established as a center of excellence in wind-diesel technology to analyze technology options, test hardware and control software, educate engineers, train operators, and provide technical assistance to wind-diesel stakeholder.

The Wind-Diesel Center was developed as a result of the dependence of Alaskan villages on diesel fuel to power generators and heat homes. With the increasing fuel prices, the demand strain on villages is expected to continually increase in the coming years, thus increasing the interest in renewable energy resources. Assessments in Alaska have suggested that wind energy is a promising resource. There remain a number of challenges to the implementation of wind-diesel hybrid technology which include gaps in technology, lack of equipment availability, unmet human capacity, and technology acceptance (University of Alaska, 2010). The Alaska Wind-Diesel Applications Center (WiDAC) seeks to address these challenges through the development of an integrated program including research, testing, and monitoring; analysis; education; training; and technical assistance.

The Alaska Wind-Diesel Applications Center partnered with the Renewable Energy Alaska Project to implement the national Wind for Schools Project. Currently, there are five installed Wind for Schools Projects in the communities of Palmer, Juneau, Sitka, and Nome. There are several other schools working to install wind turbines, the most recent installation was Northwestern Alaska Career and Technical Center in 2011 (University of Alaska, 2012). The Alaska Wind for Schools has also initiated the KidWind Challenge, a student-oriented wind turbine design contest. The Alaska Wind for Schools Project has been successful so far in terms of installing Wind for Schools Projects as well as the development of the Alaska Wind-Diesel Application Center to continue improvement of technology, addressing barriers to implementation, and the involvement of the stakeholders.

Arizona

The Landsward Institute of the Northern Arizona University (NAU) houses the Wind for Schools Project. The Arizona Wind for Schools Project installed a SkyStream turbine to supply renewable energy to the LEED certified Applied Research and Development Building in November 2011 (Northern Arizona University, 2011). The Wind for Schools Project is working to develop a larger Sustainable Energy Solutions Institute alongside the office of the Vice President for Research at NAU. The Arizona Wind for Schools Project aims to advance renewable energy and energy efficiency education as well as research initiatives from the K-12 to university level (Northern Arizona University, 2011). This particular project is promoting the implementation of wind energy, solar energy, and energy efficiency installations and curriculum at schools statewide and at Native American schools. This project supports installations and public education systems (information kiosks, etc) at community or local government buildings (Northern Arizona University, 2011).

The Arizona Wind for Schools Project works with students in the development of design projects. Electrical Engineering students designed and helped to perform a solar installation at Tuba City Junior High School in 2010 as part of the junior-level design course. The student team worked together with the school as their client to design the solar energy installation and related energy education activities. In 2011, students in the same course designed a hybrid wind-solar installation for Ponderosa High in Flagstaff (University of Arizona, 2012). These two projects are examples of the many Wind for Schools Projects bringing renewable energy installations and curriculum to K-12 schools, with a focus on the partner Native American schools (University of Arizona, 2012). There are13 installations, 6/7 in the funding process, in Alaska.

Colorado

In 2006, the Wind Powering America team based at the National Renewable Energy Laboratory (NREL) launched the pilot project in Colorado to develop the Wind for Schools Project model. The pilot project identified key elements to a successful Wind for Schools Project (U.S. DOE, 2012e). The elements identified were: identify a champion; select sites with good wind resources; be flexible with your project model; choose partners throughout the community; research economic options and challenges; be aware of local and state policies; and evaluate the wind system (U.S. DOE, 2012e). These key elements were integral components to the development of other Wind for Schools Projects. The pilot project resulted in the installation of a small wind turbine in Walsenburg and the development of wind energy curriculum (Colorado State University, n.d.). The Colorado Wind Application Center is attempting to become the information source for those in Colorado that wish to install wind energy for both small scale and large scale developments (Colorado State University, n.d.). The Colorado Wind for Schools Project has 8 participating K-12 host schools.

Idaho

Wind Powering America introduced the Wind for Schools Project in Idaho in 2008. The aim of the project was to install small wind turbines at K-12 schools with the initial target of rural areas, in order to demonstrate wind energy basics to the community and students. There are currently 7 K-12 installations in the state. The Wind for Schools Project built upon an existing wind energy research program at Boise State University and created Idaho's Wind Application Center (Boise State University, 2011).

The Boise State College of Engineering has been involved in wind energy research since 2002, with research partners including the U.S. Department of Energy Wind Powering America, Bonneville Power Administration, Idaho National Lab, Idaho Power Company, John Deere Renewable Energy, PowerWorks LLC, Renaissance Engineering & Design, as well as private donors (Boise State University, 2011). Before establishing the Wind for Schools Project, Boise State had an active role in the anemometer loan program as early as 2001.The anemometer loan program is an attempt to get land-owners interested in wind energy by loaning Meteorological (MET) towers and assessing wind resources at a particular site. At the end of an assessment period, the WAC will assess the data received and make suggestions about the possible wind installations at the site. In 2008, Boise State's Wind Application Center became an official partner and has since assisted in collecting, analyzing, and posting met-data (Boise State University, 2011).

Kansas

The Wind for Schools Project in Kansas began in 2007 at Kansas State University. The Wind for Schools Project at Kansas State aims to install 5 wind turbines at K-12 host schools each year and to provide assistance to wind and renewable energy education in schools (Kansas Wind Applications Center [KWAC], 2012). Also, as part of the roles and responsibilities of the Wind for Schools Project, Kansas State University developed the Wind Applications Center. The Kansas Wind Applications Center (KWAC) mission is to educate electrical engineers on the basics of wind energy and to serve as the source of information on wind energy for the people of Kansas (KWAC, 2012). In partnership with Midwest Energy Inc., Colby Community College, and Kansas State University, the High Plains Small Wind Test Center was established to test wind turbines.This center is located on the Kansas State University agricultural land, with a mean wind speed of 7 m/s at 50-m. Most tests are run over a 6-month period but may take up to two years (KWAC, 2012).

Montana

The Montana Wind Application Center was established in 2008 at Montana State University (MSU). The Center offers Wind Energy educational opportunities to students at Montana State

University, supports wind-related outreach efforts throughout Montana, and assists in Wind for Schools Projects in Montana (Montana State University, 2011).

The Montana Wind Applications Center supports various aspects of the Wind for Schools Project, it provides manpower for site selection and installations through the use of student interns, provides technical support to K-12 host schools, and develops/coordinates web-based monitoring systems to make wind turbine data available to the public (Montana State University, 2011). In the fall of 2008, five Skystream 3.7 wind turbines were installed through the Montana Wind for Schools Project, one located on the MSU campus and 4 others installed at K-12 host schools. Six additional turbines were installed at K-12 host schools during the summer of 2010 (Montana State University, 2011). As of August 2011, the Montana Wind Applications Center is working on bringing the KidWind Challenge to Montana (Montana State University, 2011).

Nebraska

Nebraska became involved with the Wind for Schools Project in 2007 at the University of Nebraska-Lincoln. It was the goal of the Nebraska project to install three to five wind turbines each year; within the first three years they saw great success averaging seven schools per year (U.S. DOE, 2010). The Nebraska WfS program has so far installed 20 wind turbines at K-12 host schools, three at colleges/universities, and have two more installations scheduled for this year. As part of the Nebraska project, it is required that the K-12 school commits $1,500, while the balance is sourced from grant funding, local/community donors, and in-kind support. There are various grand funding sources, including the Nebraska Public Power District, Nebraska U.S. Department of Agriculture’s Rural Development Program, Nebraska State Environmental Protection program, and the Nebraska Energy Office (U.S. DOE, 2010).

The Nebraska Wind Application Center works in collaboration with the Nebraska Center for Energy Sciences Research and is funded by the Nebraska Public Power District (Hudgins, 2008). In addition to the WAC, the University of Nebraska-Lincoln offers a minor in Energy Sciences, compromising four introductory courses that provide an overview of energy in society, fundamental energy principles, the economics of energy, and environmental issues relating to producing/using energy (U.S. DOE, 2012f). In addition to these four courses, a set of three to five upper divisions, discipline-oriented elective courses are being developed for each of the thematic areas: energy and natural resources, plant and animal bioenergy, energy engineering and economics, and policy and human dimensions (U.S. DOE, 2012f).

North Carolina

Appalachian State University is home to the North Carolina Wind for Schools Project which aims to install small wind turbines for educational use throughout the state. In 2011, Appalachian State installed 10 wind turbines, all located at K-12 host schools along the coast and in the mountains.

As part of the Wind for Schools project, Appalachian State University founded the North Carolina Small Wind Initiative, a public service program sponsored by ASU and the NC State Energy Office. This service aims to raises awareness about the benefits and feasibility of wind power in the southern Appalachian region (Appalachian State University, 2012). There are four basic components which make up with Small Wind Initiative: research and development on Beech Mountain, a direct mailing campaign, the Western North Carolina Anemometer Loan Program, and hands-on workshops, tours, and events (Appalachian State University, 2012).

Pennsylvania

The Pennsylvania Wind for Schools Project is housed at Pennsylvania State University. The aim of the project is to work with three to five K-12 schools per year to conduct feasibility studies, develop funding opportunities, and install small wind turbines to support wind energy curricula. The Pennsylvania Wind for Schools Project accepted applications for the first round of projects in the spring of 2011 (The Pennsylvania State University, n.d.). The have recently installed their first WfS system at a K-12 host school and have one installation planned for the near term. University-level wind energy education is also a main focus of the Wind for Schools Project. Students in the College of Earth and Mineral Sciences and the College of Engineering assist with the preliminary siting and installation of wind turbines as part of existing wind energy courses. A graduate certificate in Wind Energy Engineering and an online Professional Masters in Renewable Energy and Sustainability Systems with a Wind Energy concentrations are being developed (The Pennsylvania State University, n.d.).

South Dakota

South Dakota initiated its Wind for Schools project in 2008 and is housed at South Dakota State University (SDSU). In August 2008, eight schools participated in the inaugural launch of the program (South Dakota Public Utilities Commission, n.d.). South Dakota currently has 15 K-12 installations.

The main function of the South Dakota State University Wind Application Center is to provide technical support to Wind for Schools (South Dakota State University, 2012). The WAC uses engineering students to help with K-12 schools, doing wind assessments, siting, permitting, etc. The WAC offers technical support for community wind projects as well and trains engineers to enter the wind industry (South Dakota Public Utilities Commission, n.d.).

Virginia

James Madison University (JMU) is home to the Virginia Wind for Schools project, which was initiated in 2010 as part of the Virginia Center for Wind Energy. It is understood that the wind resource in Virginia is patchy and mainly limited to mountain ridges and coastal regions as well as offshore. However, the main goal of installing wind for schools systems in Virginia is to increase awareness and education, while economics are of lesser importance. In recognizing the diverse wind resource that exists in Virginia, the project offers a partner program which loans 20-meter meteorological towers to provide classrooms with real wind data collection capabilities (James Madison University, 2012). There are currently two Wind for Schools installations in Virginia and two projects being installed at the end of November 2012. In addition to these four installations, there are five projects in the funding phase, one partner school with a MET tower, and 3 more MET tower installations during the 2012-2013 year. A final component of the Virginia Wind for Schools Project is their participation in the KidWind Challenge. Virginia hosted its first two challenges in the spring of 2012 and has a challenge scheduled for March of 2013.

The Small Wind Training and Testing Facility (SWTTF) was installed at JMU in Spring 2012. The purpose of the SWTTF is to address a range of needs associated with the development of a small wind workforce in Virginia. The facility will conduct training and K-12 education to advance the development and deployment of wind power in the Commonwealth. The SWTTF is equipped with a 7.5-kW Bergey XL on a 120-ft lattice tower, six anemometers, four wind vanes, two 3-dimensional sonic sensors, and a WeatherBug Professional Sytem (Virginia Center for Wind Energy, 2012a). The SWTTF will provide an independent turbine-testing facility in the region which does not otherwise exist in Virginia. It is anticipated that this facility will be useful in characterizing and testing new technologies, in attracting small wind manufacturers to VA, and in providing students at 4-year, 2-year, and K-12 levels, as well as established installers, the opportunity to learn the skills associated with testing of wind power technologies (Virginia Center for Wind Energy, 2012a).

A final component of the Virginia Wind for Schools Project is the State-Based Anemometer Loan Program. This program was established with the goal of spurring wind power development in the state. In order to do this, the program provides landowners with MET towers to measure the available wind resource. Once a year of data is collected, it is analyzed and a full report is written which assess the wind resources and makes suggestions about wind energy systems for the site (Virginia Center for Wind Energy, 2012b).

Affiliate Projects

In order to accommodate the many stakeholders interested in Wind for Schools, an affiliate project has been implemented. As discussed earlier, a WfS Affiliate Project will not receive financial support from the DOE and the National Renewable Laboratory (NREL), but they will receive technical assistance, project websites, and information (U.S. DOE, 2009). This project is designed to support both K-12 host schools that wish to install wind turbine systems as well as states that intend to implement a statewide program. The focus of this section is on statewide affiliate project. At present, Illinois is the only Wind for Schools Affiliate project, but there are a number of similar projects nationally. One such project is Kilowatts for Education based in Ohio. Another example of a project that promotes wind energy education in the classroom is the Ohio Wind Working Group.

Illinois Wind for Schools

The Illinois Wind for Schools Project comprises individuals from the Illinois Institute for Rural Affairs at Western Illinois University, the College of Business and Technology and the Center for Renewable Energy at Western Illinois University, and the College of Education at Illinois State University (Illinois Wind for Schools, n.d.). The Illinois Wind for Schools project is funded solely by a grant from the Illinois Department of Commerce and Economic Opportunity, but additional funding is being pursued (DOE, 2012g).

Similar to the state projects, the Illinois Wind for Schools Project offers curriculum development resources, teacher development, on-site technical assistance and instruction equipment to middle and high school teachers to incorporate wind energy topics into the classroom. This project addresses Illinois Learning Standards Goals 7 and 10 in mathematics (estimation and measurement; data analysis and probability) and Goals 11, 12, and 13 in Science (inquiry and design, concepts and principles; science, technology, and society) (Illinois Wind for Schools, n.d.).

The Illinois Wind for Schools project provides technical assistance to school administrators who are interested in pursuing a wind turbine system. Two of the three pilot schools have moved forward with site assessments and are pursuing grant funding for wind installations (DOE, 2012g). As of spring 2012, five middle and high schools were selected from the statewide application process to participate in the project (Western Illinois State University, 2012).

Kilowatts for Education

Kilowatts for Education is a consortium of schools and other educational institutions interested in energy efficiency and renewable energy initiatives (The Renaissance Group, 2011). Kilowatts for Education offers renewable energy projects that not only offset power use with sustainable resources, but also education students on the benefits of renewable energy. Membership to the Consortium is free and members receive opportunity updates, share information, share curriculum, partnership opportunities, and help with fund raising (The Renaissance Group, 2011). This project combines solar and wind energy in order to find the best fit for a particular institution. There are various projects under construction and five installed wind turbines at educational institutions.

The Ohio Wind Working Group

The Ohio Wind Working Group strives to promote awareness of wind energy in the state through collaboration with environmental advocacy groups, electric utilities, wind developers, government, agriculture organizations, and universities (Ohio Wind Working Group, 2008). One of the ways in which the working group does this is through the promotion of wind energy education in K-12 schools. The Ohio Wind Working Group offers the NEED curriculum materials, professional development opportunities, and evaluation tools to teachers in the state. The working group installed a 10-kW Bergey wind turbine at Lake High School in Logan County in May 2006. This system was designed as a data monitoring and reporting/education resource (Ohio Wind Working Group, 2008). The Ohio Wind Working Group does not offer all that the Wind for Schools Project does, but it is a key example of the promotion of wind energy curriculum in the classroom and promotes awareness of wind energy in the state.

The Statewide Affiliate Project and similar projects is especially important because it allows for the continued expansion of the project goals without direct funding for the U.S. DOE and NREL.

The development of affiliate and similar projects will directly benefit from the *Best Practices Manual* because it will provide them with a resource full of key methods and techniques resulting from the development and success of the national Wind for Schools Project

V. Wind for Schools Best Practices Manual

The focus of this effort is to develop a *Best Practices Manual* for the United States Department of Energy's Wind for Schools Project. The results of this research effort will culminate in a resource that provides to future Wind for Schools participants the means by which to identify the various options and resources available when developing a Wind for Schools or related project in a particular states. *The Best Practices Manual* will provide developing projects with a comprehensive list of *best practices* that have been identified and can be applied through the development of a Wind for Schools Project. The term *best practice* is a popular industry phrase which refers to methods or techniques that offer high success rates when implemented (University of Kansas, 2012). However, a *best practice* is more than an industry term; many variables influence the identification of a *best practice*. The adoption of a *best practice* is often very advantageous to a particular organization or institution. In this particular case, *best practices* have been identified in regard to the development and success of the various Wind for Schools Projects including the involvement of the K-12 community, as well as to the development of the WACs. These *best practices* in turn address the various elements of the Wind for Schools Project, in order to meet the national goals.

Best Practices Manual

The term *best practice* has been coined by industry to describe various methods or techniques that bear better than average results. A *best practice* is often a particular method or technique, but it can also refer to a program or intervention (University of Kansas, 2012). A *best practice* is a technique that shows superior results than those achieved by other means. To become a *best practice*, the method or technique must be measurable, notably successful, and replicable. For a method or technique to be considered measureable it must have a clear goal with assessable progress. Notable success refers to a method or technique that gains good results as well as progresses toward goals quicker than for other methods. Finally, when a method is documented clearly so that it can be reproduced elsewhere, then it is considered replicable (University of Kansas, 2012). It is important for a *best practice* to be measureable, replicable, and have notable success in order for it to be applied with the same success by other organizations or institutions. Thus, *best practices* are methods and techniques that are successful in accomplishing their goals in a manner that can be adapted for use in similar circumstances (University of Kansas, 2012).

There are many advantages to the adoption of *best practices.* The adoption of *best practices* is important because they provide a systematic and professional approach to meeting a specific goal. A *best practice* is based on experiences of industry experts and provides a proven approach, allowing for increased productivity, and increased satisfaction (itSMF India, 2012). By employing a *best practice* the chances of achieving success increase because the methods or techniques have been demonstrated as effective. Not only does a recognized *best practice* show increased success, but it is also easier to justify its use. For example, an organization may be skeptical of what is being proposed, but by demonstrating that the method or approach has had previous success, much of the skepticism will be relieved (University of Kansas, 2012). There are additional advantages to using *best practices* such as: acceleration of the level of innovation, saving time and reducing risk, improving the speed of adoption, and maintaining flexibility (Noventum Service Management, 2012). *Best practices* provide a cushion for organizations and institutions by providing a proven means of success, enabling them to act quickly and efficiently in meeting their goals. It is also important to note that often the creators of the best practice are available for consultation, which allows for troubleshooting when difficulty or adjustment of the practice is needed to meet a specific goal. Finally, the most advantageous part of a *best practice* is that it has already been proven and used effectively with the best outcomes (University of Kansas, 2012). Thus, the adoption of *best practices* can be very beneficial to a particular community or organization.

There is no standard for choosing *best practices*, in some cases almost any program that shows success is labeled a *best practice.* In other cases a *best practice* is established when the method or technique meets a stringent list of criteria. (University of Kansas, 2012). Credibility can be increased by the use of *best practices* because the organization is using a tested process in order to guarantee that it is doing the best possible job. In some cases, the application of *best practices* opens access to funding since funding agencies often look more favorably on those who can demonstrate proven success (University of Kansas, 2012). It is important to consider where the best practices are being used and how they were chosen, and to consider all the options before progressing forward with one particular method or technique. When choosing to adopt a *best practice*, there are many variables to consider. The *best practice* should: fit with your community and population, be appropriate to your goal, fit with the structure and philosophy of the organization or initiative that will use it, the availability of resources, and the cost-effectiveness of the method (University of Kansas, 2012). A best practice that meets all or most of these criteria should be expected to work effectively for an organization or institution to meet its goals.

A *Best Practices Manual* provides the means to combine the varying methods and techniques that have been deemed *best practices* into one relevant resource. A *Best Practices Manual* in turn supplies a variety of best practices in one main source, allowing organizations to choose those practices that are best suited for their particular project. Thus, it provides *best practices* that are specific to a particular project, allowing the program developer to choose which is the most applicable to the goals they are trying to meet. A *Best Practices Manual* describes each of the *best practices*, categorized appropriately, in order to provide a developer with a full description of the *best practices* as well as examples of success. This is a very beneficial resource because it provides an overview of the various methods and techniques used by the organization or institutions involved, thus providing direct assistance with the development of similar projects. A *Best Practices Manual* in turn serves as a resource where the varying *best practices* are categorized and explained, in order for the reader to understand and choose the one that best fits their particular situation.

Wind for Schools Best Practices Manual

The *Best Practices Manual* under development at the Virginia Center for Wind Energy focuses on the United States Department of Energy's Wind for Schools Project. As the Wind for Schools Project has evolved, a variety of approaches and methodologies have been implemented by the various state projects. Each state project reflects the institution and university in which it is support; this means that each state employs various approaches to meet the national goals. It is important to note that each state has a varying wind resource, which directly affects the way in which the Wind for Schools Project develops and proceeds, as well as the structure of the WAC. In turn, each state Wind for School Project looks and functions differently in order to meet the national goals while be impacted by local resources and constraints. In order to provide for the future development of Wind for Schools Projects and affiliate projects, it is critical that a repository of the varying approaches and methodologies be created. This repository will take into account the different strategies used by each Wind for School Facilitator and Director, the structure of each Wind Application Center, as well as the successes and failures associated with each project. The effort to develop a Best Practices Manual was intended to provide this repository for Wind for Schools at large.

The Wind for Schools *Best Practices Manual* represents an effort in which will recognize the successes realized to date among the WACs and within the participating states. This effort emphasizes the varying strategies and methods employed by the WAC Director and the WfS

Facilitator in each state in regards to the development of the various project, promotion of undergraduate learning, identification of K-12 schools, involvement of the local community, and K-12 curricula among other activities. Thus the *Best Practices Manual* will present a comprehensive list and explanation of the myriad of approached developed by individual states, in order to serve as a resource to those developing Wind for Schools and similar projects. This effort is of the upmost importance to the U.S. Department of Energy as it will provide for the future success of the Wind for Schools Project.

VI. Development of the Best Practices Manual

It was established early on that the intention of the *Best Practices Manual* was to provide a resource to sustain the development of new Wind for Schools Projects as well as similar projects. In order to create the *Best Practices Manual* it was necessary that adequate data and research be provided. Through basic research of the Wind for Schools Project it was clear that each of the 11 states WfS Projects function in various manners to meet the national goals of the project. Knowing this information in order to provide adequate data regarding each state project, it would be necessary to create a survey to accurately assess methods and approaches utilized by each project. Survey creation occurred while simultaneously thoroughly researching the Wind for Schools Project. This research and data collection culminated in the creation of a comprehensive outline for the *Best Practices Manual*, taking into account the data and research collected during this process.

Survey Development

The 11 Wind for Schools Projects span across the United States, thus a comprehensive survey was created to assess the development and functioning of each project. To accurately assess each project, two surveys were created. The two surveys created addressed the Wind for Schools Facilitator and the Wind Application Center Director, the two participants with the most involvement in the WfS Project. The surveys addressed the varying roles and responsibilities of the WAC Director and WfS Facilitator as well as focused on the methods and techniques used to meet the national WfS goals. The development of these surveys took into consideration the knowledge provided by the Virginia WAC Director and WfS Facilitator aas well as the resources available for each state project.

Once developed, the surveys were reviewed and approved by the James Madison University Institutional Review Board (IRB) since they involved research with human subjects. The process involved in submitting the surveys to the IRB included training modules on the use of human subjects in research. Once these modules were completed, the surveys were submitted to the IRB. Since this survey did not pose any threat to human subjects, they were expedited. In order to follow IRB procedure, each survey was distributed with a cover letter explaining the survey as well as a request for consent to participate in research. Both the cover letter and the consent to participate in research are presented in Appendix I. These two documents were intended to inform the participant of their rights and to understand the purpose of the surveys, highlighting the many advantages of the *Best Practices Manual*.

These surveys were distributed to all Wind for Schools Directors and Facilitators in the 11 participating states. In some cases there was more than one person serving in each position, surveys were sent to each. Consent was given by each of the participants and responses were received. Not all of the individuals who were sent the survey responded, but the responses received were extremely valuable to the development of this manual.

Wind Application Center Director Survey

The creation of the Wind Application Center Director survey considered the roles and responsibilities as laid out by the Wind for Schools Project. This survey focuses on how the WAC functions, the WAC activities, outreach, technical assistance, as well as what organizations are active in supporting the WAC. The survey instrument is provided in Appendix I. The WAC director survey provides various best practices utilized by the WAC director to meet the WfS goals. The responses among the WAC directors were analyzed in order to identify which best practices were utilized the most and which practices were the most effective.

Wind for Schools Facilitator Survey

The creation of the Wind for Schools Facilitator survey, like the WAC director survey, took into consideration the roles and responsibilities laid out by the Wind for Schools Project. This survey focuses on how the WfS facilitator identifies K-12 host schools, engages the K-12 community, builds relationships with the K-12 and local community, as well as what organizations support the WfS project. This survey is also provided in Appendix I. The WfS facilitator survey provides best practices utilized by the facilitator to meet the various WfS goals. The responses among the WfS facilitators were analyzed in order to identify which are the most commonly used and most successful of the practices developed.

Both surveys provide critical information regarding the Wind for Schools Project, especially pertaining to the development and successes of each individual project. Through these surveys, *best practices* were identified in regards to the various elements of the Wind for Schools project. The degree of feedback provided was instrumental in support of the development of the *Best Practices Manual*.

Survey Results

As expected, not all the surveys distributed were returned. A total of 24 surveys were distributed with less than half being returned. There is still an effort being made to receive more feedback, but the surveys received provided a significant amount of information pertaining to the Wind for Schools Project. The feedback provided from both surveys contained examples of methods and approaches used by the various WfS Project to meet national goals. This feedback contained *best practices* in regards to the various elements of the WfS Project as well as challenges and impediments faced in the development and sustainability of the project. This data is key to the development of the *Best Practices Manual* and will provide a significant portion of the manual.

Wind Application Center Director Results

The Wind Application Center Director survey provided feedback pertaining to the development of the WAC, activities employed to share knowledge and expertise, and technical assistance provided by the WAC. This information was then used in the identification of *best practices.* The *best practices* identified pertaining to the Wind Application Center Director are provided in Table 1 . These *best practices* are approaches and methods used in the development and sustainability of the WAC and the WfS Project, which have proven to be successful and utilized by the various projects to meet national goals.

Table 1: Wind Application Center Director *Best Practices*	
Wind Application Center Activities	– Undergraduate and graduate level courses – Capstone projects – Engaging in design, analysis, and permitting
Activities employed to share knowledge and expertise	– Participation in community events – Offering presentations at the WAC – Organization of wind energy related meetings – Leading site tours
Technical assistance provided by the WAC	– Wind resource and energy usage analysis – Siting, permitting, and land use – Performance data analysis – Overseeing site installations
Activities used to engage the community	– Promotion of WAC – Assistance in installation – Participation in educational events – Teacher outreach clinics – KidWind Challenege – Participation in town meetings – State wind conferences – Wind working groups

Along with receiving feedback pertaining to sustaining and developing the WfS project, the surveys also provided information regarding challenges and impediments faced by the WAC. These challenges are highlight below in table 2.

<table>
<tr><th colspan="2">Table 2: Challenges and Impediments in WAC Development and Sustainability</th></tr>
<tr><td>Challenges/impediments in WAC development and sustainability</td><td>– Financial resources
Lack of funding for turbine installations and WAC activities
Lack of funding to support people in WAC efforts
– Supporting educational resources to motivate teachers to use wind turbines for education
– Lack of training
– Political opposition</td></tr>
<tr><td>Challenges/impediments in serving K-12 schools</td><td>– Teachers uncertainty of turbine use in classrooms
– Turn around at local schools (changes in administration, teachers, etc)
– Lack of engaged staff
– School cut backs
– Dedicated undergraduate and graduate student time</td></tr>
</table>

The *best practices* and challenges identified through the WAC Director survey highlighted the many ways to develop and sustain a WfS project and WAC. The practices used among the states vary in accordance with the resources available in that state, but many similarities are seen throughout the WfS Projects. This is also true about the challenges/impediments identified in these surveys. Even with the varying Wind for Schools Projects, the challenges seen were often universal. The identification of these challenges is pivotal to the development of the *Best Practices Manual* because in future development of such projects they can be avoided if the developer is aware of them. Thus, the feedback provided by the WAC Director survey will be utilized in the development of the *Best Practices Manual*.

Wind for Schools Facilitator Results

The Wind for Schools Facilitator survey, similar to the WAC Directory survey, provided feedback pertaining to the development and sustainability of the WfS Project in each state. Specifically, the Wind for Schools Facilitator survey provided feedback in regards to the activities employed to identify K-12 host schools, to engage the K-12 community, and to develop relationships with the local community and school administration. The information identified in turn are *best practices* related to the WfS project. These *best practices* are provided in Table 3. These *best practices* were utilized by the Wind for Schools Facilitator in order to develop and sustain various WfS projects in each state.

Table 3: Wind for Schools Facilitator *Best Practices*	
Activities used to identify K-12 host schools	– GIS analysis – Marketing: emails – Schools visits – Third Party: Department of Education, Teachers – Teacher trainings – Outreach events, exhibits
Activities used to engage the K-12 community	– Teacher workshops – Classroom visits – Loaning/borrowing of educational resources – Tours of WAC – Special events: Earth day, science festivals, and STEM nights
Activities used to develop relationships with the local community	– Attend school board and town hall meetings – Newspaper articles about wind applications – Participation in local events
Activities used to develop relationships with school administration	– Presentations at school board meetings – Identification of a “champion of the school”

Along with the *best practices* identified, the survey provided feedback in regards to challenges and impediments faced by the Wind for Schools Facilitator in the development and sustainability of the Wind for Schools Project. These challenges are impediments are provided below in Table 4.

Table 4: Challenges and Impediments in WfS Project Development and Sustainability	
Identification of Host Schools	– Lack of funding for installations – Lack of motivation – Communication: lack of a strong point person at the school – Incomplete applications – Lack of wind resource
Developing relationships with the local community	– Dispelling myths – Keeping interest in projects
Developing relationships with school administration	– Lack of understanding of the Wind for Schools Project – Lack of interest in the project – Changes in school administration

The data provided by the WfS Facilitator survey provided key insight into the *best practices* used to sustain and develop a Wind for Schools Project. The challenges and impediments faced by the Wind for Schools Facilitator were similar among the states, with the exception of wind resource availability. Not all of the states in the project have the same wind resource, so in the case of the Virginia Wind for Schools Project, many of the K-12 host schools lack a good resource, so the wind turbines installed are mainly utilized for educational purposes. Many of the Wind for Schools Projects have a much greater wind resource, making the wind turbine installations of a much greater economic value. Wind resource was the only exception to the similarities in challenges and impediments faced by the Wind for Schools Projects. Dispelling myths and lack of funding were the main challenges identified through the survey. The feedback received will be used in the *Best Practices Manual*.

Organization of the Best Practices Manual

Once the data and research was collected on the various elements of the Wind for Schools Project, an outline was created to be used for the *Best Practices Manual*. This outline takes into account the research done on the background of the Wind for Schools Project as well as the data collected through the surveys. It is intended for the *Best Practices Manual* to have four chapters, which will represent a full and comprehensive study of the Wind for Schools Project as well as the multitude of *best practices* identified through the Wind for Schools Facilitator and Wind Application Center Director surveys.

The first chapter focuses on background and justification of the Wind for Schools Project. It will begin with an introduction describing the need and intention of the manual to provide for future Wind for Schools and similar project development as well as the sustainability of the current Wind for Schools Projects. This chapter will also describe the development of the Wind for Schools Project in order to address U.S. science education needs as well as the need to provide for the growing wind industry. The chapter will conclude with a description of the Wind for Schools project goals.

The focus of the second chapter is a Wind for Schools overview, the original intention of the Wind for Schools Project. The focus here is on the infrastructure of the Wind for Schools Project including: WfS participants' roles and responsibilities, WAC structure, K-12 projects, and curricula. The purpose of this chapter is to provide an understanding of the original intention of the Wind for Schools Project as designed by Wind Powering America. This chapter aims to provide an understanding of the intended structure of the project, while accepting that the project has evolved since.

The third chapter looks at the 11 established Wind for Schools Projects. This chapter will provide background, WAC structure, and progress/status of K-12 installations in regards to the 11 projects. The focus of this chapter is to provide information pertaining to how the structure of each WfS Project developed to meet the needs of the state and institution which houses it. This will in turn provide an understanding of how each state established the Wind for Schools Project to reflect its needs while meeting the national needs of the project.

The fourth and final chapter of the *Best Practices Manual* presents the *best practices* identified through the Wind for Schools Facilitator Survey and the Wind Application Center Director survey. This chapter will present descriptions and lessons learned through the development of the WfS Project as well as the activities and methods used in order to establish a successful project. In turn this is the meat of the *Best Practices Manual* because it provides methods and approaches used to meet the national project goals as well as challenges and impediments faced by the Wind for Schools Project.

The organization of the *Best Practices Manual* reflects the intention that this manual will provide information for the development of new and similar Wind for Schools projects as well as the continued sustainability of the project. The research and data collected is not only useful to future developments but will also be useful for the established projects to learn from each other. It is important that the manual provide more than a list of *best practices*, and also includes information pertaining to the need for the project, the original intention of the project, as well as information regarding the structure of the 11 established projects. The full outline is provided in Appendix II.

VII. Conclusion

The Wind for Schools Project developed out of the need for hands-on science curricula as well as to provide for the growing wind industry in the U.S. The three main goals of the Wind for Schools Project focus on introducing K-12 and college students to wind energy as well as engaging the American communities on the benefits and challenges associated with wind applications. The three goals are: to equip college students with an education in wind energy applications; to engage American communities in wind energy application, benefits, and challenges; and to introduce teachers and students to wind energy. These three goals are an attempt to curb the national disparity in wind energy knowledge and provide a lasting education tool through the installation of wind turbines at K-12 host schools. The educational value provided by the installation of these wind turbines is of much greater importance than the economic values returned to the school through the installation of renewable technology.

In the course of this project, the effort made was to provide all the necessary elements in order for the *Best Practices Manual* to be established. This effort included a comprehensive study of the Wind for Schools Project, beginning with identifying and researching the need for the project. The need to provide hands-on science curricula and provide for the growing wind industry still exists. In studying the Wind for Schools Projects, the structure and original intention of the project was discussed at length. This led to the discussion on the various Wind for Schools Project in order to understand the structure of each state project. The final element of this effort was the data received through the survey distribution identifying the *best practices* used by each WfS Project.

In order to meet the three national goals, the 11 Wind for Schools Projects have applied various techniques and approaches. The 11 projects developed at different times since 2005 and face various obstacles and challenges in each state, thus each projects meets the national goals using various techniques and approaches. The 11 Wind for Schools Projects reflect the institution and state where they are based. The techniques and approaches utilized by each state in turn become *best practices*. A *best practice* is a method or technique with better than average results. These are important to the future success of the Wind for Schools Project because they will help new developments identify which methods, techniques, and approaches will have the best results in meeting the national goals.

When assessing the Wind for Schools Projects, *best practices* were identified in regards to WAC activities, sharing of knowledge and expertise, providing technical assistance, engaging the local and K-12 community, identifying K-12 host schools, and developing relationships with the local and K-12 community. In many cases the approaches and methods were utilized by the majority of the Wind for Schools Projects. For example, identification of K-12 schools often utilized similar methods such as GIS analysis, school visits, teacher trainings, and participation in outreach events. On the other hand, the involvement in the K-12 installation process varies greatly. Some Wind for Schools Projects, such as the Virginia Project, uses a hands-on approach for all levels of the wind system installation. While other Wind for Schools Projects take a back seat to the installation process leaving the host school in charge of it, this is true about Arizona. Many of the Arizona K-12 installations resulted from K-12 schools with installed turbines contacting the project. One of the main challenges faced by the Wind for Schools Project is the acceptance of wind energy. Some of the Wind for Schools Projects are located in areas where wind resource is low and there is no established wind industry in the state, this is true of Virginia. While other projects are located in greater wind resource states, where wind energy is more feasible and accepted. This is true about the Midwest projects such as Idaho, Colorado, Arizona, Kansas, Montana, Nebraska, and South Dakota. The main challenge faced by the Wind for Schools Project is a lack of funding to provide adequate resources for the WAC, K-12 installations, and outreach/education events. To address this issue, each project provided information regarding funding in their state in hopes that this will give other state projects new ideas about where to find funding.

One of the most important elements of the Wind for Schools Project is their development in each state. Each state project reflects the institution and available resources in that state. This is critical to the development of the *Best Practices Manual* because it will allow other states to look at the project with the most similarities to the resources available in their state. It is important that the Wind for Schools Project reflects the state in which it is housed in order for it to provide the most benefits to the state. For example, the Alaska Wind for Schools Project established the Alaska Wind-Diesel Application Center. Since most of Alaska's communities are remote, they depend almost exclusively on diesel energy, thus the WAC tied in wind energy with diesel in order to make it more widely accepted in the state. Similarly, many of Arizona's installations include solar panels because of the high solar resource in the state. When a Wind for Schools Project reflects the needs of the state, it is more likely to be accepted by the communities because it is filling their needs and directly benefitting the state communites.

The Wind for Schools *Best Practices Manual* consolidates all the available knowledge regarding the success of the Wind for Schools Project into one resource which serves as a repository of strategies employed by each Wind for Schools Project. This manual will play a valuable role in the development and success of future Wind for Schools Project, affiliate projects, and similar projects because readers will be able to identify strategies to use in the development of their own projects. The manual provides critical knowledge regarding the structure and intention of the Wind for Schools Project as well as background on the 11 established projects. Having this information in one source will provide a valuable tool for the success of future projects as well as the success of established projects. In conclusion, the research and data collected will provide an important resource for the development of the Wind for Schools *Best Practices Manual*.

Appendix I

Institutional Review Board Cover Letter

Dear [Name],

I am a graduate intern with the Virginia Center for Wind Energy at James Madison University, working on my master’s thesis to develop a Best Practices Manual for the U.S. Department of Energy’s Wind for Schools Program. In order to develop this manual, I’ve created a survey to gather information and feedback pertaining to Wind for Schools in your state.

The Best Practices Manual will provide insight into the Wind for Schools program for states and institutions that are not already engaged and wish to initiate their own program. It will serve as a repository of strategies employed by past and present Wind for Schools facilitators and will present a comprehensive list and explanation of different approaches employed by individual WACs to promote learning at the undergraduate level.

The feedback provided is a critical element in the development of the Best Practices Manual as it will provide insight into how Wind for Schools has evolved and is implemented in each state. This insight will help inform the development of Wind for Schools programs at other Universities and institutions and help to ensure success elsewhere.

I appreciate your taking the time to complete this survey. Attached to this email please find the consent form/survey. Kindly return the survey with the signed consent form at your earliest convenience, ideally before September 21, 2012.

Many thanks in advance for your time and contribution.

Jessica Fox

Graduate Intern
Virginia Center for Wind Energy
M.S. Sustainable Environmental Resource Management
James Madison University 2012

Institutional Review Board Consent to Participate in Research

Identification of Investigators & Purpose of Study

You are being asked to participate in a research study conducted by Jessica Fox from James Madison University. The purpose of this study is to develop a Wind for Schools Best Practice Manual with feedback provided by the survey. The study will contribute to the researcher’s completion of her Master’s Thesis, Development of a Best Practices Manual for U.S. Department of Energy Wind for Schools Program.

Research Procedures

Should you decide to participate in this research study, you will be asked to sign this consent form once all your questions have been answered to your satisfaction. The study consists of a survey that will be administered via email. You will be asked to provide answers to a series of questions related to your role in the Wind for Schools Program in your state.

Time Required

Participation in this study will require no more than 30 minutes of your time.

Risks

The investigator does not perceive more than a minimal risk from your involvement in this study (that is, no risks beyond the risks associated with everyday life).

Benefits

Potential benefits from participation in this study and the research as a whole include the access to vital information for the development and continuation of the Wind for Schools Program.

Confidentiality

The results of this research will be presented in the Best Practice Manuel. As a result of the surveys inquiring about personal experiences within the Wind for Schools program, there is a likely chance that identifiable data may be provided.

Participation and Withdrawal

Your participation is entirely voluntary. You are free to choose not to participate. Should you participate, you can withdraw at any time without consequence.

Questions about the Study

If you have any questions or concerns during the time of your participation in this study, or after its completion please contact:

Jessica Fox
Virginia Center for Wind Energy
James Madison University

Dr. Jonathan Miles
Integrated Science and Technology
James Madison University

fox2jc@jmu.edu milesjj@jmu.edu

Questions about Your Rights as a Research Subject

Dr. David Cockley

Chair, Institutional Review Board

James Madison University

(540) 568-2834

cocklede@jmu.edu

Giving of Consent

I have read this consent form and I understand what is being requested of me as a participant in this study. I freely consent to participate. I have been given satisfactory answers to my questions. The investigator provided me with a copy of this form. I certify that I am at least 18 years of age.

____

Name of Participant (Printed)

____________________________________ ______________

Name of Participant (Signed) Date

____________________________________ ______________

Name of Researcher (Signed) Date

Wind Application Center Director Survey

1. What is the Name of your University and Department and/or College affiliation?

2. In what year was Wind for Schools founded in your state?

3. For how long have you been involved with WfS?

4. What were the two greatest challenges or impediments to developing your WAC?

5. List the organizations that have supported WfS in your state.

6. How many systems have been installed at K-12 schools under WfS in your state?

7. Which of the following activities are active within your WAC (circle each that applies):
    - Creating courses at undergraduate and/or graduate level
    - Supporting capstone projects
    - Installing wind turbines
    - Engaging in design, analysis and/or permitting
    - Other (please explain)

8. Which of the following activities are employed by the WAC to share knowledge and expertise (circle each that applies):
    - Participation in events (speaking, attending)
    - Organizing meetings
    - Offering Presentations
    - Leading Site tours
    - Other (please explain)

9. The University's surrounding community has been (circle whichever applies)
   somewhat moderately very involved in WfS efforts.

   Please describe how you have engaged the community.

10. What technical assistance has your WAC provided to the surrounding community (circle each that applies)?
    - Wind resource and energy usage analysis
    - Siting
    - Permitting
    - Land use
    - Financials
    - Overseeing installations
    - Performance data analysis
    - Other (please describe)

11. Which organizations aside from U.S. DOE have supported WfS in your state?
12. How many K-12 schools in the state are served by the WAC?

What is the greatest challenge to serving K-12 schools?

13. Kindly provide additional materials or information that describes the Wind for Schools program in your state (brochures, websites, flyers, etc.).

Wind for Schools Facilitator Survey

1. What is the name of our company or affiliation?

2. What is the name of the University and Department and/or College with which you are affiliated?

3. In what year did your involvement with Wind for Schools begin?

4. How many systems have been installed at K-12 schools under WfS in your state since you became involved?

5. Which of the following activities are employed to identify K-12 host schools (circle each that applies):

    GIS analysis
    Marketing (please explain how if so)
    School visits
    Third party (please explain if so)
    Teacher training
    Other (please explain)

6. Which of the following activities are employed to engage the K-12 Community (circle each that applies:

    Teacher workshops
    Classroom visits
    Loaning/borrowing of educational resources
    Tours
    Other (please explain)

7. The process of identifying host schools has been (circle whichever applies)

   Easy | Moderate | Difficult

   What are the two greatest challenged or impediments that you've face in identifying host schools?

8. Developing relationships with the local community has been (circle whichever applies)

   Frequently difficult | Sometimes difficult | Nominal

   Sometimes easy | Frequently easy

   Please explain how these relationships have been developed.

9. Developing relationships with school administrators has been (circle whichever applies)

   Frequently difficult | Sometimes difficult | Nominal

   Sometimes easy | Frequently easy

   Please explain how these relationships have been developed.

10. In your various WfS projects, community involvement has been (circle whichever applies)

    Positive | Neutral | Negative

    Please provide comments if they apply.

    What is the greatest challenge or impediment you've faced in involving the community?

11. Which organizations aside from U.S. DOE have supported WfS in your state?

12. Kindly provide additional materials or information that describes the Wind for Schools program in your state (brochures, websites, flyers, etc.).

Appendix II

Best Practices Manual Outline

1. Wind for Schools Background/Justification
    a. Introduction: purpose of the *Best Practices Manual*
    b. Development/need for the Wind for Schools Project
        i. U.S. Education—science rankings
        ii. Growing Wind Industry
    c. Goals of the Wind for Schools Project
2. Wind for Schools Overview—original intention of the project
    a. Infrastructure
        i. WfS participants' roles and responsibilities
        ii. Wind Application Center
        iii. K-12 Projects
        iv. Curricula
3. Implemented Wind for Schools Projects—background, WAC structure, progress/status of K-12 installations
    a. Alaksa
    b. Arizona
    c. Colorado
    d. Idaho
    e. Kansas
    f. Montana
    g. Nebraska
    h. North Carolina
    i. Pennsylvania
    j. South Dakota

k. Virginia

4. Best Practices

    a. Identifying K-12 Host Schools

    b. Engaging the K-12 Community and school administration

    c. Developing relationships with the local community

    d. Activities employed by WACs to promote undergraduate learning

    e. Activities employed by WACs to share knowledge

    f. Challenges/impediments

        i. WAC development

        ii. Engagement of the local community

        iii. Identifying host schools

        iv. Developing relationships with school administration

        v. Community involvement in WfS projects

        vi. Organizations aside from the U.S. DOE that support WfS

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