Proposed Academic Doctoral Degree Genesis

PhD - Wind Energy Science, Engineering and Policy (WESEP)

Talking Points on Underlying Rationale for Implementation @ Iowa State University

18 October 2012

Executive summary: Iowa is second in the nation in wind energy production and is the leading state in terms of jobs related to wind energy. The proposed Ph.D. program in Wind Energy Science, Engineering and Policy (WESEP), supported by a five-year, $3.1M award from the US National Science Foundation (with potential to be extended to ten years), will serve Iowa and the nation in an important area within ISU's land grant mission. There are seven compelling reasons for this program:
(1) this program is important to the state of Iowa;
(2) the long-term future of wind energy is very bright;
(3) there are major research needs in wind energy with attractive employment opportunities;
(4) the program imparts knowledge and skills that uniquely and broadly prepare students to lead research because of their exposure to a wide array of disciplines;
(5) current national and international imperatives make wind energy a legitimate area of specialization;
(6) wind energy is an essential option for reducing anthropogenic greenhouse gas emissions;
(7) there is consensus that the US badly lags behind Europe in graduate education related to wind energy.

We are excited to serve our state and the nation via this new Ph.D. program. With the Board of Regents' approval, we look forward to working with highly talented students, helping to position Iowa for the long-term as a regional hub for energy resources.

(1) This program is important to the state of Iowa

Wind energy has provided Iowa and the US with a significant growth path. This is effectively captured in Senator Chuck Grassley's most recent newsletter [1], where he said:

> *"In Iowa, the wind energy industry employs nearly 5,000 full-time workers, with a number of major wind manufacturing facilities. Iowa generates 20 percent of its electricity needs from wind, and wind energy powers the equivalent of a million homes. Almost 3,000 utility-scale turbines in Iowa generate lease payments to landowners worth $12.5 million every year. Across the country, wind energy production supports 75,000 jobs and drives as much as $20 billion in private investment."*

The WESEP Ph.D. program directly supports this strategy for economic growth by providing research-capable graduates likely to pursue employment in Iowa.

(2) The long-term future of wind energy growth is very bright

The dramatic growth in wind energy seen over the past decade is due in part to federal subsidies via production and investment tax credits. Although these subsidies may not be renewed at the end of this year, the long-term need for wind energy production will remain very great. There are four reasons why this is the case:

- Wind energy must play a significant role in any long-term electric resource scenario, independent of government subsidization. This is because, in comparison with other resources from which electric energy is derived, its levelized cost of energy (LCOE, which accounts for investment, fuel, operations, maintenance, and retirement over each technology's life) is modest, its environmental impact is low, its public receptivity is high, and it can be built quickly. This is why wind power has been second only to natural gas in providing the most generating capacity additions in the US for the past decade. It is also why the latest ten-year projection of the North American Reliability Corporation [2] indicates this trend will continue for the next decade.
- Research results have shown that the LCOE can be further decreased, moving it to a point where it is likely to economically out-perform most other forms of electric energy production [3].

- There are 29 states, Washington DC, and two territories that have Renewable Portfolio Standards (RPS) [4]. Of these, only Iowa's has been met, and it is certain that a significant percentage of the remaining states' RPS will be met by additional wind energy developments.
- Wind energy has an international market, and there is strong indication that other countries will continue to heavily invest in it, particularly China and countries in Europe.

(3) There are major research needs in wind energy with attractive employment opportunities

It is commonly held that growth in wind capacity will continue for decades, but maximizing benefits will require highly trained researchers to further decrease LCOE via new materials, designs and manufacturing methods; to improve turbine availability through better monitoring and maintenance practices; to enhance meteorological understanding of wind dynamics and increase wind forecasting accuracy; to address inherent variability in power production and the need for transmission; to understand impacts on agriculture and wildlife; and to continue shaping federal- and state-level energy policy. Nineteen organizations [5] have agreed to participate as partners in the WESEP Ph.D. program. These organizations include wind turbine manufacturers, electric utilities and wind developers, power grid and electricity market operators, policy-focused organizations, and government labs. All have indicated a strong interest in considering our graduates for employment. The following statements are typical of what these organizations wrote in their letters of support for the program:

- Joe Baker, Acciona: "We anticipate a growing need for employees with advanced degrees, including at the Ph.D. level."
- Garry Pealer, Clipper Windpower: "This is an important endeavor given the need that we have to trained personnel, including a growing need for PhDs trained in wind sciences and engineering."
- Michelle Arenson, Alliant Energy: "Availability of a well-educated workforce is critical to our ongoing ability to extend wind energy penetration levels in the most cost-effective manner."
- Thomas Budler, MidAmerican Energy: "MidAmerican strongly endorses the proposed idea of establishing a PhD program in Wind Energy Sciences, Engineering and Policy at ISU, as there is a strong need in the industry for graduates having a Ph.D. in WESEP, reflecting the interdisciplinary nature of the wind energy business."
- Sujeet Chand, Rockwell Automation: "As one of the leading suppliers of control systems for wind turbine generators, Rockwell Automation understands firsthand the need for an educated workforce to support this growing industry. The wind energy industry represents a growing customer base which includes condition-based monitoring systems to optimize the performance of existing and new wind farms."
- Lanny Kirkpatrick, Siemens Energy: "We anticipate hiring additional wind energy professionals over the next five years with approximately 10-15 at the Ph.D. level. Because wind energy design and development requires expertise crossing boundaries of traditional educational disciplines, the WESEP Ph.D. program will fill a significant need in the industry. Therefore we see the new WESEP graduate program at ISU as a very valuable educational and recruiting resource for Siemens Energy as we continue to grow in our Wind Energy business."
- Stephen Nolet, TPI Composites: "As our business grows, we are going to have an increasing need for a talented engineering workforce to meet the increasing demands of this industry. As evidence of this technical need, our company recently announced that we are establishing a Wind Blade Innovation Center. This Center will necessitate the hiring of scientists and engineers to support the innovations in design and manufacturing that we feel are critical to stay competitive. When we hire a new engineer or scientist we look at the total experience of the candidate. We believe that graduates of this WESEP program will be of particular interest to help us solve the design and manufacturing issues of advanced wind blades. I expect that approximately 10% of our new technical hires would have a Ph.D. in the future."
- Hamid Elahi, General Electric Company: "GE EA&SE currently employs over 20 professionals at the Ph.D. level, and we think it likely that we would make between five to ten new Ph.D. hires over the next five years. I would expect graduates of the proposed ISU WESEP Ph.D. program to compete very well for many of these positions."
- Clair Moeller, Midwest Independent System Operator (MISO): "As the organization responsible for maintaining the reliability of the wholesale bulk electric system in the Midwest, the Midwest Independent Transmission System Operator (MISO) is pleased to provide support to the ISU proposal in response to the National Science Foundation Integrative Graduate Education and Research Traineeship (IGERT) solicitation)….Our company currently employs more than 40 professionals at the Ph.D. level. Based on anticipated industry changes and needs, we may seek up to 30 Ph.D. hires over the next five years."

- Brian Parsons, National Renewable Energy Laboratory (NREL): "The increasing complexity of the wind energy industry motivates our need for employees with advanced training including specialization in aspects peculiar to wind energy production."

All of the above-represented organizations have offices in Iowa, with exception of the last three. Of these, GE is the leading wind turbine supplier in the US, MISO is the power grid and market operator for the region that includes Iowa, and NREL is the nation's leading national laboratory for R&D in wind energy.

(4) The WESEP Ph.D. program imparts knowledge and skills that uniquely and broadly prepare students to lead research through their exposure to a wide array of disciplines

The WESEP Ph.D. program trains students to work within and across a variety of disciplines, including meteorology, engineering, economics, agronomy, sociology, public policy, and communication, led by an multi-disciplinary faculty from three colleges and 13 departments. Students are familiarized with the fundamentals of multiple disciplines while integrating their skills and knowledge to solve problems at the boundaries of and intersections between these disciplines. A three-level curriculum [6] covers basics and advanced concepts in wind energy while ensuring that students are exposed to the core fundamentals of various disciplines. As a result, WESEP Ph.D. graduates will not only be wind energy experts—they will also be highly effective interdisciplinary problem-solvers with unique strengths to think seamlessly in developing solution strategies that could not evolve from a traditional single-disciplinary program. These features characterize the WESEP Ph.D. program as being much more broad-based than overly-specialized.

(5) Current national and international imperatives make wind energy a legitimate area of specialization

Specialized Ph.D. programs are common, motivated by the need to produce researchers capable of solving difficult problems in an arena expected to be of long-term societal importance. Such specialization is often observed when multiple Ph.D. programs are administered by the faculty of a single department. For example, at ISU, there are six physics-related Ph.D. programs administered by the Physics and Astronomy Department, and there are five chemistry-related Ph.D. programs administered by the Chemistry Department. Such specialization is also observed in interdepartmental Ph.D. programs, including Bioinformatics and Computational Biology, Human Computer Interaction, Neuroscience, and Genetics, among others. The Ph.D. is by its nature a degree which seeks to build focused expertise. The importance of wind energy as a national resource justifies its position among similarly focused Ph.D. programs.

(6) Wind energy is an essential option for reducing anthropogenic greenhouse gas emissions

The impetus to develop wind as a significant energy resource is also motivated by recent indications that climate change may be accelerating. The recent *Science* report on the 2012 Arctic sea-ice loss [7] adds new urgency to the debate on greenhouse gas emissions, showing that we are now on a pathway far higher than the highest scenario used for climate modeling since the 1990s. To underscore the impact, Fig. 1 shows recent arctic ice measurements while Fig. 2 compares these and previous measurements with model projections from the 2007 report of the Intergovernmental Panel on Climate Change [8]. These charts indicate that we are about 40-50 years ahead of the worst-case model projection on loss of sea ice. Thus, the agreed-upon early indicator of climate change (Arctic sea ice) suggests that the models are too conservative. The WESEP Ph.D. program is needed to hone future leaders who are able to understand core issues related to the need for energy resource portfolios that balance short-term economics with long-term environmental impacts.

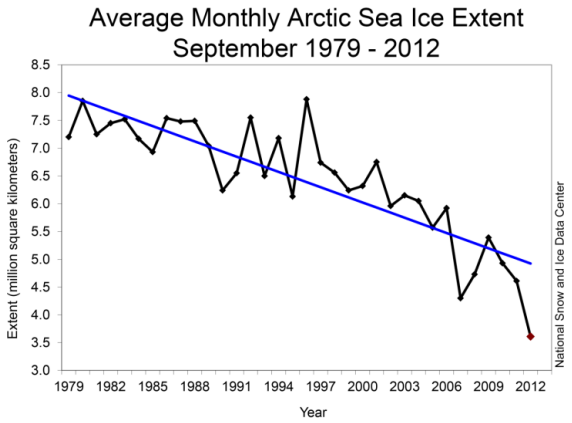

Fig. 1

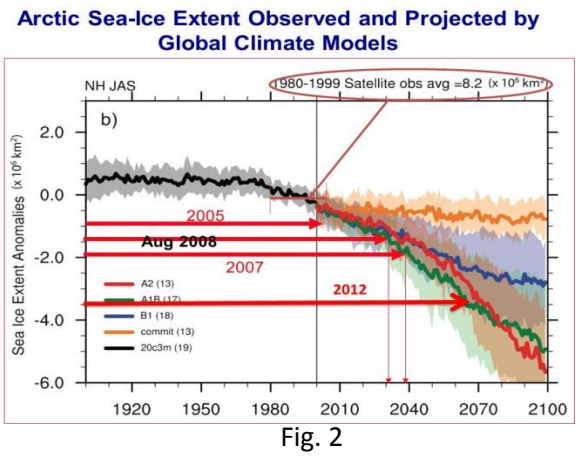

Fig. 2

(7) There is consensus that the US badly lags behind Europe in graduate education related to wind energy.

The need for wind energy-related graduate programs like WESEP is demonstrated by the following statements from the landmark 2008 DOE report *20% Wind Energy by 2030* [9]:

> *"Although this is an excellent beginning, many more programs of a similar nature will be needed nationwide to satisfy the needs stemming from the 20% wind scenario. One concern is that the number of students in power engineering programs has been dropping in recent years. Currently, US graduate power engineering programs produce about 500 engineers per year; in the 1980s, this number approached 2,000. In addition, the number of wind engineering programs in US graduate schools is significantly lower than in Europe…Even the level of US graduate programs is well below similar graduate programs in Europe (Denmark, Germany, etc). At this rate, the United States will be unable to provide the necessary trained talent and manufacturing expertise. Unless this trend is reversed, even with major new wind installations in the United States, most of the technology will be imported, and a significant portion of the economic gains will be foreign rather than domestic."*

Another more recent *Renewable Electricity Futures Study* [10] conducted in 2012 concluded that:

> *"To date, workforce needs across the industry are increasingly addressed through educational programs offered at two-year technical colleges, vocational training programs, and universities. However, compared to the significant academic wind research investment being demonstrated in Europe, low national investment has contributed to a continuing shortage of graduate-level opportunities to train researchers at US universities. Although international turbine suppliers are opening R&D offices in the United States, their role will be minor compared with European contributions if highly trained researchers are not developed at US universities. Workforce development remains important if the industry is to reach the wind power penetration levels suggested in the RE futures scenarios."*

As a result, the US Department of Energy (DOE), National Renewable Energy Laboratory (NREL), National Oceanic and Atmospheric Administration (NOAA), and National Center for Atmospheric Research met with over a dozen universities, including ISU, to define the vision and mission for the National American Wind Energy Academy (NAWEA) [11]. NAWEA was formed following indications that the US was falling behind Europe and Asia in meeting the demands for undergraduate and graduate education and research in the energy sector. NAWEA aims to expand the competence of the academic community in advancing wind energy through collaborations in curriculum development, research partnerships, and strategic planning. It sees WESEP as an excellent example of how to address this need.

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