

Wind energy resource management in Kenya

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Introduction

Kenyatta University's faculty and students, particularly those in the departments of Environmental Studies and Community Development and Energy Engineering, are working toward sustainable energy development. A visiting scholar position at Kenyatta University, facilitated by a Fulbright Scholar award, would enable me to exchange ideas with Kenyan faculty, students, and citizens and contribute toward Kenya's goals for reducing energy poverty.

As an assistant professor of natural resources management at Grand Valley State University (GVSU), my research focus has been on the social and spatial aspects of wind energy development, mainly in Michigan. For the past three years I have served as the principal investigator for the West Michigan Wind Assessment, a Michigan Sea Grant-funded project analyzing the benefits and challenges of wind energy development in Michigan's coastal zone. I am also leading an offshore wind energy outreach and education program¹. I am a member of the research leadership team for an offshore wind resource assessment in Lake Michigan². I have also taught a wide range of classes in GVSU's Natural Resources Management program, including courses in geographic information systems, environmental economics, natural resource policy, forest ecosystem management, and a series of graduate seminars on climate change.

I will be eligible for a sabbatical leave in the 2012-2013 academic year during which I will expand my teaching and research efforts to include renewable energy resource management in the developing world. In my classes at GVSU, I use many case studies to illustrate natural resource management concepts. Many of these case studies are from Michigan, the home of most GVSU students and a place to which they can relate. However, the developing world faces a plethora of challenges to sustainable development. I would like to investigate some of these challenges first hand and be able to present a broader range of case studies, both local and international, to my students.

While Kenya has some of the most promising wind resources in Sub-Saharan Africa, the vast majority of its population lacks access to electricity. Kenya also has many fine universities, such as Kenyatta University. The practical need for expanding sustainable energy resource development and the well-developed universities make it a suitable place to teach and conduct research as a visiting scholar. Dr. Fuchaka Waswa of the Department of Environmental Studies

¹ The Offshore Wind Energy Outreach and Education project is a collaboration among Grand Valley State University, the GVSU Michigan Alternative and Renewable Energy Center, and the Great Lakes Commission. It is funded by a grant from the Michigan Energy Office.

² The Lake Michigan Offshore Wind Resource Assessment is a collaboration among Grand Valley State University, the GVSU Michigan Alternative and Renewable Energy Center, the University of Michigan, and the Michigan Natural Features Inventory. The project is funded by grants from the US Dept. of Energy, Michigan Public Service Commission, We Energies, and the Sierra Club.

and Community Development (ESCD) has extended an invitation for me to visit KU (letter attached). I am requesting that the Fulbright Scholar Program fund my sabbatical leave as a visiting lecturer in Kenyatta University's (KU) ESCD department, in partnership with KU's Department of Energy Engineering.

I have been corresponding with Dr. Waswa and Dr. Thomas Thoruwa (Department of Energy Engineering) to collaborate on teaching and research opportunities at KU. Faculty in both departments are actively investigating the potential for renewable energy to improve the livelihoods of Kenyans. We have developed a teaching and research plan that will benefit not only my own professional development, but also our respective institutions, the discipline of sustainable energy management, and, most importantly, the lives of rural Kenyans.

Teaching

My home institution, GVSU, and KU are remarkably similar. In 1997 both universities had less than 10,000 students. Today, both universities have more than 24,000. Both universities have grown from small liberal arts colleges to full-fledged universities with graduate programs. The similar institutional trajectory of GVSU and KU make them well suited for establishing a connection which the Fulbright program can foster.

While I do not have any professional experience teaching abroad, I have many friends and colleagues from Africa, including Niger, Uganda, Ghana, and South Africa. I have also traveled internationally, including trips to Costa Rica, Venezuela, Macedonia, and many countries in Western Europe. These friendships and travel experiences have provided me with a cultural sensitivity that will be an asset in Kenya. I look forward to teaching Kenyan students and learning their perspectives on natural resource management and sustainable development.

KU's ESCD department offers many courses that I am well qualified to teach, ranging from introductory to graduate courses. GVSU's Natural Resources Management (NRM) program offers similar courses, many of which I have previously taught. Table 1 summarizes the courses I would be most qualified to teach at KU by virtue of my degrees, research, and teaching experience. I am also qualified to teach other courses in the ESCD department and could do so as needed.

Kenya needs more wind energy technicians, engineers, and conservationists to support wind energy development. I also propose to teach one or more short courses on wind energy at KU and remote communities.

The Fulbright award for Kenya does not specify a teaching/research percentage. I have discussed the matter with Dr. Waswa and Dr. Thoruwa and we have agreed on a 50/50 split between teaching and research. We have agreed that I will teach three courses over the two semesters during the 2012-2013 year. I will continue to work with Dr. Waswa to identify courses I could teach that will best meet the needs of the Environmental Studies department during the 2012-2013 academic year.

Table 1: Comparison of courses between Kenyatta University and GVSU.

Kenyatta Course	Similar Course at GVSU	Previously Taught by E. Nordman
ECD 206 Principles of Natural Resources Management	NRM 150 Introduction to Natural Resources Management	No
	NRM 495 Trends in Natural Resources Management (capstone)	Yes
ECD 209 Climate Change and Community Livelihoods	NRM 580 Graduate Seminar on Climate Change (I, II, and III)	Yes
ECD 211 Introduction to Geo-Spatial Techniques	NRM 395 GIS Applications in Resource Management	Yes
	NRM 450 Applied Spatial Analysis of Natural Resources	Yes
ECD 402 Environmental Economics and Valuation	ECO Environmental and Resource Economics	Yes
ECD 300 / 401 Environmental Law and Policy I and II	NRM 451 Natural Resource Policy	Yes

Research

My research plan is to conduct a wind energy resource assessment of the rural regions around Kenyan tea farms. Rural Kenyans are overwhelmingly energy-poor with only 4% of the rural population having access to electricity³. Wind energy offers substantial opportunity to improve access to electricity and the livelihoods of rural residents. Kenya currently has only one small utility-scale wind farm in operation. The Ngong Hills project has a 5 MW (megawatt) capacity but a planned expansion will increase it to 25 MW. Wind developer Lake Turkana Wind Power plans to develop a 300 MW wind energy facility in northern Kenya⁴. Wind energy clearly has potential to expand the breadth and reach of Kenya's electricity grid.

For my research project, I plan to investigate the potential for wind energy development to improve the livelihoods of rural Kenyans living near tea farms by 1) enhancing access to electricity in communities, schools and homes; and 2) providing power to water pumping systems. I will work closely with Dr. Thoruwa of KU's Department of Energy Engineering on the research aspect of the sabbatical.

Colleagues working in Kenya have indicated that the Kenya Tea Development Agency may be interested in siting utility-scale wind turbines at some tea farms and factories. Many, if not most, tea factories rely on firewood to fuel their boilers⁵. While some factories use dedicated biomass crops to fuel their boilers, it is possible that the tea factories' firewood requirements could put pressure on local forests and may compete with residential demand for fuelwood. On-site electricity generation, such as wind turbines, could provide a clean energy source that can benefit

³ Kammen, D. and C. Kirubi. 2008. Poverty, energy, and resource use in developing countries: Focus on Africa. *Annals of the New York Academy of Science* 1136: 348-357.

⁴ Oirere, S. 2011. Market Status: Sub-Saharan Africa – Hope and uncertainty as countries take first steps. *Windpower Monthly*, March 1, 2011.

⁵ Kenya Tea Development Agency. 2011. KTDA web site: <http://www.ktdateas.com>. Accessed 15 July 2011.

the local environment and local residents while providing a new revenue stream for the tea factories. Wind generation not only earns revenue from the sale of electricity, but also from the sale of carbon credits.

Wind energy can also be used to power water pumping systems which are critical for tree planting. More than 70% of rural Kenyans use biomass for cooking. The reliance on woody biomass has led to widespread deforestation. Reforestation and biomass cropping relies on the availability of water.

My research will include a high-level wind resource assessment of Kenyan tea plantations. I will use geographic information system software (ArcGIS 10) to integrate data on wind speeds, topography, sensitive ecological areas, the electricity grid, and population. The results will include:

- an assessment of the wind energy generation potential of the tea farms;
- the economic value of the electricity production;
- the feasibility of powering homes, schools, and factories with local wind resources in the regions surrounding tea farms; and
- the feasibility of using wind to power water pumps in support of reforestation projects.

The Risø National Laboratory of Denmark produced a national wind energy atlas for Kenya with a 5 km grid resolution. Other spatially-referenced information is available, including conservations areas and transmission infrastructure. These data would be appropriate for a high-level assessment of the wind resource which could lead to more site-level analysis if appropriate. The resource assessment can aid in understanding the real potential for wind energy to improve the livelihoods of rural Kenyans.

Importance

The vast majority of rural Kenyans, like many in Sub-Saharan Africa, are energy-poor. About 47% of Kenyans live below the poverty line. Per capita electricity use is 104 kWh per year, about 2.5% the use per capita electricity use in South Africa. Only 4% of rural Kenyans have access to the central electricity grid⁶. While electricity access is not one of the eight Millennium Development Goals (MGDs), the United Nations has stated that “energy services are essential to both social and economic development and that much wider and greater access to energy services is critical in achieving all of the MGDs.”⁷

Wind energy development in and around tea plantations could lead to improved access to clean energy services for Kenya’s rural poor. For example, a wind- or solar-powered central charging station could allow rural residents to charge batteries to power lamps, radios, and phones. In the

⁶ Kammen, D. and C. Kirubi. 2008. Poverty, energy, and resource use in developing countries: Focus on Africa. *Annals of the New York Academy of Science* 1136: 348-357.

⁷ Modi, V., S. McDade, D. Lallement, and J. Saghir. 2006. *Energy services for the Millennium Development Goals*. New York: Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project, and World Bank.

case of lighting, electric lamps could replace kerosene lamps, which are not only more expensive to operate, but whose smoke and soot contributes to indoor air pollution⁸.

Benefits for hosts, discipline, applicant, home institution

This Fulbright proposal will provide benefits to KU, GVSU, the field of renewable energy resource management, and me in several ways.

Benefits to the host institution

KU will benefit directly from having additional staff to cover courses in Environmental Studies. Staffing is a major challenge in a rapidly growing university like KU and GVSU. My visit to KU could allow existing staff to participate in other activities, such as research or sabbaticals, and may enable the department to offer additional sections of popular classes. The short courses on wind will build capacity in the wind energy sector. The wind energy research will contribute toward sustainable wind energy development in Kenya's tea-growing regions. Such electricity infrastructure could help reduce rural energy poverty and make progress toward the MGDs.

Benefits to the applicant and his family

I will benefit professionally from the association with KU. The visit will allow me to collaborate with Dr. Thoruwa and Dr. Waswa who are experts in the fields of renewable energy engineering and sustainable community development, respectively. The collaboration will also allow me to work abroad, which is something I have been eager to do. The direct experience of working on the ground in Kenya will help me understand the complexities of providing sustainable energy services in a rural environment. All of this will provide me with a richer understanding of natural resources management in developing countries. I plan to use these experiences in examples and case studies in my regular classes at GVSU. My wife, daughter and son will also benefit from the cultural exchange afforded by living and studying in Kenya.

Benefits to the home institution

KU's School of Education already has a successful, longstanding relationship with my alma mater, Syracuse University. GVSU has a strong history of International Fulbright scholars, including a NRM adjunct professor's visit to Vietnam, but no faculty member from a science department has had a placement on the African continent. This proposal offers an opportunity to establish a connection between GVSU and KU and in particular, GVSU's NRM program and KU's ESCD department. Such a connection could eventually lead to an exchange of undergraduate or graduate students between the programs.

Benefits to the discipline

Wind energy development is a mature technology in Europe, North America, and, to a lesser degree, Asia, but has yet to become established in Africa. Kenya has more wind energy resources than many other sub-Saharan countries, as evidenced by the planned 300 MW Lake Turkana project. The wind energy resource assessment would be a practical application of current technologies which could incrementally advance wind energy development at tea farms by identifying those at which wind energy is most promising.

⁸ Modi et al. 2006.